US Army Corps
Of Engineers

Final Environmental Impact Statement For the Proposed Honolulu Seawater Air Conditioning Project, Honolulu, Hawai‘i

Prepared for:

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HONOLULU SEAWATER AIR CONDITIONING PROJECT FINAL ENVIRONMENTAL IMPACT STATEMENT

Location: City and County of Honolulu, Hawai'i

Lead Agency: U.S. Army Corps of Engineers, Honolulu District

Authorities: Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) and Section 404 of the Clean Water Act (33 U.S.C. 1344)

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Abstract: Honolulu Seawater Air Conditioning, LLC (applicant) proposes to construct a seawater air conditioning system in downtown Honolulu. The system of the proposed preferred alternative would consist of: (1) a 63-inch diameter seawater intake pipe extending approximately 25,000 feet offshore from Kaka'ako to a depth of 1,755 feet; (2) a 54-inch seawater return pipe extending approximately 5,225 feet offshore from Kaka'ako to a depth of 423 feet; (3) a pump station containing pumps, heat exchangers and auxiliary chillers in the Makai District of the Kaka'ako Community Development District; and (4) a network of chilled water distribution pipes from the pump station to customer buildings in the downtown area. A staging area for pipe assembly is proposed for an area along the western shore of Sand Island and in the adjoining channel in Ke'ehi Lagoon. This final Environmental Impact Statement (FEIS) is being prepared to inform a decision by the U.S. Army Corps of Engineers (USACE) on an application for a Department of the Army (DA) permit under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. Accordingly, the scope of this FEIS is focused on evaluating the impacts of activities associated with the installation of the seawater intake and return pipes, which require DA authorization, as well as the cooling station, the location of which could potentially affect the location and configuration of the seawater intake and return pipes. The proposed shoreside improvements and upland infrastructure are briefly described to provide an overview of the project, but their impacts to terrestrial environmental resources are not a focus of this document. Environmental resources potentially affected by the action include marine biota and habitat, water quality, navigation and other water uses, traffic, noise, and air quality.

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EXECUTIVE SUMMARY

This final Environmental Impact Statement (FEIS) has been prepared to inform a decision by the U.S. Army Corps of Engineers (USACE) on a Department of the Army (DA) permit application submitted by Honolulu Seawater Air Conditioning, LLC (applicant) to construct a seawater air conditioning (SWAC) system at Kakaʻako on the south shore of Oʻahu, including installation of seawater intake and return pipelines in adjacent coastal waters. Aspects of the proposed project subject to regulation by the Corps under Section 10 of the Rivers and Harbors Act of 1899 include the structures and work in or affecting navigable waters (i.e., the seawater intake and return pipelines and the staging and installation work). Because the installation work would involve a discharge of fill material, the proposed project is also subject to regulation under Section 404 of the Clean Water Act.

In order to address comments on the draft Environmental Impact Statement (DEIS), several additional surveys, studies and analyses were completed. Accordingly, major changes were made to the DEIS in the following areas: (1) the addition of two new alternatives that incorporate deeper return seawater discharges, (2) the results of new quantitative biological surveys along the entire pipeline route, including information on mesophotic ecosystems and mesopelagic boundary layer organisms, (3) new water quality data from the proposed discharge location, (4) analysis of the potential effects of discarded military munitions in the project area, (5) the results of additional coordination with a homeless shelter near the proposed location of the shoreline jacking pit, (6) additional analysis of options for screening the intake, (7) incorporation of entrainment monitoring data from shallow water Oʻahu generating station cooling water intakes into an entrainment analysis and monitoring plan to satisfy requirements of Clean Water Act Section 316(b) (8) completion of an antidegradation analysis, (9) acquisition of an Incidental Harassment Authorization from the National Marine Fisheries Service (NMFS) for construction noise effects on protected marine species, (10) completion of a proposed mitigation plan to minimize impacts to aquatic resources to the maximum extent practicable, (11) completion of an Environmental Hazard Management Plan for dealing with toxic and hazardous materials, (12) incorporation of biological data on Keʻehi Lagoon, and (13) analyses of potential effects to coral reef ecological services. In addition, USACE completed consultations pursuant to the National Historic Preservation Act, the Endangered Species Act, and the Magnuson Stevens Act.

PURPOSE AND NEED

There is a need, based on economic and environmental considerations, to increase the use of renewable energy resources and decrease the use of imported oil to generate electricity in Hawaiʻi. There are also mandates at both State and Federal levels to increase energy efficiency and renewable energy use in their facilities, reduce potable water consumption, and decrease toxic chemical use. The purpose of the Honolulu Seawater Air Conditioning (HSWAC) project is to significantly contribute to meeting these needs by developing a SWAC system to serve the downtown area of Honolulu.

BRIEF ACTION DESCRIPTION

The applicant proposes to construct a SWAC system at Kakaʻako on the southern shore of the island of Oʻahu. The HSWAC project is intended to provide 25,000 tons of centralized air conditioning for downtown Honolulu. The following paragraphs describe the applicant's preferred alternative.

Four areas near downtown Honolulu would be used in four discrete functions associated with construction and operation of the HSWAC system:

- Seawater intake and return pipes would be deployed offshore of Honolulu in the area between Honolulu Harbor and Kewalo Basin;
- An onshore cooling station would be built on a site in Kakaʻako;

- Freshwater distribution pipes would be installed beneath streets in the downtown area; and
- A shoreline site in Ke‘ehi Lagoon would be used for staging and pipeline assembly.

In addition, dredged materials would be disposed of at an upland disposal site.

SWAC uses available deep cold seawater instead of energy-intensive refrigeration systems to cool the chilled water in one or more buildings. Typical air conditioning systems use refrigerant-based chillers to cool water, which is then used to cool the air that is circulated throughout the building. In a SWAC system, rather than cycling water through a chiller, the water is routed through a heat exchanger. Fresh water circulates through one side of a system of titanium (or other corrosion-resistant alloy) plates, giving up its heat to the cold seawater on the other side of the plates. The fresh water loop is closed; that is, the water circulates from the heat exchanger to connected buildings and back again to the heat exchanger. In contrast, the cold seawater passes through the heat exchanger only once before being returned to the sea. The main components of a basic seawater air conditioning system are the seawater circulation system, the cooling station where pumps, heat exchangers and other equipment are housed, and the fresh water distribution system.

The aspects of the HSWAC project requiring a DA permit are the seawater intake and return pipelines and the in-water staging and installation work. Accordingly, the scope of this FEIS is limited to pipeline staging and installation of the seawater circulation system and the cooling station, the location of which could potentially affect the location and configuration of the seawater circulation system.[1]

The HSWAC seawater circulation system would consist of seawater intake and return pipelines extending from the cooling station to their respective terminal points offshore. The intake pipe would extend to a depth of 1,755 feet; the return pipe would terminate with a diffuser extending from 326 feet to 423 feet. From the microtunnel breakout point, where subterranean pipe sections would connect to surface mounted sections of pipes, to the end of the diffuser, the two pipes would parallel each other. The discrete segments of the intake and return seawater pipelines are: (1) from the cooling station underground to the offshore breakout point; (2) from the breakout point to the return seawater diffuser; and (3) from the diffuser to the intake (intake pipe only).

The applicant proposes to use microtunneling (remote control pipe jacking) for the underground segment extending from the cooling station to the offshore breakout point. Two jacked pipelines would be installed:

- For the cold seawater intake pipeline, a minimum 71-inch internal diameter (ID) reinforced concrete pipe (RCP), polymer reinforced concrete pipe (PCP) or steel pipe casing would be jacked from the shoreline to the breakout point for connection to the offshore pipelines. A nominal 57-inch ID fiberglass pipe would be installed inside the jacked casing and the annulus space between the casing and the carrier pipe would be grouted.
- For the return seawater discharge pipeline, a 48-inch (ID) RCP or PCP pipe would be jacked from the same pit.
- As an alternative, the contractor would jack only one RCP or PCP pipe with an internal diameter of up to 120 inches. The crown of the 120-inch pipe would be at an equal or lower elevation compared to the crown of either of the two separate pipes. Inside the large pipe, fiberglass carrier pipes for the intake and return waters would be installed.

[1] Due to the limited scope of this FEIS, the proposed shoreside improvements are described for completeness, but their impacts to terrestrial resources are not assessed in detail. A detailed assessment of the impacts of the landside improvements on terrestrial environmental resources is available in the applicant’s EIS that was prepared according to State of Hawai‘i laws in order to support State and county permitting decisions.

Microtunneling and installation of the casings would require 6 to 7 months, and installation of the carrier pipelines and annulus grouting would require an additional 1 to 2 months.

In selecting the preferred breakout point for the drilled microtunnel and the offshore route of the seawater intake pipe, the following factors were considered:

- Bathymetry,
- Biological characteristics, and
- Use of the area.

A marine biological survey of the breakout area was conducted. Progressing seaward from the nearshore area, the following four biotopes are present:

- The biotope of scoured limestone,
- The biotope of scattered corals,
- The biotope of dredged rubble, and
- The biotope of sand.

Literature reviews conducted as part of the survey indicated that the proposed pipe route traverses an area that historically has been impacted by industrial discharges, sewage disposal, freshwater runoff into Honolulu Harbor, and disposal of dredged materials, debris and military munitions.

The breakout point for the seawater intake and discharge microtunnels would be in the biotope of dredged rubble where the bottom predominantly consists of sand and rubble. Seaward of that point to a depth of 150 feet, the intake pipe would be pinned to the bottom with hollow steel piles driven through anchor collars (shaped concrete weights) mounted on the pipeline. Below 150 feet, the collars would serve as gravity anchors only; no piles would be used below 150 feet.

The microtunnels would intersect the bottom at a water depth of approximately 31 feet. At this breakout point sheet piles would be driven into the bottom to surround an area to be excavated. The receiving pit would be completely isolated and contained from the seafloor to the sea surface by installing sheet piles all the way to the surface or by installing sheet piles that extend part way to the surface and installing silt curtains above them. After the sheet piles (and silt curtains, if used) are in place, the receiving pit would be excavated. The receiving pit would be about 40 feet by 40 feet in plan view and 20 feet deep. This pit would be used to recover the microtunnel boring machine (MTBM) and connect the microtunneled pipes to the surface-mounted pipes extending seaward.

After completion of the connections, the pit would be backfilled and covered with a concrete cap. The backfill would be crushed basalt gravel graded between 3/8-inch and 2-inch size and pre-washed to remove any fines. The sheet piles would be removed or cut off below the existing seafloor grade.

From the breakout point seaward, a 63-inch outside diameter (OD) pipe is proposed to supply cold seawater to the heat exchangers on shore. The pipe would be made from high density polyethylene (HDPE). The length of the pipe from shore to the intake location would be approximately 25,000 feet. The intake would be at a depth of 1,755 feet. The pipe would terminate with an elbow, such that water would be drawn down into the pipe from about 14 feet above the bottom (1,741 feet). The maximum flow rate through the pipe would be 44,000 gallons per minute (gpm). Temperature of the intake water would be approximately 44°F.

A seawater return pipe would lie adjacent to the intake pipe from the microtunnel breakout point to a depth of 423 feet. The seawater return pipe would be constructed of the same material using the same techniques as the intake pipe, but be somewhat smaller in diameter (54 inches OD) than the intake pipe.

This is possible because the return flow would be under pressure. The temperature of the return seawater would vary between 53°F and 58°F depending on system demand. The seawater return pipe would terminate in a diffuser extending from a depth of 326 to 423 feet. The return seawater would not meet State water quality standards for total nitrogen, nitrate+nitrite nitrogen, total phosphorus, dissolved oxygen, or temperature modification. However, the applicant has applied for a Zone of Mixing (ZOM) permit from the State of Hawaiʻi, Department of Health, Clean Water Branch, which if issued would establish an impact zone where water quality criteria could be exceeded.

The exposed portions of the pipes from the breakout point to the intake would be held on the bottom with concrete collars (gravity anchors or weights). At depths down to 150 feet, for additional stability, steel pipe piles would be driven through sleeves in the collars using a barge-mounted percussion hammer. Sand from inside the pipe would be removed to a level about 6 feet below the original seafloor. Tremie concrete would be used to fill and cap the piles.

Prior to installing the offshore pipes, a series of “test piles” (about 15) would be driven along the proposed alignment between the proposed locations of the receiving pit and the 150-foot depth. All of these piles would be removed immediately after installation. No pile driving would be done between December 1 and March 31 to avoid the peak humpback whale season in Hawaiʻi.

The applicant proposes to use a staging area of approximately 18 acres near the shore on Sand Island to store pipe, concrete anchor blocks and other components, and to fuse the pipe lengths into longer segments. Individual pipe segments 40 to 80 feet long would be heat-fused to form longer segments (~3,300-feet) and then flange bolted into a continuous pipeline. The pipe segments would be launched into a storage area in Keʻehi Lagoon directly as fused. The overall in-water staging area would be about 49.9 acres in size. Concrete collars and stiffening rings would be added to the pipe from a barge while the pipe sections float in the staging area. These floating segments would be stored (moored) in the water pending completion of all segments. Connecting the segments by lifting the ends slightly above the water would complete final assembly of the pipe, removing the blind flanges, and bolting the flanged ends together.

Deployment of the seawater pipes would be done once all the segments are bolted together. The pipelines would be towed into place, the land side temporarily secured to allow the pipelines to be put under tension, and the pipeline sunk in a controlled manner from shallow to deep water by controlled flooding. At least three tugs would be used to maneuver the pipelines into their final positions. As the pipelines would be deployed off the south side of Oʻahu, deployment would likely be scheduled during the winter, when large southern swells are absent. The pipelines would be pulled into place in a single day and sunk at night to avoid the effects of differential heating of the pipe segments during the day. The nearshore ends of the pipelines would be close to but not connected to the end of the microtunneled segment of the route. A spool piece would be prepared to fill the gap and flange bolted in place by divers.

A system of paired (supply and return) fresh-water distribution pipes throughout downtown Honolulu would complete the system.

Because the project would involve both structures and work in or affecting navigable waters of the United States and the discharge of dredged or fill material into waters of the United States, the project requires authorization under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) and Section 404 of the Clean Water Act (33 U.S.C. 1344).

ALTERNATIVES CONSIDERED

Four action alternatives and the no-action alternative are being considered. The DEIS considered only action Alternatives 1 and 2. However, to address comments on the DEIS received from the U.S. Environmental Protection Agency (USEPA) and the U.S. Fish and Wildlife Service (USFWS), this FEIS considers two additional alternatives, Alternatives 3 and 4, for which the location of the diffuser is located in successively deeper water. Alternative 1 was the applicant's preferred alternative in the DEIS; the applicant's preferred alternative is now Alternative 4. Most of the preceding description of the applicant's preferred alternative (Alternative 4) also describes the other three action alternatives. Differences among the action alternatives include:

- Location of the cooling station,
- The microtunnel route from the cooling station to the breakout point,
- Location of the breakout point,
- The pipe route seaward of the breakout point, and
- The location (depth) of the diffuser.

Alternative 1 would include a microtunnel from a jacking pit located adjacent to the ‘Ewa-makai corner of Kaka‘ako Waterfront Park to an offshore receiving pit from which to recover the MTBM. The breakout point for the seawater intake and return microtunnels would be in the biotope of dredged rubble at a depth of -31 feet mean lower low water (MLLW). This point is approximately 1,800 feet offshore, and is the closest point to shore where the biotope of scattered corals can be avoided.

From the breakout point, the return seawater pipeline would run an additional 1,900 feet offshore (approximately 3,700 feet from the shoreline) and terminate in a 25-port diffuser extending between the depths of 120 and 150 feet. The seaward route of the pipes under Alternative 1 would be off the western portion of the area between Honolulu Harbor and Kewalo Basin, i.e., relatively close to the Honolulu Harbor entrance channel.

A concern with respect to use of that area was to protect the pipes from barge tow cables. Tug-towed barges entering and exiting Honolulu Harbor use very long tow wires which, in the shallow water near the harbor entrance, drag on the seabed. Consequently, specially designed snag-resistant anchor weights would be used down to a depth of 150 feet.

In Alternative 2, the cooling station would be located on Pier 1 of Honolulu Harbor, slightly west of the Alternative 1 location. Components of the system, including the seawater pipes, the cooling station, and the distribution system would be the same as for Alternative 1. The microtunnel from the cooling station would emerge to the east of the breakout point for Alternative 1, i.e., near the Kewalo Basin entrance channel. Seaward of the breakout point, the seawater intake and return pipes would be installed as under Alternative 1, terminating at a point to the east of the diffuser location under Alternative 1. Beyond the diffuser, the intake pipe would continue seaward and terminate at the same intake location as under Alternative 1.

Alternative 3 would be identical to Alternative 1 except that the return seawater pipe would extend approximately 1,500 feet longer and terminate in a diffuser between the depths of 276 and 300 feet.

Alternative 4, the applicant's preferred alternative, also would be identical to Alternative 1, but the return seawater pipe would extend approximately one mile offshore and terminate in a diffuser between the depths of 326 and 423 feet. The diffuser under this alternative would lie on a relatively steep slope of an alluvial channel that begins at a depth of about 330 feet and continues to 600 feet deep.

A comparison of the effects of the four action alternatives is contained in Table ES-1. The applicant has demonstrated compliance with Clean Water Act Section 316(b) regarding impingement and entrainment in the intake in a Track II analysis (Appendix N). Discharges under any of the action alternatives would not meet State water quality standards because deep seawater does not meet State water quality standards. As noted above, the applicant has applied for a ZOM where water quality criteria may be exceeded. The No Action Alternative would have no impacts, adverse or beneficial, as there would be no modification of the existing environment.

PROPOSED MITIGATION MEASURES

The applicant is proposing a number of measures to avoid and minimize the potential impacts of the HSWAC project. During the early stages of planning and engineering design, decisions about possible siting, routing, and construction methods were made based on their potential to reduce environmental impacts. In particular, a form of trenchless technology is proposed to route pipes beneath the nearshore area where the majority of the corals are located and its preferred breakout point was selected to avoid coral reefs and coral-dominated communities. It is also proposed to surface mount the seawater pipes with piles, as opposed to trenching and burying the pipes, in order to further minimize potential impacts to marine communities and water quality. Table ES-2 summarizes the additional proposed measures to avoid and minimize potential adverse effects of the HSWAC project on various environmental resources.

Two receiving pit locations and two routes from the receiving pit to the diffuser were evaluated. By selecting the western alignment, an area of dense coral development near the Kewalo Basin entrance channel was avoided as was potential interference with an existing array of bottom mounted sensors of the University of Hawai‘i’s (UH) Kilo Nalu Observatory. For this segment of the route, cut and cover trenching was again evaluated and in this case rejected in favor of surface mounting the pipes due to the potential impacts of trenching to benthic habitats and communities.

Four alternative locations for return water discharge were initially evaluated: Honolulu Harbor, shallow coastal waters, deep coastal waters, and oceanic waters. Adequate dilution could not be attained in Honolulu Harbor and impacts to corals would be problematic with a shallow coastal discharge, so these alternatives were dismissed. Three terminal discharge depths, 150 feet, 300 feet, and 423 feet, were further evaluated. Modeling studies showed highly efficient near-field mixing of the discharge under all water current conditions. The deepest alternative was selected as the applicant’s preferred alternative as it would place the discharge near the top of the thermocline where the relatively low temperatures and high macronutrient concentrations of the discharge would be closer to ambient conditions, and limited light penetration would minimize the potential for eutrophication.

The applicant proposes to mitigate the unavoidable impacts to coral colonies within the footprint of the receiving pit that would be lost as a result of the HSWAC project by transplanting coral colonies greater than 10 cm in size.

Resource	Alternative 1						Alternative 2						Alternative 3						Alternative 4 (Applicant's Preferred)					
	Direct		Indirect		Cumulative		Direct		Indirect		Cumulative		Direct		Indirect		Cumulative		Direct		Indirect		Cumulative	
	ST	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST	LT
Cultural	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B
Archaeological	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Historic	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Harbors	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Shipping	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Navigation	SM	N	N	N	N	N	SM	N	N	N	N	N	SM	N	N	N	N	N	SM	N	N	N	N	N
Pipelines	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Outfalls	N	N	N	B	N	B	N	N	N	B	N	B	N	N	N	B	N	B	N	N	N	B	N	B
Dump Sites	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Recreation	L	N	L	B	L	B	S	S	L	B	L	B	L	N	L	B	L	B	L	N	L	B	L	B
Ocean Research	N	N	N	B	N	B	S	S	S	S	L	S	N	N	N	B	N	B	N	N	N	B	N	B
Comm. Fishing	L	N	L	B	N	B	L	N	L	B	N	B	L	N	L	B	N	B	L	N	L	B	N	B
Military Ops	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Potable Water	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B
Electricity	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B
Wastewater	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B
Solid Waste	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Noise	S	N	N	B	N	B	S	N	N	B	N	B	S	N	N	B	N	B	S	N	N	B	N	B
Haz/Toxics	SM	N	N	B	N	B	SM	N	N	B	N	B	SM	N	N	B	N	B	SM	N	N	B	N	B
Traffic	L	N	N	N	L	N	L	N	N	N	L	N	L	N	N	N	L	N	L	N	N	N	L	N
Health/Safety	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Socioeconomic	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Visual	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Natural Hazards	SM	SM	L	L	L	L	SM	SM	L	L	L	L	SM	SM	L	L	L	L	SM	SM	L	L	L	L
Mar. Geology	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Tides/Currents	L	N	N	N	N	N	L	N	N	N	S	N	L	N	N	N	N	N	L	N	N	N	N	N
Water Quality	SM	SM	N	B	N	B	SM	SM	N	B	N	B	SM	SM	N	B	N	B	SM	SM	N	B	N	B
Benthic Biota	L	S	L	B	L	L	SM	S	L	B	L	L	L	SM	L	B	L	L	L	L	L	B	L	L
Pelagic Biota	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Protected Spp.	SM	L	N	N	N	N	SM	L	N	N	N	N	SM	L	N	N	N	N	SM	L	N	N	N	N
EFH	L	SM	L	B	L	L	SM	SM	S	B	L	L	L	SM	L	B	L	L	L	L	L	B	L	L
Terres. Geology	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Climate	L	B	N	N	N	B	L	B	N	N	N	B	L	B	N	N	N	B	L	B	N	N	N	B
Air Quality	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B
Surface Water	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Groundwater	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B
Terres. Biota	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Notes: ST = Short-Term; LT = Long-Term; S = Potentially Significant Adverse Effect; SM = Potentially Significant Adverse Effect Mitigable to Less Than Significant; L = Less Than Significant Adverse Effect; N = No Effect; B = Beneficial Effect

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Table ES-1: Proposed Mitigation Measures

Resources Potentially Adversely Affected	***Proposed Mitigation Measures***
Cultural/ Archaeological	Implement the "Archaeological Monitoring Plan" approved by the Hawaii State Historic Preservation Officer on November 10, 2008.
Navigation	Coordinate with the USCG for issuance of a "Notice to Mariners" for construction and installation operations. Leave room for recreational craft to maneuver around pipe strings when they are stored in Keʻehi Lagoon. Store pipe strings so as to avoid blocking access to docks serving Keʻehi Lagoon residences. Post picket boats in the Keʻehi Lagoon channel during tow-out of the pipe strings. Use snag resistant collars on seawater pipes to depths where they might snag barge tow cables.
Recreation	Minimize the size of restricted areas. Restore areas of Kakaʻako Waterfront Park and Sand Island State Park to prior or better condition after use.
Utilities/Traffic/ Health & Safety	The applicant would continue to participate in the City and State Utilities Coordinating Committee to minimize conflicts with existing systems and scheduled improvements.
Noise	Adhere to State regulations on noise levels and permitted construction times. Acquire necessary noise permits and variances and comply with conditions attached thereto.
Solid Waste	Beneficially reuse asphalt, soil and sand to the extent possible and permitted.
Hazardous and Toxic Materials/ Health & Safety	Test excavated sediments and, if contaminated, segregate, characterize, and dispose of in accordance with all applicable laws and regulations. Implement proven and effective best management practices (BMPs) and standard operating procedures (SOPs) to: • Prevent, contain, and/or clean up spills and leaks, and • Provide personnel training, operational protocols and procedures, and any necessary equipment required to protect human health and the environment. Specific mitigation measures that would be implemented include: • Create and implement a "Facility Response Plan," • Create and implement a "Spill Prevention Control and Countermeasure Plan" (to include training, spill containment and control procedures, cleanup procedures, agency notifications, etc.), • Create and implement an Environmental Protection Plan, • Create and implement a Contaminated Soil Management Plan, • Create and implement a Worker Health and Safety Plan, • Ensure personnel are trained as to proper labeling, container, storage, staging, and transportation requirements for hazardous substances. Also, ensure they are trained to effectively implement spill prevention, control, and cleanup methods, • Provide adequate and appropriate personal protection equipment, an eyewash fountain, and quick-drench facilities in the work area • Perform all vehicle maintenance activities off-site, and • Prepare a public notification plan to be implemented in the event of a spill or leak of a toxic or hazardous substance. An "Environmental Hazard Management Plan" has been produced and contains the following mitigation measures: • Initial excavation of surface materials at both the jacking pit and the cooling station receiving pit would be monitored by an independent industrial hygiene technician using a photo-ionization detector (PID). Any soils that show visual (discoloration) or olfactory (odor) indications of petroleum, or trigger elevated PID readings, would be segregated and managed as petroleum contaminated materials pending results of characterization for the identified chemicals of potential concern identified above in accordance with the requirements contained in the HDOH

Resources Potentially Adversely Affected	***Proposed Mitigation Measures***
	Technical Guidance Manual (HDOH, 2009). • Any excavated materials that show signs of ash or other debris, which may indicate the historic use of landfill materials as fill materials, would be segregated and managed as contaminated materials pending results of characterization for the identified chemicals of potential concern identified above in accordance with the requirements contained in the HDOH Technical Guidance Manual (HDOH, 2009). • Surface soils from the jacking pit location that do not show signs of either ash or debris would be segregated and managed separately as potentially contaminated materials pending results of characterization for the identified chemicals of potential concern identified above in accordance with the requirements contained in the HDOH Technical Guidance Manual (HDOH, 2009). • All imported fill materials would be certified as clean fill materials per HDOH guidance (HDOH, 2009). Native materials that show no signs of contamination may be reused on site as fill materials. In the event that these materials are transported off-site for temporary storage pending eventual reuse as fill materials, the materials would be tested and characterized for reuse as clean fill materials per HDOH guidance (HDOH, 2009). Excavated materials would be handled and stored in compliance with all applicable State and Federal Regulations, and in such a manner as to prevent potential escape, leakage or transport off-site of contaminated or potentially contaminated materials. Dewatering activities would generate groundwater that would require management during each phase of construction. Construction methods and procedures would be implemented to minimize groundwater infiltration into excavated areas. Excess groundwater generated during construction activities would be managed according to the following options: • If possible, all excess groundwater generated during this project would be returned to the water table via recharge into one or more specially constructed recharge basins that would be constructed in the immediate vicinity of the dewatering location(s). Excess groundwater may be pumped directly from the active work site(s) (i.e., excavation or slurry separator) into the recharge basin(s), or may be pumped into a mobile storage container designed for that purpose pending recharge at a later date. • If excess groundwater quantities are such that recharge, for whatever reason, is not feasible, then a waste disposal contractor may remove excess groundwater pumped into temporary storage containers from the site for offsite disposal. The waste disposal contractor would be required to dispose of the excess groundwater in full compliance with all applicable State and Federal regulations. • In the event that subsurface petroleum contamination is encountered to such an extent that a sheen is observed on groundwater being dewatered, then this water would be pumped directly into an oil-water separator. Once the petroleum has been separated from the water, the water may be recharged as described above while any petroleum product would be characterized and disposed of by a waste disposal contractor. All holding areas would be lined to prevent fluids from leaching into the ground and transportation of spoils from one location to another would be done in lined and covered trucks. No holding areas would be established inland of the State's Underground Injection Control line to avoid potential leaks in areas above potable groundwater aquifers.
Traffic	Employ the following restrictions in the region of influence (ROI) for traffic impacts: • Standard work hours would be between 7:00 am and 5:30 pm, • Off-duty policemen would be used to direct traffic when working on major/busy

Resources Potentially Adversely Affected	***Proposed Mitigation Measures***
	intersections, • When activities cross intersections, safe crossings would be provided for vehicles and pedestrians, • When work is being done in pedestrian walkways, an alternate walkway for pedestrians would be provided, • Access to driveways would be provided when feasible, • Depending on the situation, steel plates or jersey barriers would be used to protect open trenches during non-working hours, and • No equipment storage or stockpiling would be done in the street right-of-way. Mitigation measures to be implemented by the contractor would include: • Ensure conformance with the "Traffic Management Plan," • Establish a telephone hotline with advance schedule information and feedback capability, • Provide construction schedules at least two weeks in advance to emergency providers, transportation companies, and affected businesses and residents, • Launch a project website with similar capabilities, • Hold a community meeting prior to beginning construction, and • Prohibit lane closures during the following times: o Chinese New Year, o Thanksgiving Day and the following day, o Christmas Day and two weeks before and after, o King Kamehameha Day Parade, o Honolulu Marathon, and o Great Aloha Run.
Health & Safety	Use police escorts for oversized loads on public roadways. Implement applicable OSHA requirements. Create a Health and Safety Plan for all work including possible offshore encounters with discarded military munitions.
Natural Hazards	Comply with appropriate design codes and construction specifications.
Water Quality	Enclose offshore receiving pit in sheet piling or a combination of sheet piling and silt curtains to the water's surface. Employ BMPs during construction, including: • Standard BMPs for construction in coastal waters, such as daily inspection of equipment for conditions that could cause spills or leaks, • Clean equipment prior to deployment in the water, • Proper location of storage, refueling, and servicing sites, and • Implement adequate spill response and storm weather preparation plans. Backfill receiving pit with pre-washed basalt gravel. Dispose of or beneficially reuse excavated material on land. Conduct water quality monitoring during construction and operations. Grout the space between the microtunneled pipes and the tunnel wall. Outfit return seawater pipe with a terminal diffuser.
Protected Species	The following NMFS-recommended BMPs would be followed during in-water work: 1. Constant vigilance would be kept for the presence of Federally-listed species. 2. When piloting vessels, vessel operators would alter course to remain at least 100 yards from whales and at least 50 yards from other marine mammals and sea turtles. 3. Vessel speed would be reduced to 10 knots or less when piloting vessels in the proximity of marine mammals. 4. Vessel speed would be reduced to 5 knots or less when piloting vessels in areas of known or suspected turtle activity. 5. Marine mammals and sea turtles would not be encircled or trapped between

Resources Potentially Adversely Affected	***Proposed Mitigation Measures***
	multiple vessels or between vessels and the shore. 6. If approached by a marine mammal or turtle, vessel operators would put the engine in neutral and allow the animal to pass. 7. Unless specifically covered under a separate permit that allows activity in proximity to protected species, all in-water work would be postponed when whales are within 100 yards, or other protected species are within 50 yards. Activity would commence only after the animal(s) depart the area. 8. Should protected species enter the area while in-water work is already in progress, the activity would continue only when that activity has no reasonable expectation to adversely affect the animal(s). 9. No attempt would be made to feed, touch, ride, or otherwise intentionally interact with any protected species 10. Except for pipe deployment, limit work to daylight hours so the BMPs can be carried out. Measures to mitigate potential effects on marine mammals may include the following (including requirements for Marine Biota): • Establishment of Safety and Exclusion Zones. Before any pile driving, a clearly marked safety zone (typically 50 yards; 100 yards during pile driving) for potentially affected species would be established. The safety zone would be marked by buoys for easy monitoring. A minimum of one biological observer on a boat per pile driver barge would survey the safety zone to ensure that no marine mammals are seen within the zone before pile driving begins. If marine mammals were found within the safety zone, pile driving would be delayed until they move out of the area. If a marine mammal is seen above the water and then dives below, pile driving would wait a specified amount of time and if no marine mammals are seen by the observer in that time it would be assumed that the animal has moved beyond the safety zone. • Soft Start. Although marine mammals would be protected from Level harassment by establishment of a safety zone, mitigation may not be 100 percent effective at all times in locating marine mammals. In order to provide additional protection to marine mammals near the project area by allowing marine mammals to vacate the area, thus further reducing the incidence of Level B harassment from startling marine mammals with a sudden intensive sound, a "soft start" could be implemented. Under a soft start, pile driving would be initiated at an energy level less than full capacity (i.e., approximately 40-60 percent energy levels) for at least 5 minutes before gradually escalating to full capacity. This would ensure that, although not expected, any marine mammals that are undetected during safety zone monitoring would not be injured. • Shut Down. If a marine mammal is seen approaching or within the exclusion zone, pile driving operations would be shut down until the animal has left the exclusion zone or 15/60 minutes (pinniped/cetacean) have passed without the animal being seen. • No vibratory pile driving would be done during the period December 1 to March 31 to avoid peak humpback whale season in Hawai'i. To reduce entrainment (and impingement): • The intake location is approximately 25,000 feet offshore at a depth of 1,741 feet. At the intake depth biological productivity is much less than at shallower depths and the lower density of organisms reduces the potential for impingement and entrainment. • The maximum intake velocity (approximately 5 feet/sec. or 3.4 miles per hour) would limit entrainment of macroorganisms. • Variable speed pumps would be used which would provide for greater system

<table>
<tr><th>Resources Potentially Adversely Affected</th><th>Proposed Mitigation Measures</th></tr>
<tr><td></td><td>efficiency and reduced flow requirements (and associated entrainment).</td></tr>
<tr><td>Marine Biota</td><td>Use divers to assist with anchor placement to avoid corals.
All coral colonies larger than 10 cm in size (15 colonies) would be transplanted from the proposed footprint of the receiving pit to a position approximately 15 meters further inshore within the same biotope of dredged rubble. Additionally a monitoring plan would be implemented to document success.
Prior to constructing the receiving pit and the pipelines a preconstruction survey would be conducted to minimize impacts to coral aquatic resources to the maximum extent practicable.</td></tr>
<tr><td>Terrestrial Geology/ Surface Water</td><td>Prepare and implement an “Erosion Control Plan.”</td></tr>
<tr><td>Air Quality</td><td>Fugitive Dust Source Controls:
Stabilize open storage piles and disturbed areas by covering and/or applying water or chemical/organic dust palliative where appropriate. This applies to both inactive and active sites, during workdays, weekends, holidays, and windy conditions.
Install wind fencing and phase grading operations where appropriate, and operate water trucks for stabilization of surfaces under windy conditions.
When hauling material and operating non-earthmoving equipment, prevent spillage and limit speeds to 15 mph. Limit speed of earth-moving equipment to 10 mph.
Mobile and Stationary Source Controls:
Reduce use, trips, and unnecessary idling from heavy equipment.
Maintain and tune engines per manufacturer’s specifications to perform at the USEPA certification levels and to perform at verified standards applicable to retrofit technologies. Employ periodic, unscheduled inspections to limit unnecessary idling and to ensure that construction equipment is properly maintained, tuned, and modified consistent with established specifications.
Prohibit any tampering with engines and require continuing adherence to manufacturer’s recommendations.
If practicable, lease newer and cleaner equipment that would meet the most stringent of applicable Federal or State standards.
Utilize USEPA-registered particulate traps and other appropriate controls where suitable to reduce emissions of diesel particulate matter and other pollutants at the construction site.
Administrative Controls:
Identify where implementation of mitigation measures is rejected based on economic infeasibility.
Prepare an inventory of all equipment prior to construction and identify the suitability of add-on emission controls for each piece of equipment before groundbreaking. (Suitability of control devices is based on: whether there is reduced availability of the construction equipment due to increased downtime and/or power output, whether there may be significant damage caused to the construction equipment engine, or whether there may be a significant risk to nearby workers or the public.)
Utilize cleanest available fuel engines in construction equipment and identify opportunities for electrification. Use low sulfur fuel (diesel with 15 parts per million or less) in engines where alternative fuels such as biodiesel and natural gas are not possible.</td></tr>
<tr><td>Groundwater</td><td>Implement BMPs, including the use of settling ponds, tanks or filtration systems, to treat dewatering effluents.</td></tr>
<tr><td>Terrestrial Biota</td><td>Note the location of “Exceptional Trees” on construction plans.</td></tr>
</table>

Resources Potentially Adversely Affected	Proposed Mitigation Measures
	Survey for white terns prior to construction.

UNAVOIDABLE ADVERSE EFFECTS AND IRREVERISBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Unavoidable adverse effects that would result from implementation of the HSWAC project include the following:

- Construction of the cooling station and installation of the distribution system would be accompanied by increased noise, dust and traffic congestion.
- Offshore construction would create temporary turbidity at the receiving pit and where collars impact the bottom.
- Once operational, the system would impact water quality and marine biota within a defined ZOM. The seawater return flows would be lower in temperature and dissolved oxygen concentrations and higher in dissolved inorganic nutrient concentrations than the receiving water. A ZOM permit is being sought by the applicant to authorize an area in which adequate dilution could occur.
- Construction activities would affect less than two hundred square feet of living coral colonies in the vicinity of the preferred microtunnel breakout point and along the seaward path of the pipes. More than a half million square feet of potential habitat for sessile benthic organisms would be created by the receiving pit and pipe collars.

Irreversible and irretrievable commitments of resources required to implement the HSWAC project include the following:

- Human productivity would be expended in planning, constructing, and operating the system.
- Much of the construction material and hardware used in the system would not be reusable (although some could be recycled).
- Fuels and lubricants would be used in vehicles and equipment (some could be recycled).
- Oil would be burned in producing electricity for those components of the system requiring it (pumps, auxiliary chillers, etc.).

UNRESOLVED ISSUES (INCLUDING CHOICE AMONG ALTERNATIVES)

The U.S. Environmental Protection Agency (USEPA) is evaluating the applicant’s proposed method of compliance with Clean Water Act (CWA) Section 316(b), which establishes requirements for screening and maximum intake velocities for cooling water intakes. The adequacy of the applicant’s Proposed Coral Transplantation and Monitoring Plan (Appendix O) to appropriately mitigate impacts to aquatic resources is under evaluation.

AREAS OF CONTROVERSY

Areas of controversy included depth of the seawater return discharge, potential impacts to mesophotic corals, presence of and potential impacts to mesopelagic boundary layer organisms, impingement and entrainment of organisms at the intake, and mitigation of adverse impacts to aquatic resources associated with the construction of the receiving pit and placement of pipeline collars.

STATUS OF STATE AND LOCAL PERMITS, LICENSES AND APPROVALS REQUIRED

The applicant has acquired many of the permits and approvals necessary for planning work, such as geotechnical testing of soils and rights-of-entry for such testing. Applications for a number of major State of Hawaiʻi permits and Federal permits delegated to the State have been submitted by the applicant and are under review by the appropriate agencies. These include an Individual National Pollutant Discharge Elimination System (NPDES) permit required by Section 402 of the CWA for the return seawater discharge, a CWA Section 401 Water Quality Certification, a ZOM permit, and a Coastal Zone Management (CZM) Program Consistency Determination. The State Board of Land and Natural Resources (BLNR) have approved a Conservation District Use Permit (CDUP) and a non-exclusive easement for the pipes is being sought. A Special Management Area (SMA) Use Permit – Major has been granted by the State Office of Planning. The Hawaiʻi Community Development Authority has granted Project Eligibility and Development Permits for work in Kakaʻako. The State Office of Planning has accepted a Final State EIS. A Special Activity Permit would be sought from the Department of Land and Natural Resources (DLNR) Division of Aquatic Resources (DAR) for taking of coral and live rock. A SMA Use Permit – Minor has been granted by the City and County of Honolulu Department of Planning and Permitting for the proposed staging area. A number of additional permits from the State and the City and County of Honolulu would be required for the construction and operation of the cooling station.

STATUS OF REQUIRED FEDERAL CONSULTATIONS

USACE has completed consultation with the State Historic Preservation Officer (SHPO) pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended (Appendix B). USACE made a preliminary determination of "no historic properties adversely affected." Based on the SHPO's decision to allow the consultation period for USACE's request for concurrence to lapse, USACE has presumed concurrence with that determination.

USACE preliminarily determined that the applicant's proposed action may adversely affect species listed as threatened or endangered under the Endangered Species Act (ESA). Accordingly, pursuant to Section 7 of the ESA, USACE consulted with the Protected Resources Division of the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) Pacific Islands Regional Office. Formal consultation was completed with NOAA's issuance of its Biological Opinion on September 13, 2012 (Appendix M).

USACE has determined that the applicant's proposed action may adversely affect essential fish habitat (EFH). Accordingly, under the Magnuson-Stevens Act, on February 28, 2012 USACE completed consultation with the Habitat Conservation Division of NOAA's NMFS Pacific Islands Regional Office (Appendix J).

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LIST OF ACRONYMS AND ABBREVIATIONS

µg	Microgram
$\mu g/m^3$	Microgram per Cubic Meter
µM	Micromole
µmole/kg	Micromole per Kilogram
<	Less Than
≤	Less Than or Equal to
§§	Sections
©	Copyright
3-D	Three Dimensional
°	Degrees
°F	Degrees Fahrenheit
°C	Degrees Celsius
AAQS	Ambient Air Quality Standards
APE	Area of Potential Effect
bbl	barrel
BCOE	Barrels of Crude Oil Equivalent
BLNR	Board of Land and Natural Resources
BLVD.	Boulevard
BMPs	Best Management Practices
BOD	Basis of Design
BOD	Biological Oxygen Demand
Btu	British Thermal Unit
CDUP	Conservation District Use Permit
CEQ	Council on Environmental Quality
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
CIA	Cultural Impact Assessment
CIH	Certified Industrial Hygienist
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
cm/s	centimeters per second
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CORMIX	Cornell Mixing Zone Expert System
CSMP	Contaminated Soil Management Plan
CSP	Certified Safety Professional
CV	Coefficient of Variation
CWA	Clean Water Act
CWB	Hawai‘i Department of Health Clean Water Branch
CZM	Coastal Zone Management
DA	Department of the Army
DAR	Hawai‘i Division of Aquatic Resources
dB	Decibel(s)
DBEDT	Hawai‘i Department of Business, Economic Development and Tourism
DEIS	Draft Environmental Impact Statement
DLNR	Hawai‘i Department of Land and Natural Resources
DMM	Discarded Military Munitions
DP	Development Plan
EAL	Environmental Action Level
EO	Executive Order
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EHMP	Environmental Hazard Management Plan
EIS	Environmental Impact Statement
EPP	Environmental Protection Plan
ESA	Endangered Species Act
FCC	Frank Coluccio Construction Co.
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMP	Fishery Management Plan
fps	feet per second
FPVC	Fusible Polyvinyl Chloride (PVC)
ft	foot/feet
FTEPY	Full-time Equivalent Person-years
gpm	gallons per minute
GSP	Gross State Product
HAPC	Habitat Area of Particular Concern
HAR	Hawai‘i Administrative Rules
HASP	Health and Safety Plan
HCDA	Hawai‘i Community Development Authority
HCFC	Hydrochlorofluorocarbon
HDD	Horizontal Directional Drilling
HDOH	Hawai‘i Department of Health
HDOT	Hawai‘i Department of Transportation
HDPE	High Density Polyethylene
HECO	Hawaiian Electric Company
HEER	Hawai‘i Hazard Evaluation and Emergency Response Office
HFC	Hydrofluorocarbon
HMS	Hawaiian Monk Seal
HRS	Hawai‘i Revised Statutes

HSWAC	Honolulu Seawater Air Conditioning, LLC
HUMMA	Hawai‘i Undersea Military Munitions Assessment
HURL	Hawai‘i Undersea Research Laboratory
ID	Inside Diameter
IPCC	Intergovernmental Panel on Climate Change
IHA	Incidental Harassment Authorization
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
JABSOM	John A. Burns School of Medicine
kg	Kilogram
kg/m^3	kilograms per cubic meter
kV	kilovolt
kW	Kilowatt
kWh	Kilowatt Hour
l	liter
L_{dn}	Day-Night Sound Level
LEDPA	Least Environmentally Damaging Practicable Alternative
LLC	Limited Liability Corporation
m	meter
MBTA	Migratory Bird Treaty Act
mg/l	Milligrams per Liter
MGD	Million Gallons per Day
MHI	Main Hawaiian Islands
MLLW	Mean Lower Low Water
mm	millimeter
MMPA	Marine Mammal Protection Act
MOE	Makai Ocean Engineering, Inc.
mph	Miles per Hour
MSA	Magnuson-Stevens Act
MSRA	Magnuson-Stevens Reauthorization Act
MSL	Mean Sea Level
MTBM	Microtunnel Boring Machine
MUS	Management Unit Species
MW	Megawatt
N	North
NAAQS	National Ambient Air Quality Standards
NELH	Natural Energy Laboratory of Hawai‘i
NELHA	Natural Energy Laboratory of Hawai‘i Authority
NEPA	National Environmental Policy Act
NHP	Hawai‘i Natural Heritage Program
NHPA	National Historic Preservation Act
nm or nmi	Nautical Mile(s)
NMFS	U.S. National Marine Fisheries Service
NOx	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NOI	Notice of Intent
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
ntu	Nephelometric Turbidity Unit
NWHI	Northwestern Hawaiian Islands
OD	Outside Diameter
PCB	Polychlorinated Biphenyls
PCP	Polymer Reinforced Concrete Pipe
PET	Polyethylene Terephthalate
$PM_{2.5}$	Particulate Matter Less Than 2.5 Microns in Aerodynamic Diameter
PM_{10}	Particulate Matter Less Than 10 Microns in Aerodynamic Diameter
POL	Petroleum, Oil and Lubricants
PPE	Personal Protective Equipment
ppm	parts per million
ppt	parts per thousand
psi	pounds per square inch
RCP	Reinforced Concrete Pipe
RCRA	Resource Conservation and Recovery Act
ROI	Region of Influence
ROV	Remotely Operated Vehicle
SAAQS	State of Hawai‘i Ambient Air Quality Standards
SCUBA	Self-contained Underwater Breathing Apparatus
SDWA	Safe Drinking Water Act
sec	Second(s)
SFA	Sustainable Fisheries Act
SHPD	Hawai‘i Historic Preservation Division
SHPO	Hawai‘i Department of Land and Natural Resources State Historic Preservation Officer
SMA	Special Management Area
SO_x	Sulfur Oxide
SO_2	Sulfur Dioxide
SOP	Standard Operation Procedure
SWAC	Seawater Air Conditioning
TBM	Tunnel Boring Machine
UBC	Uniform Building Code
UH	University of Hawai‘i

UIC	Underground Injection Control
U.S.	United States
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
VARS	Video Annotation and Reference System
VOC	Volatile Organic Compound
WPRMFC	Western Pacific Regional Fishery Management Council
WWTP	Wastewater Treatment Plant
yr	Year
ZOM	Zone of Mixing

CHAPTER 1.
PROJECT PURPOSE AND NEED

1.1 PURPOSE AND NEED

There is a need, based on economic and environmental considerations, to increase the use of renewable energy resources and decrease the use of imported oil to generate electricity in Hawai‘i. The purpose of the Honolulu Seawater Air Conditioning (HSWAC) project is to significantly contribute to meeting these needs by developing a seawater air conditioning (SWAC) system to serve the downtown area of Honolulu. To accomplish this, the applicant proposes to construct seawater intake and return pipelines in coastal waters.

1.2 BACKGROUND

SWAC uses renewable, deep cold seawater instead of electricity-intensive refrigeration systems to air condition one or more buildings. Typical large building air conditioning systems use refrigerant vapor compression cycle chillers to generate chilled water, which is then used to cool the air that is circulated throughout the building. In a SWAC system, rather than cycling water through a chiller, the water is routed through a heat exchanger. Fresh water circulates through one side of a system of titanium (or other corrosion-resistant alloy) plates, transferring its heat to the cold seawater on the other side of the plates. In existing SWAC systems, all of which utilize proven technology, the fresh water loop is closed, that is, the water circulates from the heat exchanger to connected buildings and back to the heat exchanger, while the cold seawater passes through the heat exchanger only once before being returned to the sea.

The main components of a basic SWAC system are a seawater circulation system including the supply pipe, pumps, and return pipe; a fresh water circulation network, including pumps that provide chilled water to each connected building; heat exchangers that transfer heat from the fresh water loop to the seawater; and auxiliary chillers to optimize the distribution water temperature.

Deep water cooling systems have been successfully installed and operated in a number of areas worldwide from Stockholm, Sweden to the Natural Energy Laboratory of Hawai‘i (NELH) on the Big Island of Hawai‘i.

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CHAPTER 2. **DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES**

2.1 INTRODUCTION

The purpose of this Chapter is to describe the alternatives and summarize their impacts. It begins by presenting feasibility criteria for a Honolulu SWAC system. Following that the No Action Alternative and the four action alternatives considered are described. It then describes alternatives that were considered, but not carried forward in detailed analysis, and provides rationale for that decision. Finally, the impacts of the alternatives considered are compared.

The DEIS considered action Alternatives 1 and 2. To address comments on the DEIS received from USEPA and USFWS, this FEIS considers Alternatives 3 and 4, for which the location of the diffuser is located in successively deeper water. Other additions made in response to comments received on the DEIS include: (1) the results of new quantitative biological surveys along the entire pipeline route, including information on mesophotic ecosystems and mesopelagic boundary layer organisms, (2) new water quality data from the proposed discharge location, (3) analysis of the potential effects of discarded military munitions in the project area, (4) the results of additional coordination with a homeless shelter near the proposed location of the shoreline jacking pit, (5) additional analysis of options for screening the intake, (6) incorporation of entrainment monitoring data from shallow water O‘ahu generating station cooling water intakes into an entrainment analysis and monitoring plan to satisfy requirements of Clean Water Act Section 316(b) (7) completion of an antidegradation analysis, (8) acquisition of an Incidental Harassment Authorization from the National Marine Fisheries Service (NMFS) for construction noise effects on protected marine species, (9) completion of a proposed coral transplantation and Monitoring plan., (10) completion of an Environmental Hazard Management Plan for dealing with toxic and hazardous materials, (11) incorporation of biological data on Ke‘ehi Lagoon, and (12) analyses of potential effects to coral reef ecological services.

2.2 APPLICANT’S SEAWATER AIR CONDITIONING FEASIBILITY CRITERIA

The technical feasibility of SWAC systems has been proven in numerous applications. All of the necessary hardware components are commercially available and the technology to deploy large-diameter pipes to sufficient depths in the ocean has been developed and demonstrated in Hawai‘i. The applicant’s feasibility issue is economic. Cold, deep seawater is abundantly available, so operating costs for a SWAC system are lower than air conditioning systems that depend on electrical chillers. To access cold seawater and provide chilled water to customer buildings requires a large capital investment in pipes, pumps and other equipment and their installation, and in a structure (cooling station) to house the equipment. To be economically viable, therefore, a SWAC project must satisfy the following criteria.

- An adequate demand for air conditioning must exist to permit the system to be economically sized. For the HSWAC project, this size was determined to be 25,000-tons[2]. That demand exists in downtown Honolulu.
- Demand must be concentrated within a small enough geographic area to minimize distribution system (pumping and piping) costs. The downtown area of Honolulu satisfies this criterion.
- There must be an available, adequately-sized site for a cooling station that is within close proximity to a source of cool water and to the potential customer buildings. For the HSWAC

[2] **Tons** is a unit of measure for the output of a heating or cooling system. One ton equals the amount of cooling that can be provided by one ton of ice melting over a 24-hour period, or 12,000 BTU/hr. One ton of cooling is roughly enough to cool one hotel room.

system, a site of at least 25,000 square feet in the makai portion of Kakaʻako satisfies this criterion.

- Electricity and water utilities must be available at the cooling station site. Utilities are adequate in the Kakaʻako area.
- There must be a source of water both cold enough to minimize potential supplemental chilling costs and close enough to the cooling station to minimize costs of source and return piping. Seawater of about 44°F is available within 4-5 miles offshore of Kakaʻako, an economically feasible distance for installation of pipes, given the overall size of the proposed HSWAC system.
- The difference in the cost of conventional and SWAC air conditioning must be sufficient to permit pricing that motivates potential customers to connect to the SWAC system and also support amortization of the capital costs and satisfaction of the ongoing operational costs of the SWAC system. As the cost of electricity increases, SWAC systems become more viable. The extremely high electricity rates on Oʻahu provide the necessary cost differential for viable implementation of SWAC systems.

The above criteria are satisfied by all of the action alternatives. The economic feasibility of such a system is determined by the rates that can be offered to customers. As the price of electricity increases, the economic feasibility of a SWAC system also increases.

2.3 THE NO ACTION ALTERNATIVE

The No Action Alternative would not implement a SWAC system in downtown Honolulu. No seawater pipes would be installed offshore of Kakaʻako. No breakout point for trenchless installation would be excavated. No DA permit would be required. The potential environmental impacts associated with the action alternatives would be avoided; however, downtown buildings would continue to be independently cooled with on-site, electrically-powered chillers. Potable water would continue to be used in cooling towers, and the Sand Island Wastewater Treatment Plant would continue to treat and dispose of the wastewater through its Māmala Bay ocean outfall.

Currently, Hawaiʻi relies on oil for approximately 75 per cent of its electricity generation. The State of Hawaiʻi has a goal of achieving 70% clean energy by 2030 through both implementation of energy efficiency measures and development of renewable energy technologies. At the present time, efforts to lower petroleum use in Hawaiʻi through energy efficiency are producing about the same level of reduction as all renewable energy technologies combined; they each met about 12% of electricity needs in 2011 (DBEDT, 2013). In the longer-term, however, the contribution of renewable energy technologies is expected to satisfy a much greater percentage of Oʻahu's electricity needs than conservation measures.

Development of renewable energy resources in Hawaiʻi has accelerated in recent years and would be expected to continue under the No Action Alternative. On Oʻahu, the technologies that have been developed to the greatest extent to date are solar (commercial and distributed), wind, and bioenergy, respectively (DBEDT, 2013). Solar and wind, however, are typically intermittent producers, incapable of contributing to baseload needs without some type of energy storage system such as batteries or heat storage. Such storage systems are in various stages of development, but are not generally available or employed yet due to the developmental stage or the economics. Unlike wind or solar technologies, the renewables most employed on Oʻahu, SWAC systems may be considered firm power because they replace the need for some amount of baseload power.

Other well-established renewable energy technologies have lower potential on Oʻahu. Examples are hydroelectric and geothermal, for which the natural resources are inadequate for commercial development. Still other technologies are being developed that may eventually be employed and reduce the use of fossil fuels on Oʻahu, but are still in the developmental stages. These include Ocean Thermal Energy Conversion and hydrokinetic technologies that tap the power of ocean waves, tides and currents.

Projects that would implement any of the above renewable energy technologies would meet at least part of the purpose and need for the proposed action, i.e., increasing use of renewable energy. Any of these technologies would also decrease use of imported oil for electricity. However, the most feasible of these technologies on O‘ahu at present, solar and wind, would not provide firm, baseload power and none of the technologies would directly increase energy efficiency in government buildings.

Implementation of any of these renewable energy technologies could have adverse effects on environmental resources. Depending on the project type, size and site, environmental concerns may include such things as diversion of land use, potable water consumption, water quality, protected species and habitats, cultural resources, and aesthetics. The effects of implementation of a given technology at a specific site require project-specific analysis and cannot be generalized here, but in a relative sense could be greater or less than the effects of the proposed action.

2.4 THE ACTION ALTERNATIVES

The four action alternatives share some basic characteristics, which are described in the following sections. Subsequently, the four alternatives are described, pointing out their differences. Alternative 1 was the applicant’s preferred alternative in the DEIS; the applicant’s preferred alternative is now Alternative 4.

2.4.1 Common Features

2.4.1.1 Project Size

The overall capacity of the proposed HSWAC system, 25,000 tons of centralized air conditioning, was established in consideration of the potentially available cooling load in downtown Honolulu, the costs to connect buildings of various sizes and locations, system capital and operating costs, the availability of appropriate equipment, and the offshore bathymetry and seawater characteristics. The proposed system capacity, in turn, determined the sizes of the major system components. Component sizes, their respective operating environments, and life-cycle costs determined component materials, for example, high density polyethylene (HDPE) is specified for the seawater pipes because of its strength, flexibility, inertness in seawater, and good thermal insulating properties. Similarly, system component size, material composition, and environmental constraints drove selection of construction methodologies.

2.4.1.2 Project Setting and Use of Public Lands

The HSWAC project is proposed for the downtown area of Honolulu, on the leeward shore of O‘ahu. The island of O‘ahu is part of the City and County of Honolulu. Four areas near downtown Honolulu (Figure 2-1) would be used in four discrete functions associated with construction and operation of the HSWAC system:

- Seawater intake and return pipes would be deployed offshore of Honolulu in the area between Honolulu Harbor and Kewalo Basin,
- A cooling station would be built on a site in the Makai District of the Kaka‘ako Community Development Area,
- Freshwater distribution pipes would be installed beneath streets in the downtown Honolulu area, and
- A shoreline site on Sand Island would be temporarily used for materials staging and pipeline assembly.

In addition, dredged materials would be disposed of at an upland disposal site to be determined. Use of public lands would include State submerged lands where the seawater pipes would be installed, State highways and City streets where the distribution system pipes would be installed, and State lands where the seawater pipelines would be assembled.

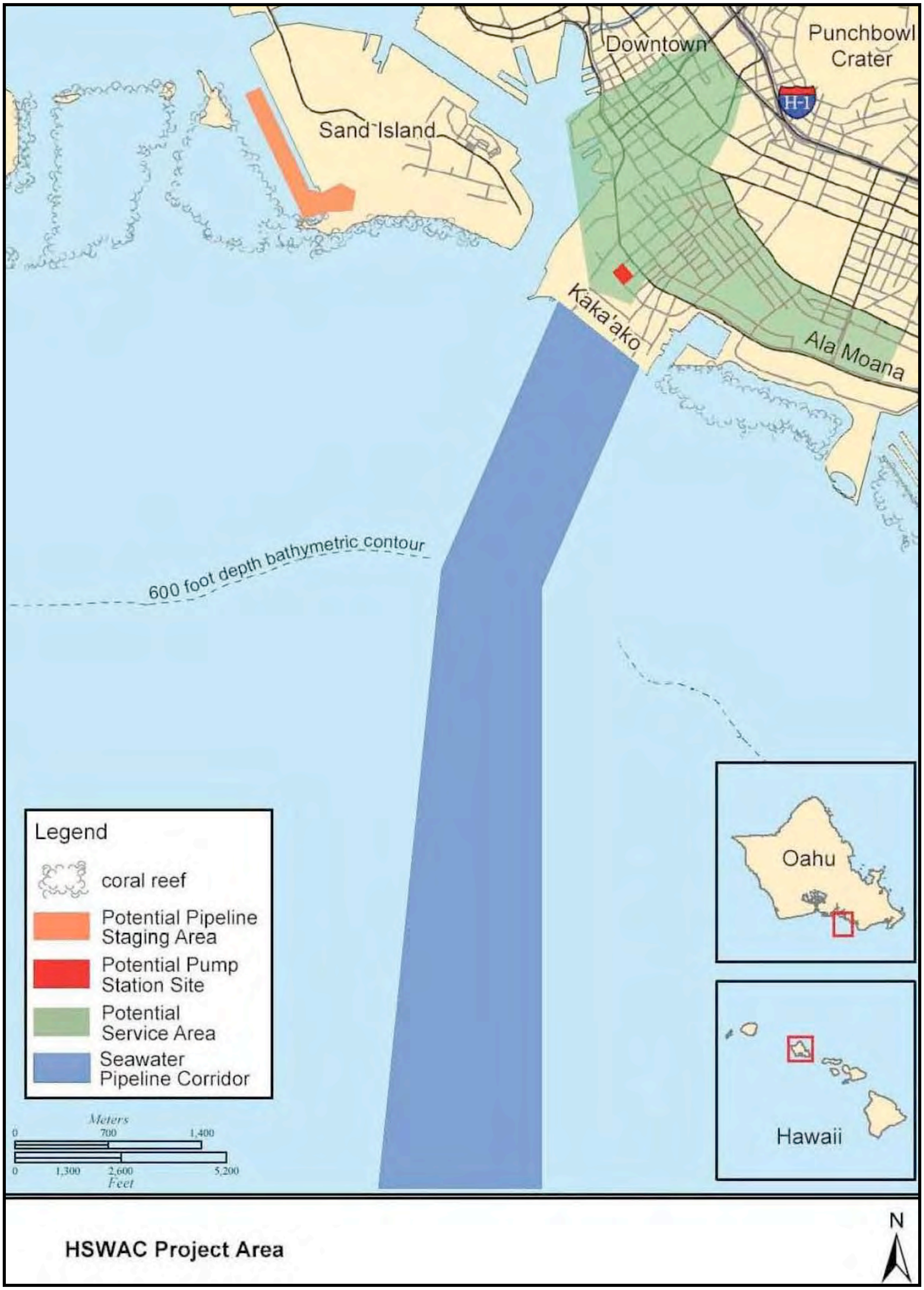

Figure 2-1: HSWAC Project Area

A portion of the project would extend into Federal waters beyond three miles from shore. The U.S. Department of the Interior Bureau of Ocean Energy Management, Regulation and Enforcement[3] administers "renewable energy" projects in Federal waters. The applicant requested and received guidance from that agency stating that no lease, easement or right-of-way is needed from that agency because the project does not produce or support production, transportation or transmission of energy (Appendix A).

2.4.1.3 Project Components and Operations

The primary means of cooling would be through the use of deep, cold seawater accessed through a long offshore intake pipeline. The system is shown conceptually in Figure 2-2. The primary system components are as follows:

- Seawater intake and return pipes;
- A seawater cooling station containing:
  - Seawater pumps,
  - Fresh water pumps,
  - Heat exchangers,
  - Auxiliary chillers, and
- A chilled (fresh) water distribution system.

A staging area would be required for materials storage and pipeline assembly and testing.

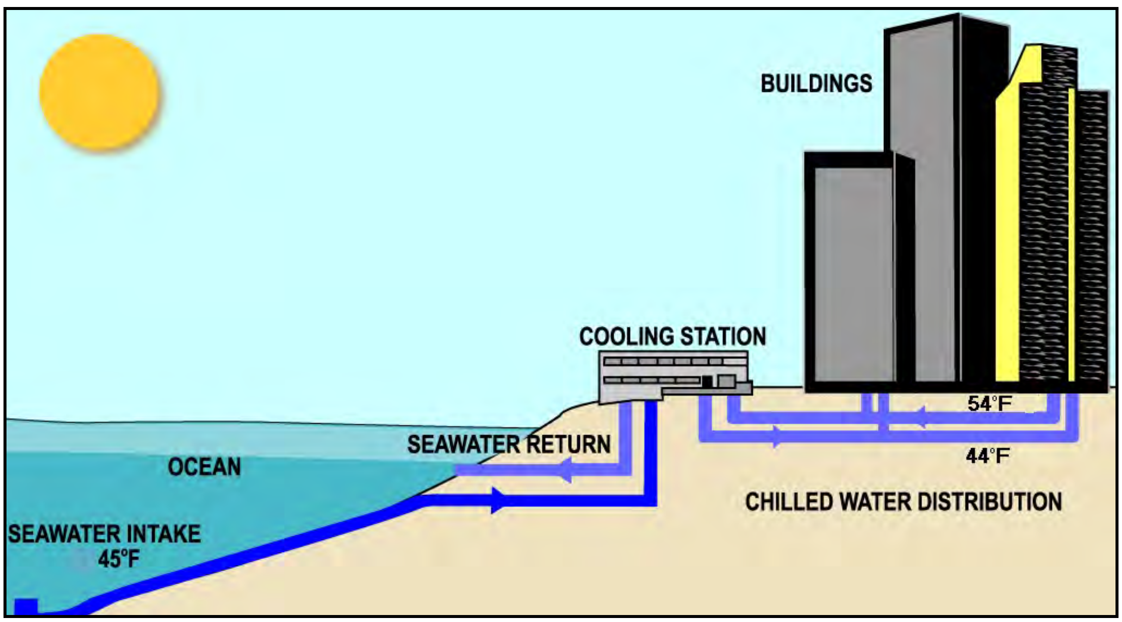

Figure 2-2: Conceptual Drawing of Major Components of the HSWAC System
(Source: HSWAC, LLC)

Figure 2-3 is a schematic drawing of HSWAC system operations. Cold seawater would be pumped through heat exchangers and then through condensers in auxiliary chillers before being returned to the sea. Freshwater would circulate through the heat exchangers and the auxiliary chillers before returning to the connected buildings.

[3] On October 1, 2011, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), formerly the Minerals Management Service (MMS), was replaced by the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE) as part of a major reorganization.

Operation of the HSWAC system relies on readily available materials and equipment including pipes, pumps, heat exchangers and chillers. Piping and heat exchangers need no direct operational considerations and the operation of pumps and chillers would be fully automated through a plant control system.

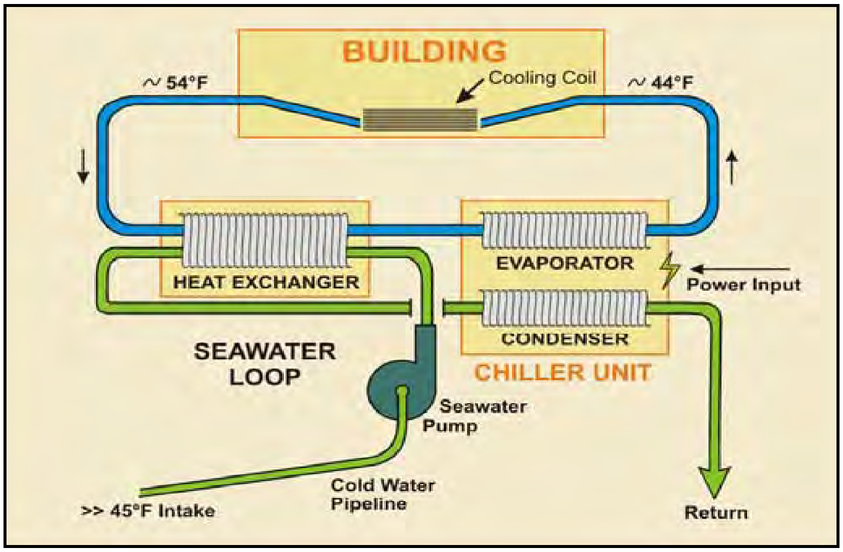

Figure 2-3: Schematic Drawing of the HSWAC System with Chiller Enhancement
(Source: Makai Ocean Engineering, 2005a)

2.4.1.4 Seawater Circulation System

The seawater circulation system would consist of seawater intake and return pipelines extending from the cooling station to their respective terminal points offshore. Considered were various combinations of construction/installation methodologies and pipe types for different segments of the intake and return routes. In particular, the available trenchless technologies for pipeline installation were thoroughly evaluated for potential use in installing the two pipes underground from the cooling station to a breakout point offshore where living corals give way to coral rubble and sand. Trenchless technologies evaluated included horizontal directional drilling, microtunneling and conventional tunneling. Microtunneling was selected as being the most economical and environmentally protective and is described here. Horizontal directional drilling and conventional tunneling were not carried forward for detailed analysis and the reasons for that are presented in Section 2.5.5.

Pipe jacking is a method of tunnel construction where hydraulic jacks are used to push specially made pipes through the ground behind a tunnel boring machine or shield. This technique is commonly used to create tunnels under existing structures, such as roads or railways. Tunnels constructed by pipe jacking are normally small diameter tunnels. Microtunneling is a specialized form of pipe jacking used to install pipelines without the need for personnel to enter the pipe. It is therefore conducive to small diameter pipes (e.g., internal diameters less than 36 to 48 inches) but is by no means restricted to these diameters. Jacking of 60-inch to 120-inch diameter reinforced concrete pipes is not uncommon. Microtunnel construction techniques may be used to install a carrier pipe by direct jacking or to install a casing into which the carrier pipe is installed. The microtunnel boring machine (MTBM) is a specialized tunnel boring machine with the following general characteristics:

1. It is operated by remote control.
2. The front of the MTBM consists of a cutterhead, which must be designed and equipped to mine through the range of anticipated ground conditions.
3. It controls the soil at the face by use of an earth pressure balance technique and counterbalances the groundwater by a slurry pressure technique.

4. Soil cuttings are removed from the face of the machine by use of a slurry system or an auger system. For this project, an auger system would not be appropriate.
5. It is steerable and generally laser guided.
6. The tunnel lining installed by pipe jacking can be a larger diameter casing (steel, reinforced concrete pipe, composite, or concrete-polymer pipe). Based on the project considerations and anticipated mixed subsurface conditions, a steel or reinforced concrete casing can be considered for straight drives, and reinforced concrete casing pipe should be considered for curved drives. In the U.S., microtunneling drives completed to date are generally straight drives. Many curved drives from 650 feet to over 1,000 feet bend radius have been completed in Western Europe and some Asian countries.

Microtunneling methods require jacking pits and receiving pits. A microtunnel begins at an excavation called the jacking pit where the MTBM is launched and pipe is inserted. A receiving pit is another excavation at the end of the microtunnel where the MTBM is recovered. The construction staging area is generally located at the jacking pit and/or receiving pit. Selecting the location of jacking and receiving pits is based on evaluation of a number of factors, such as identifying acceptable staging areas and maintaining feasible drive lengths. In order to minimize the number of jacking pits required, each jacking pit can be utilized for installing pipe in both directions. Figure 2-4 provides an example of microtunnel jacking pit construction on a narrow public roadway in Kailua, O‘ahu.

Figure 2-4: Microtunnel Jacking Pit Construction on a Narrow Public Roadway in Kailua, O‘ahu
(Source: Yogi Kwong Engineers, Inc.)

The following three figures show aspects of microtunneling over water. Figure 2-5 shows a microtunneling rig near the Pearl Harbor entrance channel. Figure 2-6 shows the inside of a microtunnel pit in the ocean off Pearl Harbor, and Figure 2-7 shows wet retrieval of the microtunnel boring machine.

Figure 2-5: Microtunnel Rig off Pearl Harbor
(Source: Yogi Kwong Engineers, Inc.)

Figure 2-6: Forty-foot Deep Microtunnel Pit off Pearl Harbor
(Source: Yogi Kwong Engineers, Inc.)

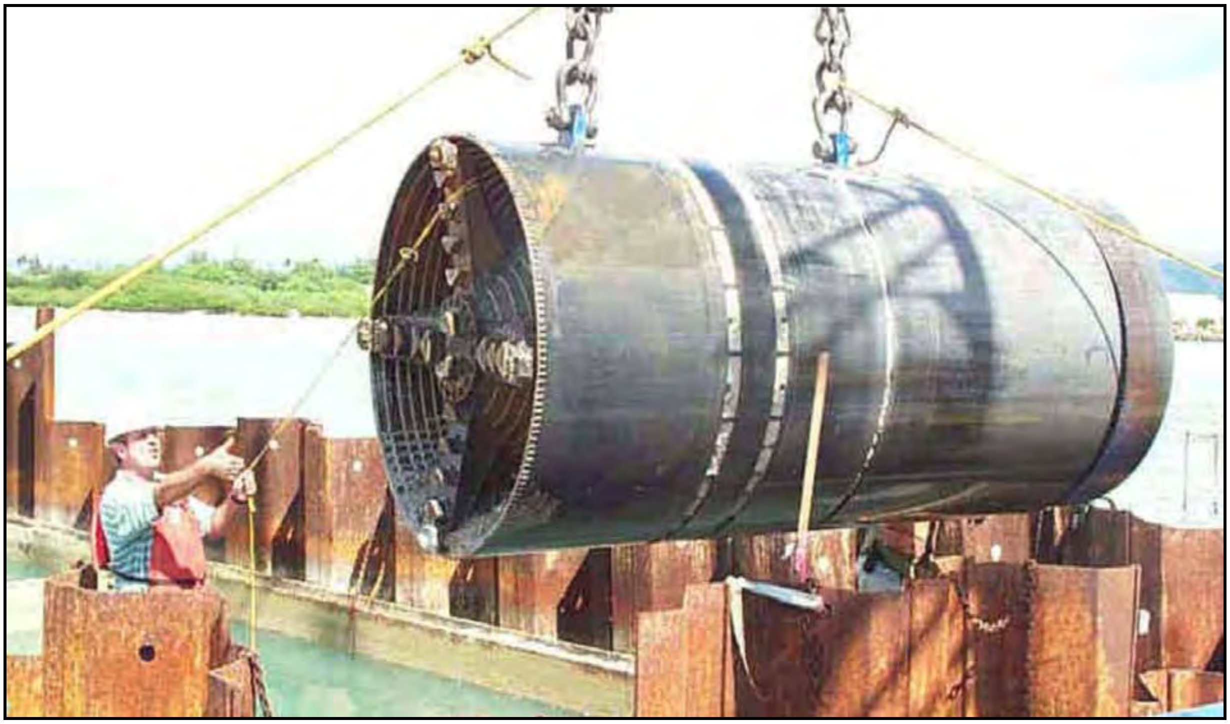

Figure 2-7: Wet Retrieval of Microtunnel Boring Machine
(Source: Yogi Kwong Engineers, Inc.)

Based on the available geotechnical data, the shoreline crossing could be constructed using microtunneling methods and that would require a narrower easement corridor than horizontal directional drilling (HDD). However, along the Keawe Street corridor, the approximately 3,600 linear feet shore crossing far exceeds the single-drive jacking distance previously attempted by U.S. contractors. Therefore, a jacking pit would be required close to the shoreline, either on shore (applicant's preferred alternative) or offshore, to break the route into two sections of approximately 1,600 to 1,700 lineal feet each. The applicant's preferred alternative route is shown on Figure 2-8. The cooling station location and the preferred jacking pit location are outlined in green.

Use of microtunneling would substantially reduce both the required over water and on land work areas compared to HDD, however, the cost may be somewhat higher and it would likely take longer, due to the need to construct an offshore receiving pit from which to recover the microtunneling machine and a deep jacking pit at the cooling plant site.

In the analysis of trenchless construction technologies and their implications for potential offshore pipe routes, an eastern onshore microtunneled route beneath Kaka'ako Waterfront Park was considered to connect the cooling station and the breakout point. Potential mobilization and migration of contaminants from beneath the park was an unresolved issue, and the route option was eliminated from further consideration.

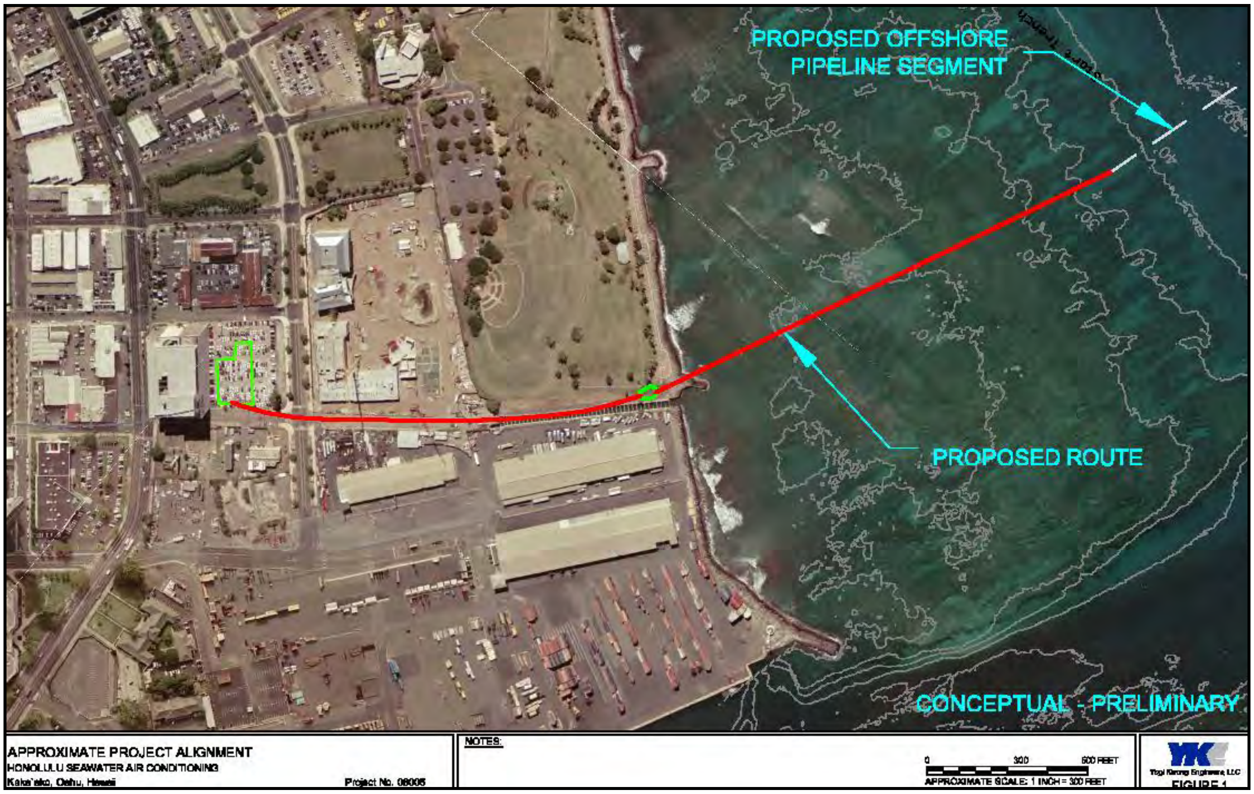

Figure 2-8: Preferred Microtunneling Route to Breakout Depth
(Source: Yogi Kwong Engineers, Inc.)

Seaward of the breakout point, the seawater intake and return pipes would be surface-mounted. The discrete segments of the intake and return seawater pipelines are: (1) from the cooling station to the offshore breakout point (within the microtunnel); (2) from the breakout point to the return seawater diffuser (surface-mounted); and (3) from the diffuser to the intake (surface-mounted).

2.4.2 **Alternative 1**

Alternative 1 was the applicant's preferred alternative in the DEIS. The complete route for the seawater pipes under Alternative 1 is shown on Figure 2-9.

2.4.2.1 **Cooling Station to Breakout Point**

Construction would begin at a jacking pit behind the shoreline at the ‘Ewa-makai corner of Kaka‘ako Waterfront Park. The coordinates at the center of the jacking pit makai wall are 157°51.986’ W, 21°17.676’ N. In plan view it would be a polygon with approximate maximum dimensions of 29 feet by 68 feet. A microtunnel boring machine (MTBM) would be installed in the jacking pit and would be used to tunnel in two directions, first in an inland direction passing beneath Keawe Street to a receiving pit adjacent to the proposed cooling station. Separate microtunnels would be drilled for the seawater intake and return pipes.

The second set of two tunnels would extend from the jacking pit to an offshore receiving pit. From the jacking pit to the offshore receiving pit the microtunnels would pass beneath the seafloor and the biotope of scattered corals to a breakout point in the biotope of dredged rubble where the bottom is predominantly composed of sand and rubble. The offshore receiving pit mauka wall midpoint would be located at 157°52.125’ W and 21°17.410’ N. Its dimensions would be approximately 40 feet by 40 feet and 20 feet deep.

The breakout point was selected based on a set of engineering, economic and ecological criteria. The practical maximum drive length for the microtunnel boring machine established the maximum distance between the on-shore jacking pit and the offshore receiving pit (breakout point). Different jacking pit locations were considered for the two cooling station locations. Within the maximum drive length, economic and ecological factors were considered to position the receiving pit to minimize both the microtunnel length and the amount of coral disturbed. The location proposed for the breakout point for all action alternatives satisfies these criteria. For the FEIS, an additional inspection and GPS measurements were made of the preferred location of the receiving pit. This survey resulted in a slight change to the coordinates to ensure the pit would be positioned in a sand channel.

One reviewer of the DEIS asked if the microtunnel could be extended to 80 feet depth to avoid shallower impacts. To reach a depth of 80 feet, a second drive would be necessary. This would entail construction of an intermediate jacking/receiving pit at approximately the same location as currently planned for the receiving pit. Impacts to the benthos and water quality at the intermediate pit would be substantially the same as under the current proposal and they would be duplicated at the second pit at 80 feet. In addition, installation of sheet piles to contain and partially isolate the receiving pit could be problematic at 80 feet. If sheet pile installation is not possible at that depth, impacts to water quality and nearby benthic resources could be greater due to slumping of the pit side walls and greater dispersion of turbidity.

Two jacked pipelines would be installed in each direction from the jacking pit:

- For the cold seawater intake pipeline, a minimum 71-inch internal diameter (ID) reinforced concrete pipe (RCP) or polymer reinforced concrete pipe (PCP) casing for the required curved drive to the cooling station receiving pit from the shoreline jacking pit, and a similar sized RCP, PCP or steel casing jacked from the shoreline in the opposite direction to the offshore breakout point for connection to the offshore pipelines. A nominal 57-inch (ID) diameter fiberglass pipe would be installed inside the jacked casing and the annulus space between the casing and the carrier pipe grouted.
- For the return seawater discharge pipeline, a 48-inch (ID) RCP or PCP pipe would be jacked in either direction from the same jacking pit described above.
- As an alternative, the contractor would jack only one RCP or PCP pipe with an internal diameter of up to 120 inches. The crown of the 120-inch pipe would be at an equal or lower elevation compared to the crown of either of the two separate pipes. Inside the large pipe, fiberglass carrier pipes for intake and return waters would be installed.

Alternative 1 would require construction access through and staging and work areas near the ‘Ewa corner of Kaka‘ako Waterfront Park between the old landfill and the open drainage culvert. Microtunneling and installation of the casings would require 6 to 7 months, and installation of the carrier pipelines and annulus grouting an additional 1 to 2 months.

The jacking pit, receiving pits and microtunnels would intersect the groundwater table. It is anticipated that all soil and water removed from the tunnel, jacking pit, and receiving pits would be disposed of on land. The applicant has prepared Phase I and Phase II Environmental Site Assessments and an Environmental Hazard Management Plan (EHMP) which has been accepted by the State of Hawai‘i Hazard Evaluation and Emergency Response (HEER) Office. The plan specifies testing requirements for the excavated materials and disposal requirements for spoils found to be contaminated with toxic chemicals from the former landfill. Uncontaminated spoils would be processed by a solids separation plant at the onshore receiving and jacking pits (at the cooling station and just behind the shoreline in Alternative 1, respectively). The solids and slurry would be transported in lined dump trucks to the contractor’s own yard for drying and then disposed of properly, likely at the construction waste landfill. The cooling station receiving pit would be about 20 feet by 25 feet by 70 feet deep with an excavated volume of about 35,000 cubic feet or about 1,300 cubic yards, and the shoreline jacking pit would be about 29 feet by 68 feet and 70 feet deep with about 138,000 cubic feet or 5,100 cubic yards of excavated material. Spoil from the offshore receiving pit would be barged and then hauled to the contractor's yard. This pit would be about 40 feet by 40 feet and 20 feet deep with an excavated volume of about 32,000 cubic feet or about 1,185 cubic yards. The two microtunnels would generate about 5,900 cubic yards of material, which would be extracted from the shoreline jacking pit and disposed of on land.

2.4.2.2 **Breakout Point to Diffuser**

The microtunnels would intersect the bottom at a water depth of approximately 31 feet. At this breakout point, sheet piles would be driven into the bottom to surround an area to be excavated. The receiving pit would be completely isolated and contained from the seafloor to the sea surface. This may be done by installing sheet piles all the way to the surface or by installing silt curtains above sheet piles that extend part way to the surface. A vibratory hammer would be used to drive the sheet piles. After the sheet piles (or the combination of sheet piles and silt curtains) are in place, the receiving pit would be excavated. A crane on a barge in four point mooring or an eight pile supported crane platform would be used in operations to drive the sheet piles, install the silt curtains if they are used, and excavate the offshore receiving pit. A clamshell excavator or open bucket excavator would be used to excavate the receiving pit. This pit would be used to recover the MTBM and connect the microtunneled pipes to the surface-mounted pipes extending seaward. Because of the size of the MTBM a smaller receiving pit would not be possible. Installation of the sheet piles and excavation of the receiving pit would take approximately one month. The plan for connecting the two segments of pipes is shown on Figure 2-10.

After completion of the connections, the pit would be backfilled and covered with a concrete cap. These operations would take about one week. The backfill would be crushed basalt gravel graded between 3/8-inch and 2-inch size and pre-washed to remove any fines. After backfilling and capping of the receiving pit, the sheet piles would be removed or cut off below the existing seafloor grade.

Seaward of the breakout point, the seawater intake and return pipes would parallel one another to the end of the diffuser at a depth of 150 feet. Both pipelines would begin at approximately 1,800 feet offshore at a water depth of 31 feet (MLLW). The return seawater pipeline would run an additional 1,700 feet offshore (approximately 3,500 feet from the shoreline) and terminate in a 25-port diffuser extending between the depths of 120 and 150 feet.

To protect the pipes from the effects of large storm waves in the shallower reaches of the route down to about 150 feet, several options were evaluated, including trenching and burying, installing anchor piles, attaching additional gravity anchors (concrete collars) or a combination of these methods. Initial considerations indicated that trenching and burying the pipes from the breakout point to a depth of about 80 feet and then surface mounting the pipes with steel pipe piles driven through concrete collars in the depth range of 80 to 150 feet would provide the protection required. In subsequent evaluations, including analysis of effectiveness, logistics, costs, and environmental impacts, it became clear that excavating a trench on the order of 1,000 feet long and 20 feet wide, with gradually sloping sides to avoid slumping of sediments back into the trench, sidecasting and stockpiling the excavated material, and burying the pipes would affect a large area of the seafloor and could cause unacceptable turbidity in the water column. In addition, the necessity to mobilize the equipment to excavate the trench and then mobilize different equipment to drive piles would unnecessarily inflate construction costs. It was concluded that securing the pipes to the bottom using piles and collars would cost-effectively provide the necessary protection while minimizing environmental impacts.

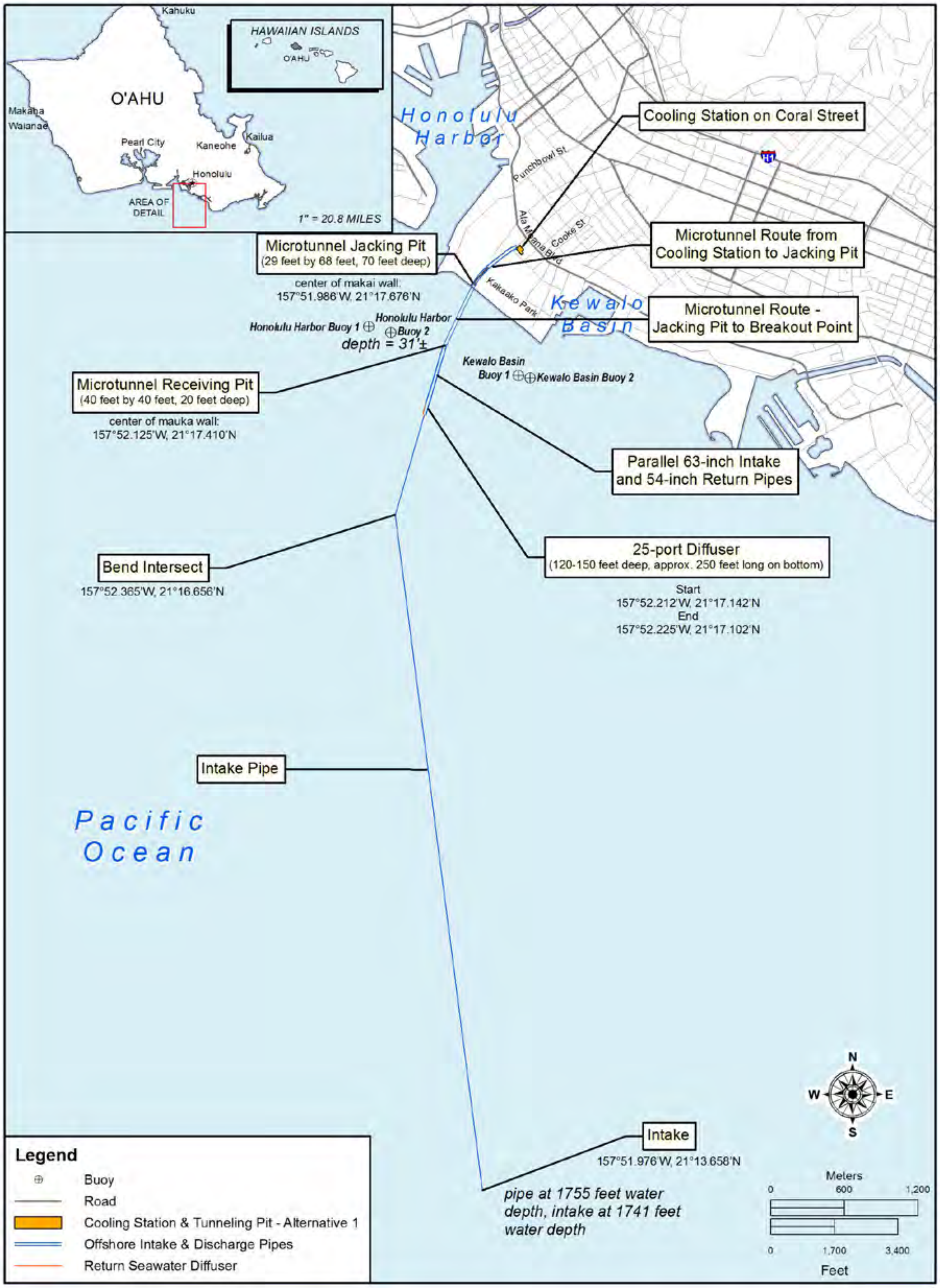

Figure 2-9: Alternative 1 – Cooling Station to Intake

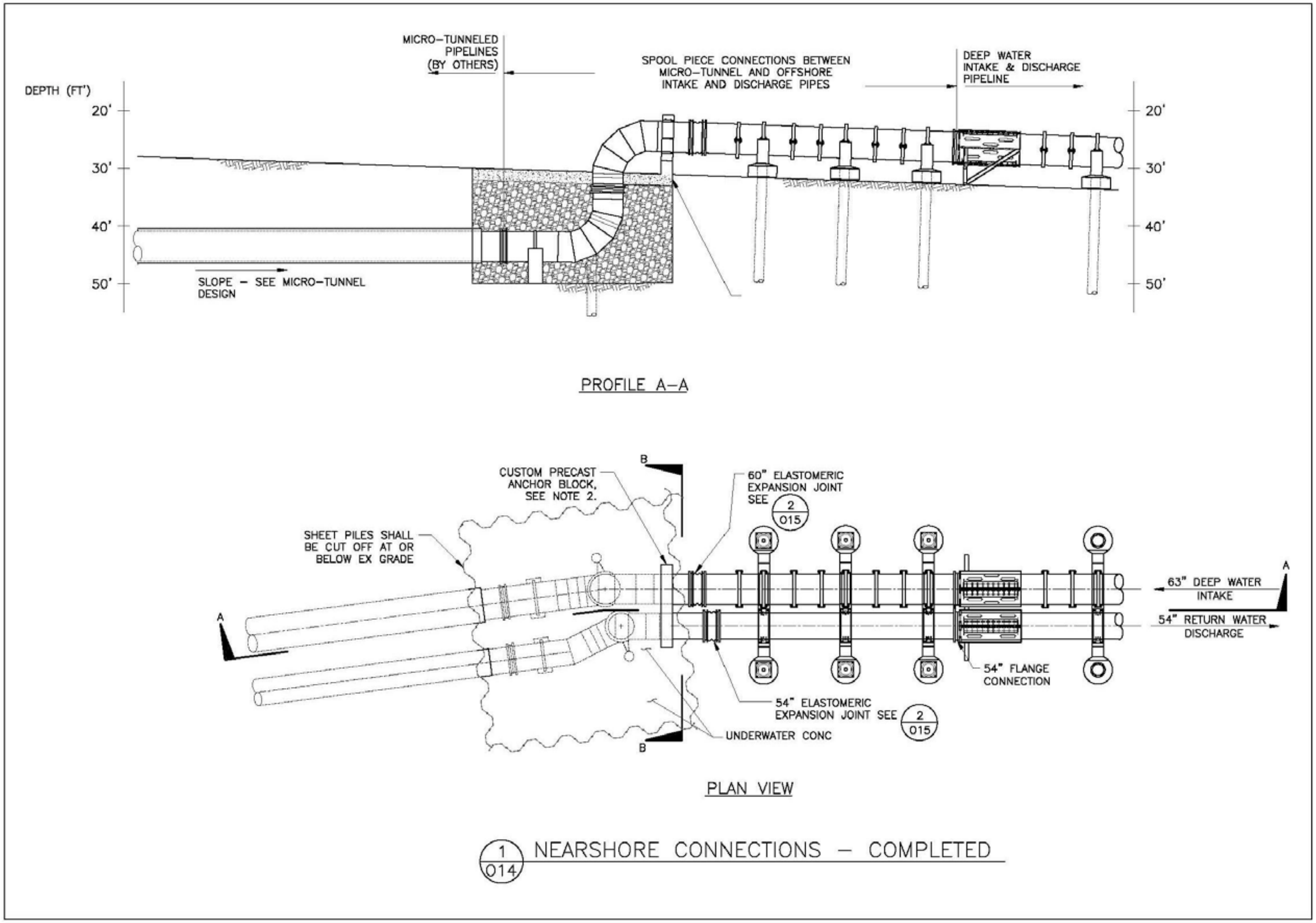

Figure 2-10: Details of Connection Between Microtunneled and Surface-mounted Segments of Seawater Pipes
(Source: Makai Ocean Engineering, Inc.)

Collars would be spaced along the entire length of the pipes. The pipes themselves would not rest on the bottom, but would be held above the bottom by the lower half of each collar. Spacing of the collars varies with depth. Shallower pipe sections need more weight to protect them from movement during high wave events and therefore collars are closer together in shallower water. Over the length of the pipes, the average separation between collars is about 30 feet.

The pipes would be fitted with concrete collars, or gravity anchors, of four types, depending on depth. From the breakout point to the end of the diffuser, combination collars (Type A; Figure 2-11), which would hold both pipes, would be used, and most of these would be further secured to the bottom with piles. Steel pipe piles 20 inches in diameter would be driven through sleeves in the collars using a percussion hammer. Sand from inside the pipe would be removed, probably with an airlift siphon system, to a level about six feet below the original seafloor. The amount excavated from each pile would be about 8.7 cubic feet. This material would be brought to the surface and stored in a hopper barge or large roll-off container. Excess seawater would be discharged from the top of the container when the sand has settled. The sand would be disposed of as clean fill at the county landfill or for another beneficial purpose. Tremie concrete would be used to fill and cap the piles. There would be a total of 91 of these “combination” weights, but only about 52 of them would have two piles driven through. Nine others would have one anchor pile, giving a total of 113 piles from the breakout point to the end of the diffuser. The total quantity of material to be excavated from the pipe piles would be about 983 cubic feet. Collars without piles (30) would serve only as gravity anchors.

As can be calculated from Figure 2-11, the footprint of the combination collars is about 76 square feet per collar. Thus, the 90 combination collars between the breakout point and the end of the diffuser would cover approximately 6,840 square feet of substratum.

The total area of substratum covered by all of the collars under Alternative 1, including those from the diffuser to the intake, would be 14,302 square feet. The collars would create new substratum of 153,978 square feet and the pipes would add 396,326 square feet for a total area of substratum created of 550,304 square feet and a net area of substratum created of 536,002 square feet.

Prior to installing the offshore pipes, a series of “test piles” (about 15) would be driven along the proposed alignment between the proposed locations of the receiving pit and the 150-foot depth. All of these piles would be removed immediately after installation. No pile driving would be done between December 1 and March 31 to avoid the peak humpback whale season in Hawai‘i.

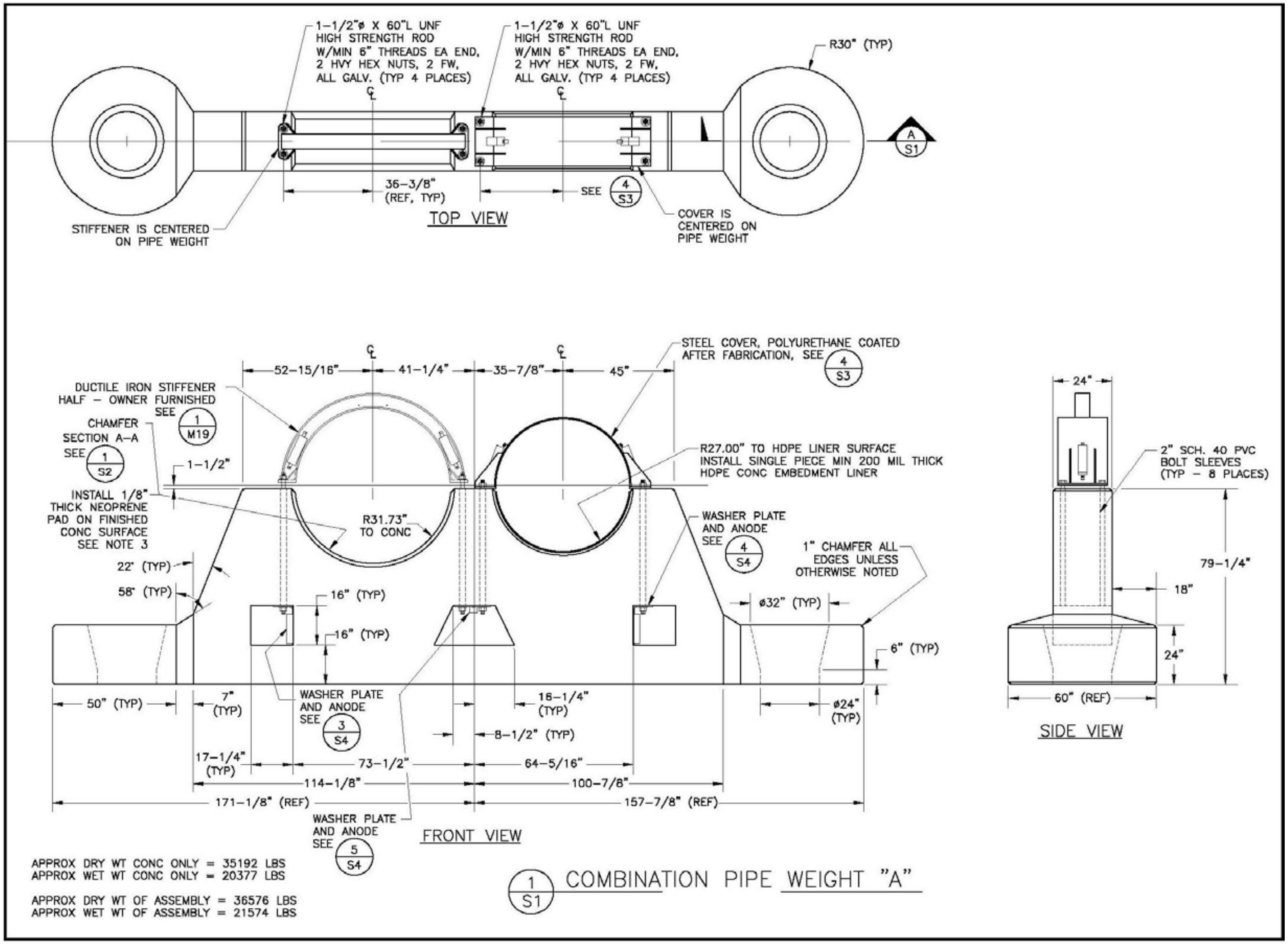

Figure 2-11: Shallow Water (Type A) Combination Collars
(Source: Makai Ocean Engineering, Inc.)

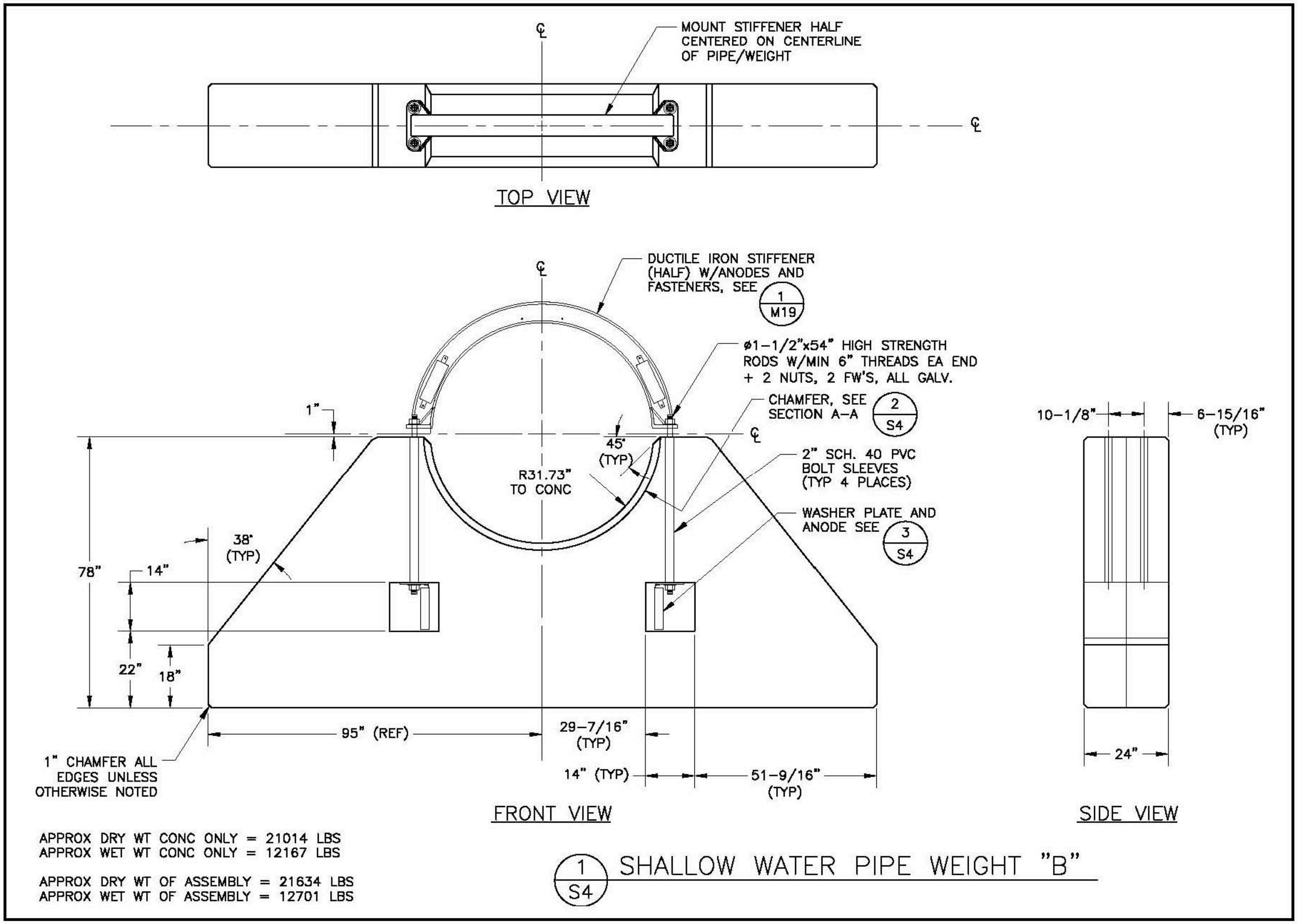

Figure 2-12: Shallow Water Single Pipe Collars (Type B)
(Source: Makai Ocean Engineering, Inc.)

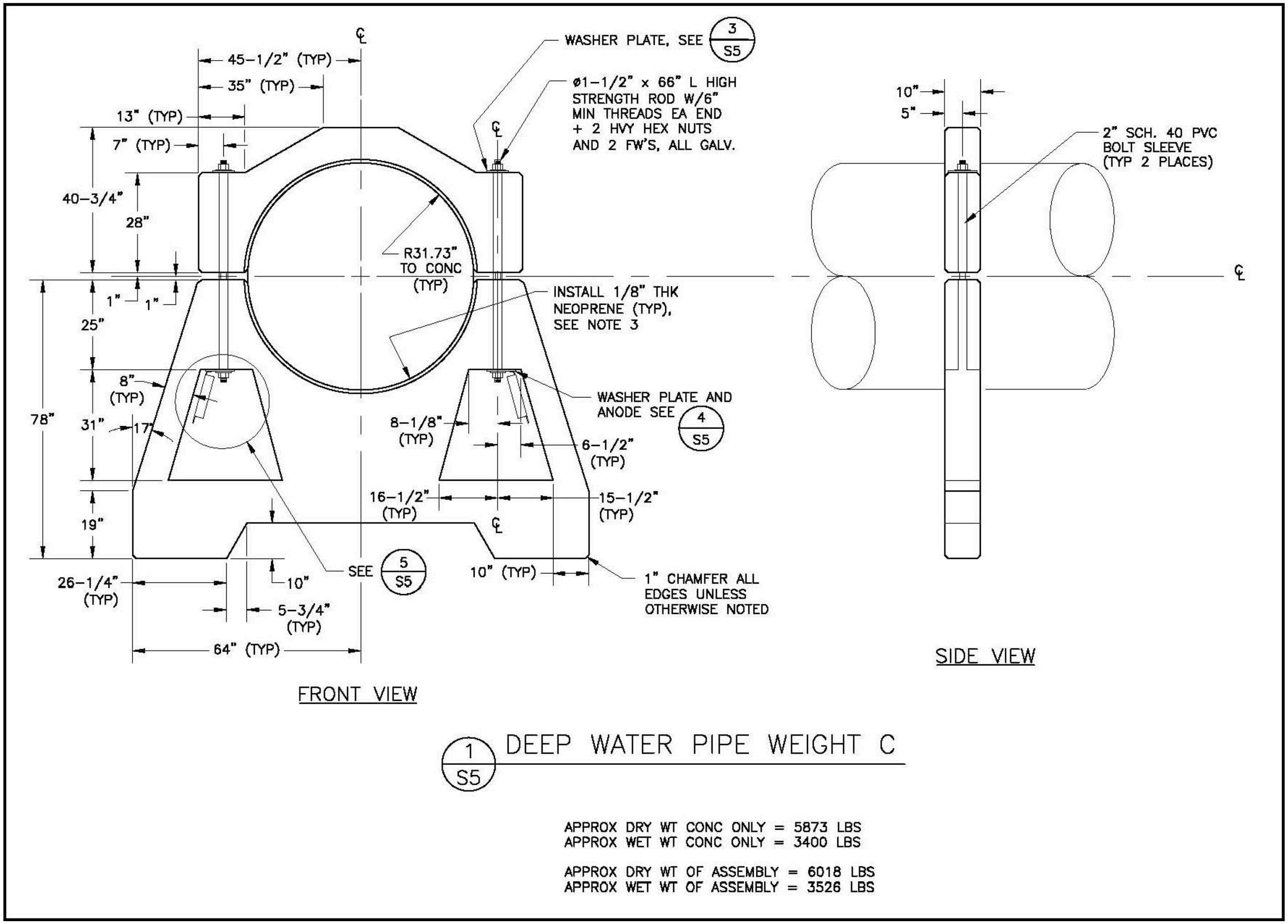

Figure 2-13: Deep Water Pipe Collars (Type C)
(Source: Makai Ocean Engineering, Inc.)

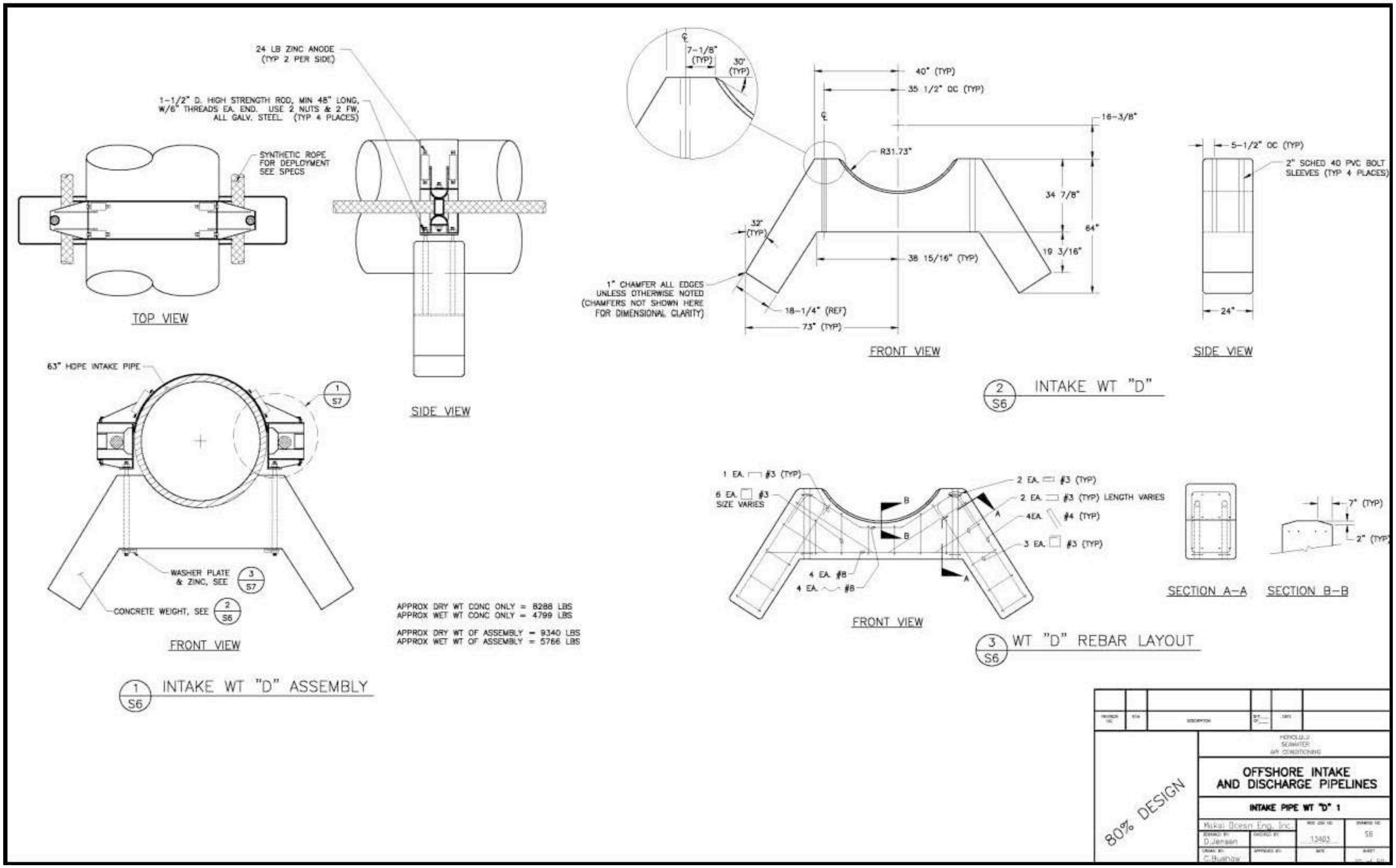

Figure 2-14: Deep Water Pipe Collars (Type D)
(Source: Makai Ocean Engineering, Inc.)

2.4.2.3 **Diffuser Design, Location and Depth**

The 54-inch diameter seawater return pipe would terminate in a 25-port diffuser (Figure 2-15) about 250 feet long extending between the depths of 120 and 150 feet.

2.4.2.4 **Diffuser Operation**

Discharging the return seawater through a diffuser situated at a depth of 120-150 feet (Alternative 1) was modeled to examine potential water quality effects. The return seawater, while warmed 9-14°F from its temperature at the intake location, would still be relatively low in temperature and dissolved oxygen content and high in dissolved macronutrient concentrations compared with coastal waters. A ZOM would be required to permit discharge of waters not complying with ambient water quality standards. To optimize the diffuser design and understand how the plume of returned seawater would behave, two computer models were used. The assumptions used in the modeling were:

- a 54-inch outside diameter HDPE return seawater pipe would extend from the microtunnel breakout point to a depth of 150 feet,
- the flow rate from the diffuser would be 44,000 gpm,
- the lowest return temperature (worst case) would be 53°F,
- the ambient temperature of the receiving water would be 77°F,
- the density of the return water would be 64.09 lb/ft^3 (1,026.6 kg/m^3) and that of the receiving water 63.88 lb/ft^3 (1,023.3 kg/m^3),
- the roughness factor of the bottom would be 0.05,
- the ambient wind speed would be 11mph (5m/s),
- a 25-port diffuser section would extend from a depth of 120 to 150 feet (a diffuser length of approximately 250 feet),
- the diffuser would be oriented parallel to the intake pipe (i.e., perpendicular to shore),
- the diffuser ports would be vertically facing and equally spaced (approximately 10.4 feet on centers),
- the diffuser ports would be basic orifices (rounded) in the pipe wall and 8 inches in diameter, and
- because the collars support the pipe, the discharge would originate about fourteen feet above the seafloor.

The first modeling effort used CORHYD[4] to optimize the diffuser design. It was determined that the flows through the diffuser as specified above would be quite well balanced; only about a 10% variation in flow rate would be experienced along the diffuser. The greatest port velocity, 11.7 feet per second (fps), would be at the port farthest from shore, and the smallest port velocity, 10.5 fps, would occur at the port nearest shore. The design of the diffuser is shown on Figure 2-15.

[4] The CORHYD computer program has been developed for the calculation of velocities, pressures, head losses and flow rates inside the diffuser pipe and, especially, at the diffuser port orifices to analyze and optimize diffuser design alternatives as well as existing diffuser configurations for different and varying discharge and ambient conditions.

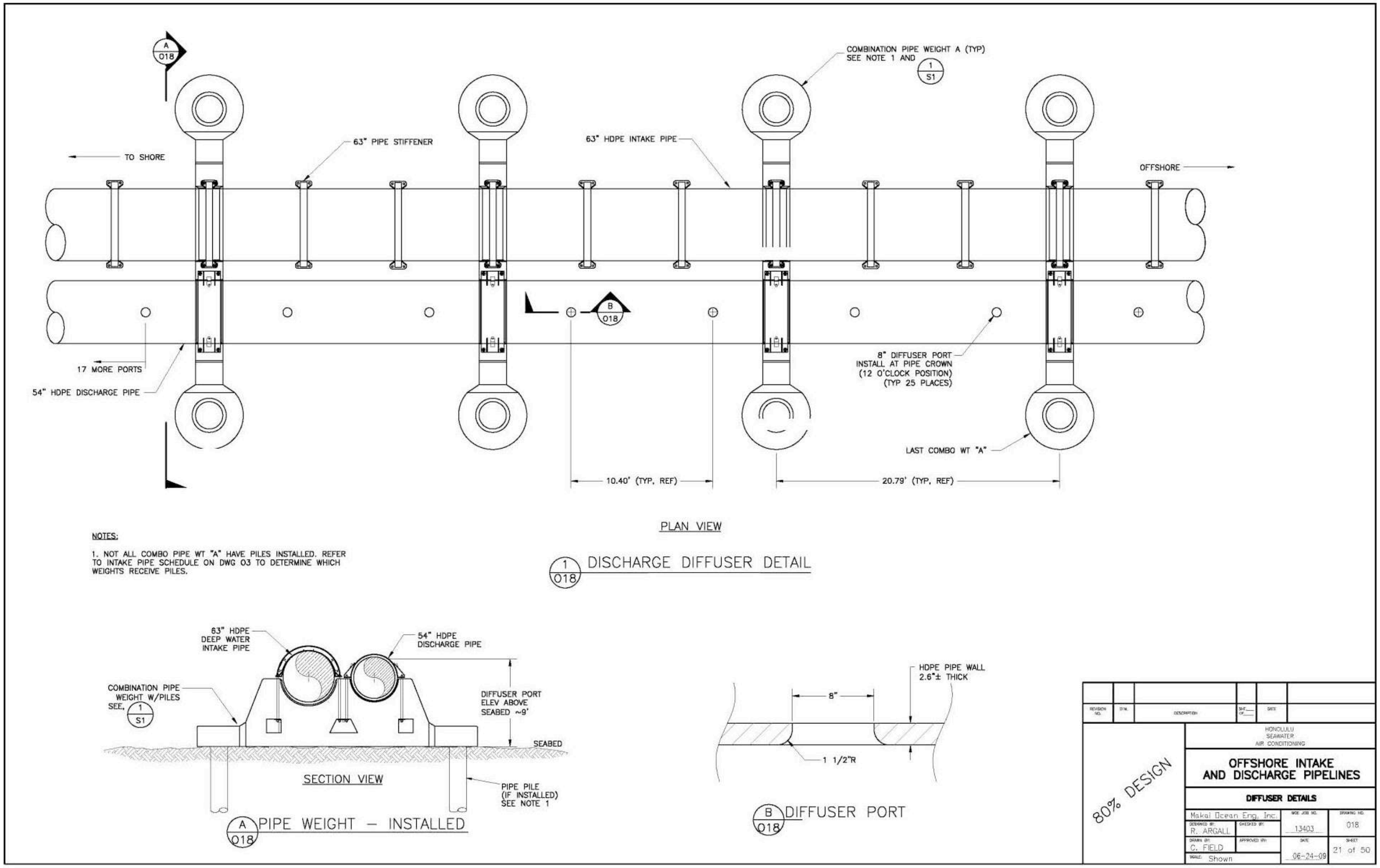

Figure 2-15: Diffuser Design
(Source: Makai Ocean Engineering, Inc.)

The differences between the ambient water quality at the Alternative 1 diffuser location and that of the return seawater were compared in light of the water quality standards in Hawai‘i Revised Statutes (HRS) Chapter 54 for wet open coastal waters to determine how much dilution would be required in the ZOM. The parameter that requires the greatest dilution is not temperature, which requires a dilution of only 13, but nitrate+nitrite nitrogen, which requires a dilution of 113.

The second modeling effort used CORMIX[5] to analyze the plume of return seawater from the discharge diffuser. Three different water current regimes were modeled: low current (0.16 fps [0.05 m/s]), mean current (0.46 fps [0.14 m/s]), and high current (2.0 fps [0.6 m/s]). Each scenario was run until the output reached steady state. The conclusions were as follows:

- The design of the diffuser facilitates substantial near-field initial mixing of the return water for all current cases considered.
- The negative buoyancy of the plume dominates the discharge near-field behavior. Surfacing of the plume (at a low dilution) is not anticipated; after initial mixing, the plume would have a tendency to sink.
- Some plume-seabed interaction is anticipated in the immediate vicinity of the diffuser, however, substantial initial dilution implies plume properties would be close to ambient when the plume encounters the seabed. Within a few meters from the centerline of the diffuser the dilution would be sufficient to meet water quality standards for temperature.
- Under low current conditions, port velocity of the diffuser would provide good initial mixing, but the weak ambient flow would allow considerable upstream intrusion of the plume. This is presumed to be acceptable, as the ZOM would not be directionally restricted. The required dilution of 113 for nitrate+nitrite nitrogen would be reached within 525 feet of the diffuser centerline.
- Under high current conditions, the initially mixed plume would be rapidly advected away from the diffuser, and the plume dispersed rapidly by the turbulent energy associated with the high flow. The required dilution of 113 would be achieved within 16 feet of the diffuser centerline.
- Under mean current conditions the required dilution would be reached within 285 feet of the diffuser centerline.

Discharge of the return seawater to deep coastal waters is therefore included as part of all action alternatives.

2.4.2.5 **Diffuser to Intake**

Beyond the end of the diffuser, the deep seawater intake pipeline would extend to a depth of 1,755 feet depth approximately 25,000 feet from shore. An elbow fitting would be installed at the end of the pipe such that the actual water intake would be at 14 feet above the bottom, or a depth of 1,741 feet.

Seaward of the diffuser, shallow-water single pipe collars would be used to support the intake pipe (Type B; Figure 2-12). From depths of 150 feet to 700 feet, 155 of these collars would be used. The footprint of each of these collars is about 31.7 square feet; hence, the total area covered by these collars would be about 4,960 square feet.

Beyond a depth of 700 feet, a third type of collar would be used (Type C; Figure 2-13). From a depth of 700 feet to 1,755 feet, 706 of these collars would be used. The footprint of these collars is about 3.6 square feet. The bottom area covered by these collars would be about 2,471 square feet.

Five special collars (Type D; Figure 2-14) would be used at the extreme terminal end of the pipe.

[5] CORMIX (Cornell Mixing Zone Expert System) is a USEPA-supported mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones resulting from continuous point source discharges.

HDPE pipelines are limited in maximum suction. Over time, pipelines can oval and eventually collapse if too high a suction pressure is applied. In order to increase the suction capability of this pipeline, ductile iron stiffeners would be added to the outside of the pipeline. Each stiffener would be coated and additionally protected with zinc anodes. Figure 2-16 illustrates similar stiffeners and anchor collars in place on a floating pipeline.

Figure 2-16: A 63-inch Pipeline with Ductile Iron Stiffeners and Anchor Collars
(Source: Makai Ocean Engineering, 2005a)

2.4.2.6 Staging and Assembly of Offshore HDPE Pipelines

HDPE pipes (intake and return) would be constructed on-shore from 40 to 80 feet long segments. A staging area of approximately 17.7 acres near the shore would be temporarily required to store pipe, concrete collars, and other components, and to fuse the pipe lengths into longer segments.

The pipe segments would be fused together into longer (~3,300-feet) segments, the ends sealed with blind flanges (so the segments float), and launched directly as fused. Concrete collars and stiffening rings would be added to the pipe from a barge while the pipe sections float in the staging area. These floating segments would be stored (moored) in the water pending completion of all segments. Final assembly of the pipe would be done by connecting the segments by lifting the ends slightly above the water, removing the blind flanges, and bolting the flanged ends together.

The applicant has submitted a proposal to the Land Division of the Hawai‘i Department of Land and Natural Resources (DLNR) for temporary (12 month) use of land on Sand Island and adjoining waters of Ke‘ehi Lagoon. These sites include:

- an on-land pipe storage and assembly site on the southwestern corner of Sand Island currently occupied by four condemned baseball fields,
- an offshore pipe assembly and preparation site which would occupy what was originally a seaplane runway that extends along the western shore of Sand Island, and
- an existing unimproved access roadway that runs from Sand Island Access Road around the Sand Island Wastewater Treatment Plant to the baseball park site.

The offshore pipe assembly area is labeled Channel D on Figure 2-37. It is suitable for pipeline assembly for several reasons:

- The area is long and, because there is no direct passage to the ocean, vessel traffic is minimal,
- There is sufficient room that the entire pipeline could be assembled from 5-8 sections,
- The deployment site may be accessed easily with a short towing distance,
- Assembly and towing out of the lagoon can be reasonably accomplished by the marine contractor,
- There is excellent access to the major center of marine construction equipment in the Hawaiian Islands, and
- There is adjacent land available on Sand Island for fusing and launching the pipe sections.

For these reasons, Ke‘ehi Lagoon Channel D and the adjacent shoreside area is the applicant’s preferred staging area in all four action alternatives. An aerial photo of the proposed staging sites identifying the primary features is shown on Figure 2-17.

Figure 2-17: Proposed Sand Island and Ke‘ehi Lagoon Staging Areas
(Source: Makai Ocean Engineering, Inc.)

The boundary of the site proposed for temporary HSWAC contractor use as an on-land pipe storage and assembly area is shown in Figure 2-18. This is an area of approximately 17.7 acres and it includes the entire baseball park area, the improved and unimproved roadways around the baseball park, the area between the park and the water and an almost 400’ long frontage on the water.

Figure 2-18: Boundaries of Proposed Sand Island Staging Area
(Source: Makai Ocean Engineering, Inc.)

The proposed offshore staging area consists of one portion of the Ke‘ehi Lagoon seaplane runway channels dredged between 1941 and 1944. The applicant has stated that seaplanes have not used the particular portion of the runway system that is proposed for use as an in-water staging area at any time in the last 30+ years. Other uses of this particular seaplane runway section have developed over the years. The area mainly serves as a practice area for outrigger and one man canoe paddlers as well as for some small sail boats. At the northern end there are several individual residences that have been built near the vertex of the coral shelf where this seaplane runway meets the Kalihi Channel. To accommodate the boat traffic to and from these residences, the in-water staging area would be set back from the western shoreline by about 200 feet and by at least 150 feet from the eastern shoreline. This would allow adequate space for small boats to easily access the small docks built in front of the residences on the western side of the channel. The overall in-water staging zone with approximate dimensions is shown in Figure 2-19. The area inside the yellow bordered zone equals about 49.9 acres.

Figure 2-19: Boundaries of Proposed Ke'ehi Lagoon Staging Area
(Source: Makai Ocean Engineering Inc.)

In order to access the proposed staging area with large trucks and other contractor equipment, the applicant is seeking permission to use an existing unimproved access roadway that runs from Sand Island Access Road around the Sand Island Wastewater Treatment Plant to the baseball park site.

This road has been used for contractor ingress and egress in the past, and the open space on either side of this road near the entry to Sand Island Access Road is currently used by a microtunneling contractor, Frank Coluccio Construction Company (FCC). FCC has stockpiled pipe and unused equipment on either side of this road over about the first 500 feet of the roadway closest to Sand Island Access Road. Figure 2-20 shows the approximate zones where FCC equipment is stored and that the overall length of this access road is about 1,576 feet. An approximately 20-ft wide roadway would be needed by the HSWAC contractor to provide adequate room for large trucks and equipment to pass safely from the park to Sand Island Access Road.

Figure 2-20: Access Road Requested from Sand Island Access Road to Staging Area
(Source: Makai Ocean Engineering, Inc.)

The marine contractor who is hired to carry out the assembly and installation of the marine pipelines would determine the exact use of the proposed staging site. However, from past deep water pipeline projects of a similar nature, it is possible to define and describe the range of activities that would take place on land and in the adjacent waterway. These activities, in roughly chronological order, are summarized as follows:

1. 63” and 54” HDPE pipe in 40-80-foot lengths would be stored on the baseball field areas where the ground is flat and has been previously graded. Pipe would most likely be trucked in from one of the commercial piers in Honolulu Harbor. The access road shown in Figure 2-20 would be used for truck traffic to and from the staging site. Pipe would be stored in tightly spaced rows taking up much of the open baseball park surface. Figure 2-21 shows a similar pipe being unloaded and stored.

Figure 2-21: Large Diameter HDPE Pipe Being Unloaded and Stored at Kawaihae Harbor
(Source: Makai Ocean Engineering, Inc.)

2. The contractor would set up a mobile office trailer on the site to use as his base for construction operations.
3. Various containers of tools and equipment needed to carry out the work would be brought to the site.
4. The contractor would have to widen the existing passages in the dredge spoils that separate the baseball park from the shoreline in order to allow pipe transport to the water from the park with a front end loader and/or bulldozer. This would probably involve movement of less than 50 cubic yards of material as passages already exist between the mounds down to the water (see Figure 2-22).

Figure 2-22: Proposed Truck Circulation Routes Within Staging Area
(Source: Makai Ocean Engineering, Inc.)

5. An area between the shoreline and the spoil mounds would be cleared of old concrete piles and debris, and an HDPE fusion machine together with pipe support rollers would be set up in this area. The fusion machine would be used to join the HDPE pipe sections into continuous lengths. Figure 2-23 and Figure 2-24, respectively, show pictures of a fusion machine set up to fuse 63-inch diameter pipe for another deep water pipeline project and the roller bed that is set in place to guide the air filled pipe into the water. The air-filled pipe with ends closed by flange plates would float very high in the water.

Figure 2-23: HDPE Pipe Fusion Operation
(Source: Makai Ocean Engineering, Inc.)

Figure 2-24: Roller Bed to Launch HDPE Pipe into Water
(Source: Makai Ocean Engineering, Inc.)

6. HDPE pipe would be transported from the baseball field down to the fusion machine. Pipe would be fused into lengths up to approximately 3,300 feet long and pulled out onto the waterway as they are fused. The exact length of fused segments would be a function of the contractor's plan and lengths permitted by State DOT authorities.
7. Floating sections of pipe would be temporarily moored in the seaplane runway. Moorings would be formed using steel pipe piles temporarily driven into the bottom (to a depth not exceeding 20 feet). Piles would be removed after the pipelines are pulled from the lagoon for installation offshore. Traffic by public boaters would have to be restricted on this waterway during pipe assembly operations (see Figure 2-25).

Figure 2-25: Stored Floating Pipeline with Stiffeners and Anchor Weights Being Attached
(Source: Makai Ocean Engineering, Inc.)

8. Assembled pipe segments would be hydrostatically tested while floating on the waterway. This would be done before pipe ballast weights are clamped onto the pipe segments, so pipe segments would continue to float even when filled with water.
9. Using a crane barge, pipe ballast weights and stiffeners would be mounted on the pipe while it is stored in the waterway. Precast concrete collars would either be loaded on barges and towed in from Barber's Point Harbor, or trucked in and loaded onto barges from a crane at the site. To mount the pipe weights and stiffeners onto the pipes, the lower halves of pipe weights and stiffeners would be lowered into the water and then lifted up from below the pipe. The top half then would be lowered down from above and the pieces bolted together. This work would be done from a crane barge with an elevator assembly mounted on one side. The air filled pipe can support all the weights and stiffeners when floating on the waterway.
10. Weights and stiffener bolts would be re-tightened several times before deployment. This would be accomplished from a small boat or by walking down the length of the floating pipe segments.
11. Other pipe attachments and end flange preparations would be installed while the pipelines are floating in the waterway. Several crane barges, flat barges and work boats would be moored in the waterway during staging operations, especially as final preparations commence.
12. The final task before deployment would be assembly of the floating pipe segments into one continuous length. A representation of this process is shown in Figure 2-26. This would occupy a continuous period of 36-48 hours and would involve mooring a barge on one side of the Kalihi Channel and pulling the pipe segments into a large arc in order to join the flange joints at this barge (see Figure 2-27). Multiple barges and work boats would be used to hold the pipe in the bent shape and to restrain the offshore pipe that would lengthen as each new segment is joined. The offshore end of the pipeline would extend out the channel into the open ocean (see Figure 2-28).

Figure 2-26: Plan for Connecting Pipe Segments and Towing From Ke'ehi Lagoon
(Source: Makai Ocean Engineering, Inc.)

Two weeks prior to initiation of the deployment activities, notices of the operations would be given to the harbormasters to post or distribute, and a Notice to Mariners published. During the deployment, contractor supplied escort (picket) boats would be on site throughout the pipe joining and towing operations to divert boaters who are curious or are entering or leaving the harbor via the Kalihi Channel. Escort boats would have a large sign notifying boaters to tune to VHF channel 72 or 16 for instructions. Escort boats would guide boaters safely around the marine operations.

Figure 2-27: Assembling Flange Joints on Elevator Platform on Crane Barge
(Source: Makai Ocean Engineering, Inc.)

Figure 2-28: Fully Assembled NELHA 55-inch Pipe Being Towed From Kawaihae Harbor
(Source: Makai Ocean Engineering, Inc.)

2.4.2.7 **Installation of Offshore HDPE Pipelines**

The deployment methodology for the offshore portions of the HDPE pipeline has been developed and tested in previous projects and is specific to the nature of the HDPE pipe and available handling equipment. All but a small length of the intake and return seawater pipes seaward of the breakout point (the spool sections connecting them to the microtunneled segments) would be deployed using the following methodology.

Deployment of the pipes would be done once all the segments are assembled. The pipelines, with weights and stiffeners attached, would be towed into place, the nearshore ends temporarily secured to allow the pipelines to be put under tension, and the pipelines sunk in a controlled manner from shallow to deep water by controlled flooding. At least three tugs would be used to maneuver the pipelines to their final position. As the pipelines would be deployed off the south side of O‘ahu, deployment would ideally be scheduled during the winter or early spring, when large southern swells are absent. The pipes would be pulled into place in a single day and sunk at night to take advantage of the HDPE pipe’s superior strength properties when it is cool and not exposed to the sun.

The deployment process is illustrated in Figure 2-29. The air-filled and anchor-weighted HDPE pipelines would be floated on the surface of the ocean and controllably submerged by flooding from the shore end and venting air on the offshore end. At all times, the pipeline configuration would be in equilibrium with the air-filled portion supporting the flooded section. To avoid kinking the pipelines at the two bends, the seaward ends would be pulled (90 to 100 tons tension) by a tug boat during deployment, while the landward ends would be held in place by attachment to holdbacks (i.e., anchors or piles driven closer to shore) (Figure 2-30). The positions of these holdbacks would be along predetermined angles from the pipe ends, and at least 100 feet shoreward of the pipe ends. The precise location of the holdbacks would be adjusted to avoid corals or other protected biota. A remotely operated vehicle (ROV) would be used to monitor the deployment.

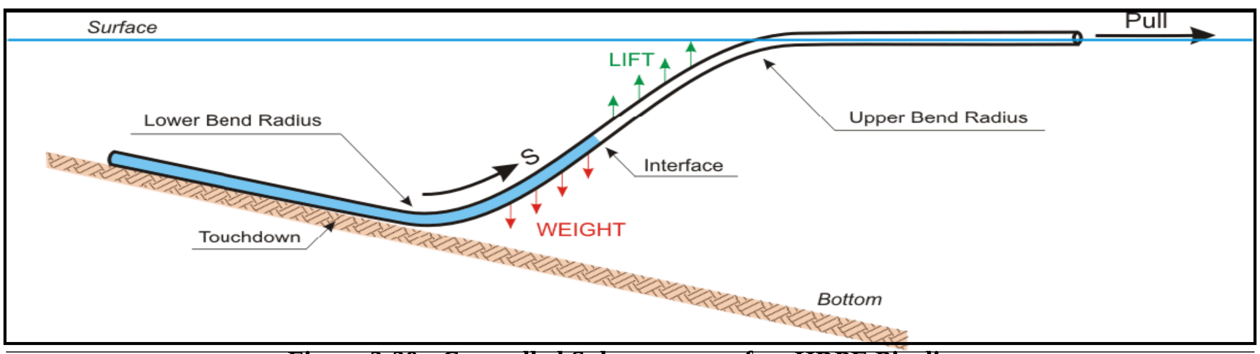

Figure 2-29: Controlled Submergence of an HDPE Pipeline
(Source: Makai Ocean Engineering, 2005a)

The size of the intake pipe (length and diameter) would require a total flooding time of approximately eight hours to completely fill the pipe at a deployment flow rate of 5,000 gpm. At least another eight hours would be required for contingency delays and lowering the end of the pipe. Once the pipeline is completely flooded, the blind flange would be removed from the seaward end of the pipeline and the end would be lowered to the seafloor at the full intake depth. The ROV would inspect the location and condition of the pipeline prior to release of the lowering cable.

The nearshore ends of the pipelines would be close to but not connected to the end of the microtunneled segment of the route. A spool piece would be prepared to fill the gap and flange bolted in place by divers.

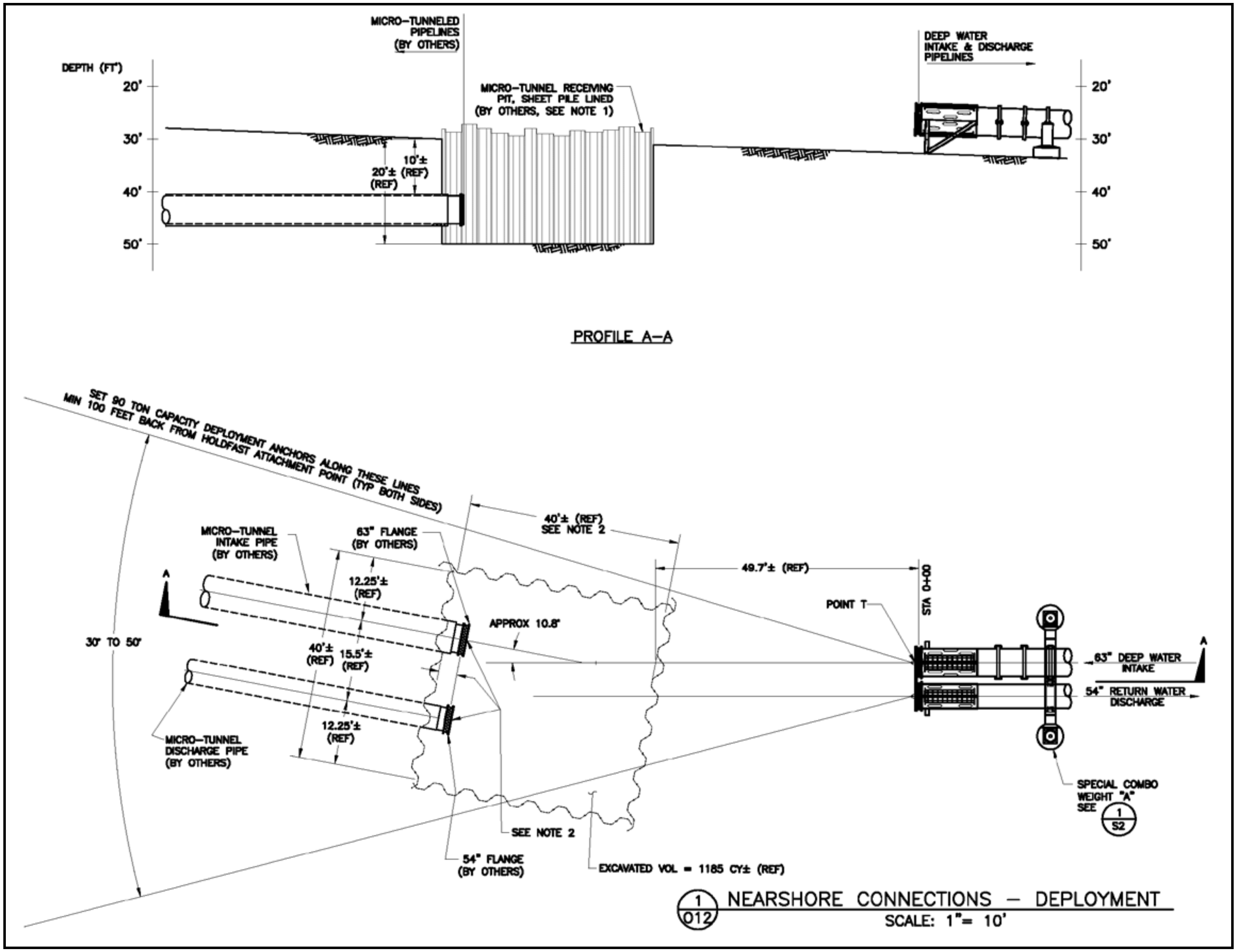

Figure 2-30: Nearshore Holdbacks during Deployment

Once the pipelines are in place, their location would be added to the appropriate nautical charts of the area. Large ocean-going vessels would be prohibited from anchoring on the pipelines, but there would be no restrictions on recreational uses of overlying waters. Small boat anchors would not harm the pipelines.

2.4.2.8 **Operation of Seawater System**

The cold seawater from the intake pipe would pass through the cooling station and, in the heat exchangers, receive heat from the fresh water distribution loop. The seawater, warmed 9-14°F from its original temperature but still cooler than the receiving water, would be returned to the ocean through a diffuser. A description of the modeling that was done to optimize the design of the diffuser and the characteristics of the resultant return seawater plume are provided in Section 2.4.2.4. A negatively buoyant plume would be formed at the discharge depth. The maximum flow rate through the intake pipe would be 44,000 gpm. The average temperature of the intake water would be approximately 44°F. The return mass would equal the intake mass in this open loop system. (Insignificant changes in volume would occur as a result of differences in water density at different temperatures and pressures.) The temperature of the return seawater would be approximately 58°F at peak demand, but this would vary with system demand, customer installations, and distribution pipe insulation.

2.4.2.9 **Repair of Pipelines**

The applicant anticipates that the economical service life of the pipelines is minimally 25 years. By incorporating appropriate safety factors into the pipe design, installing pipe stiffeners, and by maintaining operating flow rates (pressure losses) below design guidelines, the useful service life of these pipes is expected to be in excess of 75 years. HDPE pipe is used in marine applications due to its strength, ruggedness, ductility, abrasion resistance, impact resistance, corrosion resistance and biofouling resistance. These qualities make it possible to install a marine HDPE pipe by the controlled submergence process described above. During this installation process the pipe would experience combined pressurization, tensioning and bending that would constitute the most extreme loads the pipe would see at any time during its entire service life. Therefore, if the pipe survives the deployment process, the chance of pipe failure while in service is very low.

While the loads on the pipe are very low during operation, as an exposed submarine pipeline there is always the chance that a large vessel anchor could make contact with the pipeline and cause damage. Also the manufactured fittings in shallow water that are used to make the final connection between the offshore pipe and the tunnel shore crossing pipes are generally more susceptible to damage due to the large miter bends involved in their fabrication. In general, both of these types of damage are repairable and the repair process for each is discussed below.

<u>Anchor Damage:</u> According to the applicant's engineers, small vessel anchors generally do not have the weight nor does the vessel have the power to damage the pipeline. A large anchor (from a freighter or large Navy vessel – destroyer or larger) contacting the pipeline would not necessarily damage it, but the types of damage it could do include puncture damage or point load damage (crimping or over bending) from catching on the pipe and then dragging it to one side. The chance of such damage causing the pipe to part is extremely small, as the force needed to shear the very heavy wall HDPE pipe is beyond the capacity of most ships. If the pipe were damaged, steps involved in the repair would include:

1. *Inspection:* If the damage were at diver depth (depth of 150 feet or less), a diver would be used to survey the damaged portion of the pipe and provide photographic or video documentation. If the damage were deeper than diver depth, a remotely operated vehicle (ROV) would provide the same inspection service. Locally operated ROV's are available for work down to 300 feet deep (it is unlikely that anchor damage would occur deeper than that) or an inspection class ROV could be air freighted in from the West Coast on short notice.
2. *Puncture Damage:* If some form of cut or puncture occurred in the pipe wall from a sharp high force contact with an anchor, the repair would generally involve installation of a repair

coupling. Several major mainland manufacturers fabricate large repair couplings and could be special ordered for delivery within a week or two. While the coupling is on order, it may be possible to temporarily plug the damaged area by winding sheet metal and/or neoprene around the damage and tensioning it with wide polyester slings. Thus, the intake pipeline could continue to be pumped until the proper repair parts are brought in.

3. *Point Load Damage:* If the pipe were dragged to one side with a very large point load, this could cause the pipe to crimp or buckle locally. Such damage would require inspection as discussed above. In all likelihood the repair would involve correcting any remaining misalignment of the pipe and then reinforcing the damaged portion of the pipe to allow full design flows through the pipe once again. Correcting the misalignment would be accomplished by installation of slings (diver depth) or use of a specially designed grapnel to make an attachment to the pipe and pull it back to its original alignment. An ROV or diver would help guide this process. This would only be done if it were essential to repair the damaged portion of the pipe. Once the pipe was realigned, the damaged portion of the pipe could be reinforced with external stiffeners bolted onto the outside of the pipe. These would be the same type of stiffeners that are applied to the pipe to allow greater long term suction loads to be applied. During the repair process, intake water flows may have to be reduced, but would probably not have to be shut down altogether.
4. *Installation of Repair Hardware:* If the repair is deeper than divers can work while breathing compressed air, it is likely that diving operations on mixed gases (helium-oxygen) would be needed to complete the final repairs. Divers and equipment from the West Coast may have to be flown in if local dive contractors cannot work at such depths. If the repairs are done in shallower waters local divers can be used to install the repair coupling or the stiffener rings as needed. Dive times for installation of either type of hardware would be relatively short as the pipeline is held off the bottom by its pipe collars, so full access to all sides of the pipeline would be possible.
5. *Environmental Interaction:* Neither of the above types of repairs would involve significant environmental impacts. There would be some contact made with the seafloor by divers, their tools and repair parts, and there may be some dragging of pipe collars along the bottom, but this would produce little in the way of sediment plumes as the collars would slide or be lifted across the bottom. As mentioned above, these repairs could probably be conducted while the intake pipeline continues to operate, perhaps at somewhat reduced flows.
6. *Time Required:* The time required to achieve the above described repairs would probably be a week or so for initial inspection and temporary patch, then two months to allow parts to be flown in, exact work scope defined, contractors hired, and work performed. Actual time on the water to perform these repairs would be a week or less.

<u>Miter Fitting Damage:</u> During the 2006 earthquakes that occurred in waters off the Big Island, two of the NELH HDPE pipelines (40-inch and 18-inch) experienced miter elbow damage in shallow nearshore waters. In both cases the damage was repaired by simple replacement of the flanged mitered joint with a replacement unit of the same dimensions. Replacement was accomplished by divers breathing compressed air.

1. *Mitered Fitting Improvements:* The HSWAC pipelines would have no mitered fittings at depths deeper than diver depths. The mitered fitting damage on the NELH pipelines occurred on pipelines that were installed over 20 years ago. Since that time the HDPE industry has developed new standards for mitered fittings that require heavier wall pipe segments and improved manufacturing and testing techniques to be used. This makes it less likely that such damage would occur on the HSWAC pipelines. As evidence of this, the 55-inch NELH intake pipeline installed in 2001 also uses shallow offshore mitered fittings, and none of these were damaged by the earthquake. These fittings were fabricated in accordance with the new standards.

2. *Repair of Miter Fittings:* If damage to a mitered fitting did occur, this would be repaired by divers using primarily hand tools, pneumatic tools, underwater lift bags and perhaps a winch or crane off a barge or workboat. The replacement of a fitting would have to be carefully planned to minimize the pipeline's operational downtime. As with puncture damage discussed above, it is very likely that some form of temporary patch could be applied to the pipe until the replacement fitting is manufactured and brought in. This was done on the NELH 40-inch pipe, which continued to operate except during the actual fitting replacement operation. There would be very little disturbance of the seafloor during this operation with the exception of some contact made with the seafloor by divers, their tools and repair parts.
3. *Time Required:* The time required to achieve the mitered fitting repairs would probably be a week or so for an initial inspection and temporary patch, then two months to allow parts to be flow in, exact work scope defined, contractors hired, and work performed. Actual time on the water to perform these repairs would be a week or less.

2.4.2.10 **Cooling Station**

The seawater circulation system and the fresh water distribution system would come together in a cooling station where the heat exchangers, seawater and fresh water pumps, and auxiliary chillers would be housed. The HSWAC feasibility criteria require an adequately-sized site for a cooling station that is within close proximity to a source of cool water and to the potential customer buildings. For the HSWAC system, a site of approximately 25,000 square feet with adequate utilities service in the makai portion of Kaka‘ako satisfies these criteria.

The applicant's preferred location for the cooling station is on a parcel owned by The Estate of Bernice Pauahi Bishop (Kamehameha Schools) adjacent to and makai of the 677 Ala Moana Building (former the Gold Bond Building). The tax map key (TMK) is 2-1-059:027 ("lot D1"). The parcel is bounded by Keawe Street, Ilalo Street, and Coral Street, and encompasses an area of 29,766 square feet. Most of the site is paved concrete currently utilized for parking; there are no existing buildings. The cooling station footprint is approximately 21,000 square feet.

2.4.2.11 **Chilled Water Distribution System**

A system of pipes would be installed beneath the streets of downtown Honolulu to provide chilled fresh water to customer buildings. Depending on the specific locations of HSWAC's customers, the total length of the distribution system may vary from approximately 16,000 to 19,000 linear feet. Distribution pipes would be larger in diameter closer to the cooling station and smaller at greater distances. Pipe sizes would vary between 6 inches and 42 inches ID, with a length-weighted average of about 26 inches. These pipes and fittings would be primarily HDPE or insulated fiberglass. The total volume of fresh water in the distribution system would be close to one million gallons. The optimum routing of the distribution system would be determined when major customer buildings are identified.

2.4.3 **Alternative 2**

The route for Alternative 2 is shown on Figure 2-31. Under Alternative 2, the route would bend at the receiving pit and proceed to a diffuser location approximately 1,500 feet east of the Alternative 1 diffuser location. The initial portion of the route is aligned in a more easterly direction than Alternative 1 and the receiving pit would be off the eastern portion of Kaka‘ako Waterfront Park rather than the western portion as under Alternative 1. Construction activities under Alternative 1 would be closer to the Honolulu Harbor entrance channel, whereas under Alternative 2 they would be closer to the Kewalo Basin entrance channel. Each alternative route would proceed from the diffuser to an offshore bend and then to an identical intake location. Because of the longer distance from the breakout point to the diffuser, Alternative 2 would require more Type A combination collars to hold both the intake and return pipes than Alternative 1. Alternative 2 would require 202 Type A collars, which would cover 15,352 square feet of substratum, more than double that covered under Alternative 1. From the diffuser seaward, fewer collars would be required under Alternative 2 due to the shorter distance to the intake location; however, the total area of substratum covered by the collars would be 21,551 square feet, about 50% more than under Alternative 1. The total area of substratum created by the collars and pipes under Alternative 2 would be 594,728 square feet and the net gain would be 573,176 square feet.

2.4.3.1 **Seawater Circulation System**

Under Alternative 2 the cooling station would be sited on Pier 1, which sits on filled land. The total microtunnel drive length from the cooling station to the breakout point would be greatly reduced from Alternative 1. The jacking pit between Kaka‘ako Waterfront Park and the drainage canal ‘Ewa of the park that would be required under Alternative 1 would not be required under Alternative 2. The microtunneled shafts would extend directly from the cooling station to the breakout point. The breakout point for Alternative 2 would be in about 35 feet of water east of the breakout location for Alternative 1. This route would avoid the alluvial channel exiting Honolulu Harbor and the known mounds of dredged materials slightly east of that channel. Seaward of the breakout point, the seawater intake and return pipes would be installed as under Alternative 1. Beyond the diffuser, the intake pipe would continue seaward and terminate at the same location as under Alternative 1.

2.4.3.2 **Cooling Station**

The cooling station would be constructed on Pier 1 of Honolulu Harbor, where an existing warehouse would be partially or completely demolished. Current (temporary) uses of the warehouse include (1) Reuse Hawai‘i - This organization accepts material from demolished buildings and makes them available for reuse in new construction or remodel projects; and (2) Next Step Homeless Shelter at Kaka‘ako. The site is controlled by the Hawai‘i Community Development Authority (HCDA) and had been considered by the Office of Hawaiian Affairs (OHA) as a potential site for their headquarters. The applicant considered utilizing approximately 33,000 square feet of the 5.266 acre site to build a 25,000 square feet facility. The applicant proposed to OHA a cooperative development of the site, but agreement could not be reached.

Additional challenges to development of this site for the cooling station and primary reasons why the site was not preferred for development of the cooling station include: (1) crossing beneath a 72-inch forced sewer main to access the site from the ocean, (2) existing tenancy in the warehouse, and (3) the site is located within the tsunami inundation zone. The presence of the sewer main adjacent to the parcel was a concern to both the applicant and City officials. There would be a risk to the sewer main from vibrations associated with sheet pile driving and tunneling.

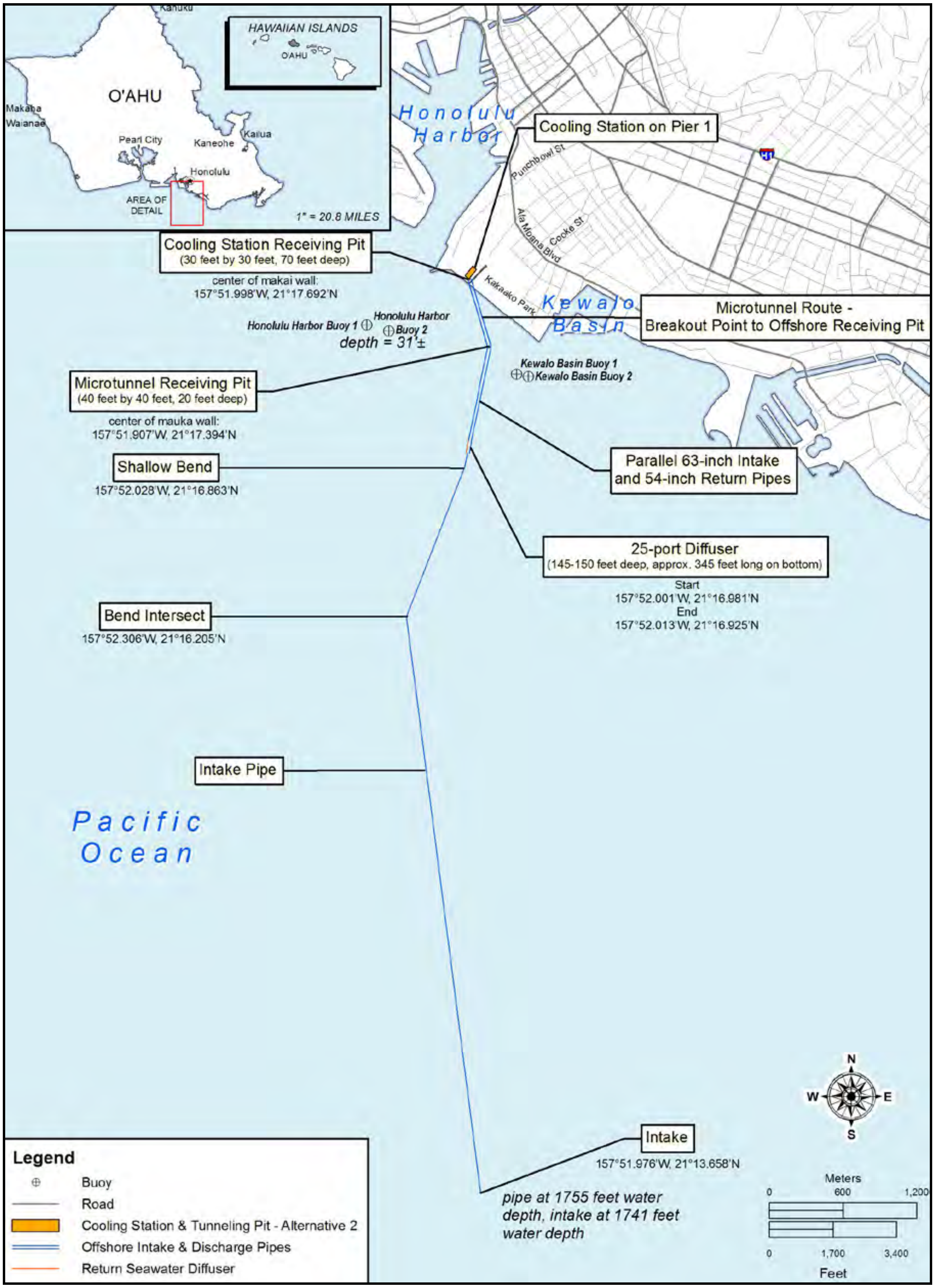

Figure 2-31: Alternative 2 – Cooling Station to Intake

2.4.3.3 Chilled Water Distribution System

Because the cooling station would be on the ‘Ewa side of the drainage canal, the initial segment of the distribution route would be routed under Forrest Avenue rather than under Keawe Street. With the cooling station closer to the ocean, the total trenchless distance to a receiving pit mauka of Ala Moana Boulevard would exceed the maximum run distance. Either open trenching or microtunneling could be employed to install the chilled water distribution piping to a point just makai of Ala Moana Boulevard. In either case, there would have to be a receiving and/or jacking pit at that location. A trenchless segment would, as in Alternative 1, pass beneath Ala Moana Boulevard and terminate mauka of Auahi Street. Instead of proceeding up Keawe Street, the route would use South Street to access Pohukaina Street. From Pohukaina Street the distribution system route would remain the same as under Alternative 1. Under this alternative there would be two sewer mains to cross with the above noted vibration risks.

2.4.4 Alternative 3

Alternative 3 was added in response to comments received from USEPA and USFWS on the DEIS. The intent of Alternative 3 is to offer a deeper discharge location for the return seawater. Most aspects of Alternative 3 are identical to Alternative 1, including the location of the cooling station, jacking pit and receiving pits, seawater pipe route, distribution system pipe route, staging area, assembly and installation, and system operation. The difference is that under Alternative 3 the return seawater pipe is longer and terminates in a 25-port diffuser between the depths of 276 and 300 feet. The route for Alternative 3 is shown on Figure 2-32. Compared to Alternative 1, the additional length of return seawater pipe needed to reach a terminal depth of 300 feet would be about 1,574 feet.

Extending the return seawater pipe from 150 feet to 300 feet deep would require substitution of combination collars (Type A) for the shallow water (Type B) collars that would be used to support the single intake pipe in this depth range. Under Alternative 3 there would be a total of 111 additional combination weights, but none of these would have piles driven through. Below the 150-foot depth, collars would serve only as gravity anchors.

The total area of substratum covered under Alternative 3 would be slightly less (18,790 square feet) than under Alternative 2 (21,551 square feet), but more than that covered by Alternative 1 (14,302 square feet). However, the greater number of Type A collars compared to Alternative 1 would result in a larger area of new concrete substratum (167,442 square feet compared to 153,978 square feet). Alternative 3 would create 416,701 square feet of new HDPE substratum, 584,143 square feet of new HDPE and concrete substratum, and 565,354 square feet net area of new substratum. These areas are all greater than the corresponding areas that would be created by Alternatives 1 or 2.

The intake location would be the same under all action alternatives.

2.4.5 Alternative 4: The Applicant’s Preferred Alternative

Alternative 4 was developed in response to Federal resource agency concerns regarding the potential effects of seawater return flows on water quality and corals. Most aspects of Alternative 4 are identical to Alternative 1, including the location of the cooling station, jacking pit and receiving pits, seawater pipe route, distribution system pipe route, staging area, assembly and installation, staging area, and system operation. This alternative would place the discharge in relatively cold and high nutrient waters near the top of the thermocline. As can be seen on Figure 2-33, the proposed pipe route seaward of the diffuser location for Alternative 3 descends steeply down the head of an alluvial channel that begins at a depth of about 320 feet and extends to about 600 feet. The Alternative 4 diffuser would be placed on that slope. The route for Alternative 4 is shown on Figure 2-34. Under Alternative 4 the return seawater pipe would terminate in a 25-port diffuser between the depths of 326 and 423 feet. Compared to Alternative 1, the additional length of return seawater pipe needed to reach a terminal depth of 423 feet would be about 1,909 feet.

Extending the return seawater pipe from 150 feet to 423 feet deep would require substitution of combination collars (Type A) for the shallow water (Type B) collars that would be used to support the single intake pipe in this depth range. Under Alternative 4 there would be a total of 119 additional combination weights compared to Alternative 1, but none of these would have piles driven through. Below the 150-foot depth, collars would serve only as gravity anchors.

The total area of substratum covered under Alternative 4 would be slightly less (19,364 square feet) than under Alternative 2 (21,551 square feet), but more than that covered by either Alternative 1 or Alternative 3. However, the greater number of Type A collars compared to the other alternatives would result in the largest amount of concrete substratum created.

The length of the return seawater pipe under Alternative 4 would be the greatest of the action alternatives, resulting in the greatest amount of new HDPE substratum (422,550 square feet), the greatest total amount of new HDPE and concrete substratum (591,150 square feet), and the greatest net area of new substratum (571,804 square feet).

The intake location would be the same under all action alternatives.

Table 2-1 compiles information on the locations and sizes of facilities for the four action alternatives. Figure 2-35 composites the routes of all four action alternatives on the same figure so that the differences in the routes can be more easily visualized.

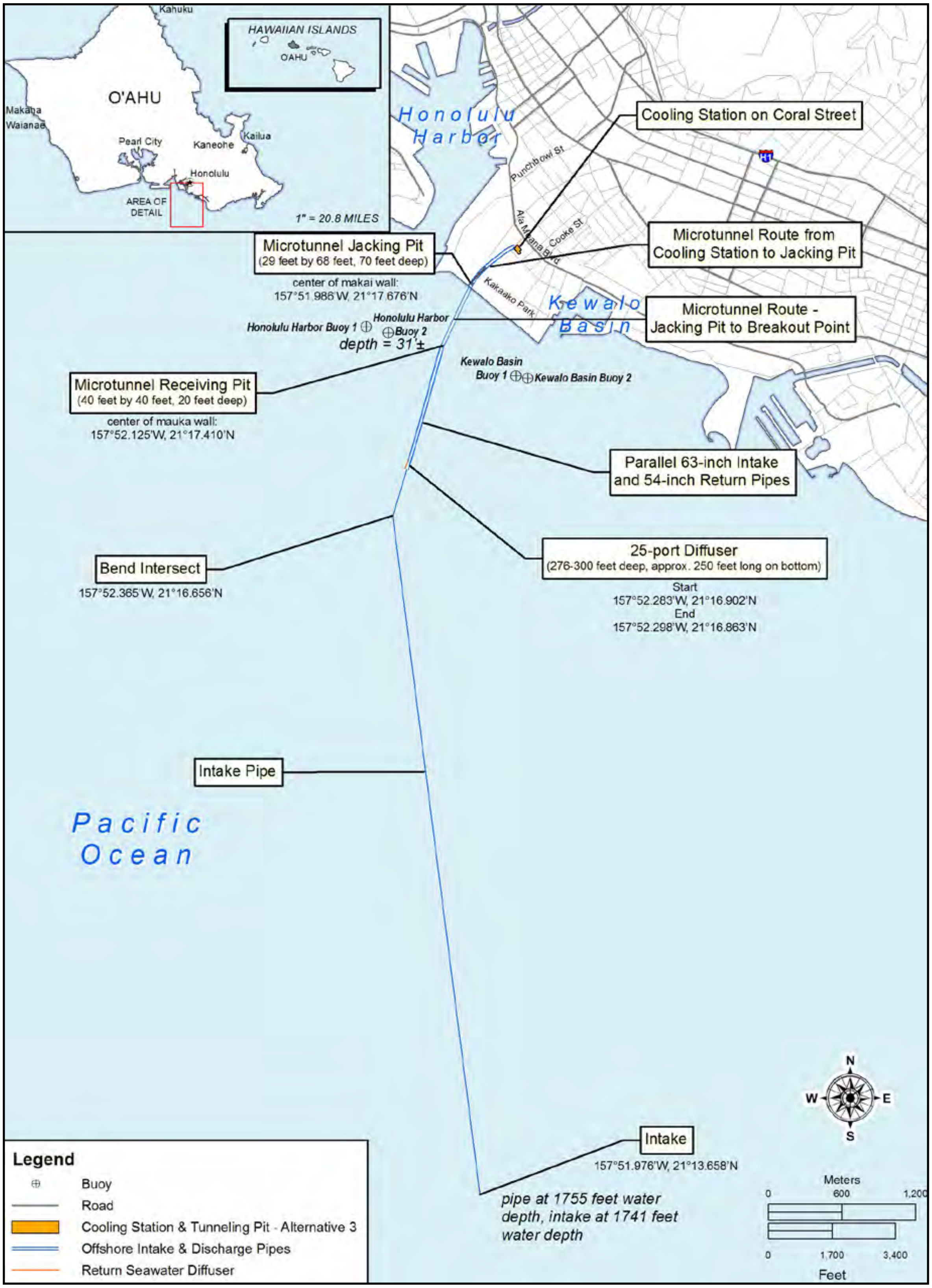

Figure 2-32: Alternative 3 – Cooling Station to Intake

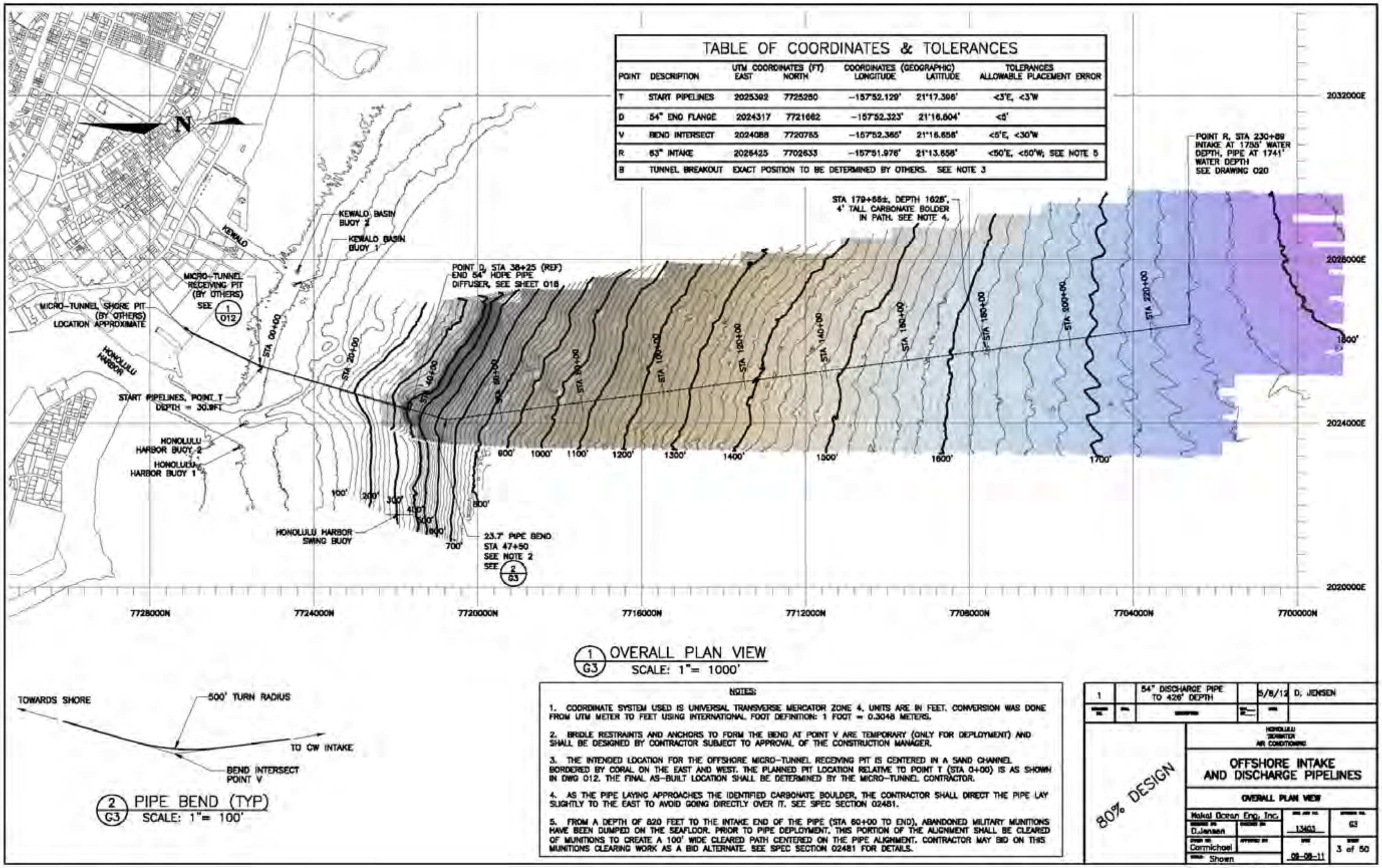

Figure 2-33: Bathymetry Along Preferred Pipeline Route
(Source: Makai Ocean Engineering, Inc.)

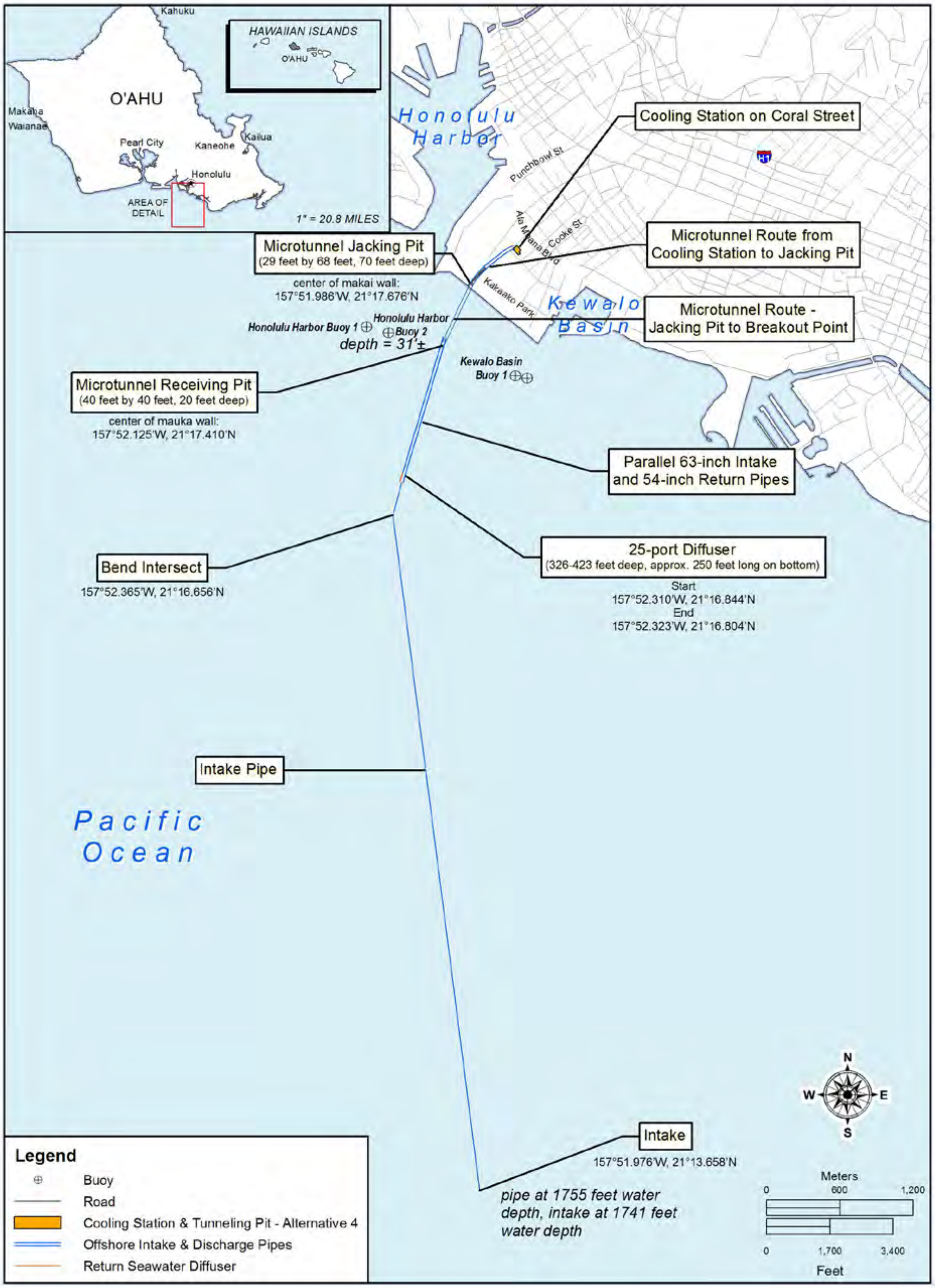

Figure 2-34: Alternative 4 (Preferred Alternative) – Cooling Station to Intake

Table 2-1: Seawater Facilities Locations and Sizes for All Action Alternatives

Facility	***Parameter***	***Alternative 1***	***Alternative 2***	***Alternative 3***	***Alternative 4***
Cooling Station Receiving Pit	Size (WxLxD) (ft)	20x25x70	30x70x70	As per Alternative 1	As per Alternative 1
	Coordinates at Center of Makai Wall	Not Applicable	157°51.998’ W 21°17.692’ N	Not Applicable	Not Applicable
Shoreline Jacking Pit	Size (WxLxD) (ft)	29x68x70	Not required	As per Alternative 1	As per Alternative 1
	Coordinates at Center of Makai Wall	157°51.986’ W 21°17.676’ N			
Offshore Receiving Pit	Size (WxLxD) (ft)	40x40x20	As per Alternative 1		
	Coordinates at Center of Mauka Wall	157°52.125’ W 21°17.410’ N	157°51.907’ W 21°17.394’ N		
	Distance from Shoreline Jacking Pit (ft)	1,796	Not Applicable		
	Distance from Cooling Station Jacking pit (ft)	Not Applicable	2,172	Not Applicable	Not Applicable
	Shortest distance from shore (ft)	1,608	931	As per Alternative 1	As per Alternative 1
Diffuser	Beginning Coordinates	157°52.212’ W 21°17.142’ N	157°52.001’ W 21°16.981’ N	157°52.283’ W 21°16.902’ N	157°52.310’ W 21°16.844’ N
	Ending Coordinates	157°52.225’ W 21°17.102’ N	157°52.013’ W 21°16.925’ N	157°52.298’ W 21°16.863’ N	157°52.323’ W 21°16.804’ N
	Distance from Receiving Pit to End (ft)	1,906	2,923	3,480	3,904
	Beginning depth (ft)	120	145	276	326
	Ending depth (ft)	150	150	300	423
	Length on bottom (ft)	250	345	250	250
	Shortest distance from shore (ft)	3,700	3,570	4,806	5,225
Intake Pipe Shallow Bend	Coordinates	Not Applicable	157°52.028’ W 21°16.863’ N	Not Applicable	Not Applicable
Intake Pipe Deep Bend	Coordinates	157°52.365’ W 21°16.656’ N	157°52.306’ W 21°16.205’ N	As per Alternative 1	As per Alternative 1
Intake	Depth (ft)	1,755	As per Alternative 1	As per Alternative 1	As per Alternative 1
	Coordinates	157°51.976’ W 21°13.658’ N			
	Distance from end of diffuser (along pipe route) (ft)	21,253	20,217	19,716	19,297
	Shortest distance from shore (ft)	19,576	As per Alternative 1	As per Alternative 1	As per Alternative 1
Pipe Collars (Number)	Type A	90	202	192	209
	Type B	155	137	53	36
	Type C	706	503	706	706
	Type D	5	9	5	5
	Total collars	951	800	951	951
Piles	Number	113	112	113	113

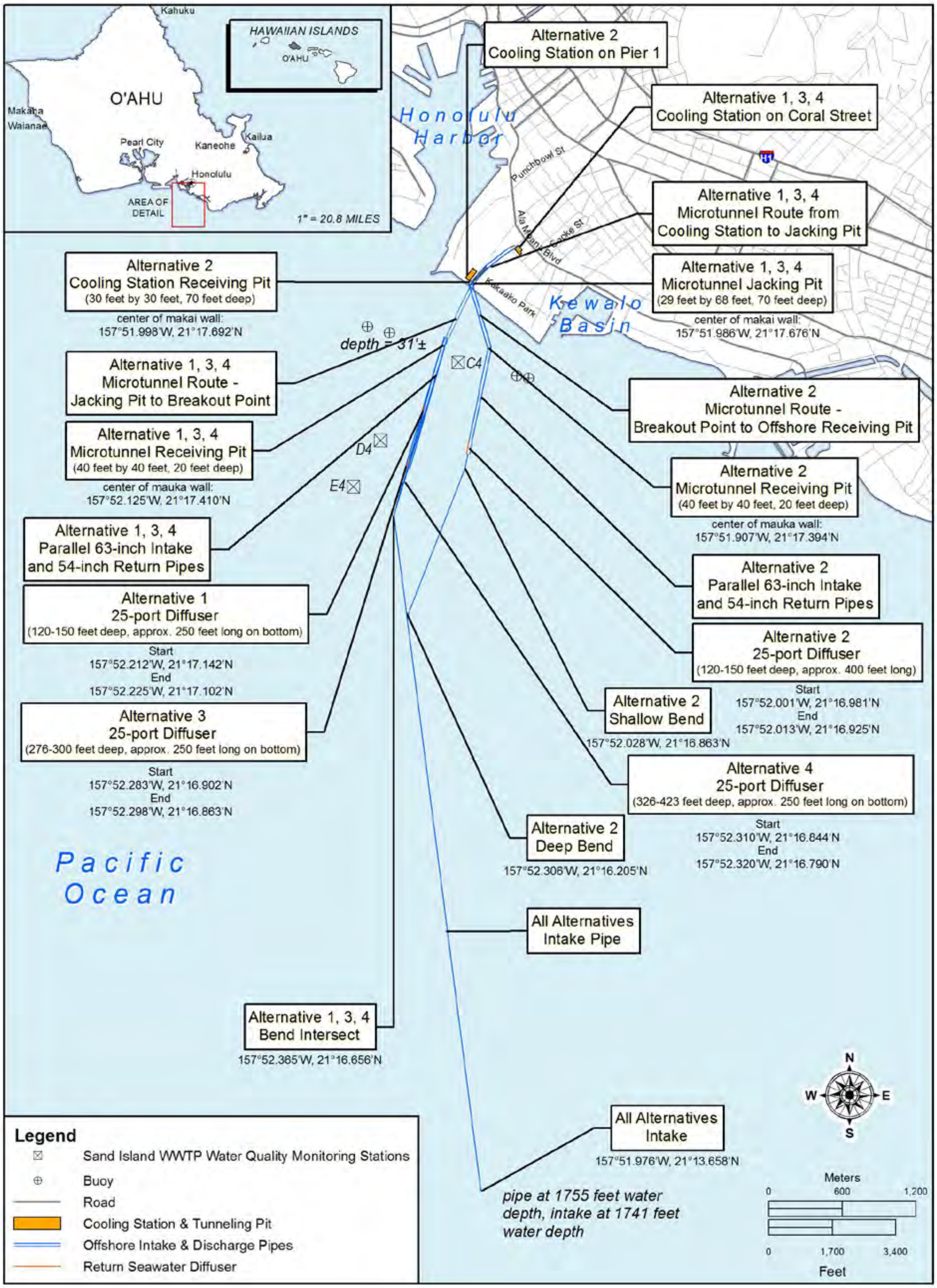

Figure 2-35: Comparison of Action Alternatives' Seawater Pipe Routes

2.5 Alternatives Considered but not Carried Forward for Detailed Analysis

Alternatives for numerous aspects of the HSWAC Project were evaluated as the project developed. Alternatives for a number of system components that were considered but not carried forward for detailed analysis are described in the following sections.

2.5.1 Double Closed Loop SWAC System

In its review of the DEIS, the USEPA suggested consideration of a "double closed loop system." To the applicant's knowledge, such a system has never been designed, fabricated, or installed. In order to transfer the seawater to the cooling station at the desired temperature of 44°F, the seawater intake pipe must have excellent thermal insulating properties. As the seawater passes through the heat exchangers in the cooling station, heat is transferred from the freshwater in the distribution loop to the seawater. The result is a warming of the seawater to between 53°F and 58°F. In a closed loop, as the seawater then traveled through the remainder of the loop it would retain much of this heat. It would return to the cooling station at a temperature well above the desired 44°F and would continue to add heat with each passage around the loop until the seawater and freshwater were at the same temperature. The applicant has stated that for this concept to be feasible, it would require some form of heat exchanger, possibly a matrix of small diameter, thin-walled pipes, to be located at the intake depth. The applicant met with a potential supplier of an offshore closed-loop system. The supplier has installed closed-loop heat diffusers underground and thought the technology might be adaptable to an offshore application. After discussions with the applicant, the supplier realized there were several issues that would have to be resolved, including (1) fouling of the pipe which would affect the heat transfer coefficient, (2) determining the heat transfer coefficient in seawater, and (3) determining the effects of water circulation patterns on heat exchanger efficiency, among other issues. Because the feasibility of such a system is speculative, this alternative is not carried forward for detailed analysis.

2.5.2 Alternative District Cooling Technologies

District cooling systems may employ various technologies to source or generate cool water for air conditioning. There are at least three ways other than SWAC in which a district cooling system for downtown Honolulu could be proposed, although none would achieve the HSWAC project purpose, satisfy the need for the project, or produce the net benefits of a SWAC system. The technologies not carried forward for detailed analysis include deep wells, centralized chillers, and ice storage, as described below.

2.5.2.1 Deep Wells

The Honolulu Board of Water Supply has implemented a small district cooling system for the John A. Burns School of Medicine (JABSOM). The system uses cold water drawn from deep wells. However, the deep groundwater does not provide cold enough temperatures to use directly for air conditioning. The minimum temperature of the groundwater (i.e., 69°F) is cool enough to use for condenser cooling for conventional chillers, and thereby slightly increases the efficiency of the air conditioning system. Cooling towers are eliminated, but chillers are still required and well water pumps are added. A larger-scale well-based condenser cooling system designed for downtown Honolulu would experience the same constraint, and many of the potential benefits associated with the HSWAC system would not be realized using groundwater condenser cooling. Such a system would not satisfy the purpose and need for the HSWAC Project and this potential alternative was eliminated from further evaluation.

2.5.2.2 District Cooling with Central Chillers

In areas without access to cold seawater or lake water, district cooling systems may still be practical. In such systems a few large central chillers replace many individual building chillers. Cooling towers are still required. While there are possible economic and environmental benefits to such systems, primarily resulting from slightly reduced energy consumption and other benefits of scale, there are no renewable energy components. Many of the benefits of the HSWAC system would not be realized with a conventionally-powered district cooling system. Such a system would not satisfy the purpose and need for the HSWAC Project and this potential alternative was eliminated from further evaluation.

2.5.2.3 District Cooling Using Ice-Making Chillers and Ice Storage

A district cooling system based on production of ice was proposed for the downtown Honolulu area by a subsidiary of Hawaiian Electric Industries (HEI District Cooling) in 1999 (Dames & Moore, 1999). The concept was to produce ice at a central facility during nighttime hours when electricity rates are lower than during the daytime. The ice would be used to cool water, which would be pumped through a system of underground pipes to customer buildings throughout the downtown area. The cool water would be used to chill water in a closed loop, and ultimately the air within each customer building. The benefits of such a system primarily stem from electricity rate savings rather than energy savings. In fact, ice storage systems can use more energy than conventional air conditioning or district energy systems; however, as with central chiller systems, there may also be energy savings related to economies of scale. Additionally, this type of system shifts electricity demand from peak hours to off-peak hours, deferring expansion of electricity generating capacity. As with central chiller-based systems, however, many of the benefits of the HSWAC system would not be realized with an ice storage system. An ice storage system would also require a considerably larger amount of floor space to accommodate the ice tanks and for larger chillers, as they would have to be upsized to accommodate their derating for making ice. Such a system would not satisfy the purpose and need for the HSWAC Project and this potential alternative was eliminated from further evaluation.

2.5.3 Alternative Cooling Station Designs

The seawater pumps in a cooling station require a sump from which to draw water. The design of a cooling station, its layout and footprint, is determined in large measure by the type of sump employed. Two alternative types of sumps were considered: wet sump and dry sump. A wet sump requires much more land area. Given the proposed location of the HSWAC cooling station near downtown Honolulu and the cost of land there, a dry sump - direct connect pump arrangement was determined most practical and economical for this cooling station. It would provide an overall lower cost and also less flooding risk. The potential wet sump alternative was therefore eliminated from further evaluation.

2.5.4 Alternative Cooling Station Locations

A number of candidate sites were evaluated for suitability for a cooling station in a comprehensive site selection process. Technical criteria evaluated for each site included:

- Size, configuration and existing structures,
- Soil conditions,
- Exposure to waves and tsunami run-up,
- Site contamination or presence of old buried utilities,
- Availability of access corridors for tunneling. It is higher risk to tunnel under adjacent sites (the contractor may not be able to retrieve his machine if it gets stuck), permission may not be granted, and there may be obstacles such as foundation piles, and
- Distances for tunneling both toward the sea and toward downtown so that energy consumption for pumping would be minimized to the extent possible.

A number of State-owned and privately-owned sites were evaluated, including part of Aloha Tower, an unused portion of Hawaiian Electric Company’s (HECO) Honolulu Generating Station, six State-owned sites within the Makai District of the Kaka‘ako Community Development District and three privately-owned sites in the same District. Based on the criteria above, all but two of these sites, one privately-owned and one State-owned, were eliminated from further evaluation. The two sites that satisfy the selection criteria are analyzed as part of Alternatives 1, 3 and 4 (the preferred location) and Alternative 2, respectively. The sections below summarize the cooling station site evaluation process.

2.5.4.1 **State-owned Sites Evaluated**

A number of locations for the cooling station were evaluated. Exploratory efforts were made to coordinate HSWAC development with the anticipated further development of the Aloha Tower area of the waterfront, but plans for that complex were too preliminary to allow the HSWAC project to proceed in a timely manner. Likewise, HECO was approached about the possibility of occupying an unused portion of their Honolulu Generating Station. This alternative had several potential synergistic effects, including using SWAC water to cool the HECO generators thereby increasing their efficiency and reducing fuel use, and blending cool SWAC water with warm discharge water from the generating station to reduce potential thermal impacts of both. However, the elevated nutrient concentrations in the HSWAC return seawater could not be adequately diluted in Honolulu Harbor, so this alternative was not pursued any further.

A number of potentially feasible sites for the cooling station were identified within the Makai District of the Kakaʻako Community Development District, administered by the Hawaiʻi Community Development Authority (HCDA). The Kakaʻako Community Development District is situated between Waikiki and Downtown Honolulu, and is divided into two separate districts. The Makai District extends southwest of Ala Moana Boulevard to the ocean and the Mauka District extends northeast of Ala Moana Boulevard to King Street. In preliminary discussions, HCDA identified several State-owned parcels under their control that might be available (Figure 2-36).

The first sites investigated are shown under the red “X’s” in Figure 2-36 (Piers 1 and 2 of Honolulu Harbor). This area had two underutilized warehouses set back from the pier, either of which could house the cooling station. The first warehouse (upper red X) was demolished to make way for the Cancer Research Center. The second warehouse (lower red X) is currently being used for other purposes, including a homeless shelter; however, discussions with HCDA and subsequently with the Office of Hawaiian Affairs (OHA), which was contemplating establishing a headquarters facility on the site, indicated that a portion of Pier 1 might be available for the HSWAC cooling station. This site was considered a viable option according to the site selection criteria, and is described further as part of Alternative 2 in Section 2.4.3.

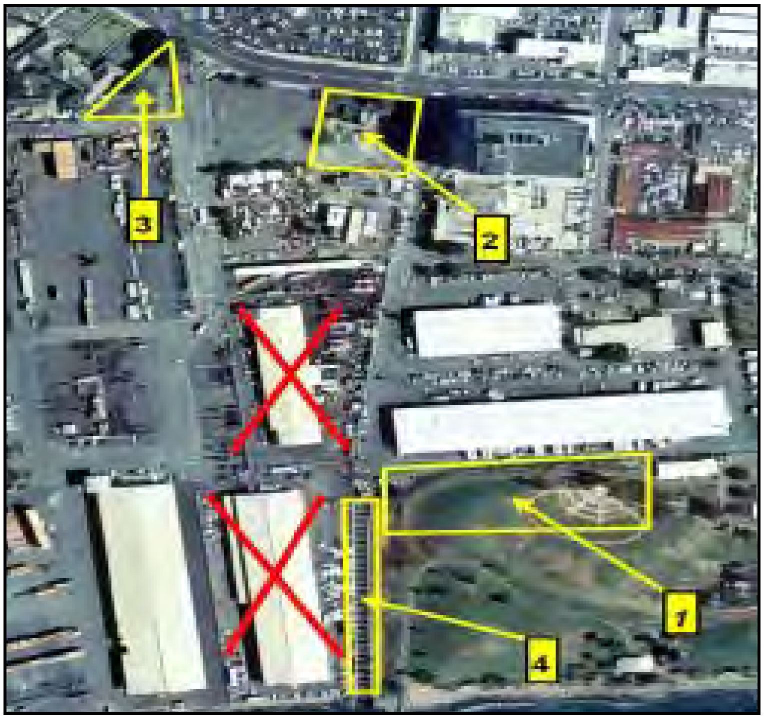

Figure 2-36: Potential Cooling Station Sites Proposed by HCDA
(Source: HSWAC, LLC)

HCDA subsequently suggested several other potential locations, shown outlined in yellow on Figure 2-36. Evaluations of these sites led to the following conclusions:

- *Site 1:* The cooling station could be located in the northwest corner of this large site. The site has good access to the ocean, and is sufficiently far from the shoreline to be protected from waves. The tunneling access corridors would probably be adequate. Most of this parcel is currently part of the Kakaʻako Waterfront Park; however, this area is little used and HCDA plans to develop it for other uses. The primary unknown is the nature of the soil, as it lies on the periphery of the former incinerator ash dump and the extent of subsurface contamination is unknown. It is possible that soil remediation work would be required by the regulatory agencies if excavation was undertaken, and excavation would be necessary to construct the cooling station. Of the four State-owned sites considered, this would be the best, although it is not ideal because of the potential soil contamination.
- *Site 2:* This site is a potentially feasible location for the cooling station; however, it has several constraints that render it less suitable according to the site selection criteria. The primary disadvantage is an existing historical building that takes up valuable real estate and would be costly to repair and maintain. The building would only be suitable for offices and the control system; it is too small to house any of the HSWAC machinery. It also has pipe access constraints and increased pressure loss as negatives.
- *Site 3:* This triangular site is only 15,000 square feet in area and is an odd shape. It would be difficult to design and relatively expensive to construct the cooling station on this site and within building codes, even with a three-story design having 10,000 square ft per floor. It also has increased pressure loss as a negative.
- *Site 4:* This site was initially attractive because there was no competitive use being considered by HCDA. However, there is an existing fresh water drainage canal through the site, which could present costly issues relative to repair/stabilization of the walls of the drainage canal, tunneling, and building the deep pump room. Building over the canal could be attractive and economical if

not for the need to go deep for seawater pumping. In addition, this site could be inundated in a tsunami and protection from high waves (increasing the height of the rip rap breakwater) would be required.

In summary, only one of the State-owned sites offered by HCDA (Pier 1) has the potential to meet all of the technical site selection criteria for cooling station siting. The footprint for the cooling station at this alternative site would be essentially the same as for the preferred alternative. The orientation of the cooling station could vary.

2.5.4.2 **Privately-owned Sites Evaluated**

Several potentially available sites in the Makai District of Kakaʻako that are privately owned were evaluated using the same site selection criteria as above. These included: (1) the parking lot adjacent to the Honolulu Generating Station; (2) the parking lot makai of 677 Ala Moana Blvd.; and (3) the parking lot Diamond Head of 677 Ala Moana Blvd. The first alternative was eliminated because it would necessitate a longer intake pipeline and a difficult pipeline route through the Honolulu Harbor entrance channel. The third alternative above was eliminated because of future landlord plans for the site. That left the second alternative above as the preferred site for the cooling station.

2.5.4.3 **HSWAC, LLC's Preferred Cooling Station Location and Building Configuration**

Based on evaluation of the technical siting criteria and the receptiveness of the landowner to the intended use, the preferred location for the cooling station is on a parcel owned by The Estate of Bernice Pauahi Bishop (Kamehameha Schools) adjacent to and makai of the 677 Ala Moana Building (former the Gold Bond Building). The address of the parcel is 210 Coral Street and the tax map key (TMK) is 2-1-059:012 ("lot 12"). The parcel is bounded by Keawe Street, Ilalo Street, and Coral Street, and encompasses an area of 1.884 ac (0.762 hectares; 82,067 sf). Most of the site is paved concrete currently utilized for parking; there are no existing buildings. The parcel is in the State Land Use Urban District. It is zoned Commercial by HCDA, and the applicant has obtained permission from HCDA to use the site for the cooling station.

2.5.5 **Alternative Staging Area Locations**

Several potential locations for the staging area were investigated, including Kalaeloa Harbor (Barbers Point), Keʻehi Lagoon, Kāneʻohe Bay, and Molokaʻi Harbor. The latter two locations were evaluated and not carried forward for detailed analysis for the following reasons:

- Kāneʻohe Bay: This large bay on the windward side of Oʻahu is well protected, but is an intensively used recreation area, typically has many recreational vessels present, is a popular dive location, has many shallow patch reefs, and is the home of the Hawaiʻi Institute of Marine Biology. Using this bay could inconvenience users and is not likely to get community acceptance. Furthermore, access to an appropriate shoreside staging area might be difficult and maneuvering the fully-assembled pipeline could also be difficult.
- Kaunakakai Harbor: The harbor on Molokaʻi was considered but is too small for the staging equipment. In addition, it is far from the final deployment area, which would considerably increase costs and risks related to towing the pipeline from the assembly site.

The applicant discussed use of an area within Kalaeloa Harbor or Keʻehi Lagoon with representatives of the Harbors Division of the State Department of Transportation. Each of these sites has the advantage of being very close to the heaviest industrial infrastructure in the Hawaiian Islands on the south side of Oʻahu. The curved northern shoreline of Kalaeloa Harbor was evaluated for suitability for pipe assembly and mooring. This area would allow assembly of pipe sections, each of which is approximately 3,300 feet long. About five to eight such pipe sections would be necessary to complete the deep water pipe assembly. The subject area is currently unused. Shore protection has been installed in the northern corner of the harbor to protect it from surge motion during the winter months. Further discussions with the

Harbors Division, however, indicated that placing obstructions, such as pipeline sections, in Kalaeloa Harbor could constrain the movement of large ships, and its use for pipeline staging would be incompatible with its primary function. It was therefore eliminated from further evaluation.

The most suitable location for the staging area would be along the shore of Keʻehi Lagoon, with completed sections of the pipeline stored in the adjoining channel. Figure 2-37 illustrates the channels in Keʻehi Lagoon that could be used for pipeline assembly and storage. Four channels have been dredged in the lagoon and each has a different level of existing use. The characteristics and uses of each channel are listed below:

- Channel A: parallels Lagoon Drive, roughly 1.55 miles long, dredged to 12 feet, used by a single seaplane. Very few moored vessels.
- Channel B: approximately parallels the Reef Runway, roughly 1.46 miles long, dredged to 12 feet, used by jet skis. Could also be used by the seaplane. Very few moored vessels.
- Channel C: parallels Sand Island Access Road, roughly 0.92 miles long, dredged to 12 feet, widely used for small boat mooring, Keʻehi Marine Center located on shore here.
- Channel D: parallels western shore of Sand Island, roughly 0.75 miles long, dredged to 12 feet, lightly used for small boat moorings, channel at southern end is closed off - no access to ocean.

Channel A was eliminated from further evaluation because of potential interference with seaplane operations. Channel B was eliminated from further evaluation because of a lack of direct access from a shoreside staging area. Channel C was eliminated from further evaluation because of interference with vessel operations and recreational uses. The applicant's preferred location for a staging area is in and adjacent to Keʻehi Lagoon Channel D.

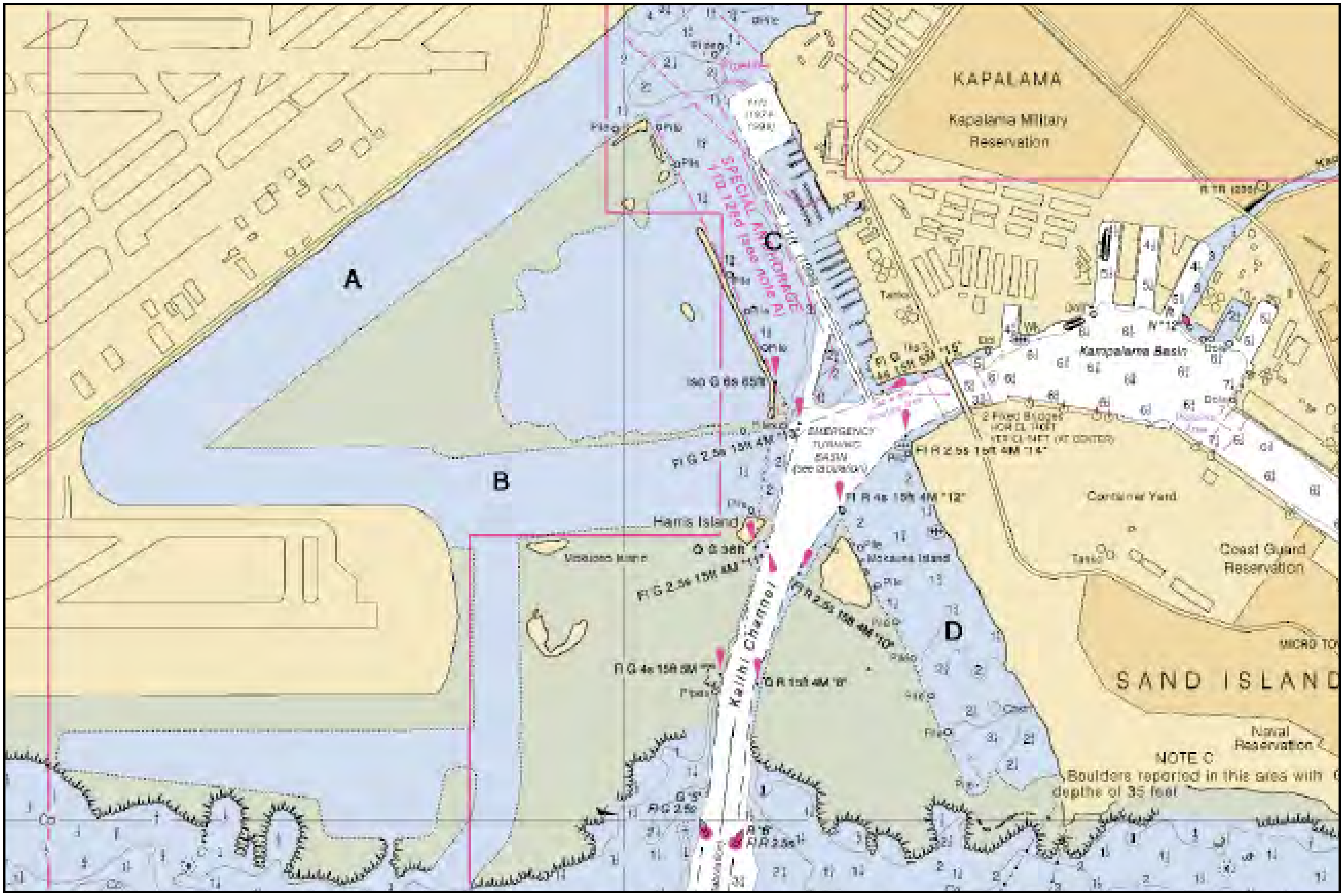

Figure 2-37: Possible Pipeline Assembly Areas in Ke'ehi Lagoon
(Source: Makai Ocean Engineering, 2005b)

2.5.6 **Alternative Pipeline Installation Methods**

2.5.6.1 **Cooling Station to Breakout Point**

To minimize potential environmental impacts, reduce the seawater intake and return pipelines' exposures to wave loads, and avoid existing utility installations in the vicinity of the cooling station, a trenchless technology (microtunneling) is proposed for routing the seawater pipes from the cooling station to the offshore breakout point. Microtunneling is described in Section 2.4.1.4 as a common feature in all alternatives. Two other trenchless pipeline installation methods were considered:

- Horizontal directional drilling (HDD) methods (drill pilot hole, ream/enlarge drill hole and pull back pipeline/casing), and
- Tunneling (man entry tunneling using a tunnel boring machine and reinforced concrete segmental liner).

Trenchless design considerations included existing geological and geotechnical information, interpretation of the nearshore geology from aerial photographs, underwater reconnaissance at and near the proposed offshore breakout point, and geotechnical field investigations. The potential trenchless corridor was evaluated for the potential to encounter very soft or loose lagoonal deposits, or very hard basalt lava flows. Either of these conditions would create problems for trenchless technologies. Basalt was found to occur at approximately 120 feet below the existing ground surface, or on the order of approximately 115 feet to 150 feet below mean sea level (MSL). It was determined that the objectives of the trenchless installation could be met by installing the pipes at approximately 40 feet or deeper below sea level. The subsurface in that depth range consists of coralline silts, sands, gravel, cobbles, boulders (detritus), and reef limestone ledges, layers and masses, with and without voids and cavities.

The next two subsections describe the trenchless technologies that were evaluated but not selected for the HSWAC application, potential offshore routes considered for them, and conclusions as to the applicability of those technologies and routes to the HSWAC project.

<u>Horizontal Directional Drilling</u>

HDD has been used for over 15 years to complete pipeline installations beneath rivers and other waterways, and also to construct ocean outfalls. Recently, several HDD projects staged over water have also been completed. Important design considerations for HDD applications include geotechnical conditions, the horizontal and vertical alignment, pipe materials, pipe stresses during installation, constructability, construction staging, spoil, drilling mud disposal, and construction cost. In general, pipelines from 2,900 feet to as long as 8,400 feet and ranging in outer diameter from 10-inch to 56-inch have been constructed using HDD methods. The longest HDD installed pipelines tend to be smaller diameter, generally less than 30-inch, and tend to be steel pipes.

HDD methods for the construction of pipelines involve using sophisticated drilling techniques to drill a pilot hole, which is subsequently enlarged by reaming with various reaming tools to obtain a hole of the desired size. Drilling mud is used to flush the cuttings from the hole and to stabilize the hole to reduce the potential for cave in. When the hole has reached the required size, the pipeline (or a casing) is pulled back into the hole in a single operation. An HDD drill rig can be staged on land or over water, and for this project, if HDD were the selected technology, most likely both on land and over water staging would be necessary.

Over water, the HDD drill rig would have to be mounted on pile-supported steel platforms or large spud barges. A spud barge is a vessel that uses heavy timber or pipe as a means by which to moor. The timber or pipe is located in a well at the bottom of the boat, and acts in the same manner as would an anchor. Spud barges are riverboats that are most commonly used as work barges, or as loading or unloading platforms. An example of over water HDD pipeline pull back and underwater connection of a spool segment is shown on Figure 2-38.

Figure 2-38: Over Water HDD Pipeline Pull Back (HPA Pipe) in Pearl Harbor
(Source: Yogi Kwong Engineers, Inc.)

Due to the open ocean conditions offshore of Kaka‘ako, the use of spuds to stabilize barges or a platform in 40 feet or deeper water may not be cost effective. Alternatively, barges may be moored to pre-installed underwater mooring anchor piles. Steel pipe piles, for example from 20 to 30 inches diameter, could be used to reduce potential barge anchor impact to corals, if present. A similar underwater mooring was provided for mooring of the sunken *Ehime Maru.* The underwater steel piles would be abandoned in place, and may protrude a few feet above the sea floor.

In evaluating HDD for the HSWAC application, it became apparent that there were several serious constraints to use of that technology. These constraints are related to the maximum pipe size that can be installed with this technology and the volume of water required for the HSWAC project. In the U.S. to date, the largest HDD installed pipe size is 48-inch OD steel. However, steel will corrode in seawater. HDPE pipes, such as those proposed for the offshore portions of the HSWAC seawater system, as large as 42-inch have been installed directly, but not at the lengths that would be required in this application. HDPE pipes do not have the tensile strength to withstand the pipeline pulling stress that would be exerted during the installation. The conclusion was that HDD cannot be used to directly install pipes of the diameter required by the HSWAC system, and HDPE pipes cannot withstand the stress of direct installation for the required pipe lengths.

In order to use HDD for the HSWAC system, a series of smaller diameter steel pipes would have to be installed in separate tunnels, and then a smaller, non-corrosive pipe such as HDPE or fusible PVC (FPVC) installed inside the steel casing and the annulus between them grouted to provide support for the suction forces on the interior pipe. To handle the volume of water required for the HSWAC system, five tunnels would be required. The seawater intake would consist of three tunnels, each holding a 42-inch OD steel casing with a 36-inch FPVC pipe inside. The seawater return would consist of two 36-inch FPVC pipes, with or without a larger casing.

The necessity to install five pipes to complete the system would create two other problems. First, because of the inherent limitations in steering the HDD machine underground and the characteristics of the soils, the individual pipes would have to be separated by at least 20 feet to avoid the possibility of the tunnels affecting one another. Second, because of this requirement for separation of the pipes, the entry and exit pits would be wide. The easement corridor would have to be correspondingly wide. On the shore end there are right-of-way constraints that would make it difficult to acquire an adequate work area and on the seaward end this would create a much larger excavation at the breakout point than would be the case with fewer pipes.

Four HDD alternative routes were investigated to compare with the other trenchless technologies. These routes are shown in Figure 2-39. Three of the potential routes pass ‘Ewa of Kaka‘ako Waterfront Park and the landfill buried beneath it. The fourth alternative, going beneath the park at a more Diamond Head location could combine microtunneling and HDD technologies.

Figure 2-39: Potential Horizontal Directional Drilling Routes to Breakout Depth
(Source: Yogi Kwong Engineers, Inc.)

Staging of the HDD entry point from behind the shoreline was found to be impractical due to the lack of available easements and work areas on the ‘Ewa side of this potential corridor (Hawai‘i Department of Transportation [HDOT] Harbors yard) and Kaka‘ako Waterfront Park and buried landfill on the Diamond Head side. In addition, there is only an approximately 20-foot wide space between major sewer lines under Keawe Street from outside the proposed cooling station. Consequently, the entry location would have to be in a large, deep pit dug and dewatered just offshore of the existing drainage canal. From that point to the cooling station, tunneling or microtunneling methods would be required to install fewer, larger diameter pipes in the available space.

In addition, up to 3,800 linear feet of steel casing and HDPE or FPVC pipe would have to be floated offshore during pipeline pull back, an operation estimated to require approximately 30 days for each of the five pipelines required. This would require boat and ship traffic to be re-routed around the over water work zone.

In general, the minimum work area for HDD methods at the entry and exit locations is an area approximately 200 feet by 200 feet. Additional staging area is required for pipe storage, spoil handling with dewatering, and for laying-out the pipe when the pipe string is assembled for pull back. Additional off-site staging areas for materials and equipment storage and handling of construction spoils, etc., are required. For previous trenchless projects on O'ahu, yard spaces on Sand Island and in Campbell Industrial Park were used.

For on-land disposal of spoils, a temporary spoil stockpiling and dewatering area would be needed during construction to allow spoils separated from the drilling fluids (or mud) to be stockpiled, inspected, sampled and tested prior to disposal. In addition, some space to allow the drilling fluids to be dewatered to separate the spoil from the drilling fluids would be desirable, as there would be a considerable volume of drilling fluids. A minimum 200 feet by 200 feet area for processing of drilling fluids would probably be needed. The dewatering basin would have a plastic liner to prevent infiltration of the drilling fluids into the ground. Typically, a layer of sand protects the plastic liner.

Detailed bathymetric surveys conducted to better define potential offshore routes identified two areas of constraint that further discounted use of HDD in favor of microtunneling. First, to the west, near the entrance to Honolulu Harbor, there is a probable buried ancient alluvial channel with a probable area of submarine landslide further offshore. Alluvium would not support HDD methods and the submarine landslide area would put the pipes at risk. Further to the east are several large mounds of dredge spoils that must also be avoided in pipe laying. The result is that the pipeline alignment would have to go farther to the east than would be possible with all but the eastern-most HDD alternative that, as noted above, would create potential interferences with the Kilo Nalu Observatory. In consideration of the above, HDD technology was eliminated from further evaluation.

Tunneling

Conventional tunneling methods (man entry) involve the use of a tunnel shield or tunnel boring machine (TBM), the installation of an initial support system to support the surrounding ground, and then placement or installation of a final lining or carrier pipes. TBMs utilize a full-face rotating cutterhead to excavate tunnels at a higher advance rate. There are open TBMs and shielded TBMs. Open TBMs are used mainly for excavating hard rock formations with no or minor ground water inflow. The cutterhead of the open or main beam machine is thrust forward with hydraulic rams supported by grippers, which are mounted on each side of the main beam of the machine and bear against the tunnel walls. In soft ground, the material is not strong enough to withstand the bearing pressure of the grippers and a shielded TBM with thrust jacks would normally be used.

In general, a shielded TBM has a full circular shield that provides temporary ground support while the initial support system (usually cast steel liner plates, or precast concrete segments) is erected within the tail of the shield. Shielded TBMs advance by thrusting against the tunnel's initial support system with hydraulic jacks. Such an approach requires an initial support system that can withstand ground loads, the TBM thrust forces, and hydrostatic pressures, if present. Closed face and more sophisticated pressurized face shields can be used for tunnel excavation below the groundwater level. The cutterhead of either type of TBM can be equipped with disc cutters for excavating rock or drag teeth for excavating soil and soft rocks. A slurry TBM would be the appropriate choice for the anticipated subsurface conditions in the HSWAC project area. An example of a tunnel lined by precast reinforced concrete segments is shown on Figure 2-40.

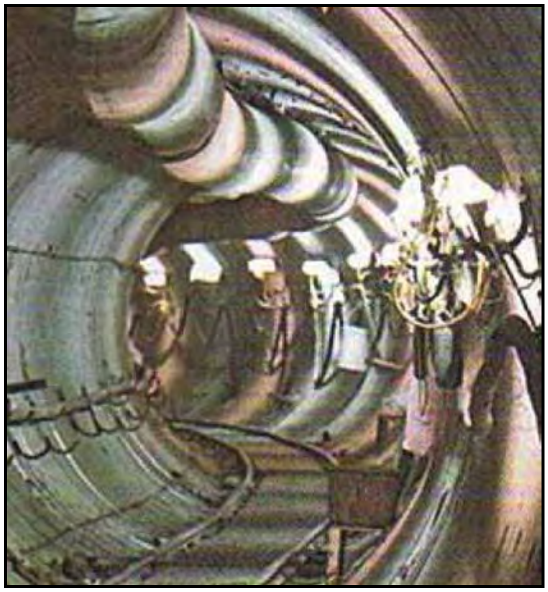

Figure 2-40: Tunnel Lined with Precast Reinforced Concrete Segments
(Source: Yogi Kwong Engineers, Inc.)

The potential use of man-entry conventional tunneling methods using a closed face slurry tunnel boring machine (slurry TBM) was evaluated for installation of the HSWAC seawater pipes from the cooling station to the breakout point. The tunneling option would reduce the excavations of pits to two: a large entry shaft at the cooling station and an underwater TBM retrieval pit at the breakout point. Only one route was examined as the most direct route that could be employed using this technology (Figure 2-41).

The tunnel itself would mostly likely be lined with a minimum 11 to 12 feet inside diameter pre-cast reinforced concrete segmental liner, due to the tunnel length and slurry TBM equipment and other tunneling needs, such as the space necessary to provide a compressed air chamber at the front of the TBM to allow for man-entry intervention to the TBM cutter head to replace worn cutter discs periodically during the underwater tunneling operation. The required 63-inch diameter HDPE seawater intake pipeline and 54-inch diameter HDPE seawater return pipeline would be installed inside the tunnel liner. The pipelines would be secured inside the liner and the annulus between the casing and the intake and return pipelines grouted. Tunneling would require a larger offshore retrieval pit than microtunneling. The construction cost estimate would be expected to be much higher than HDD or microtunneling installations. Tunneling would be expected to take 9 to 11 months; installation of the carrier pipelines and annulus grouting would be expected to take an additional one to two months. Due to cost and safety considerations, the potential conventional tunneling alternative was eliminated from further evaluation.

Figure 2-41: Potential Tunneling Route to Breakout Depth
(Source: Yogi Kwong Engineers, Inc.)

2.5.6.2 Seaward of the Breakout Point

From the breakout point seaward, alternatives to protect the pipelines at depths susceptible to severe storm surge were evaluated. The initial concept was trenching and burying the pipelines from the breakout point to a depth of approximately 80 feet and securing them with gravity anchors (concrete collars) at deeper depths. This was considered the most protective of the pipelines and the most economical alternative. It was acknowledged that this would create greater impacts to water quality and coastal marine habitats than surface mounting the pipelines from the breakout point seaward. Subsequent analyses indicated that surface mounting with piles would adequately secure the pipelines from the breakout point to the end of the diffuser and that that alternative would be less expensive and reduce the potential impacts to water quality and marine communities. Hence, the potential alternative involving submarine trenching was eliminated from further evaluation.

2.5.7 Alternative Diffuser Location and Depth

Four alternative locations for return water discharge were evaluated: Honolulu Harbor, shallow coastal waters, deep coastal waters, and oceanic waters. All of the action alternatives would discharge to deep coastal waters. The other alternatives are discussed below.

2.5.7.1 Honolulu Harbor

Located on Māmala Bay, Honolulu Harbor is Hawai‘i’s major port facility. The harbor was created by freshwater flows from Nu‘uanu Valley, which inhibited coral growth within a small reef basin and cut several channels through the surrounding reef. The main channel, which was the deepest, was flanked to the west by shallower outlets. Between these outflows rose occasional spots of earth and coral - the beginnings of Sand Island. The harbor water is used by HECO as a heat sink for condenser cooling of its Honolulu Generating Station, as well as waste discharges. The Honolulu Generating Station is permitted (NPDES clean water permit #HI0000027) to discharge effluent in the quantities shown in Table 2-2.

Table 2-2: Hawaiian Electric Company Honolulu Generating Station Permitted Discharges to Honolulu Harbor

Operation	*Average Flow*	*Description*
Condenser Cooling	187 MGD	Ocean Discharge
Turbine Condensate	20,000 GPD	Neutralization
Boiler Blowdown	15,000 GPD	Neutralization
Misc. Low Volume Waste (intermittent)	24,000 GPD	Neutralization
Treated Metal Cleaning Waste (intermittent)	65,000 GPD	Chemical Precipitation and Neutralization
Storm water (intermittent)	36,000 GPD	---
(Source: HDOH Permit Files)		

The possibility of blending the HSWAC return seawater flow with the HECO discharge as a means to reduce temperature effects of both discharges on receiving waters was investigated. At 44,000 gpm, or about 63 million gallons per day (MGD), the HSWAC return seawater flow would be about one-third the volume of the HECO discharge to Honolulu Harbor. Two approaches, flux analysis and temperature analysis, were taken to estimate the achievable dilution in the harbor. Considering Honolulu Harbor as a discrete water body, estimates of the main fluxes were made (tidal flush and stream flow) and achievable dilution implied. The expected level of dilution was found to be 6.2.

Using technical data and permit compliance records available for the HECO discharge, an approximation of the achievable dilution was deduced. Specifically, temperature measurements distributed spatially within the ZOM were used in conjunction with ambient values and discharge values to derive a relationship in terms of mixing. From the data analyzed, the lower and upper bounds of dilution were 2.9 and 21, respectively.

The results of the two initial mixing analysis methods are in close agreement; an approximation of the achievable dilution within the harbor is likely to be in the bounds 2.9 to 21. This implies discharge into the harbor could result in exceedances of water quality standards for nitrate+nitrite, ammonia, dissolved oxygen and potentially for temperature. Initial analysis, therefore, indicates the dilution requirement cannot be met and therefore returning seawater to Honolulu Harbor is not considered feasible. This potential alternative was therefore eliminated from further evaluation.

2.5.7.2 **Shallow Coastal Waters**

Corals cannot tolerate temperatures of less than 64°F for extended periods of time. The temperature of the return seawater would be less than 58°F under most operating conditions. Owing to the potential impacts of this cold discharge water on corals (and other marine organisms), return seawater discharge into shallow coastal waters was eliminated from further evaluation.

2.5.7.3 **Oceanic Waters**

Reviewers of the DEIS, including USEPA and USFWS, suggested disposing of the HSWAC seawater in deep oceanic waters. Such a discharge, however, would violate State water quality criteria because ambient conditions at depth exceed the water quality criteria and there is no assimilation capacity for discharges of regulated constituents. Discharging in deep oceanic waters would also add risks to pipe deployment. To discharge at the intake depth, for example, would require separation of the intake and discharge pipelines to avoid recirculating the discharge water into the intake. This would require surveying another route and conducting a separate deployment because the pipes couldn't be deployed together in combination collars. Another option suggested by reviewers would be to discharge at a depth where the temperature of the discharge approximately matches the temperature of the ambient water. From measurements in the project area that would occur at a depth of about 1,000 feet; however, this would also be below the thermocline where water quality criteria are violated and there is no assimilation capacity for new discharges. By positioning the diffuser in deep coastal waters above or slightly within the thermocline where the characteristics of the discharge would be closer to ambient than in shallow coastal waters, but where some assimilation capacity remains, it would be possible for the applicant to be granted a ZOM. Consequently, a discharge in oceanic waters was not further considered.

2.5.8 **Intake Screen**

Section 316(b) of the Clean Water Act requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. The applicant can comply with Section 316(b) in two different ways, one of which (Track I) requires the installation of a screen over the intake structure. The applicant's engineers evaluated the feasibility of installing a grate or screen over the HSWAC deep seawater intake to reduce or eliminate entrainment of macroorganisms in the intake. This project would be the first application of deep seawater SWAC technology in the U.S., and consequently the first project required to address this issue. While there are numerous types of intake screens designed for shallow water applications, there are none designed to be installed, operated and maintained in the deep ocean. Consequently, project engineers evaluated a range of potential designs. Considerations for design and construction were:

1. The screen area must be sufficiently "oversized" to maintain design flow even if the screen becomes biofouled or blocked by organisms or debris.
2. A blocked screen that raises the head losses in the intake pipe could cause premature collapse of the HDPE pipe. Stiffeners on the pipe must therefore be overdesigned to allow for an increased head loss.
3. A deep water HDPE intake is installed by the controlled submergence deployment process. Complete unhindered access to the offshore end of the pipe is necessary for controlled release of pressurized air as well as cable attachment for tension during the deployment process. Large structures at the offshore end would significantly increase the risk during deployment, in regards to deployment failure as well as personnel safety.

Operational considerations were:

1. Equipment for planned or emergency maintenance of a deep water screen is not readily available in Hawaiʻi.
2. If the seawater flow is impeded or blocked altogether, air conditioning for HSWAC's customers would be severely affected.

Given the above considerations, five alternative designs for a screen were evaluated.

1. Simple Pipe Screen – A screen covering the pipe opening would be the most feasible in regards to not adding to the deployment risk. However, the screen area would be very small increasing the risk for impeded or blocked seawater flow. The small screen would not lower the intake velocity but it would increase the risk of impingement of organisms against the screen surface.
2. Multiple Intakes – Multiple intakes would significantly increase the deployment risk. Multiple intakes would lower the intake velocity and/or minimize the risk of impeded or blocked flow through a screen. However, adding one more intake opening would not significantly reduce the intake velocity.
3. Intake Diffuser – Adding a diffuser, for example in the shape of a "mushroom" as used in thermal storages would reduce the intake velocity. However, deploying such a large structure at the end of a 4-mile long pipe to be deployed to a depth of 1,700 feet would significantly increase the deployment risk. One alternative, installing the diffuser after the pipe deployment, has never previously been attempted at this depth. Also, the intake structure area exposed to currents and other water movements would increase substantially the risk to the pipe and thereby increase the risk of intake failure. This risk could be mitigated by adding additional concrete collars to the end

of the pipe. However, the increased pipe stress during deployment would add to the risk. An intake diffuser without a screen could also be counterproductive. Even though the diffuser's edge intake velocity could be designed to 0.5 fps, animals could swim into the diffuser and get trapped in the gradually reduced opening and increasing flow velocity. If a screen were installed around the diffuser's edge it would be susceptible to impediment as described above.

4. Intake Screen Cage Mounted on Pipe – An intake screen cage could be mounted on the pipe end. To achieve a screen surface velocity of less than 0.5 fps the cage would have to be about seven feet high with a diameter of 15 feet. The cage would have to be installed after the pipe deployment. Additional support and concrete collars would have to be installed due to the increased area of the intake structure exposed to currents and water movements. No such screen cage is readily available nor has one been designed, tested and proven to be feasible or effective.
5. Freestanding Intake Screen Cage – A free standing cage surrounding the intake would avoid adding forces to the intake pipe due to currents and water movements. The drawbacks with this alternative would be a large construction, approximately 20 feet high and 20 feet in diameter with the risk of it collapsing over the intake or moving due to current or other water movements and thereby dragging the intake out of position. Such an approach has never previously been implemented and the cage would have to be deployed after the pipe, adding to the risk of the project.

The engineering challenges inherent in design and fabrication of an effective screen would necessitate a research and development program and add significantly to project risks. The concept of constructing an intake structure with a maximum throughput intake velocity of 0.5 ft/s is infeasible for both construction and operation of the HSWAC system for the following reasons:

1. A deep water intake screen would have an important impact on the overall HSWAC pipe design:
    a. Screen design would require careful consideration of screen area required to maintain flow even if the screen becomes biofouled or blocked with organisms or debris. Prediction of the percent blockage for design would be very difficult as there are no data on screens designed for open ocean intakes at this depth. Under such circumstances the typical approach is to use a what is believed to be a conservative design, but again the lack of solid data would make such design prediction difficult to document whether it is truly conservative.
    b. A blocked screen that raises the headlosses in the pipe could cause the premature collapse of the HDPE pipe. Prediction of the percent blockage would become a major consideration in the pipe design and pipe stiffening requirements for this intake pipeline. The HSWAC pipeline is already planned to be heavily stiffened due to its long length and high flow requirements, so increasing the headlosses especially, at the offshore end, would mean adding more stiffeners along the entire length, and the major question is how much is enough? Again data on deep water screen fouling is non-existent.
    c. The deep water HDPE intake would be installed by the controlled submergence deployment process. In this process the contractor needs complete access to the offshore end of the pipe as pressurized air would be discharged at that end during the deployment process and when the end flange is removed by divers during the final, most critical stages of the deployment. Therefore, it is most reasonable to anticipate that any intake screen would have to be a separate structure that is lowered down to the intake in a separate operation. Installation of such a device with adequate care and tight tolerance would be a time consuming, equipment intensive and risky marine operation in the open ocean. At a minimum, a large capacity crane barge that is dynamically positioned by a tug boat and a deep diving work class remotely operated vehicle would be needed.
2. A deep water intake screen would make the pipeline that supplies air conditioning to downtown Honolulu susceptible to a shutdown that could take a minimum of a week and probably much longer to repair.

a. Screen fouling or blockages in deep water would constitute an emergency situation for HSWAC customers. If seawater flows are impeded or blocked, the AC system for many downtown Honolulu buildings would have to operate at reduced flow or be cut off altogether.
b. A deep water intervention would be necessary to determine the nature and extent of the blockage. Such an intervention at 540m depth could only be accomplished by a Hawaiʻi Undersea Research Laboratory (HURL) submersible or by a deep diving ROV. The HURL submersible has a relatively short dive season, is frequently disassembled during the non-dive season or is away from the islands diving. Its support vessel is not always in port during the non-dive season. HURL's submersible cannot be counted on as an emergency repair vehicle. No deep diving work class ROV's are immediately available in Hawaii, and mobilization of such equipment would take a minimum of a week, more likely two weeks to a month, if the required equipment is available on the US West Coast. All of this work would have to be done under the pressure associated with a total or partial shutdown of air conditioning to a large part of downtown Honolulu.
c. The intervention needed to complete the screen cleaning may require bringing the intake screen to the surface. Equipment equivalent to that used for its initial installation would have to be assembled on an emergency basis.

For these reasons, a screening alternative was not carried forward for further analysis. Where a cooling water intake structure does not comply with the Track I requirements of Section 316(b), it must comply with Track II, which requires the demonstration that the technologies employed would reduce the level of adverse environmental impact from the cooling water intake structure to a level comparable to that achieved by implementing Track I. To this end, the applicant's Section 316(b) analysis is included as Appendix N and summarized in Section 3.7.5.2.

2.6 COMPARISON OF THE ENVIRONMENTAL EFFECTS OF THE ALTERNATIVES

Table 2-3 summarizes the environmental effects of the four action alternatives for the HSWAC system. By definition, the No-Action Alternative would have no impacts.

Table 2-3: Comparison of the Effects of the Alternatives

Resource	***Alternative 1***						***Alternative 2***						***Alternative 3***						***Alternative 4 (Applicant's Preferred)***					
	Direct		***Indirect***		***Cumulative***		***Direct***		***Indirect***		***Cumulative***		***Direct***		***Indirect***		***Cumulative***		***Direct***		***Indirect***		***Cumulative***	
	ST	***LT***	***ST***	***LT***	***ST***	***LT***	***ST***	***LT***	***ST***	***LT***	***ST***	***LT***	***ST***	***LT***	***ST***	***LT***	***ST***	***LT***	***ST***	***LT***	***ST***	***LT***	***ST***	***LT***
Cultural	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B
Archaeological	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Historic	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Harbors	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Shipping	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Navigation	SM	N	N	N	N	N	SM	N	N	N	N	N	SM	N	N	N	N	N	SM	N	N	N	N	N
Pipelines	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Outfalls	N	N	N	B	N	B	N	N	N	B	N	B	N	N	N	B	N	B	N	N	N	B	N	B
Dump Sites	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Recreation	L	N	L	B	L	B	S	S	L	B	L	B	L	N	L	B	L	B	L	N	L	B	L	B
Ocean Research	N	N	N	B	N	B	S	S	S	S	L	S	N	N	N	B	N	B	N	N	N	B	N	B
Comm. Fishing	L	N	L	B	N	B	L	N	L	B	N	B	L	N	L	B	N	B	L	N	L	B	N	B
Military Ops	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Potable Water	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B
Electricity	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B
Wastewater	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B
Solid Waste	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Noise	S	N	N	B	N	B	S	N	N	B	N	B	S	N	N	B	N	B	S	N	N	B	N	B
Haz/Toxics	SM	N	N	B	N	B	SM	N	N	B	N	B	SM	N	N	B	N	B	SM	N	N	B	N	B
Traffic	L	N	N	N	L	N	L	N	N	N	L	N	L	N	N	N	L	N	L	N	N	N	L	N
Health/Safety	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Socioeconomic	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Visual	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Natural Hazards	SM	SM	L	L	L	L	SM	SM	L	L	L	L	SM	SM	L	L	L	L	SM	SM	L	L	L	L
Mar. Geology	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Tides/Currents	L	N	N	N	N	N	L	N	N	N	S	N	L	N	N	N	N	N	L	N	N	N	N	N
Water Quality	SM	SM	N	B	N	B	SM	SM	N	B	N	B	SM	SM	N	B	N	B	SM	SM	N	B	N	B
Benthic Biota	L	S	L	B	L	L	SM	S	L	B	L	L	L	SM	L	B	L	L	L	L	L	B	L	L
Pelagic Biota	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Protected Spp.	SM	L	N	N	N	N	SM	L	N	N	N	N	SM	L	N	N	N	N	SM	L	N	N	N	N
EFH	L	SM	L	B	L	L	SM	SM	S	B	L	L	L	SM	L	B	L	L	L	L	L	B	L	L
Terres. Geology	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Climate	L	B	N	N	N	B	L	B	N	N	N	B	L	B	N	N	N	B	L	B	N	N	N	B
Air Quality	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B
Surface Water	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Groundwater	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B
Terres. Biota	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Notes: ST = Short-Term; LT = Long-Term; S = Potentially Significant Adverse Effect; SM = Potentially Significant Adverse Effect Mitigable to Less Than Significant; L = Less Than Significant Adverse Effect; N = No Effect; B = Beneficial Effect

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CHAPTER 3.
AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 INTRODUCTION

This chapter describes the environmental setting of the proposed action and the potential environmental consequences of the four action alternatives and the No Action Alternative on existing environmental conditions. The potential direct, indirect, and cumulative effects of project alternatives on environmental resources are presented. Mitigation measures are also described.

3.2 ARCHAEOLOGICAL, HISTORIC AND CULTURAL RESOURCES

To comply with State law requirements, the applicant prepared an archaeological and cultural impact study[6] and an archaeological monitoring plan[7]. The State of Hawaiʻi Department of Land and Natural Resources, Historic Preservation Division (SHPD) granted acceptance of the applicant's monitoring plan by letter dated November 10, 2008. These documents were reproduced in the DEIS and are incorporated into this FEIS by reference; copies are available from the applicant upon request.

3.2.1 Definition of the Resource and the Region of Influence

Cultural resources are defined as any district, site, building, structure, object or practice considered to be important to a culture, subculture, or community for scientific, traditional, religious, or any other reason. Cultural resources include pre-Contact (before European contact) and post-Contact archaeological resources, architectural resources, and traditional cultural properties and practices. Pre-Contact and post-Contact archaeological resources are areas or locations (sites) where human activity measurably altered the earth or left deposits of physical remains. Archaeological resources can be identified and evaluated for significance according to each site's cultural importance, integrity, and ability to yield important information. Architectural resources are standing buildings, dams, canals, bridges, and other structures of historic or aesthetic significance. Traditional cultural properties are resources associated with cultural practices and beliefs of a living community that are rooted in its history and are important in maintaining the continuing cultural identity of the community; such properties may not always be represented by archaeological or architectural resources.

With respect to archaeological, historic and cultural resources, there are three possible concerns about the HSWAC project: (1) the possibility of uncovering archaeological or cultural remains including human burials in excavations for HSWAC system components, (2) use of or impacts to historic structures in downtown Honolulu, and (3) impacts to traditional Hawaiian cultural activities. The Federal nexus for this EIS is work to be done and structures to be installed in waters of the United States. Consequently, the focus of this Federal EIS is the Permit Area[8], which consists of the seawater system from the intake to the cooling station and all in-water work areas, but does not include the overland freshwater distribution system. The Permit Area therefore, includes the waters and submerged lands offshore of Kakaʻako where the seawater intake and return pipes would be deployed as well as a limited adjoining area where vessels

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[6] Archaeological and Cultural Impact Assessment Study in Support of the Honolulu Seawater Air Conditioning Project in Portions of Kakaʻako and Downtown Honolulu. Pacific Consulting Services. October, 2008.

[7] Archaeological Monitoring Plan in Support of the Honolulu Seawater Air Conditioning Project in Portions of Kakaʻako and Downtown Honolulu. Pacific Consulting Services. December, 2008.

[8] For the purposes of analyzing the potential impacts of an undertaking on historic properties under Section 106 of the National Historic Preservation Act, the ROI is referred to as the Area of Potential Effect (APE). For USACE regulatory actions, the area considered is referred to as the "Permit Area" defined per 33 CFR 325, Appendix C, which does not necessarily coincide with the APE, and that term is used here.

involved with the offshore construction activities would operate. It also includes the area proposed for construction of the onshore cooling station and the area proposed for microtunneling between the cooling station and the shoreline. The Keʻehi Lagoon/Sand Island staging area is also considered part of the Permit Area.

3.2.2 Existing Conditions

Many of the distinctive and significant historic architectural properties in Hawaiʻi are found in downtown Honolulu but several are in Kakaʻako. All of these are inland of the cooling station and the seawater piping system and there are no historic architectural properties in the Permit Area for this Federal regulatory action. There are several historic districts and contributing properties adjacent to the proposed distribution system, but none of these are within the Permit Area for the proposed project. Impacts to these areas and properties were evaluated in the State EIS and are not considered further here.

A cultural impact assessment (CIA) was prepared as a requirement of the State EIS and the results are relevant to this EIS because some of the traditional uses described by respondents involved waters within the Permit Area for the proposed project. The relevant results of the CIA are summarized as follows. Responses in the Marine Resources and Use category indicative of historic uses of the waters off Kakaʻako included:

- Kewalo Basin was a gathering place for Hawaiian, Filipino, Japanese and Chinese fishermen who crewed on reef fishing, deep bottom fishing and pelagic fishing boats,
- A variety of marine resources was collected on the reefs including octopus, reef fish, coastal schooling fish, seaweeds, crabs, sharks, barracudas, sea urchins, sea cucumbers, and limpets,
- Nearshore fishing methods included gleaning, throw net, spear fishing, and pole and line fishing, and
- Other activities engaged in included swimming and surfing.

3.2.3 Approach to Impact Analysis

Reviews of past archaeological studies, historic architectural properties, and historic districts in Kakaʻako and downtown Honolulu did not indicate significant resources in the Permit Area for this EIS. Traditional cultural uses of the shoreline and offshore areas were noted in the CIA and this is the basis for impact analysis in this EIS.

3.2.3.1 Methodology

The CIA consisted of three phases: (1) cultural and historical archival research (literature review); (2) ethnographic survey (oral history interviews), transcribing taped interviews, analysis of ethnographic data (oral histories) and (3) report writing. The level of effort for the study included a broad archival research literature review and an ethnographic survey (11 interviews). The ethnographic survey was designed so that information from ethnographic consultants interviewed would facilitate in determining if any cultural sites or practices or access to them would be impacted by the implementation of the HSWAC project.

3.2.3.2 Determination of Significance

The criterion for significance was permanent prohibition or reintroduction of any traditional cultural use of the Kakaʻako lands or adjacent offshore submerged lands or overlying waters due to the development of the HSWAC system.

3.2.4 Potential Impacts

3.2.4.1 No Action Alternative

The No Action Alternative would have no direct or indirect, long-term or short-term effect on cultural resources because there would be no construction activities. No mitigation measures would be required.

3.2.4.2 **Alternative 1**

With respect to traditional uses of the shoreline area, Alternative 1 would restrict access to the ‘Ewa end of Kaka‘ako Waterfront Park during the period of microtunneling. The offshore corridor that would be used for pipe installation would be off limits for other uses during the construction period. These would be relatively small areas. During construction traditional practices could proceed without restriction in adjoining areas.

The restrictions on use of the project area during construction would be a potential direct, short-term, but less than significant adverse effect on traditional uses of the shoreline. There would be no long-term change to accessibility of the offshore area, nor would any uses be prohibited after installation of the project facilities and therefore there would be no significant long-term adverse effects. Alternative 1, therefore, would have no significant direct or indirect short-term or long-term adverse effects on archaeological, historic or cultural resources. With respect to traditional uses of the nearshore area, there could be a potential indirect long-term beneficial effect on fishing as a result of marine community development on the pipes and supporting structures.

Mitigation Measures

Although analysis of existing documents concluded that there are no archaeological, historic or cultural resources in the Permit Area for this EIS, there are potentially affected cultural, archaeological and historic (architectural) resources along the distribution route and consequently as mitigation the applicant developed an Archaeological Monitoring Plan which was approved by the SHPD. The Archaeological Monitoring Plan would be applied in areas of moderate and high sensitivity for cultural remains (i.e., along the route of the distribution pipes) but there are no such areas in the terrestrial portions of the current Permit Area and no further mitigation is proposed in this EIS.

3.2.4.3 **Alternative 2**

The potential effects of Alternative 2 would be the same as for Alternative 1. No significant adverse effects are anticipated and no mitigation measures are proposed.

3.2.4.4 **Alternative 3**

The potential effects of Alternative 3 would be the same as for Alternative 1. No significant effects are anticipated and no mitigation measures are proposed.

3.2.4.5 **Alternative 4 (Preferred Alternative)**

The potential effects of Alternative 4 would be the same as for Alternative 1. No significant effects are anticipated and no mitigation measures are proposed.

3.3 **BUILT RESOURCES AND HUMAN USES**

3.3.1 **Definition of the Resource and the Region of Influence**

Built resources and human uses include all of the infrastructure and facilities existing in the project area and their use for any purpose. It also includes the consequences of their use such as noise, waste products and human health and safety issues. A variety of built resources and human uses are present in the marine portion of the project area. This section identifies built resources and human uses that could be affected by the proposed action. The resources considered include harbors, shipping, and navigation; pipelines, outfalls and dump sites; ocean recreation; ocean research; commercial fishing; military activities; utilities; ambient noise; hazardous and toxic materials; roadways and traffic; and human health and safety. The ROI for these resources includes the area offshore of Kaka‘ako where the HSWAC system would be constructed and operated, the area of Ke‘ehi Lagoon where assembly and storage of the pipelines would be done, and the Kaka‘ako area where the cooling station would be constructed.

3.3.2 **Harbors, Shipping and Navigation**

3.3.2.1 **Existing Conditions**

The proposed area for installation of the HSWAC intake and return pipes is between the entrances of Honolulu Harbor and Kewalo Basin. Honolulu Harbor is the largest and most important of O‘ahu’s three commercial harbors. It is the State’s port-of-entry for nearly all imported goods. The harbor was created by freshwater flows from Nu‘uanu Valley, which inhibited coral growth within a small, reefed basin and cut several channels through the surrounding reef. The main channel, which was the deepest, was flanked to the west by shallower outlets. Between these outflows rose occasional spots of earth and coral – the beginnings of Sand Island. Use of the harbor by deep-draft vessels can be first traced to fur traders in 1794. The harbor and surrounding village grew with the ensuing sandalwood trade and then the arrival of whaling ships. The harbor was the center of community life in the 1800s and gave the city its name. By 1857, Honolulu Harbor had five wharves capable of handling ships of 1,500 gross tons, with a total berthing frontage of 600 feet. By 1870, an additional 2,000 feet of wharfage had been added by filling 22 acres of reef and tideland. Filling and dredging, including formation of Sand Island, accelerated with the rise of the sugar industry, and later pineapple, in the late 1800s and early 1900s. In 1907, the Corps of Engineers widened and deepened Kapalama Basin and Kapalama Channel. Today Honolulu Harbor has over 30 major berthing facilities with over five linear miles of mooring space, and is surrounded by over 200 acres of container yards. Harbor depths range from 40 to 45 feet. Anchorage for additional deep-draft vessels exists outside the harbor and Sand Island, west of the main entrance channel.

Kewalo Basin, O‘ahu’s smallest commercial harbor, was constructed in the 1920s to ease the congestion in Honolulu Harbor and provide docking for lumber schooners. It soon became a center of fishing operations. In 1955, approximately eight acres of filled land were added along the makai side of Kewalo Basin to form a peninsula protected by a rock revetment. Once used mainly by commercial fishing vessels, including the wooden sampans that supplied skipjack tuna (*aku*) to the now closed tuna cannery that occupied its western shore, Kewalo Basin in recent years has seen increasing use by tour boats offering whale watching and dinner cruises. Some smaller commercial fishing vessels still berth there, as do the majority of O‘ahu’s charter fishing boats. The Pacific Islands Fishery Science Center’s Kewalo Research Facility occupies about one acre near the terminal end of the seaward peninsula. Two saltwater wells provide almost 100,000 gallons per hour to tanks housing pelagic fish, marine mammals, sea turtles, and other marine organisms.

3.3.2.2 **Approach to Impact Analysis**

Methodology

The ROI for harbors, shipping and navigation is that portion of Māmala Bay that could be affected by construction or operation of the HSWAC system and the eastern portion of Ke‘ehi Lagoon and its entrance channel, which could be affected by floating storage of the HSWAC seawater pipes and their transportation for installation. Commercial and recreational harbors in the vicinity of the HSWAC project area were identified. Potentially affected harbors include Honolulu Harbor, Kewalo Basin and Ke‘ehi Lagoon. Hickam Harbor and Ala Wai Harbor were considered too far removed from the action area to be affected directly or indirectly by the proposed action.

Determination of Significance

A significant impact would be one that requires or causes changes to harbor facilities, forces a change in vessel operations inside or outside of a harbor, or creates a hazard to navigation or public safety.

3.3.2.3 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect short-term or long-term effect on harbors, shipping or navigation because there would be no construction of the HSWAC system offshore of Kaka'ako and therefore no additional vessel operations. Honolulu Harbor, Kewalo Basin and Ke'ehi Lagoon would not be impacted directly or indirectly.

Alternative 1

Alternative 1 would have a potentially significant short-term, direct, adverse effect on navigation through the Ke'ehi Lagoon entrance channel during the 24-hours of pipeline tow-out from the staging area to the deployment site. This effect would be mitigated by posting a string of picket boats through the entrance channel to direct other vessels safely through the area during the tow-out process. Construction activities at the breakout pit and along the pipeline would proceed for seven to nine months and there would be vessels anchored offshore during that time. This would be a short-term, direct, but less than significant impact on navigation. The information would be published in the USCG "Notices to Mariners" to alert the boating public to the intended presence of these vessels. Alternative 1 would have no indirect effects on harbors, shipping or navigation. Additional details are as follows.

During construction, vessels not involved in the construction operations would be prohibited in the immediate vicinity of the offshore construction operations. A "Notice to Mariners" would be posted through the U.S. Coast Guard informing mariners of the activities to be taking place. The offshore microtunneling operations at the breakout point would require vessels and possibly a pile-supported platform to occupy that area for seven to nine months. Installation of the pipeline itself would be done in about one day, although making the final connection of the offshore pipelines to the pipes contained in the microtunnel, backfilling the breakout pit and capping with concrete would take on the order of another week. Prohibition of vessel traffic in the construction area would be a direct, short-term, but less than significant adverse effect.

Under Alternative 1, the breakout point and nearshore portions of the seawater pipelines would be installed in the western portion of the area between Kewalo Basin and Honolulu Harbor. It is unknown at this time where the construction vessels would berth, but Honolulu Harbor is the most likely harbor of origin for most of them. There would be no direct or indirect short-term or long-term effect on the facilities or operations in Honolulu Harbor from the HSWAC project. During construction, however, there would be vessels transiting in the vicinity of the Honolulu Harbor entrance channel and stationary vessels positioned to the east of the approach to the harbor. Other vessels approaching from or departing to the east of Honolulu Harbor may be required to adjust their routes to avoid transiting through the work area. Alteration of easterly routes into or out of Honolulu Harbor would be a direct, short-term, but less than significant adverse effect. Approaches or departures to the south or west would not be affected. There would be no short-term or long-term indirect effects.

Vessel traffic within the Ke'ehi Lagoon staging area for the pipelines would be restricted for a period of approximately 10 months, although access to the residences on the island there would not be impeded. In addition, as described below, access for small vessels including canoes would be provided around the floating pipe strings. Final assembly of the pipelines and towing out of Ke'ehi Lagoon would take place over a single day and night. The slowly moving pipeline would be a hazard to navigation for other vessels entering or exiting Ke'ehi Lagoon during this time. To avoid closing the Ke'ehi Lagoon entrance channel to other traffic during this time, which would be a hardship on commercial and recreational users, a fleet of picket boats would guide vessel traffic safely around the work area. Obstruction of the Ke'ehi Lagoon entrance channel during deployment of the pipelines would be a significant direct, short-term adverse effect but mitigable to less than significant. No indirect effects would result.

In discussions with HDOT Harbors Division personnel and representatives of the maritime industry it was learned that tugboats pulling barges out of Honolulu Harbor rapidly pay out their tow lines as they exit the harbor. These lines drag along the bottom and potentially could snag the anchor weights attached to the HSWAC pipeline if the pipeline were positioned too close to the harbor entrance. To mitigate this potential impact, special snag-resistant anchor collars were designed that would allow the lines to slide across the pipeline without catching. With implementation of this mitigation measure, potentially significant direct effects to navigation would be avoided. The snag-resistant anchor collars would be used to depths of at least 150 feet, regardless of the pipeline route.

In summary, the HSWAC project would have a potentially significant short-term, adverse effect mitigable to less than significant on navigation through the Keʻehi Lagoon entrance channel during pipeline deployment, in the pipeline storage area during assembly, and around the offshore construction area while construction is underway. There would be no other effect on harbors, shipping or navigation.

Mitigation measures that would be implemented to minimize the potential impacts of the HSWAC system on harbors, shipping and navigation include:

- A “Notice to Mariners” would be published to alert vessel operators to the activities. Appropriate marking and lighting of all construction vessels either underway or at anchor would be used.
- Special snag-resistant anchor collars would be used on the HSWAC pipelines to depths of 150 feet.
- To mitigate impacts of floating pipe storage in Keʻehi Lagoon, several measures would be implemented. First, as noted above, access to the residences on the island would be maintained by positioning the pipe strings to the south of the access lane. Second, to avoid impeding recreational use of the storage area by canoe paddlers, the floating pipes would be positioned such that canoes or other vessels could pass to either side of the pipes. The restricted area would be as small as possible and limited to the area where the pipes are actually present.
- During the final assembly of the pipelines and towing from Keʻehi Lagoon, a fleet of picket boats would guide vessel traffic safely around the work area, as described in Section 2.4.2.6.

Alternative 2

The effects of Alternative 2 would be the same as those for Alternative 1 except that the anchored construction vessels would be positioned closer to the Kewalo Basin entrance channel. Under Alternative 2, the breakout point and shallow portion of the seawater pipelines would be in the eastern portion of the area between Honolulu Harbor and Kewalo Basin. Potential interactions with barge tow cables would be eliminated and obstruction of the approach from the east to Honolulu Harbor would be removed. Instead, vessels approaching from or departing to the west from Kewalo Basin would have to navigate around the restricted work area. This would not be as significant an impact as that under Alternative 1, because no large vessels such as container ships or tugs with barges in tow use Kewalo Basin. Vessels using that harbor are smaller dinner cruise, wildlife viewing, recreational activity and fishing vessels. A “Notice to Mariners” would be posted to alert vessel operators to the activities. The impact of the construction operations on these vessels would be direct and short-term, but less than significant. No indirect effects would result.

Impacts to the pipelines from barge tow lines or large vessel anchors would be less likely with the greater separation from the Honolulu Harbor entrance channel. Nevertheless, the snag-resistant collars on the pipelines would be used to a depth of 150 feet to insure there would be no adverse effect.

Impacts to Ke‘ehi Lagoon users would be the same as those under Alternative 1, and the mitigation measures would be identical.

Alternative 3

The impacts of and mitigation measures for Alternative 3 would be identical to those of Alternative 1. The only difference between these alternatives would be that to accommodate both pipes, Type A (snag-resistant) combination collars would be employed from the breakout pit to the end of the diffuser at 300 feet deep.

Alternative 4 (Preferred Alternative)

The impacts of and mitigation measures for Alternative 4 would be identical to those of Alternative 1. The only difference between these alternatives would be that to accommodate both pipes, Type A (snag-resistant) combination collars would be employed from the breakout pit to the end of the diffuser at 423 feet deep.

3.3.3 Pipelines, Outfalls and Dump Sites

3.3.3.1 Existing Conditions

Honolulu Harbor historically has been and continues to be ringed with various types of industry. Pollution is well known in the harbor; degraded conditions are described as early as 1920 in references cited by Cox and Gordon (1970). Several regulated and unregulated point sources of pollution discharge into Māmala Bay. Most prominent are the three wastewater treatment plant (WWTP) outfalls (Sand Island, Fort Kamehameha, and Honouliuli). Sewage has been pumped into the ocean offshore of Kewalo and Sand Island since the 1930s. The early inputs were all raw sewage released in shallow water (not exceeding 20 feet in depth). The actual points of release varied through time as different pipes were constructed and used. The multitude of perturbations that occurred in shallow water from these early sewage inputs continued until the construction of the present Sand Island deep-water outfall in 1978 (Brock, 1998).

Other notable discharges to Māmala Bay include the Ala Wai Canal (into which Mānoa Stream discharges); Nu‘uanu, Kapalama, Kalihi, and Moanalua Streams; other small streams and drainage channels; and Pearl Harbor, which receives runoff from five perennial and three intermittent streams.

West of Kewalo Basin, on lands now occupied by Kaka‘ako Waterfront Park, stood the former Honolulu incinerator and dump. While in operation, this dump received both burned and unmodified wastes from urban Honolulu at a period of time when concern over pollution from anthropogenic sources was less than now. Because the unlined dump filled in a section of old coastline in excess of 330 feet seaward, these materials along the seaward side are exposed to seawater and there is a potential for leaching of pollutants (Brock, 1998).

The diffuser for the Sand Island WWTP deep ocean outfall lies about two miles west of the proposed site of the HSWAC seawater return diffuser.

Māmala Bay has been used as a dumping ground for dredged materials from both Pearl Harbor and Honolulu Harbor. Figure 3-1 shows the three main dump sites in Māmala Bay: the former Pearl Harbor site, the former Honolulu Harbor Site, and the active South O‘ahu Site, which was approved for use by the USEPA in 1980. That site is approximately 1.5 miles west of the proposed HSWAC seawater intake site. An old 1972 disposal site is also shown along with two study sites evaluated during the South O‘ahu designation study.

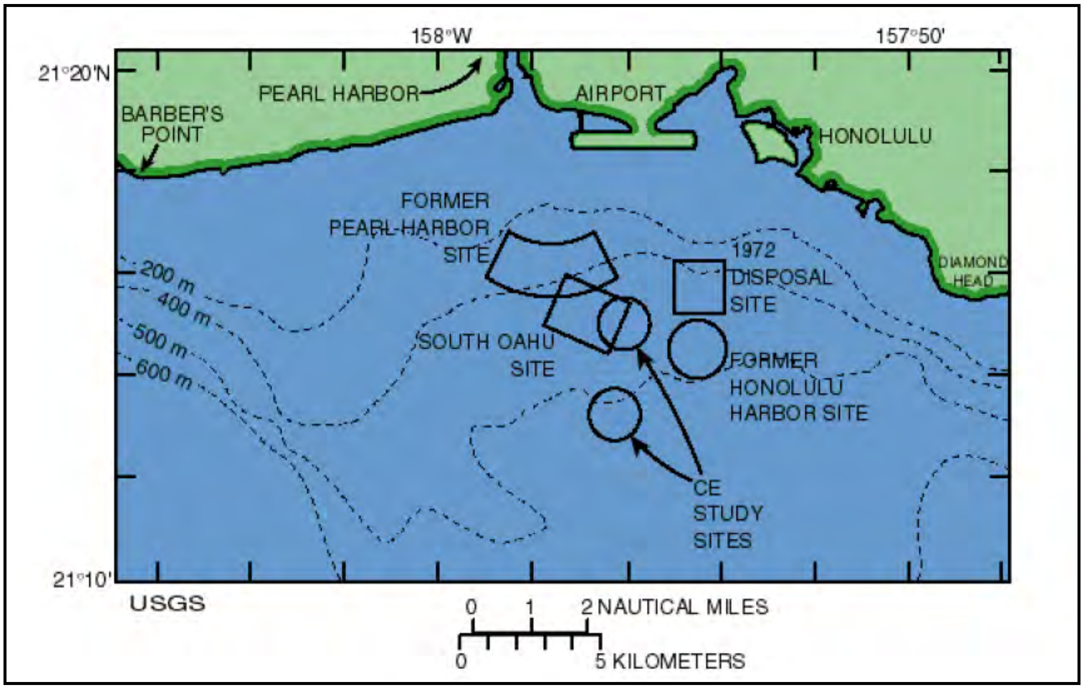

Figure 3-1: Dredged Material Disposal Sites in Māmala Bay
(Source: USGS, 2005)

In addition to dredged spoils disposal, parts of Māmala Bay have historically received discarded military munitions (DMM). In 2010 the Final Investigative Report of the Hawai‘i Undersea Military Munitions Assessment (HUMMA) (University of Hawai‘i and Environet, Inc., 2010) was released. This study, commissioned by the National Defense Center for Energy and Environment, assessed and characterized a historic deep-water munitions disposal site to determine the potential impact of the ocean environment on sea disposed munitions and of sea disposed munitions on the ocean environment and those who use it. Both chemical and conventional munitions were assessed. The HUMMA study was intended to collect data to allow risk to be evaluated so that the need for further actions (e.g., monitoring or removal) could be evaluated. The study area was off the mouth of Pearl Harbor, west of the HSWAC project area, but it was anticipated that DMM would be found within the HSWAC project area as well. In fact, when the deep water videos of the HSWAC intake pipe route were reviewed, DMM were apparent at several locations along the route. The presence of a cluster of DMM near the originally proposed intake site resulted in relocation of the proposed intake location slightly inland of the original location at a bottom depth of 1,755 feet.

Inland of Kaka‘ako Waterfront Park, the John A. Burns School of Medicine (JABSOM) has a seawater condenser cooling system to improve the efficiency of air conditioning its facilities. The system consists of two extraction wells drawing cool seawater from 750 feet deep and a gravity injection well returning the water to 1,850 feet deep. The wells are located at the southwest corner of their property, adjacent to Keawe Street. Short pipelines run from the wells to a central plant where pumps and heat exchangers are located. From there, freshwater pipelines connect to chillers.

3.3.3.2 **Approach to Impact Analysis**

Methodology

The ROI for pipelines, outfalls and dump sites is that portion of Māmala Bay that could be affected by construction or operation of the HSWAC system and the eastern portion of Ke‘ehi Lagoon and its entrance channel, which could be affected by floating storage of the HSWAC seawater pipes and their transportation for installation. It also includes the area from the shoreline jacking pit to the cooling station.

Determination of Significance

A significant impact would be one that damages an existing pipeline or outfall, disturbs a dump site such that contaminants are released to the water column, or disturbs DMM to create an unacceptable human health or ecological risk.

3.3.3.3 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect, long-term or short-term adverse effects on pipelines, outfalls or dump sites because no microtunnel would be bored and no pipelines would be installed on the seabed.

Alternative 1

The diffuser for the Sand Island WWTP deep ocean outfall lies about two miles west of the proposed seawater piping system for Alternative 1. There are a number of known former dredged material dump sites and a current dump site to the west of the HSWAC seawater pipe route, and the HSWAC project area offshore of Kaka‘ako has also been used for disposal of dredged materials from Honolulu Harbor. Alternative 1 would have no effect on the former or current dump sites because they are sufficiently distant from the proposed operations.

Indirectly, the HSWAC system would decrease the use of potable water in cooling towers and thus decrease the quantity of wastewater discharged through the Sand Island deep ocean outfall. This would be a potential direct, long-term beneficial effect.

Relevant conclusions of the HUMMA study were that no chemical agents, energetics, or their degradation products were detected in shrimp or fish tissue samples. No energetics or their degradation products were detected in any of the sediment samples from which the biota could acquire the contaminants. The study concluded that tissue results do not indicate any bioaccumulation of chemical agents, energetics, or their degradation products. Elevated levels of arsenic and lead in sediments were attributed to dredge spoil disposal. In terms of human health risk, the authors concluded the most likely exposure via dermal contact would be scientific researchers, but that adequate precautions would be taken by this group. Otherwise, the remaining exposure pathway to elevated metals concentrations would be ingestion of seafood. A conservative calculation of the risk from this remaining pathway showed that the risk was within USEPA acceptable levels.

The HSWAC project would include excavation of the receiving pit and sediment from the upper portion of the hollow pipe piles that would be used to secure shallow reaches of the pipelines to the bottom. The receiving pit would be constructed in shallow water, beginning at a depth of 31 feet. This is significantly shallower than the depths at which munitions were disposed of. This area was surveyed by divers and no munitions were observed. The deep water marine biology survey, which used video recordings to survey the route from diver-accessible depths to the intake depth, encountered no munitions at depths shallower than 200 m. The HUMMA study sampled depths in excess of 400 m, as that is where sidescan sonar surveys detected appropriate reflective targets. Consequently, it is highly unlikely that munitions would be encountered at the shallow depths of the receiving pit or at depths where piles would be used to secure the collars (to 150 feet). Nevertheless, the possibility of encountering DMM would be addressed in the project-specific health and safety plan the applicant would require of the contractor prior to initiating any in-water work.

Alternative 1 includes microtunneling under Keawe Street from the shoreline jacking pit to the cooling station. This microtunnel would not encroach beneath JABSOM property and would have no direct effect on the JABSOM wells or pipelines. The annulus between each jacked pipe and the respective tunnel wall would be grouted to prevent any potential indirect effect on the JABSOM system due to differential ground settlement.

Alternative 1 would have no direct or indirect, short-term or long-term adverse effect on the nearest pipelines, outfalls and dump sites. Elimination of the use of cooling towers in buildings connected to the HSWAC system would decrease the volume of wastewater discharged through the Sand Island outfall and this would be an indirect, long-term beneficial effect.

Alternative 2

Compared to Alternative 1, under Alternative 2, the nearshore microtunnel route, breakout point and shallow surface-mounted pipelines would be further to the east of the existing WWTP deep ocean outfall and approved dredged material dump sites. As for Alternative 1, there would be no potential effects on them or from them on the proposed facilities. The potential indirect, long-term effect would be beneficial due to a decrease in wastewater generation from cooling towers and subsequent disposal through the Sand Island outfall. The potential effects of DMM and mitigation measures would be the same as for Alternative 1. The Alternative 2 cooling station would be located across the drainage canal from the JABSOM and the Alternative 2 seawater piping would not approach the JABSOM facilities so no direct or indirect adverse effects to JABSOM would result from implementation of Alternative 2.

Alternative 3

Alternative 3 would have no direct or indirect, short-term or long-term adverse effect on the nearest pipelines, outfalls and dump sites. The deeper diffuser of Alternative 3 would be slightly further than the Alternative 1 diffuser from the active wastewater outfalls and dump sites in Māmala Bay. The potential effects of DMM and mitigation measures would be the same as for Alternative 1. Similar to Alternative 1, no direct or indirect adverse effects to JABSOM facilities would result from implementation of Alternative 3.

Alternative 4 (Preferred Alternative)

Alternative 4 would have no direct or indirect, short-term or long-term adverse effect on the nearest pipelines, outfalls and dump sites. The deeper diffuser of Alternative 4 would be slightly further than the Alternative 1 diffuser from the active wastewater outfalls and dump sites in Māmala Bay. The potential effects of DMM and mitigation measures would be the same as for Alternative 1. Similar to Alternative 1, no direct or indirect adverse effects to JABSOM facilities would result from implementation of Alternative 4.

3.3.4 **Ocean Recreation**

3.3.4.1 **Existing Conditions**

Immediately ashore of the marine portion of the Kaka‘ako project area is Kaka‘ako Waterfront Park, built on an old solid and incinerator waste dump site. The waste has been capped, and fill added to limit exposure to toxics by park users. Recreational activities on the reef fronting Kaka‘ako Waterfront Park include swimming, surfing, snorkeling, diving, body boarding and various kinds of fishing. One of O‘ahu’s popular bodysurfing sites, Point Panic, is located at the east end of the park in front of the University of Hawai‘i’s Kewalo Marine Laboratory. Since 1994 this site has been off-limits to board surfers. Waters to the west of Point Panic are open to board surfers (Clark, 2005). Activities taking place farther offshore include sailing, paddling and other types of fishing.

The proposed staging area on Sand Island is part of a large parcel that extends around the entire seaward margin of Sand Island from the northwest end of the Ke‘ehi Lagoon frontage, along the south-facing side of Sand Island, and extending around to the north fronting the interior of Honolulu Harbor. This parcel, at its eastern end, contains Sand Island State Park. The proposed staging area, however, is more than a half mile from the developed park. Ke‘ehi Lagoon Beach Park, a seventy-two-acre park on the northern shore of the lagoon, is the site of outrigger canoe regattas. Facilities include canoe storage, a viewing stand and a man-made sand beach. While the waters of the lagoon are not highly regarded for swimming, they provide an excellent venue for canoe racing (Clark, 2005).

3.3.4.2 **Approach to Impact Analysis**

Recreational uses of an area for the purposes of this EIS include any type of outdoor activity in which residents or visitors may participate. Typically (though not exclusively) focused on weekends or vacation periods, such activities may include hiking, fishing, swimming, surfing, diving, and boating. Recreational opportunities and resources can be a very important component of an area’s economy and the lifestyle of its residents. The onshore portions of the HSWAC system, in particular the shoreline jacking pit required under Alternatives 1, 3 and 4, would affect a small portion of Kaka‘ako Waterfront Park. The offshore portions of the system would affect users of Kaka‘ako Waterfront Park and potentially users of Ke‘ehi Lagoon and Sand Island State Park, so the ROI for recreational resources includes those three parks and the adjacent waters.

Methodology

Recreational facilities and uses of lands and waters in the vicinity of the HSWAC project area were identified by the applicant from books, visitor pamphlets, and websites, including those of the City and County of Honolulu and the State of Hawai‘i. The applicant consulted representatives of the DLNR Division of Boating and Ocean Recreation who assisted in developing mitigation for potential impacts to boaters using Ke‘ehi Lagoon.

Determination of Significance

For the purpose of this EIS, the proposed action and alternatives would cause a significant impact on recreational resources if they:

- Would substantially alter access to recreational resources;
- Would substantially alter recreational opportunities;
- Would substantially alter relations between recreational users; or
- Would cause substantial physical alteration of recreational resources.

3.3.4.3 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term adverse effect on ocean recreation because there would be no offshore construction and no use of the staging area and therefore no restriction of access to any potential recreational area.

Alternative 1

Alternative 1 would tunnel beneath the shoreline close to the ‘Ewa-makai corner of Kaka‘ako Waterfront Park. Approximately 5,000 square feet would have to be secured for equipment and materials staging and for excavation of a jacking pit. This area of the park is very sparsely used due to its relatively undesirable location far from parking behind a hill separating it from the remainder of the park and its developed facilities. The area affected would be returned to its previous condition or better after construction.

During initial deployment of the surface-mounted pipes, it would be necessary to position holdbacks on the landward end of the pipes to avoid kinking. The holdbacks could be in the form of anchors or piles driven between the shoreline and the microtunnel breakout point or they could be in the form of anchors or bulldozers situated in a portion of the park immediately fronting the ocean. In either case, there would be cables under tension attached to the holdbacks, creating a public safety hazard. This would necessitate restricting recreational use of the hazardous area during the deployment event. The restricted area, either onshore or offshore, would be small and restriction of recreational access would only be required during the approximately one day of pipe deployment. There would be no limitation on uses of most of the park during that time. If offshore holdbacks are used by the contractor, the applicant proposes mitigation for potential impacts in the form of construction specifications that would require that areas of sand without coral or other significant benthic macrofauna be used. If onshore holdbacks are used, the applicant proposes mitigation for potential impacts in the form of construction specifications that would require that any areas affected be returned to their previous condition or better after pipe deployment. Use of the offshore or onshore holdback areas would be a direct, short-term, less than significant adverse effect.

Recreational access to the waters offshore of Kaka‘ako Waterfront Park would also be prohibited around the breakout location, which would be occupied for seven to nine months and around a larger area along the length of the pipelines, which would be off limits only during the one-day deployment of the pipelines coincident with occupation of the holdback areas. These restrictions would be direct, short-term, less than significant adverse effects.

Indirect effects would include displacement of recreational activities to other shoreline or offshore areas, but these also would be short-term, less than significant effects due to the limited number of people affected and the large amount of other park area or offshore water available.

Once the proposed pipeline is operational there would be no long-term adverse impacts to recreational activities. The presence of the surface-mounted pipes and the anticipated development of marine communities on the pipes and the concrete collars would create a potential new destination for recreational SCUBA divers. That would be an indirect, long-term beneficial effect.

The Ke‘ehi Lagoon staging area would be in use for approximately 10 months. During staging and construction of any of the action alternatives, this area would be off-limits to ocean users for safety reasons. The size of this area would be minimized and consist of only the area actually in use for floating pipe storage. Vessel access would be permitted around the floating pipes. The restriction would be a direct, short-term, less than significant adverse effect.

The shoreside component of the staging area would be sufficiently distant from actively used recreational areas of Sand Island State Park to have any effect on them. The staging site is part of an area that is intended to be developed into an off-road vehicle park by the Sand Island Off-Highway Vehicle Association. That park is intended to be built-out over time. Limited operations are taking place on the section situated to the north of the proposed HSWAC staging area. Build-out of the area where staging of the HSWAC pipes would be done has not been scheduled. As mitigation for potential impacts, the applicant proposes to return the staging site to its previous condition or better after construction activities are complete.

In summary, Alternative 1 would have direct and indirect, short-term, less than significant adverse effects on users of Kakaʻako Waterfront Park and the waters offshore of the park and an indirect, long-term beneficial effect on users of waters offshore of the park by creation of structures that would attract SCUBA divers and fishermen.

Mitigation measures for potential impacts to recreational resources include:

- If offshore holdbacks are used by the contractor, areas of sand without coral or other significant benthic macrofauna would be used.
- All areas affected by construction would be returned to their previous condition or better after construction.
- The size of the area used for floating pipe storage would be minimized. Vessel access would be permitted around the floating pipes.

Alternative 2

The proposed breakout point for Alternative 2 would be in the biotope of dredged rubble, as for Alternative 1. However, unlike the situation offshore of the Alternative 1 breakout point where dredged rubble gives way to sand bottom further off shore, seaward of the Alternative 2 breakout point is an area of relatively high coral cover frequented by recreational divers. Alternative 2 would not require the jacking pit near the ʻEwa end of the park, but could require that areas of the park be closed during the actual laying of the offshore pipes to allow establishment of onshore positions for attachment of tensioning cables. Because of its potential adverse effect on the area of high coral cover, Alternative 2 would have significant, direct, short-term and long-term adverse effects on recreation. This would be offset in the long-term by the indirect beneficial effect of the pipes and structures on recreational diving and fishing.

Alternative 3

The impacts of Alternative 3 would be very similar to those of Alternative 1, except that the return seawater pipe would extend approximately 1,550 feet farther offshore and terminate at twice the depth. This would put the diffuser effectively out of reach of typical recreational SCUBA divers. To the extent that the pipes and collars enhance fish stocks through provision of shelter and foraging habitat, and to the extent that the region where the intake and return pipes parallel each other offer better habitat than a single pipe, Alternative 3 could provide somewhat better recreational fishing opportunities than either Alternative 1 or Alternative 2 because the region of double pipes would extend to 300 feet deep rather than 150 feet deep. Alternative 3, therefore, would have less than significant short-term, direct and indirect adverse effects, no long-term direct, adverse effect, and a long-term, indirect beneficial effect.

Alternative 4 (Preferred Alternative)

The impacts of Alternative 4 would be very similar to those of Alternative 3, except that the return seawater pipe would extend even farther offshore and terminate 100 feet deeper. The diffuser would be out of reach of typical recreational SCUBA divers. To the extent that the pipes and collars enhance fish stocks through provision of shelter and foraging habitat, and to the extent that the region where the intake and return pipes parallel each other offer better habitat than a single pipe, Alternative 4 could provide somewhat better recreational fishing opportunities than any of the other action alternatives because the region of double pipes would be longer than for any other alternative. Alternative 4, therefore, would have less than significant short-term, direct and indirect adverse effects, no long-term direct, adverse effect, and a long-term, indirect beneficial effect.

3.3.5 **Ocean Research**

3.3.5.1 **Existing Conditions**

The area offshore of Kakaʻako is used for research purposes by the University of Hawaiʻi's Kilo Nalu Oʻahu Reef Observatory. The Observatory is located offshore of Kakaʻako Waterfront Park, east of downtown Honolulu and west of Waikiki and Ala Moana. The Observatory maintains an array of instruments and conducts associated research in the areas of nearshore coral reef physical, biological and chemical oceanography. The observatory is managed and maintained by the University of Hawaiʻi at Mānoa's Department of Ocean and Resources Engineering (ORE), School of Ocean and Earth Science and Technology (SOEST). Kilo Nalu provides data and power connections to a suite of observational instruments that investigate waves, tides, currents and nearshore water quality. Figure 3-2 shows the components of the Observatory, which include nodes at 10 and 20 meter depths, T-chain arrays at 10 and 20 meter depths, acoustic Doppler current profilers at 10 and 20 meter depths, and a Seahorse moored profiler at 30 meters deep. Additional instrumentation at greater depths is planned. Additional data are collected by autonomous underwater vehicles, research ships and satellites.

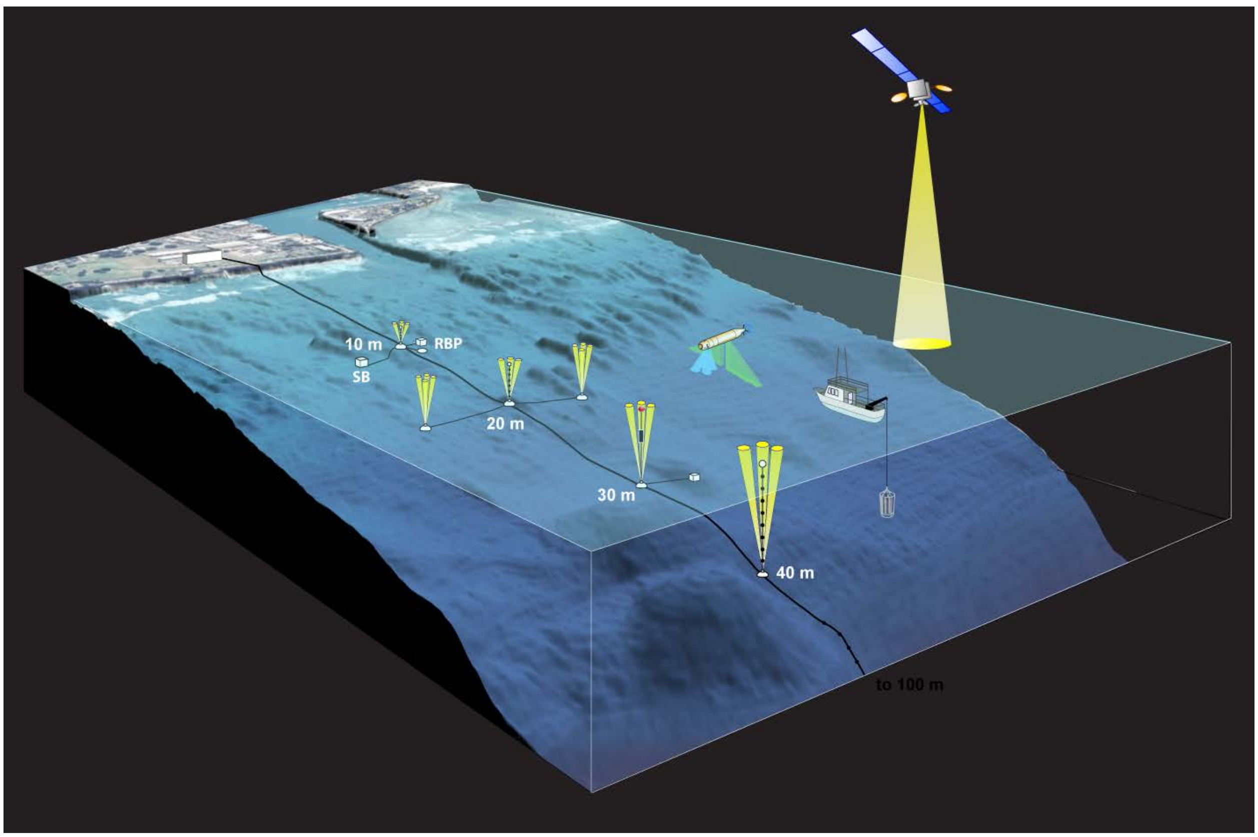

Figure 3-2: Components of the Kilo Nalu Oʻahu Reef Observatory

3.3.5.2 **Approach to Impact Analysis**

Comments received in the Federal scoping process from the University of Hawaiʻi's (UH) Kilo Nalu marine scientists indicated potential conflicts between construction and operation of the HSWAC seawater system along the eastern alternative route (Alternative 2) and the facilities and operations of the Kilo Nalu Observatory.

Methodology

Several meetings of the applicant's engineers and planners and Kilo Nalu scientists were held to develop an understanding of each other's requirements and determine if adjustments to the HSWAC route were technically feasible. As a result, additional geotechnical studies were conducted to investigate the feasibility of a route to the west of the dredge spoil mounds, closer to the Honolulu Harbor entrance channel.

Determination of Significance

For the purpose of this EIS, the proposed action and alternatives would cause a significant impact on ocean research if they:

- Would physically affect the array of instrumentation currently in place;
- Would alter access to the instrument array for data recovery, maintenance or expansion; or
- Would alter the quality of data or create a discontinuity in the time series of data collected in the research.

3.3.5.3 **Impacts**

No Action Alternative

The No Action Alternative would have no effect on the facilities or operations of the Kilo Nalu Observatory, as under that alternative the applicant would neither construct nor operate a seawater piping system offshore of Kaka‘ako.

Alternative 1

Following identification of the potential conflict of the eastern seawater pipeline route with the facilities and operations of the Kilo Nalu Observatory, additional engineering evaluations of the bathymetry, slope, sediment characteristics, and geological hazards in the area closer to the Honolulu Harbor entrance channel were conducted. A technically feasible route to the west of the dredge spoil mounds was defined. This western route was adopted as part of Alternatives 1, 3, and 4 while the eastern route was retained as part of Alternative 2.

Alternative 1 would have no direct or indirect, short-term or long-term adverse effects on research activities of the Kilo Nalu Observatory. Synergistic beneficial effects in terms of increased understanding of nearshore oceanographic processes would be possible by linking the applicant's proposed construction and operations monitoring program with the research interests of the Kilo Nalu scientists. The applicant and the Kilo Nalu staff have agreed to collaborate in future efforts. Potential collaboration may involve such activities as:

- Real-time environmental monitoring;
- Instrumentation of the deep intake pipe (temperature, pressure, velocity);
- Shore cable access;
- Video and/or acoustic monitoring; and
- ROV/autonomous underwater vehicle (AUV) surveying.

Alternative 2

In the short term, construction operations associated with creating the receiving pit could affect localized water quality and degrade the time series of water quality data collected by the Observatory. Vessel operations, in particular anchoring, could physically damage the instrument array. Installation of the seawater pipes and collars likewise could physically damage the instrument array. The long-term presence of the pipes and collars could affect local hydrodynamics and thereby permanently affect the long-term time series of water current data. Alternative 2, therefore, would have significant direct short-term and long-term adverse effects on the facilities and operations of the Kilo Nalu Observatory. Indirect adverse effects could include such things as reduced access to research grants and reduced research opportunities for students and faculty, and these would be significant in both the short-term and long-term as well. Potential collaboration between the applicant and Kilo Nalu scientists would be possible as for Alternative 1, but some reduced enthusiasm might be anticipated given the significant degradation of the observatory's mission under this alternative.

Alternative 3

Alternative 3 would have no direct or indirect, short-term or long-term adverse impacts on research activities of the Kilo Nalu Observatory. Potential beneficial effects of collaboration with the UH marine scientists would be similar to those under Alternative 1.

Alternative 4 (Preferred Alternative)

Alternative 4 would have no direct or indirect, short-term or long-term adverse impacts on research activities of the Kilo Nalu Observatory. Potential beneficial effects of collaboration with the UH marine scientists would be similar to those under Alternative 1.

3.3.6 Commercial Fishing

3.3.6.1 Existing Conditions

In Hawaiʻi, anyone who sells any part of their catch is classified a commercial fisherman. Commercial fisherman must be licensed by the State and submit catch reporting forms. Many recreational or subsistence fishermen sell portions of their catch to recover trip expenses, and thus are nominally commercial fishermen. Fishery resources in the project area are depleted as a result of habitat degradation and overfishing. Nevertheless, shore fishing is popular, and net and spear fishing are practiced nearshore. Reef fishing from small boats takes place offshore and some of the charter boats from Kewalo Basin now offer night reef fishing.

Commercial catches are reported to the Hawaiʻi Division of Aquatic Resources (DAR) monthly by statistical area. Area 400 extends two miles offshore from the middle of the Reef Runway to Diamond Head. Area 420 extends seaward from 2 to 20 miles offshore. DAR's 2005 landings summary report (the latest year for which data are available on line) show that 46,428 pounds (including fish, shellfish, and seaweed) were landed from these two areas. That represents 0.02% of the Oʻahu landings. The report does not provide data on landings by each of these areas or on the species composition of those landings, but DAR kindly provided the 2007 data for these two areas (Table 3-1).

Table 3-1: Commercial Marine Landings off Kakaʻako in 2007

Species Group	***Species***	***Area***	
		400	***420***
		lbs. Landed	***lbs. Landed***
AKULE/OPELU	AKULE/HALALU	3,365	***

Table 3-1: Commercial Marine Landings off Kaka'ako in 2007

Species Group	***Species***	***Area***	
		400	***420***
		lbs. Landed	***lbs. Landed***
	OPELU	592	***
AKULE/OPEL	***SUBTOTAL***	***3,957***	*********
BILLFISHES	BLUE MARLIN		3002
	SHORT BILL SPEARFISH		180
	STRIPED MARLIN		622
	SWORDFISH	***	
BILLFISHES	***SUBTOTAL***	*********	***3804***
DEEPBOTTOM	HAPUUPUU	***	***
	KALEKALE		***
	OPAKAPAKA	***	***
	UKU	***	***
	EHU	44	44
	ONAGA	***	781
	LEHI		***
	GINDAI		***
	HOGO		***
	TAAPE	1358	
DEEPBOTTOM	***SUBTOTAL***	***1402***	***825***
INSHORE	A'AWA	***	
	AHA	***	
	AWA	74	
	HILU	***	
	KALA	82	
	KAWALEA	***	
	KUMU	39	
	LAENIHI	4	
	MAIKO	***	
	MA'O MA'O	***	
	MANINI	385	
	MOANA	83	
	MU	***	
	NAENEA	***	
	NENUE	***	
	NUNU	***	
	OIO	***	
	PALANI	776	
	PANUHUNUHU	***	
	PUALU	***	
	PUHI (MISC.)	***	
	PUHI (BLACK/BROWN)	***	
	UHU (MISC.)	1,154	
	MENPACHI	44	
	MALU	***	

Table 3-1: Commercial Marine Landings off Kaka'ako in 2007

Species Group	***Species***	***Area***	
		400	***420***
		lbs. Landed	***lbs. Landed***
	TOAU	***	
	ROI	38	
	POO PAA	***	
	OPELU KALA	***	
	KALALEI	***	
	RED WEKE	405	
	WEKE A'A (WHITE)	***	
	MOANO KALE	***	
INSHORE	***SUBTOTAL***	***3,084***	
JACKS	OMILU	100	***
	KAGAMI	***	
	DOBE	***	
	SASA	***	
	PAPA	13	
	WHITE PAPIO/ULUA	522	
	PAPIO, ULUA (MISC.)***	22	
JACKS	***SUBTOTAL***	***657***	*********
MISC. PELAGIC	MAHIMAHI	393	6,473
	ONO	***	1,223
MISC. PELAGIC	***SUBTOTAL***	***393***	***7,696***
OTHER ANIMAL	SQUID	***	
	HE'E (DAY TAKO)	2,744	
	OPIHI 'ALINA	***	
OTHER ANIMAL	***SUBTOTAL***	***2744***	
SEAWEEDS	LIMU KOHU	***	
	OGO	471	
SEAWEEDS	***SUBTOTAL***	***471***	
SHELLS	CONIDAE	na	
	C. TIGRIS	na	
	C. MARIAE	na	
	MURICIDAE	na	
	SPNDYLIDAE	na	
	TEREBRIDAE	na	
	ARCHITECTONICIDAE	na	
SHELLS	***SUBTOTAL***	na	
TUNA	AKU	75	753
	YELLOWFIN TUNA	***	5,704
	KAWAKAWA		46
TUNA	***SUBTOTAL***	***75***	***6,503***
UNCLASS/MISC.	UNKNOWN/MISC***	1,313	1,051
UNCLASS/MISC.	***UNKNOWN/MISC******	***1,313***	***,1051***

Table 3-1: Commercial Marine Landings off Kaka'ako in 2007

Species Group	***Species***	***Area***	
		400	***420***
		lbs. Landed	***lbs. Landed***
AREA	**TOTAL**	**14,096**	**19,879**
CY2007 for 400/420	**GRAND TOTAL**	**33,975**	
***Due to low level of fishermen reporting and to preserve confidentiality, data for these species are pooled under their respective species group unclassified miscellaneous or the Unclass./Misc. category. *Source: State of Hawai'i, DLNR, Division of Aquatic Resources*			

Landings in 2007 were nearly 27% less than in 2005. Landings in Area 400, nearest to shore, were 14,093 pounds, dominated by akule, a coastal schooling fish, taape, an introduced snapper, uhu (parrotfish), and he'e (octopus). Akule is fished from a boat with nets or hook and line. Taape are usually taken on hooks. Parrotfish and octopus are usually taken by divers with spears.

Landings in Area 420 further offshore reflect the necessity to fish that area from a boat. A total of 19,878 pounds was landed, with the great majority being pelagic species typically caught by trolling including tunas, billfish, mahimahi and ono (wahoo). A small quantity of deep bottomfish was harvested, mostly onaga.

3.3.6.2 **Approach to Impact Analysis**

Methodology

The applicant consulted the DLNR DAR, which provided a breakdown of reported commercial fishing catches in the areas offshore of Kaka'ako. These were compared with the catches reported for all waters around O'ahu to assess the importance of potentially affected areas to commercial fishing. From the types of fish landed, the most likely types of fishing gear were deduced and used to assess the types of impacts that might be experienced by commercial fishermen.

Determination of Significance

For the purpose of this EIS, the proposed action and alternatives would cause a significant impact on commercial fishing if they:

- Would alter access to important fishing grounds,
- Would substantially alter the size of fishery stocks, or
- Would cause substantial physical alterations of habitat for fishery stocks.

3.3.6.3 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effects on commercial fishing because there would be no offshore construction activities or facilities.

Alternative 1

The area immediately offshore of Kaka'ako has been highly impacted by historical uses, has little relief, and is periodically subjected to high surf events that maintain the marine community in an early stage of succession. Commercial fishery landings data verify that this area is not a frequently used fishing ground. The area from the middle of the Reef Runway to Diamond Head from the shoreline out to 20 miles offshore produced 0.02% of the 2007 O‘ahu commercial landings. The primary ROI for potential effects on commercial fishing is but a small percentage of that and includes the area between Honolulu Harbor and Kewalo Basin from the shoreline out to about 5 miles. This ROI would produce an even smaller percentage of the annual O‘ahu commercial landings. A secondary ROI would be Channel D in Ke‘ehi Lagoon where floating pipes would be stored prior to deployment. During construction and pipeline deployment off Kaka‘ako, the same access restrictions would apply to commercial fishing as described above for recreational uses.

During construction, fish in the ROI may be temporarily displaced to adjacent areas by the noise and construction activities. Conversely, they may be attracted to disturbed areas by greater foraging opportunities. In either event, a substantial reduction of fishery stocks would not result and the direct effect would be less than significant.

It is unlikely that any commercial fishing takes place in the proposed Ke‘ehi Lagoon staging area, but it too would be prohibited in the operations area during pipeline assembly. Again, fishing effort could be shifted to other areas of Ke‘ehi Lagoon and both direct and indirect effects would be less than significant.

Once the system is installed, the pipeline would supply vertical relief to the benthic environment. It is possible that because of additional habitat and shelter provided by the pipeline and anchor collars that fish populations and other components of the benthic and demersal community would increase, providing enhanced opportunities for both commercial and recreational fishing. This would be an indirect beneficial effect.

In summary, Alternative 1 would have a direct, short-term, less than significant, adverse effect on commercial fishing due to the restriction of access to the offshore construction area. Fishermen, however, would be able to shift effort to other nearby grounds if so desired. Fishing effort relocation would be an indirect, short-term, less than significant impact as there is not much fishing effort in the ROI. To the extent the presence of the HSWAC structures in the water column increase localized fish density, there would be a potential indirect, long-term beneficial effect to fishermen.

Alternative 2

The potential effects of Alternative 2 would be the same as for Alternative 1.

Alternative 3

The potential effects of Alternative 3 would be similar to those of Alternatives 1 or 2, but because the length of double pipes would be greater, habitat enhancement would also be greater resulting in a comparatively greater potential indirect beneficial effect to commercial or recreational fishing.

Alternative 4 (Preferred Alternative)

The potential effects of Alternative 4 would be similar to those of Alternative3, but because the length of double pipes would be even greater, habitat enhancement would also be greater resulting in a comparatively greater potential indirect beneficial effect to commercial or recreational fishing.

3.3.7 **Military Activities**

3.3.7.1 **Existing Conditions**

The Pearl Harbor Entrance Channel is a Naval Defense Sea Area, and is closed to the public. This area begins about three miles west of the proposed HSWAC pipeline route, and extends about three to four miles offshore in the area fronting the Reef Runway of the Honolulu International Airport.

3.3.7.2 **Approach to Impact Analysis**

Methodology

The ROI for military activities is offshore of Kakaʻako from Honolulu Harbor to Kewalo Basin and from the shoreline to about five miles offshore. NOAA nautical chart 19369 (Oʻahu South Coast – Approaches to Pearl Harbor) was examined for areas designated for military use.

Determination of Significance

For the purpose of this EIS, the proposed action and alternatives would cause a significant impact on military activities if they:

- Would require transit through or operations in a prohibited area,
- Would obstruct a military activity, or
- Would create a use conflict that results in a public safety concern.

3.3.7.3 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effect on military activities because there would be no offshore construction activities or facilities.

Alternative 1

Within the HSWAC project area there are no prohibited areas or areas designated for particular military uses. The nearest prohibited area is the Pearl Harbor Entrance Channel, which is a Naval Defense Sea Area, and is closed to the public. This area begins about three miles west of the proposed HSWAC pipeline route, and extends about three to four miles offshore in the area fronting the Reef Runway of the Honolulu International Airport. There would be no reason for vessels engaged in delivery of HSWAC materials to the Sand Island staging area to enter the restricted zone, nor would any vessels engaged in construction and pipeline deployment enter this area. Approximately two miles further offshore of the proposed seawater intake location is a submarine test and trial area. No HSWAC operations would take place in that area. There would be no impacts to military activities as a result of conducting operations in a prohibited area or in areas designated for non-exclusive military use. Vessels entering or leaving Pearl Harbor would not be affected by the proposed construction operations. Therefore, the HSWAC project would have no short-term or long-term, direct or indirect, adverse effects on military operations.

Alternative 2

The potential effects of Alternative 2 would be the same as for Alternative 1.

Alternative 3

The potential effects of Alternative 3 would be the same as for Alternative 1.

Alternative 4 (Preferred Alternative)

The potential effects of Alternative 4 would be the same as for Alternative 1.

3.3.8 **Utilities**

3.3.8.1 **Existing Conditions**

Utilities service for the HSWAC system would be required only at the cooling station site. The site is within the Kaka‘ako Community Development District Improvement District, which has undergone significant utility upgrades in recent years. Existing utilities at that site are as follows. A 15-inch sewer main runs under Ilalo Street adjacent to the site. The line is enlarged to 21 inches at Keawe Street, just ‘Ewa of the site. There is a six-inch lateral connection to the sewer line at the western corner of the parcel. Adequate sewer capacity would be available for the small number of on-site employees at the cooling station.

An existing 12-inch water main runs under Ilalo Street. An eight-inch lateral connection into the proposed cooling station site is in place. New fire hydrants were installed along Ilalo Street as part of the Improvement District 9 (ID9) project. It is expected that adequate water supply would be available at the site.

Drainage improvements were made to Ilalo Street as part of the ID9 project. There is a storm drain opening on Ilalo Street opposite the site which feeds an 11.5 feet x 9 feet box drain in Ilalo Street. At Keawe Street the storm drain turns makai and parallels an existing 8 feet x 4 feet box drain that runs makai on Keawe Street.

Fire hydrants are installed throughout the Kaka‘ako Makai District area. Data for the hydrants closest to the preferred site are as follows.

- FH 4075 located on Keawe Street between Ala Moana Boulevard and Ilalo Street
    - Static Pressure: 74 psi
    - Flow at 20 psi Residual Pressure: 4,000 gpm
- FH 1725 located on Ala Moana Boulevard between Coral Street and Cooke Street
    - Static Pressure: 74 psi
    - Flow at 20 psi Residual Pressure: 4,000 gpm
- FH 4864 located on Cooke Street between Ala Moana Boulevard and Ilalo Street
    - Static Pressure: 74 psi
    - Flow at 20 psi Residual Pressure: 4,000 gpm

Recently completed improvements to Ilalo Street include underground ducts for the electrical, telecommunications, and cable television systems. The improvements include provision of service conduit stubs into the preferred cooling station site. HECO’s primary electrical infrastructure on Ilalo Street consists of six six-inch conduits and related manholes. Service stubs for parcels along Ilalo Street consist of two four-inch conduits.

Hawaiian Telcom telecommunications system infrastructure on Ilalo Street consists of eight four-inch conduits and related manholes. Service stubs for the parcels along Ilalo consist of four four-inch conduits.

3.3.8.2 **Approach to Impact Analysis**

Methodology

The applicant assessed the demands for utilities at the cooling station and determined the capacities of the existing utility systems in the immediate vicinity to determine if available service capacities were adequate.

Determination of Significance

For the purpose of this EIS, the proposed action and alternatives would cause a significant impact on utilities if they:

- Would substantially alter demand for utility services, or
- Would alter the capacity and or availability of the utility infrastructure, for other users.

3.3.8.3 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effect on utilities. The proposed system would not be constructed. There would be no additional utilities demand from the cooling station, but there also would be no net beneficial effect on utilities consumption and future infrastructure requirements.

Alternative 1

With the replacement of individual chiller-based cooling systems with a district SWAC system, the project is intended to provide reliable, lower cost air conditioning for major government, commercial and residential buildings in downtown Honolulu. Constructing the HSWAC system would reduce O‘ahu’s electricity demand. It also would reduce demands for potable water and wastewater treatment and disposal. Utilities service for the HSWAC system would be required only at the cooling station site. Although the proposed cooling station would create demands for electricity, water and wastewater treatment and disposal, the applicant states there would be a net savings that would result from system implementation. Most of the water demand would be make-up water for the distribution system. Table 3-2 summarizes the utility demands at the cooling station. The cooling station would have only one bathroom and wash-down requirements would be minimal. The electrical demand arises from the seawater pumps, fresh water pumps, chillers and support equipment.

Table 3-2: Cooling Station Utility Demands

Utility	***Units***	***Demand***			
		Daily	***Monthly***	***Annual***	***Peak***
Water	Gallons	2,740	83,333	1,000,000	N/A
Sewer	Gallons	27	833	10,000	N/A
Electric	KWH	55,479	1,687,500	20,250,000	7,500

According to the applicant, new electrical utility service connections would be provided to the cooling station. New HECO feeders from their nearby substations would provide electrical power to the project. These feeders would most likely be routed underground in ducts and manholes via two routes. The first route would start at the mauka side of the intersection of Ala Moana Boulevard and Ward Avenue and continue along Ilalo Street to the cooling station. A second route would begin near the intersection of Ala Moana Boulevard and South Street and continue along Ala Moana Boulevard and Keawe Street to the cooling station.

The annual demands include 1,000,000 gallons of water, primarily for make-up water for the distribution system; 10,000 gallons of wastewater requiring treatment and disposal; and 20,250,000 KWH of electricity for the pumps, chillers and other equipment. The existing infrastructure at the proposed cooling station location is adequate to supply the required utilities.

There is also adequate fire protection and telecommunications capacity available at the site. Hawaiian Telcom would have to provide cabling to support the new facilities. On-site fire protection would be coordinated with the Fire Protection Bureau of the Honolulu Fire Department. Final confirmation of the adequacy of all utilities at the site would be made when construction drawings are submitted for review.

Of significance is the net effect on utilities, which would satisfy the purpose and need for the project. The following paragraphs describe the beneficial effects of Alternative 1.

Cooling towers for conventional air conditioning systems require potable water to make up for evaporation, drift, and blow down. SWAC systems eliminate the need for cooling towers and, as a result, reduce potable water use, toxic chemical use, and the production of sewage.

- The 25,000-ton HSWAC project would save up to 260 million gallons of potable water per year (see Appendix C for this calculation).
- This is equivalent to nearly two days of potable water use on O‘ahu.

Evaporation from cooling towers increases the concentration of dissolved substances present in the make-up water. Also, chemicals are added to cooling tower water to prevent corrosion and the growth of organisms. This contaminated water must periodically be discharged to the sewers (blow down) and replaced with fresh water. SWAC eliminates the need for cooling towers and reduces the production of sewage.

- The 25,000-ton HSWAC project would reduce sewage generation by up to 84 million gallons per year (see Appendix C for this calculation).
- This is equivalent to nearly one day’s generation of sewage on O‘ahu.

Building cooling (chillers, cooling towers, and chilled water circulation) is the largest single component of commercial and industrial electricity use.

Conventional air conditioning systems rely on energy-intensive chillers. The cooling towers associated with these chillers also consume electricity. SWAC systems involve less energy-intensive pumping of seawater and chilled water. An insignificant amount of additional energy would be required for the high efficiency auxiliary chillers used in the SWAC system to optimize the temperature of water delivered to customers. However, the return seawater from the heat exchangers would be used for condenser cooling of the auxiliary chillers, thereby substantially increasing their efficiency. Energy savings with SWAC systems are 75%, or more, compared to conventional air conditioning.

- The 25,000-ton HSWAC project would save more than 77.5 million kWh/year. This is equivalent to more than 27,000 residential solar water heating systems.

HECO’s daily peak power demand (megawatts [MW]) is caused primarily by air conditioning usage. For the first time in many years, HECO experienced a system peak demand during the daytime in August. On August 20, 2004, at about 1:30 p.m. a record system peak was observed.

HECO typically experiences its peak demand during a weekday evening in October. This system peak is primarily due to increased residential use after people get home from work and school. SWAC considerably reduces both the broad daytime peak, as well as the sharper evening peak shown in the following diagram (Figure 3-3).

- The 25,000-ton HSWAC project would eliminate the need for more than 14 megawatts of new generation. This is equivalent to more than 17,000 residential solar water heating systems (see Appendix C for this calculation).
- This reduced demand for new energy generation is equivalent to one year of HECO's projected load growth (see Appendix C for this calculation).
- The reduced need for expensive new electricity generation capacity would help to keep O'ahu's electric rates lower for longer.

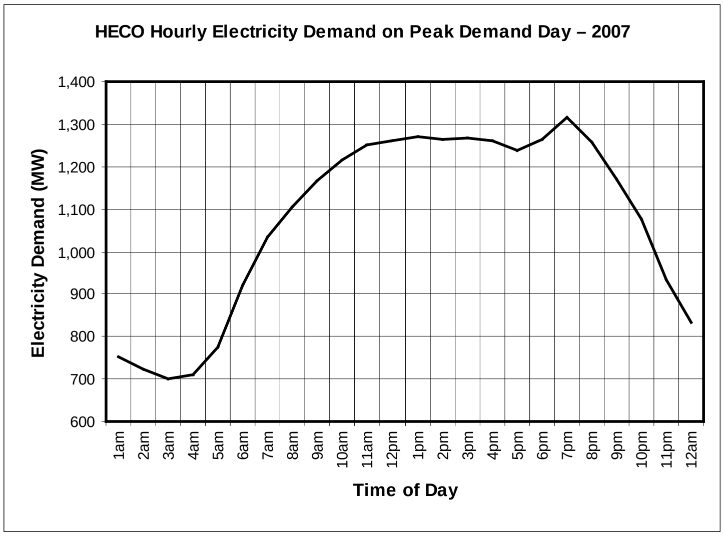

Figure 3-3: HECO Hourly Electricity Demand on Peak Demand Day – 2007
(Source: HECO, 2007)

Hawai'i is more than 90% dependent on imported fossil fuels. About 96% of the electricity generated on O'ahu comes from fossil fuels, and most of this is oil. A SWAC system can considerably reduce imports of crude oil.

- The 25,000-ton HSWAC project would reduce crude oil consumption by about 178,000 barrels per year (see Appendix C for this calculation).

Hawai'i's dependence on imported fossil fuels makes the State vulnerable to supply disruptions. Reducing this dependence through increased energy efficiency and use of renewables would help to increase energy security.

The net effect of any of the action alternatives on the power, water, and wastewater utilities would be to reduce regional demands. Localized demands at either potential cooling station site would be increased, but adequate capacities exist for the proposed facility as well as other potential developments in the area. In the downtown area, utilities demands would be lowered.

Solid waste would be generated during construction and would be reused or disposed of at the approved construction debris landfill, as appropriate. Once operational, the cooling station would generate less than significant amounts of solid waste. A commercial firm would be contracted to dispose of the solid waste.

The applicant's engineers are participating in a joint City and State utilities coordinating committee that frequently meets to coordinate utilities and traffic work to minimize conflicts between projects requiring street closures. The input from that committee would be used in scheduling where trenching would occur at any given time. Major construction projects in the downtown to Waikiki corridor are summarized on the City's Drive Akamai website (http://www.driveakamai.org). Water, sewer, and roadway projects by City, or State agencies or private developers are described and mapped.

Construction of the chilled water distribution system may require relocation of existing utility infrastructure. Where utility conflicts cannot be resolved by altering the route, new underground ducts and manholes would be constructed to reroute the existing facilities away from the chilled water distribution system. Any damage to existing utilities from construction or operation of the HSWAC system would be repaired by the applicant and their contractors.

In summary, Alternative 1 would have substantial, direct, long-term, beneficial regional and island-wide effects on demands for electricity, potable water and wastewater treatment. Benefits of the HSWAC system would include savings of more than 77.5 million kWh/yr of electricity, up to 260 million gallons of potable water, as well as elimination of up to 84 million gallons of sewage annually. The HSWAC system also would have substantial indirect, long-term beneficial impacts on electrical infrastructure including eliminating the need for 14 MW of new generation. During construction, Alternative 1 would have a short-term, direct, adverse but less than significant effect on utilities consumption and waste generation, both wastewater and solid waste. As mitigation for the construction-related increase in solid waste generation, asphalt, soil and sand from excavations would be beneficially reused to the extent possible.

Alternative 2

Under Alternative 2, the cooling station would be located on Pier 1 of Honolulu Harbor. Utilities demands for cooling station operations would be identical to those described for Alternative 1. Utilities infrastructure at the site is adequate to satisfy these demands.

Alternative 2 would have the same effects as Alternative 1: direct, long-term, beneficial regional and island-wide effects on demands for electricity, potable water and wastewater treatment and a short-term, direct, adverse but less than significant effect on utilities consumption and waste generation, both wastewater and solid waste. Mitigation for the construction-related increase in solid waste generation would be as above for Alternative 1.

Alternative 3

Alternative 3 would have the same effects as Alternative 1. The cooling station would be in the same location as under Alternative 1, and utilities there have adequate capacity for the proposed use.

Alternative 4 (Preferred Alternative)

Alternative 4 would have the same effects as Alternative 1. The cooling station would be in the same location as under Alternative 1, and utilities there have adequate capacity for the proposed use.

3.3.9 Ambient Noise

3.3.9.1 Existing Conditions

Noise in the Kaka‘ako district was surveyed as part of the Kaka‘ako Makai Waterfront Master Plan and the 1990 Supplemental EIS for the Kaka‘ako Makai Area. The three main sources of noise in the Kaka‘ako district are vehicular traffic, aircraft, and industrial equipment. Noise from industrial equipment was measured at between 72 and 80 dB. Ambient noise limits in the downtown area are 60 decibels (dB) from 7 a.m. until 10 p.m. and 50 dB at all other times (Hawai‘i Administrative Rules [HAR] Chapter 46 “Community Noise Control”).

The Day-Night Sound Level (L_{dn}) is more appropriate for describing noise from a source that generates noise both day and night. The Ldn is an average of noise levels over a 24-hour period. The average includes a penalty for noise generated between 10 pm and 7 am. The noise level from vehicular traffic on Ala Moana Blvd. to someone 50 feet from the street was 60 L_{dn}. Noise from aircraft in the area proposed for the cooling station was between 60 and 65 L_{dn}.

3.3.9.2 **Approach to Impact Analysis**

The main sources of noise and vibration resulting from the proposed project would be from construction-related equipment and operations, and from on site and off site vehicular traffic. Construction noise would be generated both onshore and offshore. Onshore noise would be generated by excavation of the jacking pit, construction of the cooling station, assembly of the pipes and other operations at the staging area and vehicular traffic on work sites and public roadways. Offshore noise would be generated by pile driving around the receiving pit, excavation of the receiving pit and operations associated with connecting the microtunneled pipes with the surface mounted pipes, installing the pipelines on the bottom, driving pipe piles through the collars, and surface vessel and equipment operations. Underwater noise and potential effects on protected marine species are discussed in Section 3.7.5.3 and in NMFS' Biological Opinion (Appendix M). Once operational, noise from the system would be largely contained within the cooling station.

Methodology

Potential sources of noise were identified and, where possible, the potential noise was estimated on the basis of published information on noise sources. Construction noise would be generated by the use of heavy equipment on job sites and by vehicles accessing the construction sites and would be short-term in duration (i.e., the duration of the construction period). Commonly, use of heavy equipment occurs sporadically throughout daytime hours. Table 3-3 provides a list of representative samples of construction equipment and associated noise levels, adjusted for the percentage of time equipment would typically be operated at full power at a construction site. Construction noise varies greatly depending on the construction process, type and condition of equipment used, and layout of the construction site. Overall, construction noise levels are governed primarily by the noisiest pieces of equipment, impact devices (e.g., jackhammers, pile drivers).

Table 3-3: Examples of Construction Equipment Noise

Equipment Description	*Impact Device[1]*	*Acoustical Usage Factor[2] (%)*	*Actual Measured L_{max} @ 50 feet[3] (dBA, slow) (Samples Averaged)*	*Number of Actual Data Samples[4] (Count)*
All Other Equipment > 5 HP	No	50	N/A	0
Backhoe	No	40	78	372
Clam Shovel (dropping)	Yes	20	87	4
Compactor (ground)	No	20	83	57
Compressor (air)	No	40	78	18
Concrete Mixer Truck	No	40	79	40
Concrete Saw	No	20	90	55
Crane	No	16	81	405
Dozer	No	40	82	55
Dump Truck	No	40	76	31
Excavator	No	40	81	170
Front End Loader	No	40	79	96
Generator	No	50	81	19
Grader	No	40	N/A	0
Impact Pile Driver	Yes	20	101	11
Jackhammer	Yes	20	89	133
Pavement Scarifier	No	20	90	2
Paver	No	50	77	9
Roller	No	20	80	16

Equipment Description	***Impact Device[1]***	***Acoustical Usage Factor[2] (%)***	***Actual Measured L_{max} @ 50 feet[3] (dBA, slow) (Samples Averaged)***	***Number of Actual Data Samples[4] (Count)***
Scraper	No	40	84	12
Tractor	No	40	N/A	0
Vibratory Pile Driver	No	20	101	44

Notes:
1. Indication whether or not the equipment is an impact device
2. The acoustical usage factor refers to the percentage of time the equipment is running at full power on the job site and is assumed at a typical construction site for modeling purposes
3. The measured "Actual" emission level at 50 feet for each piece of equipment based on hundreds of emission measurements performed on Central Artery/Tunnel, Boston MA work sites
4. The number of samples that were averaged together to compute the "Actual" emission level

Source: USDOT 2006.

The dB level of a sound decreases (or attenuates) exponentially as the distance from the source increases. For a single point source, like a construction bulldozer, the sound level decreases by approximately 6 dBs for each doubling of distance from the source.

Most of the noise generated by the HSWAC Project that could affect sensitive human receptors would be from construction at the site of the cooling station, in the proposed staging area, and along the distribution route. Microtunneling and offshore construction would also generate underwater noise and vibrations that could affect marine organisms (see Section 3.7.5.3).

Determination of Significance

The estimated noise levels were reviewed to determine if they would:

- Represent a substantial change in the current ambient noise level,
- Have an impact on a substantial population of sensitive receptors, or
- Be inconsistent with any relevant and applicable standards.

3.3.9.3 **Impacts**

No Action Alternative

The No-Action Alternative would have no direct or indirect, short-term or long-term, adverse effect on ambient noise because it would create no noise from construction or operations, but neither would it eliminate cooling tower noise from buildings connected to the proposed system.

Alternative 1

Noise from construction activity varies with the types of equipment used and the duration of use. During operation, heavy equipment and other construction activities generate noise levels ranging typically from 70 to 90 dBA at a distance of 50 feet (15.2 m). Noise levels would diminish with distance from the construction activity. During facilities construction, use of heavy equipment would occur sporadically throughout the daytime hours. Although some heavy equipment would be used throughout the construction process, the noisiest heavy equipment would be associated with site preparation. The types of equipment necessary for site preparation would be excavators, graders, pavers, dump trucks, and concrete mixers. Typical noise mitigation measures that would be employed, in addition to the time of day restrictions, include use of proper mufflers on any gas or air-powered equipment and restricting night work to less noisy tasks. Nevertheless, excessive noise would be generated during construction.

State noise regulations are contained in HAR Chapter 46 “Community Noise Control.” For State noise regulatory purposes, the downtown and Kaka‘ako areas are zoned Class B, which includes multi-family dwellings, apartment, business, commercial, hotel, resort or similar. State regulations restrict construction noise in Class B zones to 60 dBA (at the property line) during the hours of 7 a.m. to 6 p.m. Monday through Friday, 9 a.m. to 6 p.m. on Saturday, and to 50 dBA at all other times. Noise limits may be temporarily exceeded during construction of Alternative 1, and a permit would therefore be required. Because some HSWAC construction would be scheduled to take place outside of the permitted hours, a variance would also be required.

Much less noise would be associated with pipe assembly and deployment at the proposed staging area. At that location, there would be a minor amount of earth moving, vehicular traffic, offloading equipment and materials, fusing of the pipe, and transport of the pipe segments to the water. The proposed staging area is on a strip of land around the outer perimeter of Sand Island that is earmarked for future expansion of Sand Island State Park, and is zoned P2, General Preservation, by the county. The area is remote from the developed portion of Sand Island State Park and is bordered on the inland side by lands zoned I-3, Waterfront Industrial. The nearest human receptors would be in the Sand Island WWTP in the adjacent industrial zone. Nevertheless, according to HAR Chapter 46, because of its county zoning this parcel would be zoned Class A for noise regulatory purposes. State regulations restrict construction noise in Class A zones to 55 dBA (at the property line) during the hours of 7 a.m. to 6 p.m. Monday through Friday, 9 a.m. to 6 p.m. on Saturday, and to 45 dBA at all other times. Some of the staging operations would likely exceed the specified noise limits and a permit for this activity would be required. If the contractor works after hours a variance would also be required.

Vehicular noise is no longer regulated by the State since repeal of HAR Chapter 42, Vehicular Noise Control for O‘ahu. Revised Ordinances of the City and County of Honolulu prohibit unusual equipment noises in excess of that which is necessary, muffler systems designed to increase engine sounds, and spurious automobile alarms, but otherwise do not regulate vehicular noise. Backup alarms on vehicles with restricted rear visibility and certain construction equipment are frequently the cause of complaints but are required by occupational safety regulations.

Offshore construction operations under Alternative 1 would create noise from both vessels and equipment, and noise and vibration from pile driving. It is not anticipated that this noise would exceed regulatory levels at the shoreline and vibrations from construction of the receiving pit would be damped by the substratum without affecting any shoreside structures. Potential effects of noise on protected marine species are addressed in Section 3.7.5.3.

In summary, Alternative 1 would have a direct, short-term, significant adverse effect on ambient noise levels at the cooling station site, in the staging area, and along the pipeline routes during construction. The required permit and variance likely would have attached mitigating conditions such as minimizing after hours noise in the vicinity of residential buildings near the distribution route. During operation of the proposed system no ambient noise impacts are expected. Existing noise from cooling towers would be eliminated at buildings connected to the system, which would be an indirect, long-term, beneficial effect.

Alternative 2

The potential effects of and mitigation measures for Alternative 2 would be the same as for Alternative 1.

Alternative 3

The potential effects of and mitigation measures for Alternative 3 would be the same as for Alternative 1.

Alternative 4 (Preferred Alternative)

The potential effects of and mitigation measures for Alternative 4 would be the same as for Alternative 1.

3.3.10 Hazardous and Toxic Materials

3.3.10.1 Existing Conditions

The HSWAC pipelines from the cooling station to the shoreline would pass the ‘Ewa end of Kaka‘ako Waterfront Park, which was created by capping a former landfill that received the waste from nearby incinerators and other sources. According to a report of a 1989 investigation (Ecology and Environment, 1989), in addition to incinerator ash, the landfill received other wastes including unburned refuse, construction debris, household debris, drums of unknown liquids, automobile batteries and cans of paint thinner. Two incinerators, the first of which began operating in 1927 followed by the second in 1946, burned municipal refuse at the adjacent Kewalo Incinerator facility and transported the ash to Kewalo, which was located on a reclaimed area of nearshore reef and intertidal lands. A seawall was constructed in 1948 to contain the expanding ash area. From the late 1950s until the early 1960s, refuse which exceeded the incinerators’ 200 tons per day capacity was reportedly open-burned at Kewalo. During the mid-1960s, excess refuse was disposed of on-site without burning.

An earlier 1989 study (Woodward-Clyde Consultants, 1989) included drilling four soil borings through the landfill and installing groundwater monitoring wells. That study found that refuse material in the landfill consisting of ash, glass, concrete blocks, scrap metal, wire and plastics was up to 45 feet thick, and capped with 12 to 25 feet of soil. Coral was found at 56 feet below grade or 6 feet below mean sea level. A number of hazardous contaminants were found including organochlorine pesticides, semivolatile organic compounds, benzene, lead, asbestos, and heavy metals.

A 1990 study (Harding Larson Associates, 1990) found methane gas being produced in the landfill and concentrations of arsenic, cadmium, copper, and lead above background levels. Chlordane and polychlorinated biphenyls (PCBs) were also detected.

A Phase 1 environmental site assessment of the properties along the proposed route of the HSWAC pipelines, from the shoreline at the ‘Ewa side of Kaka’ako Waterfront Park along Keawe Street to Auahi Street, was completed to identify any potentially hazardous materials or conditions that could impact the construction of this section of the HSWAC Project pipeline system (Kauai Environmental, 2009). While no recognized environmental condition was observed on properties that would be directly affected by the HSWAC Project, the Kaka‘ako area has a history of industrial activities and was a site for waste disposal. Kauai Environmental’s review of environmental records on file at the State Department of Health HEER office indicated the following:

- The use of waste materials including incinerator ash and construction debris as fill material was commonplace throughout the Kaka‘ako area.
- Soil and groundwater contamination have been identified at the Kewalo Municipal Incinerator Landfill, now the Kaka‘ako Waterfront Park.
- Soil and groundwater contamination have been identified at the Ala Moana Pump Station, located at 240 Keawe Street.
- Groundwater transport of various contaminants has been documented in the Kaka‘ako area.

The Phase 1 study recommended that a Phase 2 environmental site assessment be done and that was completed by Kauai Environmental in 2009. The results were reported as follows.

Mauka Jacking Pit [near Ala Moana Boulevard]: Field screening results did not indicate the presence of volatile or semivolatile organic compounds at this location. No ash or other landfill debris was observed in surface soils. Laboratory results demonstrated that none of the contaminants analyzed in samples from this area were present at levels exceeding environmental screening levels established by HDOH for residential areas.

Receiving Pit [at the cooling station]: Field screening results indicated the presence of volatile or semi-volatile organic compounds at the groundwater interface in one of three sampling locations; however, no volatile or semi-volatile compounds were identified in the samples collected, either during field screening or laboratory analysis. No ash or other landfill debris was observed in surface soils. Laboratory results demonstrated that none of the contaminants analyzed in samples from this area were present at levels exceeding HDOH screening levels for residential areas.

Shoreline Jacking Pit: Field screening results did not indicate the presence of volatile or semivolatile organic compounds. However, surface soils above coralline deposits were almost entirely ash mixed with various types of debris. This material appeared to be consistent with incinerator waste from the historic landfill beneath Kakaʻako Waterfront Park. Laboratory results indicated that metals, pesticides and dioxins are present in this material and that lead, the pesticide dieldrin, and dioxins are present at levels exceeding HDOH screening levels.

3.3.10.2 **Approach to Impact Analysis**

There is the potential for release of contaminants from beneath Kakaʻako Waterfront Park to the ocean by the microtunneling operation. That is described in the water quality impact section. The focus of this section is use, storage and disposal of any hazardous or toxic materials associated with the construction or operation of the proposed system. The ROI for hazardous and toxic substances includes the entire project area and any adjoining area to which spills, leaks or releases could migrate and any off-site spoils processing or disposal areas.

Methodology

Hazardous or toxic substances that would be used or encountered in construction or operation of the proposed system were identified. Regulatory requirements, standard operating procedures and the likelihood of a leak, spill or release were evaluated.

Determination of Significance

For hazardous substances to be considered a significant impact, the following would have to occur:

- Leaks, spills, or releases of hazardous substances to environmental media (i.e., soils, surface water, groundwater, air, and/or biota) resulting in unacceptable risks to human health or the environment, or
- Violation of applicable Federal, State, or local laws or regulations regarding the transportation, storage, handling, use, or disposal of hazardous substances.

3.3.10.3 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term adverse effect resulting from hazardous or toxic substances because there would be no construction or operations. However, hazardous and toxic chemicals would continue to be used in the cooling towers of individual buildings throughout the downtown area.

Alternative 1

Construction of the HSWAC system would require use of petroleum, oil and lubricants (POL) which includes gasoline, diesel, oil, grease, and other related products. Proven and effective BMPs and SOPs would be used to:

- Prevent, contain, and/or clean up spills and leaks to protect human health and the environment, and
- Provide personnel training, operational protocols and procedures and any necessary equipment required to protect human health and the environment.

Operation of the HSWAC cooling station would require additives to the cooling water to control pH, corrosion and biofouling in the distribution system. These would include molybdate or other anti-corrosion agents and a biocide to control microbial activity. The biocide (bromine, chlorine bleach, or a non-oxidizing biocide) would be selected based on what is determined to be most effective at the time with some variation in type and dose to stay ahead of the microbes' ability to become resistant to the effects of any one of the products. Chlorine bleach is not particularly effective at the loop pH so it would seldom be used.

Typical products used in similar applications are:

- ChemTreat CL-6033 (sodium tetraborate pentahydrate 10-30%; potassium hydroxide 5-10%; tolyltriazole, sodium salt) – used to control pH in the distribution loop. The target pH is 10.1, with a control range of 9.0 (minimum) to 10.5 (maximum). This liquid is corrosive and will cause burns or irreversible damage to eyes, skin, lungs or digestive tract. It is considered hazardous under the Resource Conservation and Recovery Act (RCRA) 261.22 (corrosivity criteria). The CERCLA reportable quantity is 1,000 pounds. Good ventilation and personal protective equipment (PPE) are required for safe handling. An eyewash fountain and quick-drench facilities should be available in the work area.
- ChemTreat CL-2900 (sodium molybdate 35%) – used to inhibit corrosion of steel pipes and fittings in the distribution loop. The target concentration of molybdenum is 65 ppm with a control range of 50 ppm (minimum) to 80 ppm (maximum). This liquid can cause severe irritation of the eyes, skin or mucous membranes. It does not meet the criteria of a hazardous waste as described in 40 CFR 261. There is no reportable quantity under CERCLA. Good ventilation and PPE are recommended for safe handling. An eyewash fountain and quick-drench facilities should be available in the work area.
- ChemTreat CL-4123 (Tolyltriazole, sodium salt 10-30%) – used to inhibit corrosion of copper or brass fittings in the distribution loop. This liquid is corrosive and will cause burns or irreversible damage to eyes, skin, lungs or digestive tract. There is no reportable quantity under CERCLA. Good ventilation and PPE are recommended for safe handling. An eyewash fountain and quick-drench facilities should be available in the work area.

All operations would be conducted in accordance with relevant State and Federal regulations. Cleaning of the seawater pipes would not be necessary and no antifouling or cleaning agents would ever be added to that part of the system.

Excavation of the cooling station sump, the shoreline jacking pit, the offshore receiving pit, the microtunnels, the upper few feet from the emplaced pipe piles, and the distribution system trenches would all generate spoils requiring dewatering, testing and disposition. No excavated material would be stored or disposed of within waters of the United States. The applicant's intent is to beneficially reuse all non-contaminated spoils; however, contamination from some of these sources may be evident after testing. The results of the applicant's Phase 2 environmental site assessment indicate that historic landfill materials (including ash and debris consistent with material from the incinerator landfill site) would be encountered during excavation of surface soils at the shoreline jacking pit location, and that limited petroleum contamination may be encountered during excavation at the cooling station. Specific contaminants that may be encountered near the surface at the jacking pit include RCRA metals, chlorinated pesticides and dioxins, but quantities cannot be estimated in advance. However, none of these compounds were found at levels exceeding the Hawaii State Department of Health Tier 1 Action Levels for unrestricted (i.e., residential) use. The only contaminant found at levels exceeding its Tier 1 environmental action level (EAL) was lead, which was measured at 660 mg/Kg. Though in excess of the Tier 1 EAL, this lead concentration is well below USEPA's standard for acceptable levels of lead in surface soils of 1,200 mg/Kg for exposed dirt at residential, child-occupied Federal housing. At the cooling station receiving pit, RCRA metals, chlorinated pesticides and petroleum compounds may be encountered near the surface. Again, it is not possible to predict in advance quantities that may be encountered. Microtunneling would generate a slurry of ground coral and rock derived from native, undisturbed materials at depths of 22 feet and deeper. It is not anticipated that any contaminated materials would be generated in the microtunneling operation, but testing would be completed prior to final disposition.

The applicant has prepared and the State of Hawaiʻi has accepted an Environmental Hazard Management Plan (EHMP) (Appendix D) that specifies testing requirements for the excavated materials and disposal requirements for contaminated spoils. The applicant intends to implement the EHMP through imposition of relevant site specific requirements on the selected contractor. Soil excavation and handling procedures would be detailed in the contractor's site specific plans, but at a minimum the following requirements would be observed:

- Initial excavation of surface materials at both the jacking pit and the cooling station receiving pit would be monitored by an independent industrial hygiene technician using a photo-ionization detector (PID). Any soils that show visual (discoloration) or olfactory (odor) indications of petroleum, or trigger elevated PID readings, would be segregated and managed as petroleum contaminated materials pending results of characterization for the identified chemicals of potential concern identified above in accordance with the requirements contained in the HDOH Technical Guidance Manual (HDOH, 2009).
- Any excavated materials that show signs of ash or other debris, which may indicate the historic use of landfill materials as fill materials, would be segregated and managed as contaminated materials pending results of characterization for the identified chemicals of potential concern identified above in accordance with the requirements contained in the HDOH Technical Guidance Manual (HDOH, 2009).
- Surface soils from the jacking pit location that do not show signs of either ash or debris would be segregated and managed separately as potentially contaminated materials pending results of characterization for the identified chemicals of potential concern identified above in accordance with the requirements contained in the HDOH Technical Guidance Manual (HDOH, 2009).
- All imported fill materials would be certified as clean fill materials per HDOH guidance (HDOH, 2009). Native materials that show no signs of contamination may be reused on site as fill materials. In the event that these materials are transported off-site for temporary storage pending eventual reuse as fill materials, the materials would be tested and characterized for reuse as clean fill materials per HDOH guidance (HDOH, 2009).

Excavated materials would be handled and stored in compliance with all applicable State and Federal Regulations, and in such a manner as to prevent potential escape, leakage or transport off-site of contaminated or potentially contaminated materials. Specific details for handling and storage of excavated materials would be provided by the contractor in a site specific Environmental Protection Plan, or in a separate Contaminated Soils Management Plan.

Excavated materials that do not show any sign of petroleum contamination (including visual or olfactory indications or elevated PID readings), and which do not contain any visible sign of ash or debris that might indicate the presence of historic landfill materials, may be reused on site without prior characterization provided that those materials are not transported off site and are covered with at least two feet of clean material. Excavated materials that are characterized for the chemicals of concern identified above may be reused on site with HDOH HEER office approval. All materials not reused on site or transported off site for temporary storage, reuse or disposal must be characterized prior to reuse or disposal in accordance with HDOH requirements, landfill requirements, and applicable State and Federal regulations. Characterization and disposal procedures would be outlined in the contractor's approved site specific Environmental Protection Plan, or in a separate Contaminated Soils Management Plan.

The applicant's intention is to beneficially reuse uncontaminated spoils as construction fill. If a beneficial reuse cannot be identified, it is most likely they would be disposed of at the PVT Land Company, LTD construction and demolition materials landfill where they could be used for interim cover. The PVT landfill operates in accordance with Chapter 342H, Hawaii Revised Statutes and Title 11 Administrative Rules Chapter 58.1 Solid Waste Management Control, which preclude disposal of hazardous or toxic materials at the landfill.

The contractor may opt to remediate petroleum contaminated spoils rather than ship them to an approved disposal site. This would be done in accordance with HAR 11-58.1-42, Remediation Facilities. Both a permit and a leachate management plan would be required and the selected site could not be located in an area susceptible to flooding, in wetlands, close to potable water supplies, near a fault area or any other unstable location. Locations around the reef runway at Honolulu International Airport previously have been used for this purpose, and presumably could be so used again.

Dewatering activities would generate groundwater that would require management during each phase of construction. Construction methods and procedures would be implemented to minimize groundwater infiltration into excavated areas. Excess groundwater generated during construction activities would be managed according to the following options:

- If possible, all excess groundwater generated during this project would be returned to the water table via recharge into one or more specially constructed recharge basins that would be constructed in the immediate vicinity of the dewatering location(s). Excess groundwater may be pumped directly from the active work site(s) (i.e., excavation or slurry separator) into the recharge basin(s), or may be pumped into a mobile storage container designed for that purpose pending recharge at a later date.
- If excess groundwater quantities are such that recharge, for whatever reason, is not feasible, then excess groundwater pumped into temporary storage containers may be removed from the site for offsite disposal by a waste disposal contractor. The waste disposal contractor would be required to dispose of the excess groundwater in full compliance with all applicable State and Federal regulations.
- In the event that subsurface petroleum contamination is encountered to such an extent that a sheen is observed on groundwater being dewatered, then this water would be pumped directly into an oil-water separator. Once the petroleum has been separated from the water, the water may be recharged as described above while any petroleum product would be characterized and disposed of by a waste disposal contractor.

All holding areas would be lined to prevent fluids from leaching into the ground and transportation of spoils from one location to another would be done in lined and covered trucks. No holding areas would be established inland of the State's Underground Injection Control line to avoid potential leaks in areas above potable groundwater aquifers.

The EHMP further describes exposure pathways for the identified chemicals of concern. Humans are exposed to metals primarily through ingestion. Inhalation of dust is also a potential exposure pathway, but in most cases this is a minor source of exposure. Ingestion is the primary exposure pathway. Dermal exposure is generally not considered relevant, except insofar as it may lead to accidental ingestion. The same is true for chlorinated pesticides and dioxins. Based on the Conceptual Site Model developed in the EHMP, the following receptors and exposure pathways were identified:

- Potential human receptors include on-site workers, trespassers on the site, and off-site workers and the general public.
- Potential exposure pathways for human receptors include incidental ingestion or dermal contact with soil, sediment or groundwater, inhalation or ingestion (possibly based on dermal contact) with airborne dust, incidental ingestion and/or dermal contact with groundwater (either in situ or following dewatering activities).
- Potential environmental receptors include terrestrial ecological receptors, aquatic ecological receptors, and general gross contamination of the environment.

Direct exposure to contaminated media (soils and/or groundwater) would be the most likely and potentially the most detrimental hazard to human health. Gross contamination from soils due to spills, leaching, run-off or wind-blown dust and gross contamination due to spills of groundwater during dewatering activities are the most likely and potentially the most detrimental hazards to the environment.

To protect human health and the environment, both institutional and engineering controls would be implemented. Institutional controls are legal or administrative measures designed to limit or prevent exposure to contaminants or contaminated media through laws, rules, permits, restrictions, warnings or advisories. Engineering controls are durable physical barriers designed to prevent physical contact with contaminants or contaminated media, such as membranes, walls, pavement, etc.

Institutional controls that would be implemented during construction include the following.

- Chain-link fencing with “No Trespassing” signs would be erected to control access to all land-based staging and construction areas.
- A dust fence would be installed around the perimeter of the shoreline jacking pit work area to control airborne dust.
- Re-use of contaminated soils would be forbidden without express permission from the HDOH HEER office.
- Only native or clean fill materials would be used as backfill for excavated areas.

Engineering controls that would be employed, in addition to the fences noted above, include the following.

- On-site vegetation would be maintained where feasible during construction activities.
- A 6-inch layer of gravel or base course material would be used to cover the areas around the edges of the excavated shaft locations to ensure that there is no potential exposure to site workers due to exposed historic fill materials or other contaminated media.

The applicant would require the contractor to prepare an Environmental Protection Plan (EPP), a Contaminated Soil Management Plan (CSMP), and a worker Health and Safety Plan (HASP) that are specific to the requirements and hazards associated with excavation and construction activities on this project. Additional requirements of these plans may be found in Appendix D. These plans would be reviewed and approved by a Certified Industrial Hygienist (CIH) and a Certified Safety Professional (CSP). Signed, stamped copies of the approved EPP and HASP would be submitted to the Project Engineer and the HDOH HEER office prior to the start of any mobilization, excavation or construction activities for this project. The CSMP would also address public health and safety, with specific attention to adverse exposures to potentially high-risk populations including families with children who may be residing at the Next Steps Homeless Shelter (located across the drainage canal from the jacking pit site) or using Kaka'ako Waterfront Park. The applicant would prepare a notification plan to alert the public in the vicinity in the event of a spill or release of a toxic or hazardous substance.

Additional protective measures that would be put into place for construction worker and site visitor health and safety include awareness training for all personnel prior to being permitted access to the site and provision of adequate PPE.

In summary, Alternative 1 would potentially result in a significant, direct, short-term adverse effect on human health and the environment (i.e., soils, groundwater, seawater, air, and biota). However, the hazardous materials would be handled and disposed of per applicable BMPs and SOPs, as described below and according to an EHMP (Appendix D), which has been approved by the State of Hawai'i Hazard Evaluation and Emergency Response (HEER) Office, and therefore the potential adverse effects would be mitigable to less than significant. Elimination of the requirement for hazardous and toxic chemical use in cooling towers of buildings connected to the HSWAC system would be an indirect, long-term beneficial effect.

Specific mitigation measures that would be implemented include:

- Create and implement an Environmental Hazard Management Plan (EHMP),
- Create and implement a Facility Response Plan,
- Create and implement a Spill Prevention Control and Countermeasure Plan (to include training, spill containment and control procedures, cleanup procedures, agency notifications, etc.),
- Ensure personnel are trained as to proper labeling, container, storage, staging, and transportation requirements for hazardous substances. Also, ensure they are trained in accordance with spill prevention, control, and cleanup methods,
- Provide adequate and appropriate personnel protective equipment, an eyewash fountain and quick-drench facilities in the work area, and
- Perform all vehicle maintenance activities off-site.

With implementation of the above measures, Alternative 1 would have no direct or indirect, short-term or long-term adverse effect on topography, geology or soils or adverse indirect effects on air quality, water quality, human health and safety, or ecological systems.

Alternative 2

Alternative 2 would have the same potential effects as Alternative 1, except that Pier 1, where the cooling station would be located, is farther from the area formerly used for disposal of incinerator ash and debris, so the probability of encountering this material during excavation would be less.

Alternative 3

Alternative 3 would have the same potential effects as Alternative 1 as the jacking pit would be at the same location.

Alternative 4 (Preferred Alternative)

Alternative 4 would have the same potential effects as Alternative 1 as the jacking pit would be at the same location.

3.3.11 **Roadways and Traffic**

3.3.11.1 **Existing Conditions**

This analysis is based on the Corps' scope of analysis, which includes all project components that require DA authorization, including the seawater intake and return pipelines, the receiving pit, and the pipeline staging work. Site work from the shoreline to the cooling station would occur at the jacking pit and at the cooling station, and pipe assembly would take place at Sand Island. Construction vehicles, equipment and materials deliveries would create traffic in these areas. Major thoroughfares traversed would be Ala Moana Boulevard, Nimitz Highway and Sand Island Access Road. In Kaka'ako, Keawe Street makai of Ala Moana Boulevard would be used. Work in Keawe Street would require 100 feet of road closure to construct the receiving pit at the cooling station. The applicant has not yet selected a contractor that would be responsible for disposition of the excavated materials, so the location of any baseyard facility or potentially affected roadways on the route from the construction sites is not yet known. However, if some portion of the spoils is to be delivered to the PVT construction and demolition landfill, H-1 from the Nimitz Highway entrance to its western connection to Farrington Highway and Farringhton Highway to Nanakuli would be included in the ROI. The distribution system from the cooling station to downtown would involve trenching in the roadways and consequently lane closures. Traffic impacts of installation of the distribution system were evaluated in the State EIS and are not repeated here, although those mitigation measures applicable to vehicular and construction equipment traffic are included here.

3.3.11.2 **Approach to Impact Analysis**

Within the Region of Influence for these resources a temporary lane closure on Keawe Street during excavation of the cooling station receiving pit would be required. The applicant's intention, however, is to implement mitigation measures that would minimize the effects of construction on vehicular traffic, but also on pedestrians, bicyclists, emergency service vehicles, and nearby business owners.

3.3.11.3 **Impacts**

<u>No Action Alternative</u>

The No Action Alternative would have no direct or indirect, short-term or long-term adverse effect on traffic as no movements of vehicles or equipment on public roadways would be required.

<u>Alternative 1</u>

Alternative 1 would have a less than significant short-term, direct, adverse effect on traffic during construction of the cooling station, jacking pit and/or assembly of the pipelines. A traffic management plan, focused on traffic impacts to City streets and State highways during installation of the distribution pipes but applied to the entire project, would be developed to identify specific potential traffic management strategies that can be implemented to minimize the effect of the proposed construction on the Honolulu roadway system. The traffic management plan would describe the construction management, public information program, construction schedule, construction traffic, and traffic control plans during construction. During development of the traffic management plan, all neighboring properties would be surveyed for access requirements; bus routes, stops and schedules would be reviewed, and locations of nearest emergency responders would be determined. The traffic management plan would be provided to City agencies prior to requesting a Street Usage Permit.

The following restrictions would be imposed by the applicant on the contractor to mitigate impacts in the ROI for this EIS:

- Standard work hours would be between 7:00 am and 5:30 pm,
- Off-duty policemen would be used to direct traffic when working on major/busy intersections,

- When activities cross intersections, safe crossings would be provided for vehicles and pedestrians,
- When work is done in pedestrian walkways, an alternate walkway for pedestrians would be provided,
- Access to driveways would be provided when feasible, and
- No equipment storage or stockpiling would be done in the street right-of-way.

Mitigation measures to be implemented by the applicant and its contractor would include:

- Ensuring conformance with the traffic management plan,
- Establishing a telephone hotline with advance schedule information and feedback capability,
- Providing construction schedules at least two weeks in advance to emergency providers, transportation companies, and businesses and residents in neighboring vicinities of the project site,
- Launching a project website with similar capabilities,
- Holding a community meeting prior to beginning construction, and
- Prohibiting lane closures during the following times:
    - Chinese New Year,
    - Thanksgiving Day and the following day,
    - Christmas Day and two weeks before and after,
    - King Kamehameha Day Parade,
    - Honolulu Marathon, and
    - Great Aloha Run.

Alternative 2

Alternative 2 would have the same effects on traffic and employ the same mitigation measures as Alternative 1.

Alternative 3

Alternative 3 would have the same effects on traffic and employ the same mitigation measures as Alternative 1.

Alternative 4 (Preferred Alternative)

Alternative 4 would have the same effects on traffic and employ the same mitigation measures as Alternative 1.

3.3.12 Human Health and Safety

3.3.12.1 Existing Conditions

Existing risks to human health and safety at the shoreline and in the marine portions of the project area include unpredictable ocean conditions, interactions with dangerous marine organisms, and ocean user conflicts. The buried incinerator ash and debris beneath the Kaka‘ako Waterfront Park may be a risk to construction workers, residents of the nearby Next Step Homeless Shelter or park users. Vehicular traffic is a safety risk throughout the project area. Discarded military munitions (DMM) are present along portions of the intake pipe route and there is a risk of bringing up residues of chemical or conventional munitions along with the sand to be excavated from the top of the pipe piles to be used to secure the pipe collars. Risks from DMM and proposed mitigation are addressed in Section 3.3.3.

3.3.12.2 Approach to Impact Analysis

This section discusses the potential public health and safety issues related to implementation of the proposed action or alternatives. The ROI for public health and safety concerns includes the Kakaʻako and Sand Island/Keʻehi Lagoon project areas, the offshore work areas, the harbors where project materials and equipment would be landed, and the transportation corridors between them.

Methodology

Public health and safety issues include operational and construction safety, environmental health effects, traffic accidents, and reduction in access to public services such as police and fire response. Environmental health effects may result from excessive noise, degraded water quality, degraded air quality, and spills, leaks or releases of hazardous materials.

Determination of Significance

Factors considered in determining whether an alternative would have a significant public safety impact include the extent or degree to which implementation of the alternative would subject the public to an altered risk of experiencing personal injury.

3.3.12.3 Impacts

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term adverse effects on public health or safety because there would be no construction or operation of the proposed system.

Alternative 1

Alternative 1 would involve receiving and transporting large pieces of equipment and large pipes on public roadways, staging the pipes and supporting equipment on Sand Island, storing sealed pipe sections in Keʻehi Lagoon, towing completed pipe strings to the installation site, attaching the pipes to the seafloor, and constructing the cooling station and jacking pit.

Overland transportation of oversized loads would require a permit from the State Department of Transportation. It is likely that a condition of that permit would be to employ a police escort. Although this action would likely slow traffic in the immediate vicinity, the police escort would mitigate against a potential risk to public safety. Other traffic associated with construction on land would consist of delivery and worker vehicles. This traffic would be dispersed between Kakaʻako and Sand Island. Additional workers would travel to their respective work boats, likely in Honolulu Harbor. Assuming these construction workers are presently employed somewhere, no additional trips on the road network would be generated; only the destinations would change. No significant increase in traffic accidents would be expected.

Construction operations at the cooling station and jacking pit sites and staging/assembly operations on Sand Island would be conducted within fenced areas inaccessible to the public. There would be no hazardous air emissions from these operations and potential spills, leaks or releases of hazardous or toxic substances would be cleaned up according to protocols designed to protect both worker and public health and safety. There would be no direct or indirect short-term or long-term effect on public health or safety from these operations. All construction would be accomplished in accordance with Occupational Safety and Health Administration guidelines that ensure a safe environment for workers.

The applicant held two meetings with management personnel of the Next Step Homeless Shelter, which is located in a warehouse on Pier 1, on the other side of the canal adjacent to the proposed site of the near-shore jacking pit. The potential for exposure to environmental hazards was explained and the EHMP described. Shelter management would be provided with the CSMP, EPP and the HASP when they become available, and notified in the event there is a spill or release of a toxic or hazardous substance. With these measures there should be no disproportionate adverse effects to minority or low-income populations.

Offshore construction operations within Ke‘ehi Lagoon and offshore of Kaka‘ako would be subject to other measures protective of public health and safety. These would include exclusion of the public from the pipe storage area in Ke‘ehi Lagoon, the offshore work areas, and the holdback area in Kaka‘ako Waterfront Park, if used for the approximately one day pipe deployment operation. During the towing of the pipes from Ke‘ehi Lagoon to the installation area, a fleet of picket boats would be used to keep other vessels from approaching too close. With these measures in place, there would be no short-term or long-term, direct or indirect effect on public health or safety from offshore operations.

Operations of the HSWAC system would be contained within the cooling station. No public access would be permitted there and no effects on public health or safety would result. Neither construction nor operation of the HSWAC system would place demands on police or fire department services that would affect public health or safety.

In summary, Alternative 1 would have a potential direct, short-term, less than significant effect on public health and safety due to the necessity to transport oversized loads on public roadways. Other potential public health and safety concerns are addressed under the navigation, traffic, and hazardous and toxic materials sections.

Alternative 2

The potential effects of and mitigation measures for Alternative 2 would be similar to those of Alternative 1. However, with the cooling station located on Pier 1, the potential for residents of the nearby homeless shelter, including children, to access the site would be greater. The proposed physical barriers would mitigate the potential safety risks. Risks of exposure to mobilized contaminants from excavation of the jacking pit would be less than for the other alternatives, as Alternative 2 is farther from the buried landfill.

Alternative 3

The potential effects of and mitigation measures for Alternative 3 would be the same as for Alternative 1.

Alternative 4 (Preferred Alternative)

The potential effects of and mitigation measures for Alternative 4 would be the same as for Alternative 1.

3.4 SOCIAL AND ECONOMIC RESOURCES

3.4.1 Definition of the Resource and the Region of Influence

Socioeconomics is defined as the basic attributes and resources associated with the human environment. Socioeconomic “resources” include population size and demographics; employment and income; economic activity; government-funded health and human services; and social cohesion. As for the other resources analyzed, the ROI for socioeconomic resources consists of the Kaka‘ako area of O‘ahu.

3.4.2 Existing Conditions

Considering only the Ala Moana/Kakaʻako area where the HSWAC seawater system would be located, the State of Hawaiʻi 2011 Data Book (DBEDT, 2012) shows a resident population of 14,186 and 7,797 households. No other data specific to that neighborhood are available from State or Federal sources.

3.4.3 Approach to Impact Analysis

The HSWAC system would have no effect on population size or demographics, government-funded health and human services, or social cohesion. The project would not stimulate population growth or movement. It would not place any additional burdens on public services, nor is it inherently controversial or in conflict with community values. To the contrary, it is widely perceived to be a "green" technology that would benefit the community by reducing dependence on fossil fuels. Consequently, the approach in this section is to quantify the economic effects of the proposed action to the State.

3.4.3.1 Methodology

Downtown Honolulu and Kakaʻako (the service area for the HSWAC project) are in an enterprise zone. The State of Hawaiʻi administers an enterprise zone program that provides a variety of benefits to eligible businesses in these designated areas. The purpose of providing benefits to qualified businesses in enterprise zones is to stimulate business and industrial growth in areas which would result in neighborhood revitalization of those areas by means of regulatory flexibility and tax incentives. During the 2007 session of the Hawaiʻi State Legislature, legislation was introduced by the applicant to add SWAC district cooling systems to the definition of "qualified business" to qualify for State enterprise zone benefits. While this initiative was not successful, the effort produced useful estimates of the potential economic impacts of the HSWAC system.

In order to justify the addition of SWAC as an eligible technology for enterprise zone benefits, an Input/Output analysis was completed by the applicant to determine the fiscal and economic impact of local expenditures[9] in Hawaiʻi during the design, construction and operation of the HSWAC system and for a composite of alternative, stand-alone, conventional cooling systems in individual HSWAC customer buildings.

Appropriate Type II Final Demand Multipliers were applied to local expenditures in applicable industry categories to determine fiscal impacts (State taxes) and economic impacts (output, earnings, and jobs). Type II Final Demand Multipliers used in this analysis were taken from "The 2002 State Input-Output Study for Hawaiʻi."[10]

Because this EIS considers only the seawater portion of the HSWAC system, the economic benefits identified below accrue only from construction and operation of that portion of the system. As there would be no benefit to operating the seawater portion of the system without also operating the freshwater distribution system, for purposes of this EIS, economic benefits are those attributable to construction of the seawater system, including the pipes and the cooling station.

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[9] Most of the equipment, materials, and supplies that would be used in the construction of the HSWAC system would be manufactured out of State, and some of the required labor and services would also be sourced from out of State. In general, bond financing is assumed to come from out of State. The subject analysis considers only those expenditures that would be made in Hawaiʻi. This includes most of the required labor and services. A significant amount of equity financing would come from within Hawaiʻi and most of the returns on this equity investment are assumed to be expended in Hawaiʻi. Various State taxes are assumed to be paid in Hawaiʻi and expended here. The local share of personal consumption expenditures was corrected for exports, social security, medicare, retirement benefits, etc.

[10] "The 2002 State Input-Output Study for Hawaiʻi," Research and Economic Development Division. Department of Business, Economic Development, and Tourism. State of Hawaiʻi. June 2006. http://hawaii.gov/dbedt/info/economic/data_reports/2002_state_io/2002-input-output-study.pdf/download.

3.4.3.2 Determination of Significance

As the analysis focused on economic effects, significance was determined, somewhat arbitrarily, as follows:

- The economic impact was considered "significant" if it would alter expected economic levels by $40M or more at any point in time compared to the no action alternative,
- The economic impact was considered "significant" if it would add $2M to State tax revenues, and
- Quantifiable impacts related to jobs were considered "significant" if they increased the direct and indirect number of jobs by 100 or more.

3.4.4 Impacts

3.4.4.1 No Action Alternative

The No Action Alternative would not generate the economic benefits anticipated from the action alternatives.

3.4.4.2 Alternative 1

The total construction cost of the HSWAC system is currently estimated at approximately $250 million. Of that total, about 80% or $200 million is attributable to the seawater piping and cooling station. This would represent a significant benefit in terms of the general economy. Even ignoring multiplier effects, State tax revenues would be increased by more than $8M, also a significant beneficial effect. Finally, more than 100 direct construction jobs and additional indirect jobs would be created by the seawater portion of the HSWAC system, representing another short-term beneficial effect.

In summary, Alternative 1 would have direct and indirect, short-term and long-term, beneficial effects on socio-economic resources because of the spending and employment associated with construction of the HSWAC seawater system. No mitigation measures would be necessary.

3.4.4.3 Alternative 2

The impacts of Alternative 2 would be essentially identical to those of Alternative 1. There would likely be some differences in construction costs between the two cooling station locations, but these would be insignificant in scale.

3.4.4.4 Alternative 3

Alternative 3 would move the return seawater diffuser from a depth of 150 feet to 300 feet. This would entail installation of an additional 1,540 feet of discharge pipe at a cost of about $1.54M. This cost would have to be passed on to the customer base and would reduce the overall economic benefits. Nevertheless, the net effect would still be highly beneficial in both the short- and long-term.

3.4.4.5 Alternative 4 (Preferred Alternative)

Alternative 4 would move the return seawater diffuser still deeper, to a terminal depth of 423 feet. Compared to Alternative 1, this would entail installation of an additional 1,909 feet of discharge pipe at a cost of about $1.9M. This cost would have to be passed on to the customer base and would reduce the overall economic benefits. Nevertheless, the net effect would still be highly beneficial in both the short- and long-term.

3.5 VISUAL RESOURCES

3.5.1 Definition of the Resource and the Region of Influence

Public views, as defined in the City and County of Honolulu's Development Plan (DP) Common Provisions, include "views along streets and highways, mauka-makai view corridors, panoramic and significant landmark views from public places, views of natural features, heritage resources, and other landmarks, and view corridors between significant landmarks" (§24-1.4, Revised Ordinances of Honolulu.). Important views to be protected on Oʻahu, as identified in the Special Provisions for the Primary Urban Center DP, are "panoramic, mauka and makai and continuous views of the Koʻolau and Waiʻanae mountain ranges, ridges, valleys, and coastline and the sea," and "views of natural landmarks, such as Diamond Head, Punchbowl, Pearl Harbor, and major streams and forest areas" (§24-2.2(2)(A) and (B), Revised Ordinances of Honolulu).

3.5.2 **Existing Conditions**

The HSWAC project area offshore of Kakaʻako is an open coastal area from which views of Oʻahu's mountain ranges form a backdrop to nearer urban developments including Kakaʻako Waterfront Park directly inshore; Sand Island, Honolulu Harbor, the Pearl Harbor entrance channel, the Reef Runway at Honolulu International Airport and the rest of the island all the way to Barbers Point to the west and Waikiki and Diamond Head to the east. Views from the Keʻehi Lagoon staging area are of unimproved lands and industrial developments on Sand Island, including the Sand Island Wastewater Treatment Plant, to the east, Keʻehi Lagoon and the marinas to the north, and the Honolulu International Airport to the west.

3.5.3 **Approach to Analysis**

Visual resources include scenic areas, vistas or thoroughfares and locations that provide natural-appearing or aesthetically-pleasing places or views. This includes natural views such as shorelines, seascapes, cliffs and man-made views such as unique buildings, landscaping, parks, and other types of cultural features. The City and County of Honolulu's Development Plan for the Primary Urban Center, seeks to protect "panoramic, mauka and makai and continuous views of the Koʻolau and Waiʻanae mountain ranges, ridges, valleys, and coastline and the sea," and "views of natural landmarks, such as Diamond Head, Punchbowl, Pearl Harbor, and major streams and forest areas."

3.5.3.1 **Methodology**

Views are generally composed of and often described in terms of foreground, middle-ground and background depending on the site. For analysis purposes, visual resources are composed of the following:

- Dominant landscape features (e.g., a tall water tower in a landscape otherwise composed of low vegetation and one or two story buildings),
- Diversity (e.g., rows of crops adjacent to an urban area with the mountains as a backdrop),
- Elements of line, color, form, and texture, and
- Distinctive visual edges (e.g., a housing tract adjacent to a forested area).

Information on visual resources was gathered through on-site visits and analysis of photographs. The analysis of potential impacts to visual resources is based on the long term (operational) effects – i.e., after construction has occurred.

3.5.3.2 **Determination of Significance**

For the purpose of this EIS, the proposed action and alternatives would cause a significant impact to visual resources if they:

- Would substantially alter the views or scenic quality associated with particularly significant and/or publicly recognized vistas, viewsheds, overlooks, or features,
- Would substantially change the light, glare, or shadows within a given area, and
- Would substantially affect sensitive receptors – i.e., viewers with particular sensitivity (or intolerance) to a changed view (e.g., a hillside neighborhood with views of a relatively undisturbed, naturally-appearing landscape).

3.5.4 Impacts

3.5.4.1 No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effect on visual resources because it does not involve erection of any new structure. However, existing cooling towers would remain visible on many downtown buildings.

3.5.4.2 Alternative 1

During construction, construction equipment in the ocean will be visible during offshore operations where normally only the horizon would be visible. After construction, the only visible portion of the proposed system would be the cooling station. However, the cooling station would be located in a very inconspicuous location makai of a massive structure that blocks mauka-makai views from Keawe Street to Coral Street. Views toward the mountains are already blocked by the existing building and no views toward the sea are possible from the virtually windowless wall of the adjacent building that would tower over the much shorter cooling station. To both the east and west of the site are industrial buildings and warehouses two to four stories high. Alternative 1, therefore, would have a less than significant short term direct adverse effect on visual resources and have no long-term direct or short-term or long-term indirect, adverse effect on visual resources.

3.5.4.3 Alternative 2

Alternative 2 would place the cooling station on Pier 1. Currently, there is a warehouse on the site that obstructs ground level views toward the inner part of Honolulu Harbor. From the overlooking hill in Kakaʻako Waterfront Park, views toward Honolulu Harbor and ʻEwa are industrial in character and somewhat obstructed by stacks of shipping containers. The height of the cooling station would be similar to that of the warehouse, but the design would be more architecturally appealing. Views from the harbor towards Diamond Head are obstructed by the hill in Kakaʻako Waterfront Park. The effects would be similar to Alternative 1.

3.5.4.4 Alternative 3

Alternative 3 would position the cooling station at the same location as under Alternative 1, and as for that alternative would have no direct or indirect, short-term or long-term adverse effect on visual resources.

3.5.4.5 Alternative 4 (Preferred Alternative)

Alternative 4 would position the cooling station at the same location as under Alternative 1, and as for that alternative would have no direct or indirect, short-term or long-term adverse effect on visual resources.

3.6 NATURAL HAZARDS

3.6.1 Definition of the Resource and the Region of Influence

Hazards that specifically impact coastal areas and that may affect the proposed action include tsunami waves, hurricanes, earthquakes, and other severe weather and ocean events. The ROI is the area where HSWAC facilities would be constructed, although natural hazards, if experienced, would affect larger areas.

3.6.2 Existing Conditions

3.6.2.1 Tsunami Inundation

Tsunamis are waves with very long wavelengths that are generated by seismic events such as earthquakes, landslides, or volcanism. The sudden ground movement typical of these kinds of events causes a rapid displacement of water, forming high-energy waves that can travel long distances while retaining most of that energy. Ships in the open ocean often do not notice tsunami waves because the amplitude of these waves is usually less than 3.3 feet when in water that is sufficiently deep. However, as the wave approaches land and water depth decreases, the wave's energy is translated into a higher amplitude resulting in a surge of fast moving water that can quickly inundate a coastline (O'ahu Civil Defense, 2005).

The Pacific Tsunami Warning Center in 'Ewa Beach monitors seismic events and ocean surface levels in the Pacific Region to detect when and where tsunamis are generated and whether warnings are needed. The Pacific Tsunami Warning Center is the operational center for the International Tsunami Warning System program (Pacific Tsunami Warning Center, 2005).

The tsunami evacuation zone in Kaka'ako is shown on Figure 3-4 (City and County of Honolulu, n.d.). The preferred site for the cooling station is not within the evacuation zone. The site for the cooling station under Alternative 2 is within the evacuation zone. The jacking pit location under Alternatives 1, 3 and 4 is within the evacuation zone. The Alternative 2 receiving pit location is within the evacuation zone.

3.6.2.2 **Flood Hazards**

The Federal Emergency Management Agency (FEMA) assigns flood zones to areas based on the risk of flooding within that zone. These areas are indicated on Flood Insurance Rate Maps (FIRMs) as shown on Figure 3-5. The 2011 reevaluation of the flood hazard zone boundaries places the preferred site of the cooling station in Zone AE at an elevation of 5 feet. A small portion of the jacking pit for Alternatives 1 and 3 is also in Zone AE at an elevation of 7 feet. A small portion of the Alternative 2 cooling station site is in Zone AE as is its receiving pit, but most of the Alternative 2 cooling station is in Zone X. It's likely that final design of the Alternative 2 cooling station could avoid Zone AE.

3.6.2.3 **Hurricanes and Other Severe Weather Events**

Tropical cyclones include tropical depressions (wind speeds less than 39 mph), tropical storms (wind speeds between 39 and 73 mph), and hurricanes (wind speeds greater than 73 mph). Tropical cyclones periodically threaten the Hawaiian Islands. Such storms generate high winds and waves, heavy rains, marine storm surge, tornadoes, waterspouts, and small-scale, intense winds. Storm effects can be considerable even when a hurricane does not pass directly over an island. The Saffir/Simpson Scale classifies hurricanes into five categories according to wind speed and damage potential (Table 3-4).

Table 3-4: Saffir/Simpson Hurricane Scale

Category	*Description of Damage*	*Wind Speeds (mph)*	*Storm Surge (ft)*	*Examples*
1	Minimal	74 - 95	4 - 5	'Iwa, 92 mph, Nov 1982
2	Moderate	96 - 110	6 - 8	None
3	Extensive	111 - 130	9 - 12	Uleki, 128 mph, Sep 1992
4	Extreme	131 - 155	13 - 18	Iniki, 145 mph, Sep 1992
5	Catastrophic	>155	>18	Emilia and Gilma, 161 mph, Jul 1994, John, 173 mph, Aug 1994
Source: O'ahu Civil Defense Agency				

Hurricane season in Hawai'i begins in June and lasts through November. During the last 50 years many tropical storms and hurricanes have come close to the Hawaiian Islands, but there have been only three direct hits, all of which made first landfall on Kaua'i (Figure 3-6).

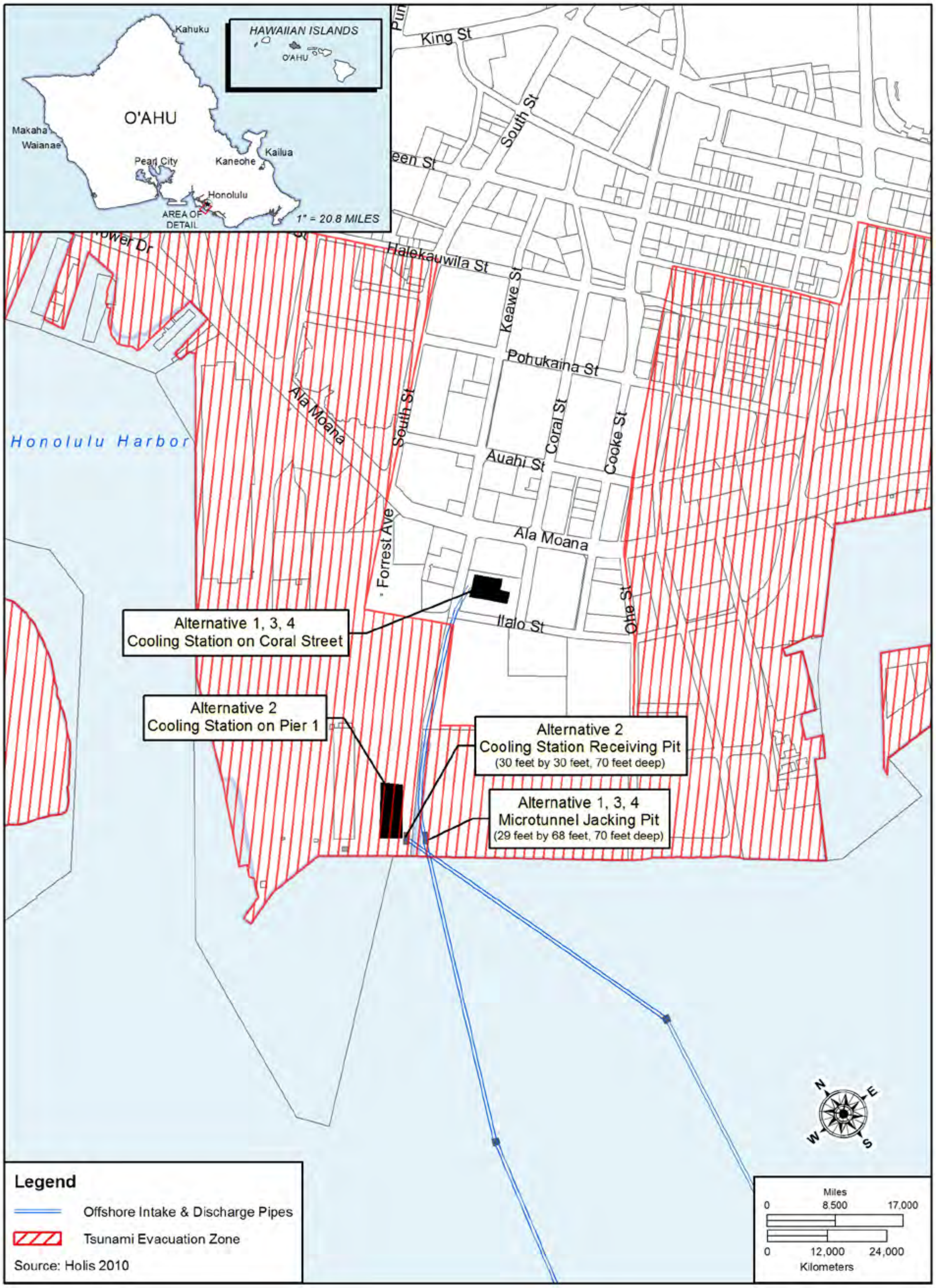


Figure 3-4: Tsunami Evacuation Zone

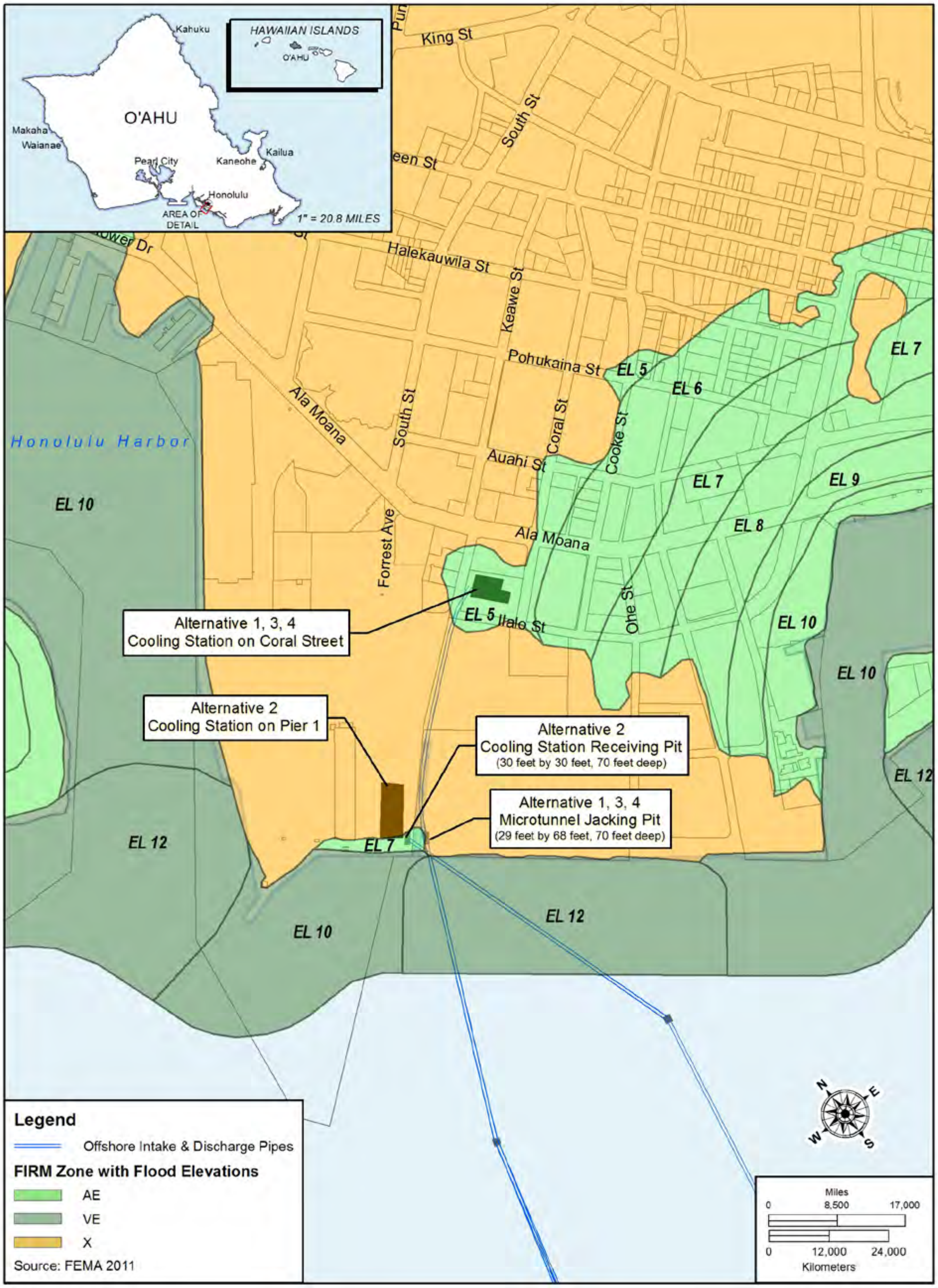


Figure 3-5: Flood Hazard Zones

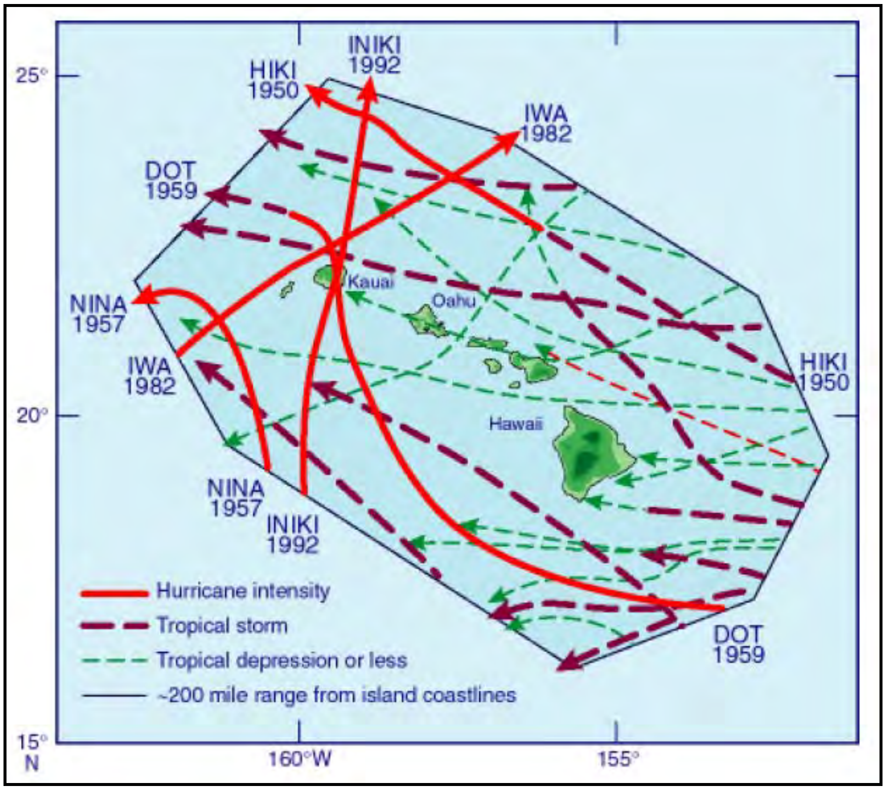


Figure 3-6: Hurricane and Tropical Storm Tracks Near the Main Hawaiian Islands
(Source: UH Mānoa Storm Evolution and Energetics Research Group)

The south coast of O‘ahu is susceptible to damage from large ocean waves. Hurricane ‘Iwa caused extensive damage, including inundation of the central sections of the coast southwest of the Wai‘anae Range, as well as oceanfront areas on the south coast of O‘ahu from Sand Island to Diamond Head. A total of 421 acres of land flooded on O‘ahu.

The storm waves generated by Hurricane ‘Iwa caused extensive underwater damage, scouring coral and sand from the bottom. Large rocks and coral heads were moved about, some for great distances. A large pipeline (30-inch diameter with three-inch concrete coating) laid two nautical miles seaward off Barbers Point and weighted to the bottom by a series of 10-ton concrete blocks was moved sideways about 400 feet. At the same time, a “header unit” (a large assembly of pipes, valves and fittings), which was anchored by 30 feet steel pilings driven full length into the hard coral bottom was pulled out of the bottom and smashed aside. According to the applicant, the HSWAC seawater pipe anchoring system has been designed with this knowledge in mind.

The major impact of Hurricane ‘Iwa on Pearl Harbor was the hazards its waves posed to ships as they attempted to leave the harbor prior to the arrival of the storm’s winds. Several ships reported waves (variously described by observers as surf, breakers, and waves) of heights ranging from 14 feet to 30 feet in the Pearl Harbor Entrance Channel between buoys 1 and 2 at its southeast end and in the channel approximately 1,500 yards northwest of buoys 1 and 2. The high waves caused several injuries, including one fatality, aboard departing ships as they attempted to sortie as ‘Iwa approached. Damage was incurred within Honolulu Harbor, but was due to wind and wave driven debris and inadequate mooring of small vessels rather than high waves.

According to wind speeds estimated from satellite photographs, ‘Iwa was a Category 1 hurricane (USACE, 1983). The U.S. Department of Commerce (1993) classifies ‘Iwa as a weak Category 2 hurricane.

Hurricane ‘Iniki (1992) is considered the strongest hurricane to hit the Hawaiian Islands this century (U.S. Department of Commerce, 1993). Based on estimated peak sustained winds of between 130 and 160 mph, ‘Iniki would be classified as a minimum Category 4 storm on the Saffir-Simpson Scale. If the classification were based on the last reconnaissance flight with sustained winds of 115 kt with gusts to 140 kt, ‘Iniki would also be classified as a Category 4 storm. Despite the strength of the storm, ‘Iniki did not cause as much damage on O‘ahu as ‘Iwa did. Post-storm estimates of wave heights range from a maximum of 16 feet on the Wai‘anae Coast to 4 to 9 feet along the south coast of O‘ahu from Sand Island to Diamond Head.

Unfortunately, the factors that influence the severity of storm-surge flooding (such as coastal topography, tidal stage and height at the time of the storm, and location relative to the eye of the hurricane) cannot be predicted more than a few days in advance (Juvik and Juvik eds., 1998).

Seasonal Storm-Generated Waves

Sudden high waves and the strong currents they generate are probably the most consistent and predictable coastal hazards in Hawai‘i. High surf is a condition of dangerous waves 10 to 20 feet high or more. On O‘ahu’s southern coast, high surf usually forms during summer when storms in the southern hemisphere generate waves of 4 to 10 feet. Sets of large waves can develop suddenly, often doubling in size within a few seconds. The coastal water level increases under these conditions, and the seaward surge of excess water generates dangerous rip currents (Juvik and Juvik eds., 1998).

Surface Wind-Generated Waves

Offshore of O‘ahu the seas are moderately rough, with wave heights of 3 to 14 feet. These vary seasonally with trade wind intensity. Between the islands, where the winds are funneled, the seas are intensified. The lee, shielded from the winds, is generally calmer. Along the shores waves become steeper and break as they enter the shallow water. The south shores of the Hawaiian Islands, shielded from northwesterly swells, are usually calm in winter. Breaking waves move water toward the shore where it escapes along shore. The water then returns to the sea as narrow rip currents, generally located where the bottom is deepest. Although forecasts about general wave conditions can be made, the size or timing of individual waves cannot be predicted (Juvik and Juvik eds., 1998).

Regional Currents

The Hawaiian Islands affect the waters around the islands by interactions with large-scale ocean currents and wind speed variations in the lee of the islands. On the southern boundary of O‘ahu, for example, trade winds with speeds of 22 to 44 miles per hour are separated from the calmer lee by a narrow boundary area (wind shear line). Variations in winds have subtle effects on current patterns. Clockwise eddies can form under the southern shear lines. Off the southern coast of O‘ahu, surface currents average about 0.33 feet per second, but can vary by as much as 1.0 foot per second (Juvik and Juvik eds., 1998).

Tides

Local underwater surface contours affect the ranges and phases of tides along the shore as the tidal waves wrap around the Hawaiian Islands. Tidal currents result from tidal variations in sea level, and nearshore they are often stronger than the large-scale offshore flow. The semi-daily and daily tidal currents tend to be aligned with the shoreline off Oʻahu. However, due to the variability of tidal currents around the island and other factors, they cannot be predicted as precisely as the general sea level. Strong swirls often result from tidal currents flowing around points, such as Barbers Point, and headlands can be hazardous to divers (Juvik and Juvik eds., 1998). Of interest to the HSWAC project is the fact that tides in Māmala Bay generate internal waves that cause temperature variations of several degrees in the depth range of the proposed seawater intake. Additional information about tides and currents in Māmala Bay may be found in Section 3.7.3.1.

3.6.2.4 Seismic Events

The U.S. Geological Survey (USGS) uses a computer model to estimate probabilities that an earthquake of a certain magnitude would occur within a certain time period. Table 3-5 summarizes the probability that an earthquake of 5.0 magnitude or greater would occur within 31 miles of Honolulu.

Table 3-5: Earthquake Probability

Time period (yrs)	*Probability of Occurrence (%)*
10	15
15	20
20	25
25	30
30	35
Source: USGS, 2005	

To categorize the risk and establish appropriate building codes, in 1997 the USGS completed a seismic-hazards assessment for the counties of Hawaiʻi. Oʻahu was assigned to Seismic Zone 2A. The Uniform Building Code (UBC) projects that an area in Zone 2A could experience seismic activity between 0.075 and 0.10 g (the earth's gravitational acceleration). In comparison, the island of Hawaiʻi is designated as Zone 4, the highest seismic zonation. Severe seismic activity with forces of 0.3-0.4 g could be experienced there.

3.6.3 Approach to Impact Analysis

The seawater pipelines would be vulnerable to tsunami, storm surge or earthquake. The cooling station could be vulnerable to flooding from a large tsunami or storm, or from earthquake. According to the applicant, previous large diameter pipeline installations in Hawaiʻi and elsewhere and their responses to natural hazards were studied during the preliminary design phase of the HSWAC project, and this information used in design of the anchoring system for the seawater pipelines. Elevation of the pipelines off the bottom, as would occur because of the anchor collars, would greatly reduce lateral stresses on the pipelines. Steel pipe piles, filled as required with concrete, would secure the collars from the breakout point to depths of 150 feet. The cooling station would be a sturdy structure to support the necessary heavy industrial equipment and volumes of water, with few exterior openings.

3.6.3.1 Methodology

As noted above, protection of the system from natural hazards was integrated into the design of both the offshore facilities and the cooling station, based on historical records of past events and their effects on similar structures and locations. Potential natural hazards and mitigation measures are described below. Effects on the HSWAC system of an increased number or severity of storm events resulting from climate change or a rise in sea level are discussed under cumulative effects in Section 3.9.2.

3.6.3.2 Determination of Significance

The criterion for significance is if a natural hazard could result in a failure of the system that would interrupt service to customers, create public/navigational hazards, alter the human or natural environment, or disrupt neighboring facilities and/or public services.

3.6.4 Impacts

3.6.4.1 No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term adverse effects resulting from natural hazards. Infrastructure supporting the No Action Alternative, including power stations, substations, transmission lines and distribution lines are all susceptible to damage due to natural hazards. To the extent possible, these facilities have been sited and engineered to withstand anticipated forces, but protection from all extreme events is not physically or economically feasible. The proposed project, however, would not have any effects on existing facilities.

3.6.4.2 Alternative 1

Under Alternative 1, the cooling station would be located approximately 1,000 feet inland of the tsunami evacuation zone, but a recent redrawing of the flood zone boundaries places it just within FIRM Zone AE. Zone AE is an area subject to inundation by the 1-percent-annual-chance flood event (i.e., the 100-year floodplain). In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone. The Base Flood Elevation at the cooling station location is five feet. Mandatory flood insurance purchase requirements and floodplain management standards apply. After redesignation of the site into the flood zone, the applicant modified plans for the building to elevate all habitable areas to elevations above the Base Flood Elevation.

A large volume of water would be passing through the cooling station and a pipe leak or other type of failure could allow water to be released inside the building. The potential for impacts to surrounding properties from flooding would be minimized by the facility design, a dry sump-direct connect system, and by emergency systems. High water alarms would be triggered notifying operators and automatically shutting off the pumps before a release reached sufficient volume to exit the premises.

Under Alternative 1, the cooling station would be susceptible to damage from an earthquake. Natural hazard impact mitigation was one of the criteria used in evaluating potential sites for the cooling station. The cooling station would be built in accordance with the City and County of Honolulu Building Code, which includes standards for wind and seismic loading.

Despite precautions taken in planning, siting, and engineering, any structure is susceptible to damage given a large enough natural hazard event. It is not possible to design or construct a facility impervious to all conceivable natural hazards. The best that can be done is to minimize the statistical probability of failure. Consequently, even with application of available measures, the direct, long-term adverse effect of natural hazards would be significant, but in most cases mitigable to less than significant. In the event of a system failure, an indirect adverse effect would be experienced by system customers. Whether this would be a short-term or long-term effect would depend on a number of things including the nature of the natural hazard, its effects on the facility, and its effects on the surrounding regional infrastructure.

Beyond reducing the vulnerability of the facilities to natural hazards by appropriate siting and design, minimization of the effects of hazard-related damage may be possible in some situations. For example, if power were lost in the Kaka‘ako area, backup power would be provided to run seawater and chilled water distribution system pumps. However, it would not be possible to run the auxiliary chillers. Cooling would be possible to deliver to buildings with power still available, however, at a slightly higher supply temperature of 46° to 47°F.

Alternative 1 could be directly adversely affected in both the short-term or long-term by a natural hazard, but planned mitigation in the form of design criteria and construction specifications would provide adequate protection from foreseeable events. Indirectly in both the short term and long term, natural hazards would have a less than significant impact.

3.6.4.3 **Alternative 2**

In general, the potential effects of natural hazards on the facilities proposed under Alternative 2 would be very similar to those described above for Alternative 1 with one exception. The makai half of the existing Pier 1 warehouse, where the HSWAC cooling station would be located under Alternative 2, lies within Flood Hazard Zones AE and X. Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, and to areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

3.6.4.4 **Alternative 3**

Under Alternative 3 the cooling station would be at the same location as in Alternative 1 and the vulnerabilities would be as described for that alternative.

3.6.4.5 **Alternative 4 (Preferred Alternative)**

Under Alternative 4 the cooling station would be at the same location as in Alternative 1 and the vulnerabilities would be as described for that alternative.

3.7 **MARINE RESOURCES**

3.7.1 **Definition of the Resource and the Region of Influence**

Marine resources are defined as marine waters, the benthic substratum and the flora and fauna living in or on the water or seafloor. The ROI is the submerged lands and adjacent waters offshore of Kakaʻako and Sand Island.

3.7.2 **Bathymetry, Geology and Sediments**

3.7.2.1 **Existing Conditions**

The shallow marine portion of the project area offshore of Kakaʻako has been heavily impacted by past uses of the area including sewage and dredged material disposal, as well as hurricane storm surge and annual episodes of high surf conditions. The Keʻehi Lagoon channel offshore of Sand Island was created by dredging for use as a seaplane runway.

A shallow reef fronts the man-made boulder revetment (sea wall) between Fort Armstrong and Kewalo Basin along the seaward side of Kakaʻako Waterfront Park, which contains the former dump. The revetment was constructed on a limestone bench in 6 to 15 feet of water.

An underwater survey in depths of 40 to 80 feet in the vicinity of the locations of the microtunnel breakout points for the action alternatives was performed on January 6, 2005 using SCUBA gear, camera equipment, soil testing equipment, and general measuring tools. The survey consisted of two dives and a period of underwater towing to capture video footage over a greater area offshore of Kakaʻako Waterfront Park bounded by the Honolulu Harbor entrance channel on the west and Kewalo Basin on the East (Makai Ocean Engineering, 2005a).

The bottom in the survey area generally consisted of variable grade, medium to coarse sands with broken coral. A loose sediment layer was observed to be at least six inches thick at all locations surveyed. The area proposed for pipeline installation was mostly coral rubble dredge spoils. The slopes encountered were variable, typically between one and nine degrees and never exceeded 15 degrees.

Dive Locations and Observations

The first dive was made at latitude 21-17.206°N, longitude 157-52.123°W. The water depth at this position was approximately 80 feet, and the substratum was old coral rubble dredge spoil with little relief. The slope was approximately one degree. Closer to shore, sand and finer material was found at a depth of 70 feet. At a depth of 65 feet the conditions were sand with some rocky dead coral patches; the slope was eight degrees. The rebar penetrated the soil to a depth of 12 in with 20 blows indicating a soft substratum (Figure 3-7).

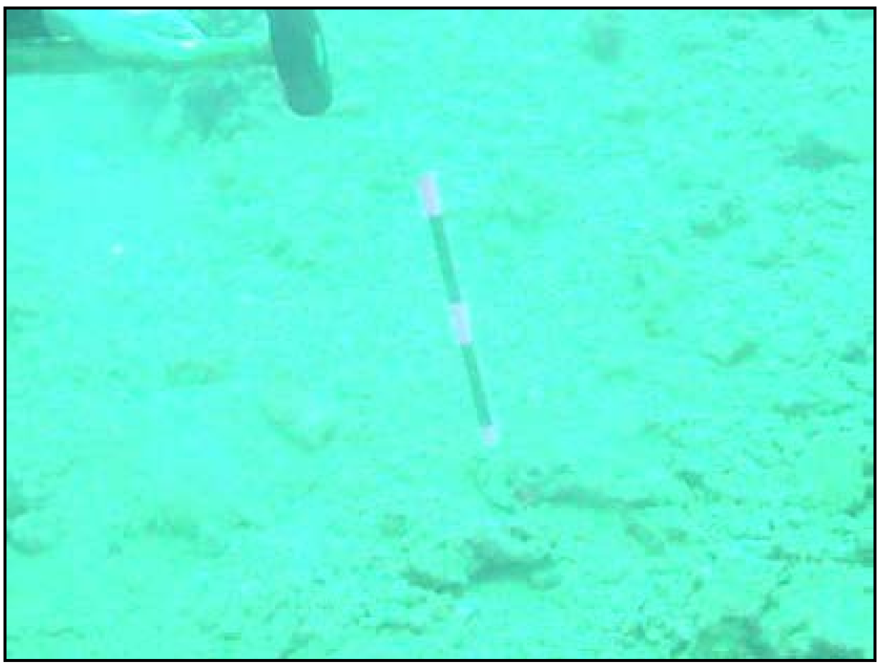


Figure 3-7: Soil Penetration Test on First Dive

The second dive was made at latitude 21-17.230°N, longitude 157-52.255°W. The bottom conditions were sandy gravel and rocky dead coral. Rebar could be penetrated to approximately 12 in with 20 blows (Figure 3-8).

Figure 3-8: Second Dive - Typical Bottom

In summary, the observed substratum generally consisted of variable grade, medium to coarse sands with broken coral. The loose sediment layer was observed to be at least six inches thick at all locations surveyed. The proposed intake pipeline route was mostly coral rubble dredge spoils. The slopes encountered never exceeded 15 degrees and were typically between one and nine degrees. There were no undesirable localized bathymetric or geotechnical conditions.

More recently, additional dives were made along the final pipeline route from the proposed receiving pit location to the mid-point of the Alternative 1 diffuser location. While these dives primarily were made to assess biological communities, the substratum along the route was also noted as it in large measure determines the composition of the benthic communities present. This information is included in Section 3.7.2 and Appendix E.

Māmala Bay Bathymetry

Honolulu Harbor is the result of dredging what was originally the drainage basin of Nuʻuanu Stream. Dredging began before 1900, and periodic maintenance dredging still occurs. Until about 1960, spoils were dropped just outside of the harbor, generally to the east of the Sand Island Wastewater Treatment Plant Ocean Outfall (Brock, 1998). The USGS, USACE, and USEPA have and continue to study the dredged material and their impacts on the marine environment. Figure 3-9 shows the locations of former (Old Pearl Harbor and Old Honolulu Harbor) and current (South Oʻahu) dredged material disposal sites. The narrow insular shelf adjacent to the island is bounded on its seaward side by an escarpment that drops off steeply from 160 to 820 feet deep. All of the disposal sites lie on the plain seaward of the escarpment.

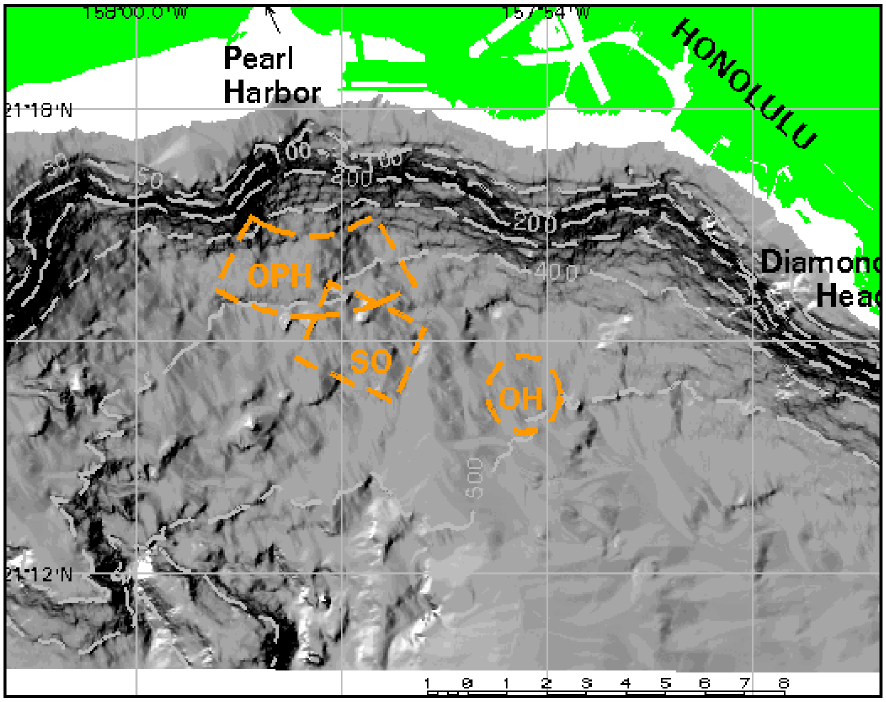


Figure 3-9: Shaded Relief Map of Māmala Bay Showing Designated Dredge Disposal Sites
(Old Pearl Harbor (OPH), South O'ahu (SO), and Old Honolulu (OH)). (Bathymetry is in meters.)
(Source: Wong et al., 1996)

The bathymetric map presented in Figure 3-10 shows that the disposal sites are located in a broad southeast sloping trough having a slope of about two feet per 100 feet (1:50). Large pinnacles and canyons are absent, but several relatively small canyons and areas of irregular topography exist in the immediate vicinity of the disposal sites (Chase et al., 1995). The seafloor is naturally irregular in texture and slope.

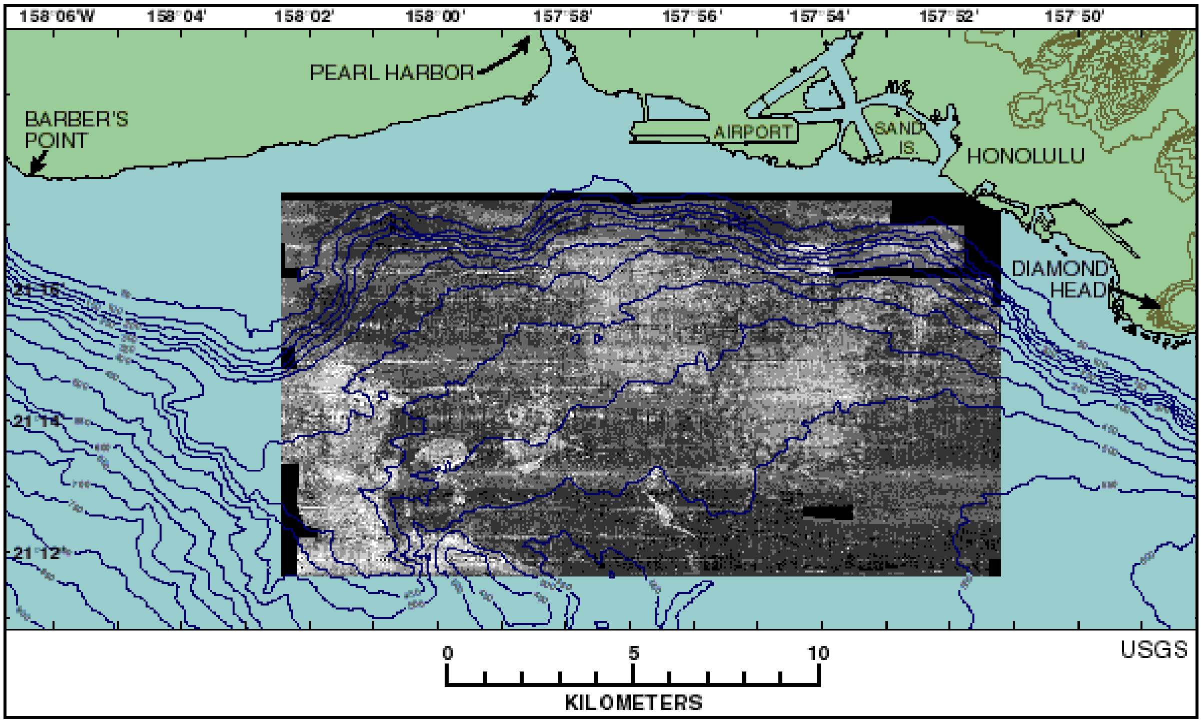


Figure 3-10: Generalized Māmala Bay Bathymetric Map Modified from Chase et al. (1995), Merged with the Sidescan Sonar Mosaic of the Seafloor
(Isobaths are in meters and a 50 m contour interval is used.)

While the breakout point and offshore pipeline routes were being investigated, detailed bathymetric surveys and sub-bottom profiling were completed. A buried ancient alluvial channel was discovered near the Honolulu Harbor entrance channel and several mounds of dredge spoils were also found further to the east. In combination, these features suggested that the safest pipeline route would be to the east of the spoil mounds.

Seafloor Sediment and Dredged Material

Some of the seafloor of Māmala Bay has bedforms visible on the sonar mosaic (Figure 3-11). Bedforms, structures that are molded on beds where deposition is taking place, also appear on bottom photographs collected during the USEPA dredged site designation studies (Chave and Miller, 1977a, 1977b, 1978; Neighbor Island Consultants, 1977; Tetra Tech, 1977; Goeggel, 1978; USEPA, 1980). The variety of bedforms common throughout the study area document active sediment movement, with the implied potential for the redistribution of dredged material beyond the original disposal site. USGS studies are now evaluating not only local and regional ocean circulation patterns, but the nature and characteristics of the dredged materials at their source (the harbors) and at the disposal sites.

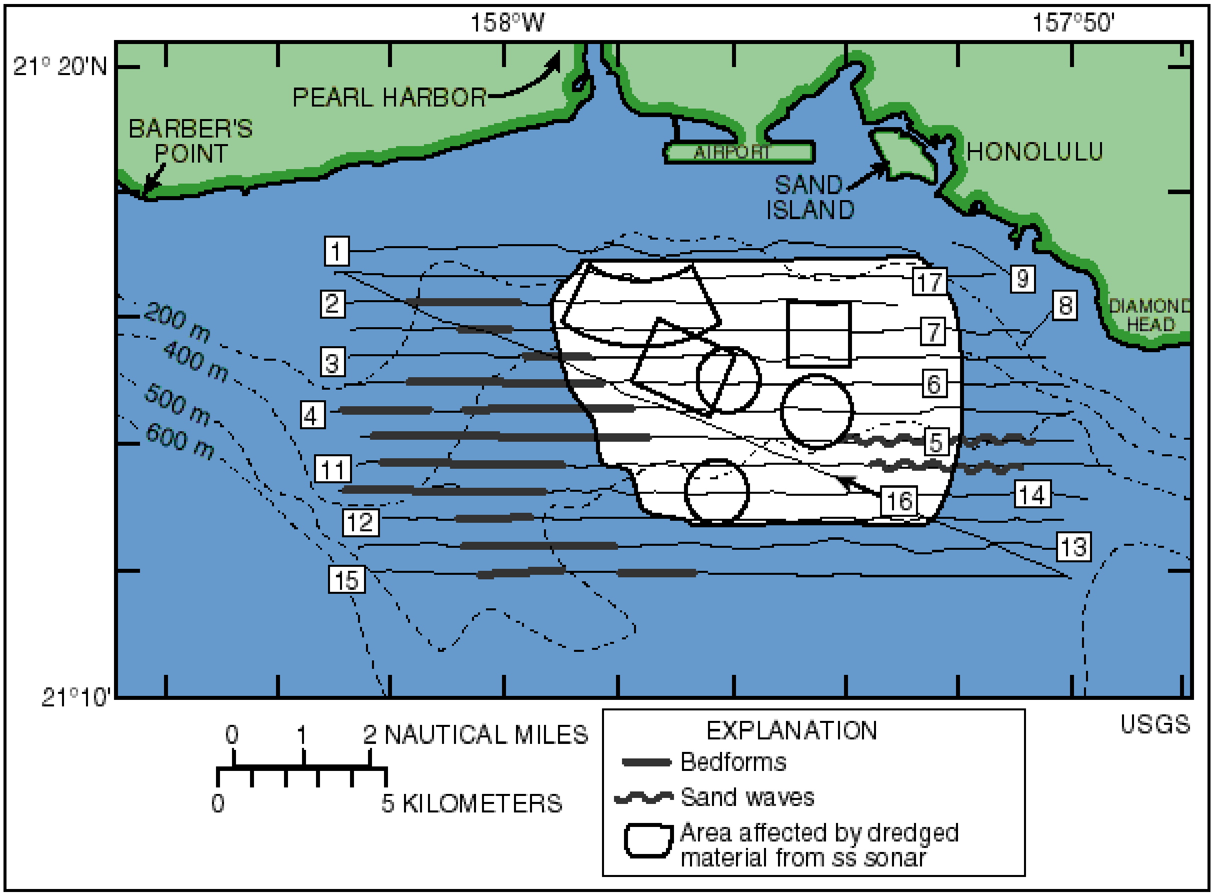


Figure 3-11: General Interpretive Geologic Map Based on 3.5kHz Acoustic Profiles and Sidescan Sonar
(Source: Wong, n.d.)

The results of the USGS 1993 acoustic survey and the subsequent May 1994 sampling program (Torresan et al., 1994a, 1994b) provide abundant evidence that the dredged material deposits are more extensive than the area defined by the official disposal site boundaries. Furthermore, preliminary interpretations of samples and photographic data collected in May 1994 indicate that the dredged material is more extensive than the area defined as dredged material deposits on the sidescan sonar mosaic and 3.5 kHz profiles (Torresan et al., 1994a, 1994 b).

Environmental studies show that the native seafloor sediment is primarily a muddy carbonate sand, with areas of outcrop and carbonate rubble that include shell, coral, and limestone (Chave and Miller, 1977a, 1977b, 1978; Tetra Tech, 1977; USEPA, 1980). Sediment sampling and bottom photography conducted during each phase of the 1977/1978 studies show that there is considerable variation in the composition of the seafloor in and around the disposal sites. Surficial sediment varies from primarily sand to sediment with substantial carbonate rubble (shell, coral and limestone), and the native seafloor sediment consists primarily of carbonate and basalt fragments that constitute about 90% and 10% of the sediment, respectively (Chave and Miller, 1977a, 1977b, 1978; Neighbor Island Consultants, 1977; Tetra Tech, 1977; Goeggel, 1978; USEPA, 1980).

The 1977/1978 site designation studies show that grain size distributions of sediment collected from the disposal sites during each phase of the study vary considerably from sample to sample, and range from sandy gravel to muddy sand. For example, pre-disposal sediment (Phase I) is poorly sorted, averaging 85% sand and 15% mud (silt and clay). Similarly, dredged material (Phase II) is also poorly sorted, but is substantially coarser, containing 49.3% pebbles, 13.8% granules and 36.9% sand. Grain size distributions of sediment collected after a disposal action varied considerably from sample to sample, and post-disposal (Phase III) samples lack mud, are poorly sorted, and vary from predominantly sand (about 80%) to predominantly gravel (about 75%) (Tetra Tech, 1977).

Bottom photography conducted during the 1977/1978 dredging cycle also shows that anthropogenic debris litters the seafloor of Māmala Bay (Chave and Miller, 1977a, 1977b, 1978; Tetra Tech, 1977). Video and still photography collected during a USGS survey conducted in May 1994 (Torresan et al., 1994b) documents the debris to include military ordnance, barrels, tires, lengths of wire rope, and a variety of canisters.

3.7.2.2 **Approach to Impacts Analysis**

The pipeline alignments were selected to avoid paralleling bottom contours where the pipelines could be broadsided by submarine landslides or turbidity flows and to minimize swell energy on the pipe. Thus to the greatest extent possible, alignments run directly downslope, perpendicular to the bottom contours. Another alignment criterion was to minimize the length of pipe needed to reach the desired intake depth and temperature. The pipe is elevated to minimize lateral loads from currents and wave energy on the pipe and to reduce displacement of sediments (scouring) below the pipe.

Methodology

Seafloor geology and sediments, especially at shallower depths, were important considerations in pipeline installation planning. At shallow depths off Kakaʻako, the bottom is covered generally with sand and rubble which is reworked during summer high wave events. In planning for installation of the pipes, trenching through the nearshore reef was considered and rejected in favor of microtunneling. Trenching from the breakout point to a point below potential storm surge effects was also considered and rejected, primarily as a consequence of potential biological and water quality impacts. In placing the pipe above the sea floor, consideration was given to greatly reducing scouring below the pipe by providing sufficient clearance between the seafloor and the pipe. Thus most potential effects on bathymetry, geology and sediments were eliminated in project planning. However, in shallow water it was still necessary to determine the feasibility of pinning the pipes to the bottom. A series of SCUBA dives was first completed to test sediment depth along the route. Subsequently, geotechnical borings were completed to determine if the anchor collars could be securely fixed to the bottom. The effects of the installations were evaluated based on the character of the bottom and the planned methods of installation.

Determination of Significance

Modification of bathymetry, geology or sediment movement would be a significant adverse effect if it resulted in:

- Changes to ocean current patterns,
- Changes to the seafloor bathymetry that would affect navigation
- Changes to the probability of underwater landslides, or
- Changes to the resuspension, transportation and redeposition of sediments that would affect navigation, recreation, public and/or aquatic resources.

3.7.2.3 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effects on bathymetry, marine geology or sediments because no marine construction would occur.

Alternative 1

To satisfy the project purpose and need, deep, cold seawater must be accessed, meaning that pipes must extend from shore to deep water. To protect the pipes from damage from waves in shallow water, they must be placed beneath the seafloor to a safe depth. There is a trade-off between pipe security and the cost of burying them to a point further offshore, but at some point the pipes must surface. The applicant proposes to use microtunneling under the shoreline to a breakout point where a receiving pit would be excavated to allow connection of buried pipes to surface mounted pipes. The connection point must be backfilled and capped to secure the connections. Washed gravel and concrete would be used to backfill and cap the breakout pit. The location of the pit was selected to be in a sand channel rather than on a living reef to minimize ecological impacts.

Construction impacts would be mainly associated with excavation of a receiving pit for the microtunneling machine at the breakout point. Sediments would be removed and bathymetry temporarily altered at the pit. The receiving pit at the off shore end of the microtunnel would be approximately 40 feet by 40 feet (1,600 ft^2) in plan view and 20 feet deep. About 1,185 cubic yards of material would be removed from the pit. After the spool section is installed to connect the surface mounted pipes to the pipes within the microtunnel, the pit would be backfilled and capped with concrete. The bathymetry would be restored to very close to original conditions so ocean currents would not be modified and the probability of underwater landslides would not be increased.

Identified temporary impacts would include potentially elevated levels of suspended sediments in waters surrounding the excavation area. To minimize this effect, sheet piles would be installed around the pit. The sheet piles either would extend to the sea surface or would be augmented by silt curtains at shallower depths to completely isolate the receiving pit from the surrounding waters. Sediments removed from the pit would be disposed of on land. Effects on water quality and biota are addressed in other sections. The applicant would implement BMPs during all operations.

Potential long term effects that have been identified include permanent scouring beneath the pipe, effectively transporting and redistributing sediments from beneath the pipe to maritime assets in the vicinity of the pipe structure. Such assets include beaches, the revetment along Kaka'ako Waterfront Park, the harbor channels into Honolulu Harbor and Kewalo Basin as well as sediment settling on and impacting the viability of coral colonies. There have been numerous studies on scouring around pipelines as this presents a structural design consideration for pipe installations. A review of the studies was conducted by Sumer and Fredsøe in 1992. This review shows the equilibrium ratio of scour depth to pipe diameter for a pipe placed directly on the seabed for practical design purposes is approximately 0.6. Therefore to eliminate scour beneath the intake and discharge pipes, a minimum clearance of 38" between the seabed and the bottom of the pipe would be required for the larger pipe. The pipe collars, which would maintain the pipes above the seabed to minimize lateral loads from currents and wave energy, would provide a 47.5" clearance, effectively eliminating the transportation or redistribution of sediments as a result of scouring. Minimal scouring around the pipe collars would be anticipated. Additionally, the pipe breaks out of the seabed at 31 foot depth. This is 1,608 feet from the shoreline, sufficiently distant to impact shoreline facilities such as beaches and shore protection or surf induced water circulation. Therefore no more than minimal impacts associated with scouring or sediment deposition is anticipated.

In summary, Alternative 1 would have a less than significant, direct, short-term adverse effect on bathymetry, geology and sediments as a result of the marine construction activities and no long term effect as a result of operations.

Alternative 2

The effects of Alternative 2 on bathymetry, geology and sediments would be the same as those under Alternative 1, and the same mitigation measures would be used.

Alternative 3

The effects of Alternative 3 on bathymetry, geology and sediments would be the same as those under Alternative 1, and the same mitigation measures would be used.

Alternative 4 (Preferred Alternative)

The effects of Alternative 4 on bathymetry, geology and sediments would be the same as those under Alternative 1, and the same mitigation measures would be used.

3.7.3 **Tides and Currents**

3.7.3.1 **Existing Conditions**

Ocean circulation in Māmala Bay is complex, driven largely by tidal fluctuations with major components paralleling the shoreline, but influenced seasonally by thermal stratification, along with trade and Kona winds. Oceanographic processes that have major effects on circulation in Māmala Bay can be divided into the following categories: (1) those caused by surface tides (semi-diurnal, with a period of 12.4 hours, and diurnal, with a period of 24.8 hours) and (2) those that result from other factors including wind forcing, propagation of long period waves and circulation in deep offshore coastal waters.

The semi-diurnal tidal wave moves in a southwesterly direction in the Pacific Ocean, and appears to split near the North Shore of Oʻahu. Two progressive tide waves are thus created; one propagating along the east side of the island and the other along the west side. Coastal trapping causes these two waves to curve around the headlands at Barbers Point and Diamond Head, and to merge within Māmala Bay before continuing toward the southwest. As a result, strong tidal velocities measured at Barbers Point and Diamond Head are oriented parallel to the depth contours and directed towards the middle of the bay. Weak currents result where the flows merge from opposite directions. Converging flows at flood tide cause a downwelling (downward flow) at the center of the bay, which reverses at ebb tide. Consequently, large changes in stratification occur over the tidal cycle, with the water column often becoming homogeneous at different sites.

Peak currents of about 20 inches per second were measured at the Sand Island Wastewater Treatment Plant outfall located about three miles southeast of the Reef Runway in approximately 250 feet of water. Figure 3-12 shows a schematic of the mean current circulation patterns in Māmala Bay (Colwell et al., 1996).

3.7.3.2 **Approach to Impact Analysis**

Methodology

The tides and currents in the offshore project area are important primarily for their influence on the behavior of the return seawater plume. This is evaluated in the water quality section where the results of the applicant's computer modeling of the plume behavior are presented. Currents are also important because of the stress they can exert on the submarine pipelines. The pipelines and the receiving pit sheet piling structure can affect currents downstream. These latter two potential effects are the focus of this section.

Determination of Significance

A significant effect would occur if the presence of the pipeline modified tides or currents such that it altered the risk level to marine operations, human safety or ecological systems.

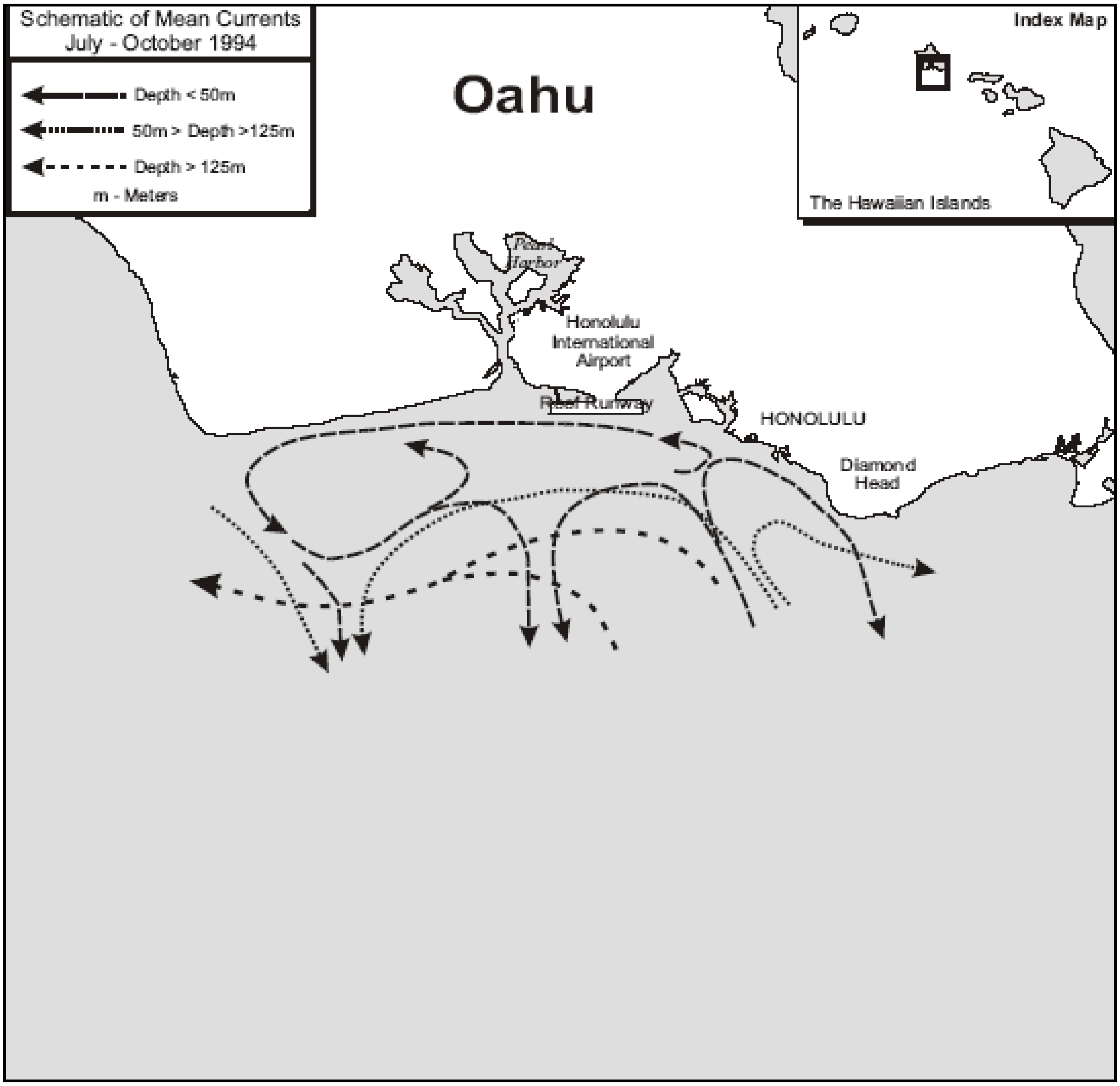


Figure 3-12: Schematic of Mean Circulation Patterns for Māmala Bay

3.7.3.3 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effect on tides or currents because there would be no marine construction or operations.

Alternative 1

Alternative 1 would have a less than significant, direct, short-term effect on currents immediately downstream of the receiving pit structure during construction only. Pipes and support structures would have a negligible effect on downstream currents due to their physical presence near the bottom. Studies have shown that ambient current velocity, while somewhat accelerated (less than 20 % greater than ambient velocity) above and below the pipe, returns to ambient velocity within 8 to 10 pipe diameters (Sumer and Fredsøe, 1992). Elevation of the pipeline in the supporting collars would result in much lower stress on the pipelines from water currents than if they were deployed directly on the bottom, making storm damage less likely.

Alternative 2

Alternative 2 is similar to Alternative 1 except in that the change in current would indirectly significantly disrupt a long-term series of current measurements being collected by the Kilo Nalu Observatory, which maintains an array of sensors on the seafloor near the breakout point and pipeline alignment for Alternative 2.

Alternative 3

The effects of Alternative 3 would be the same as those of Alternative 1.

Alternative 4 (Preferred Alternative)

The effects of Alternative 4 would be the same as those of Alternative 1.

3.7.4 **Marine Water Quality**

The HSWAC system would extract cold seawater from a depth of 1,741 feet, warm it in passage through heat exchangers, and return it to the sea at a shallower depth. This section first provides a brief overview of seawater parameters of importance in assessing the impact of the HSWAC return flows. The applicable State of Hawaiʻi water quality standards are then presented. The ambient conditions at the proposed HSWAC intake and return sites are then described and compared with the State standards. Following that, the characteristics of the return flows are compared with ambient conditions at the proposed return site, potential exceedances of standards are identified, and permitting requirements are described.

3.7.4.1 **Parameters of Interest**

The ocean is a three-dimensional medium with many parameters varying greatly with depth. In sun-warmed surface waters where light penetrates, plants produce organic material and oxygen from inorganic nutrients and other materials. Organic matter and oxygen are consumed at higher trophic levels and waste products excreted, eventually sinking below the photic zone where bacterial decomposition reduces the organics back to inorganic forms. Mixing of near-surface waters by wind and waves creates a homogeneous surface layer characterized by relatively high temperatures, high dissolved oxygen concentrations, and low inorganic nutrient concentrations. Below this layer, temperatures decrease rapidly in the thermocline to deep waters characterized by low temperatures, low dissolved oxygen concentrations, and high inorganic nutrient concentrations. The HSWAC system would remove water from below the thermocline and return it warmed 9-14°F to depths above the thermocline (Alternatives 1-3) or to the upper reaches of the thermocline in Hawaiian waters (Alternative 4). The return waters would differ from the receiving waters in temperature (and therefore density), dissolved oxygen concentrations, and dissolved inorganic nutrient concentrations. The following paragraphs briefly describe the importance and function of these parameters and others included below in the State's water quality standards.

Temperature

Water temperature is one of the most important physical characteristics of the marine environment. Temperature controls the rate at which chemical reactions and biological processes occur (Waller, 1996). In addition, most organisms have a distinct range of temperatures in which they thrive. A greater number of species live within the moderate temperature zones, with fewer species tolerant to extremes in temperature. Typically, organisms cannot survive dramatic temperature fluctuations.

Temperature gradients are created when warmer, lighter water floats above colder, denser water. A band of stable water called a thermocline separates the warm and cold layers of water. In Hawaiʻi, a wind-mixed turbulent layer varies from nearly 400 feet deep in winter to less than 100 feet deep in summer. Below this mixed layer there is a sharp decrease in temperature (the thermocline), from 77°F at the surface to 41°F at 2,300 feet depth, then a gradual decrease to 36°F at the bottom.[11] The thermocline often acts as a habitat barrier, as it represents the boundary between hospitable and inhospitable water masses for many species (Waller, 1996).

Salinity

Salinity refers to the salt content of sea water. For oceanic waters, the salinity is approximately 35 parts of salt per 1,000 parts of sea water. Variations in the salinity of ocean water are linked primarily to climatic conditions. Salinity variations are at their highest at the surface of the water. The salinity of surface water is increased by the removal of water through evaporation. Alternately, salinity decreases through dilution from the addition of fresh water (e.g., rain, runoff from fresh water sources such as streams, etc.). Estuaries represent transition zones from saltwater to fresh water. Seawater salinity has a profound effect on the concentration of salts in the tissues and body fluids of organisms. Slight shifts of salt concentrations in the bodies of animals can have stressful or even fatal consequences. Therefore, animals have either evolved mechanisms to control body salt levels or to tolerate their rise and fall with the salinity of the seawater around them (Waller, 1996).

Density

Density (mass per unit volume) of seawater is dependent upon its composition and is a function of both temperature and salinity. Dissolved salts and other substances contribute to the higher density of seawater compared to fresh water. As temperature increases, density decreases. Accordingly, water that is denser will sink, while water that is less dense will rise. Generally, the oceans can be thought of as having a three-layered system of water masses: the surface layer (0 to 550 feet), an intermediate layer (550 to 1,500 feet), and a deep-water layer (1,500 feet to the seafloor) (Waller, 1996).

pH

The measure of the acidity or alkalinity of a substance, known as the pH, is based on a scale ranging from 1.0 (highly acidic) to 14.0 (highly basic). A pH of 7.0 is considered neutral. Surface seawater often has a pH between 8.1 and 8.3 (slightly basic), but the acidity of deeper ocean water is very stable with a neutral pH. The very high concentration of carbonate ions in seawater gives it a large buffering capacity and resistance to pH changes. Nevertheless, in shallow seas and coastal areas, the pH can be altered by plant and animal activities, pollution, and interaction with fresh water (Waller, 1996).

Dissolved Gases

[11] http://www.satlab.hawaii.edu/atlas/

Oxygen is not readily soluble in sea water. The amount of oxygen present in seawater will vary with the rate of production by plants, consumption by animals and plants, bacterial decomposition, and by surface interactions with the atmosphere. Most organisms require oxygen for their life processes. When surface water sinks to deeper levels, it retains its store of oxygen until comsumed by deeper organisms (Waller, 1996).

Carbon dioxide is a gas required by plants for photosynthetic production of new organic matter. Carbon dioxide is 60 times more concentrated in seawater than it is in the atmosphere. Seawater in tropical regions has lower levels of all dissolved gases in a given volume of water compared to seawater in high latitude areas (Waller, 1996).

Inorganic Macronutrients

Plants in the ocean form the base of the food web, producing the organic compounds that feed higher trophic levels. To do this they need nitrogen, phosphorus, other nutrients and trace elements in addition to carbon dioxide and sunlight. Primary production can proceed only until supplies of that substance which is in the shortest supply relative to the needs of the organism is exhausted (Liebig's "Law of the Minimum"). Nitrate is a common limiting nutrient in subtropical ocean systems such as Hawai'i, and phosphate can be an important co-limiter..

3.7.4.2 **Applicable Standards**

Hawai'i's water quality standards (Chapter 11-54, HAR, Water Quality Standards) are broadly based to protect both terrestrial (groundwater and surface waters) and marine waters. They consist of basic standards applicable to all waters, specific numerical standards for many toxic substances, and specific numerical standards for a number of classes of State waters. As there would be no discharge of toxic substances from the HSWAC system (nothing would be added to the deep seawater in the HSWAC system, and materials comprising the pumps, heat exchangers and pipes are virtually inert), those standards are not reiterated here. The paragraphs below describe the basic standards applicable to all State waters and the specific standards pertaining to the location of the proposed HSWAC return flows.

Basic water quality standards applicable to all waters in Hawai'i are that they shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants, including the following (Chapter 11-54, HAR, Water Quality Standards):

- Materials that will settle to form objectionable sludge or bottom deposits;
- Floating debris, oil, grease, scum, or other floating materials;
- Substances in amounts sufficient to produce taste in the water or detectable off-flavor in the flesh of fish, or in amounts sufficient to produce objectionable color, turbidity, or other conditions in the receiving waters;
- High or low temperatures, biocides, pathogenic organisms, toxic, radioactive, corrosive, or other deleterious substances at levels or in combinations sufficient to be toxic or harmful to human, animal, plant, or aquatic life, or in amounts sufficient to interfere with any beneficial use of the water;
- Substances or conditions or combinations thereof in concentrations which produce undesirable aquatic life; and
- Soil particles resulting from erosion on land involved in earthwork, such as the construction of public works; highways; subdivisions; recreational, commercial, or industrial developments; or the cultivation and management of agricultural lands.

With respect to the proposed HSWAC seawater return flows, potential issues are low temperatures and high macronutrient concentrations that could stimulate algal productivity.

The State of Hawaiʻi classifies the marine waters of Māmala Bay as Class A. "It is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. These waters shall not act as receiving waters for any discharge that has not received the best degree of treatment or control compatible with the criteria established for this class" (Chapter 11-54, HAR, Water Quality Standards).

In addition to the basic standards applicable to all waters, each class of water has numerical standards for specific parameters. Generally, these standards are in the form of three numbers: (1) a value not to be exceeded by the geometric mean of the sample values, (2) a value not to be exceeded more than 10% of the time, and (3) a value not to be exceeded more than 2% of the time. Specific numerical standards have been promulgated for several types of marine waters, such as embayments (including Honolulu Harbor and Kewalo Basin), open coastal waters (less than 100 fathoms deep) and oceanic waters (greater than 100 fathoms deep). These standards recognize that proximity to land affects ambient concentrations of many water quality parameters due to the effects of surface runoff, groundwater seepage, and pollutant discharges. However, they do not recognize the three-dimensional vertical stratification of ocean waters, and all State water quality standards are based on expected concentrations of parameters at the water's surface, even though natural, ambient, unpolluted conditions may exceed State standards in and below the thermocline. Accordingly, the water quality standards apply throughout the water column.

The HSWAC system would draw water from "oceanic" waters, i.e., waters greater than 100 fathoms (600 ft) deep, and return the water to "coastal" waters, i.e., waters shallower than 100 fathoms deep. Coastal water standards would therefore apply to the receiving waters at the alternative diffuser locations. Coastal waters are further subdivided into "wet" areas, those receiving more than three million gallons per day of fresh water discharge per shoreline mile, and "dry" areas, those receiving less than three million gallons per day of fresh water discharge per shoreline mile. Māmala Bay is a "wet" open coastal area, and the standards in Table 3-6 apply at all of the alternative diffuser locations.

A note on units is necessary here. Engineers and scientists often use different sets of units to describe concentrations of parameters in the sea. The standards in Table 3-6 from HAR Chapter 54 are given in engineering units. For comparison with the ambient data sets presented later, conversions to scientific units are shown in parentheses. [12]

Pursuant to CWA Section 303(d) and CWA Section 305(b), the HDOH compiles a report assessing the quality of State waters. The report published in 2008 for year 2006 characterized the waters offshore of Sand Island and the oceanic waters of Māmala Bay as impaired, i.e., exceeding water quality standards, for total nitrogen and chlorophyll a. Discharge of a pollutant to a water body listed as impaired for that pollutant is prohibited and granting of a ZOM would not be possible. The HSWAC discharge would add nitrogen to the water body so, if Māmala Bay is impaired, the HSWAC project could not proceed. In discussions between the applicant and HDOH CWB personnel, it became clear that the listing of Māmala Bay was based on data more than 20 years old, no data had been collected by HDOH in the area in many years, there may have been problems with some of the earlier data and interpretations, and the listing had not been reviewed in recent years. In 2012 HDOH published an updated assessment report for 2008 and 2010 which delisted the offshore portions of Māmala Bay as impaired (HDOH, 2012).

[12] Parts-per-million (ppm) is the same as milligrams per liter (mg/l); a micro-mole per liter (µM/l) is the same as a micro-gram-atom per liter (µg-at/l); and a value in micrograms per liter may be converted to micro-moles (or micro-gram-atoms) by dividing by the atomic weight of the constituent. For example, to convert a value in micrograms per liter of nitrogen, divide by the atomic weight of nitrogen, 14.0067 grams per mole.

Table 3-6: State Water Quality Standards Applicable to Wet Open Coastal Areas

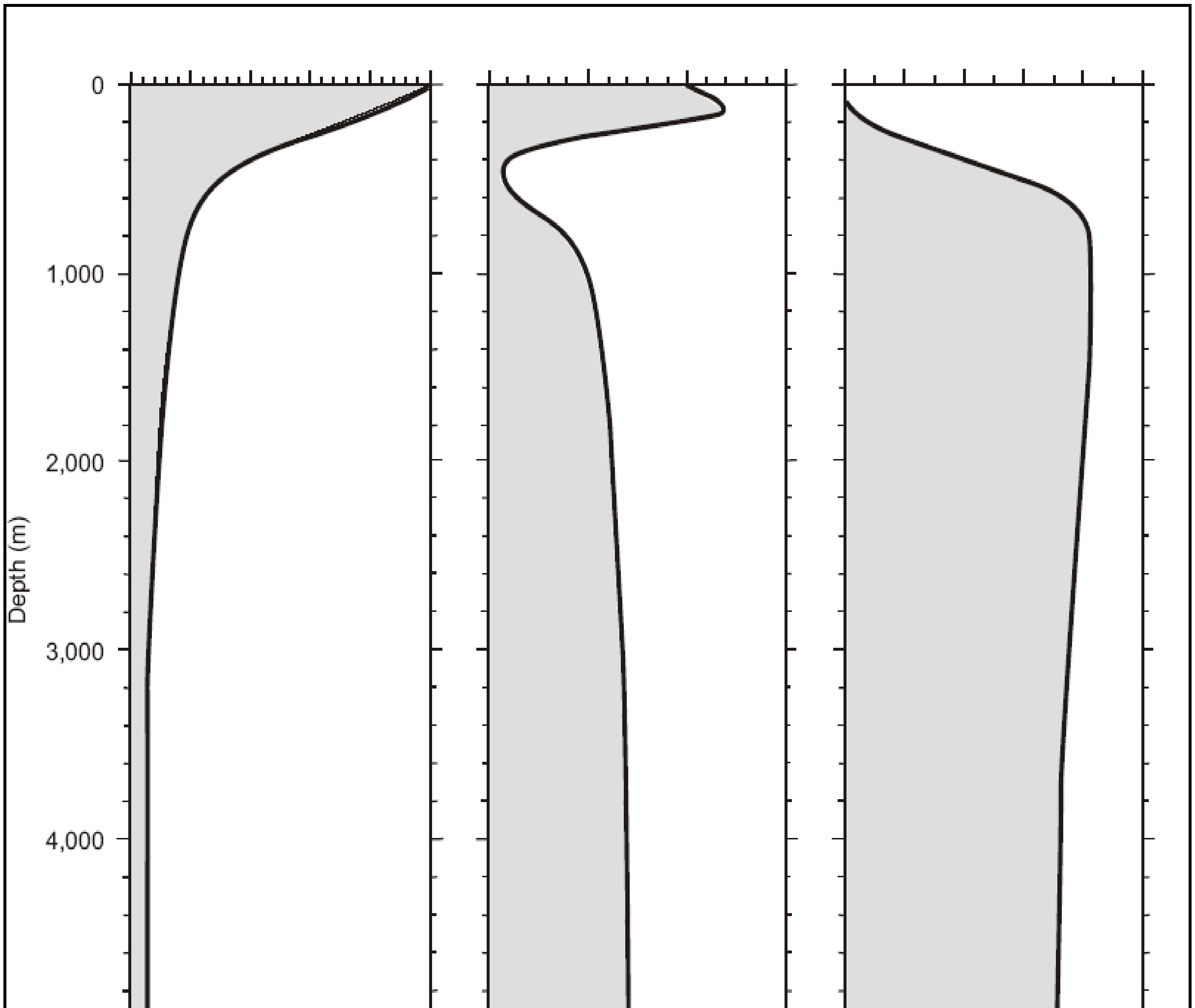
Parameter	*Geometric Mean Not to Exceed*	*Not to Exceed More Than Ten % of the Time*	*Not to Exceed More Than Two % of the Time*
Total Nitrogen (µg N/l)	150.00 (10.71 µM/l)	250.00 (17.85 µM/l)	350.00 (24.99 µM/l)
Ammonia Nitrogen (µg NH_4-N/l)	3.5 (0.25 µM/l)	8.5 (0.61 µM/l)	15.00 (1.07 µM/l)
Nitrate+Nitrite Nitrogen (µg [NO_3 + NO_2] – N/l)	5.00 (0.36 µM/l)	14.00 (1.00 µM/l)	25.00 (1.78 µM/l)
Total Phosphorus (µg P/l)	20.00 (0.65 µM/l)	40.00 (1.29 µM/l)	60.00 (1.94 µM/l)
Light Extinction Coefficient (k units)	0.20	0.50	0.85
Chlorophyll a (µg/l)	0.30	0.90	1.75
Turbidity (N.T.U.)	0.50	1.25	2.00
pH	Shall not deviate more than 0.5 units from a value of 8.1, except at coastal locations where and when freshwater from stream, storm drain or groundwater discharge may depress the pH to a minimum level of 7.0.		
Dissolved Oxygen	Not less than 75% saturation, determined as a function of ambient water temperature and salinity.		
Temperature	Shall not vary more than one degree Celsius from ambient conditions.		
Salinity	Shall not vary more than 10% from natural or seasonal changes considering hydrologic input and oceanographic factors.		
Source: Chapter 11-54, HAR, Water Quality Standards			

3.7.4.3 **Existing Conditions**

Depth Variability of Water Quality Parameters Near O‘ahu

This section provides a general characterization of relevant water quality parameters around O‘ahu. The following section summarizes data collected specifically for the HSWAC project. That is followed by presentation of relevant portions of a long-term data set at stations very close to the potential HSWAC diffuser locations. Those data were collected as part of the ongoing monitoring program associated with the Sand Island WWTP ocean outfall.

Figure 3-13 depicts the average vertical profiles of temperature, salinity, and major nutrients computed from a series of monthly surface-to-bottom measurements made between 1988 and 1995 at Station Aloha located north of O‘ahu. Essentially similar conditions would be expected south of O‘ahu. Vertical profiles of temperature, salinity and nutrients result from broad scale oceanic and climatic conditions, although there are near-shore island effects. Near the surface, the water column is mixed by wind and has uniform properties; the depth of the mixed layer varies from nearly 400 feet in winter to less than 100 feet in summer. Below the mixed layer there is a sharp decrease in temperature (a thermocline), from 77 ˚F at the surface to 41˚F at 2,300 feet depth, then a gradual decrease to 36˚F at 16,400 feet depth. The salinity distribution reflects the sinking of water from the north: higher salinity water of 35.2 parts per thousand (ppt) at 500 feet depth, traceable to the high surface salinity water north of Hawai‘i; and low salinity water of 34.1 ppt at 1,670 feet depth, traceable to low surface salinity water further to the northwest. Below this depth, salinity increases gradually to 34.7 ppt for abyssal waters. The concentrations of macronutrients are small at the surface, but increase to a maximum at about 2,600 feet depth (Flament, 1996).



Source: University of Hawaii
Legend: *C – Celsius; ppt – Parts per thousand;* NO_2 *– Nitrite;* NO_3 *– Nitrate; m – Meters*

Figure 3-13: Average Vertical Distribution of Temperature, Salinity, and Major Nutrients in Hawaiian Waters

Depth profiles for water quality parameters taken from a station in the Kauaʻi Channel west of Māmala Bay are shown in the following figures. Figure 3-14 shows the depth variability of nitrate-nitrogen. It can be seen that surface concentrations approach zero, while ambient concentrations at 1,640 feet (500 m) exceed 30 µM/L (~420 µg/L), about 84 times the State water quality standard. At all depths below about 330 feet (100 m), State water quality standards are exceeded by average ambient concentrations.

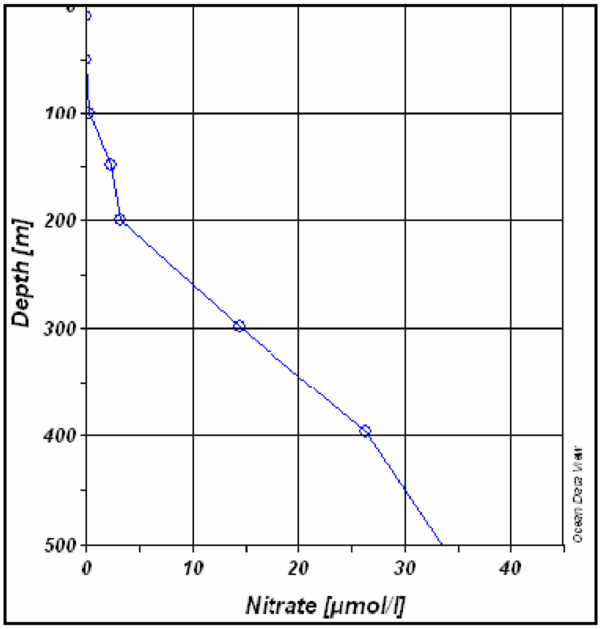


Figure 3-14: Nitrate Concentration as a Function of Depth at a Station West of O‘ahu
(21.18°N, 158.55°W) (Source: Makai Ocean Engineering, 2005b)

Figure 3-15 shows a similar trend for phosphate-phosphorous. The relevant State water quality standard is given in terms of total phosphorous, which includes organic dissolved and particulate forms of phosphorous in addition to the inorganic orthophosphate plotted here. Thus, the total phosphorus concentration would be greater than the phosphate concentration alone. It can be seen from Figure 3-15 that State water quality standards for total phosphorous are exceeded by phosphate concentrations alone at depths below about 820 feet. At 1,640 feet (500 m) phosphate concentrations are about 2.5 µM/L (~77 µg/L) or nearly four times the total phosphorous standard.

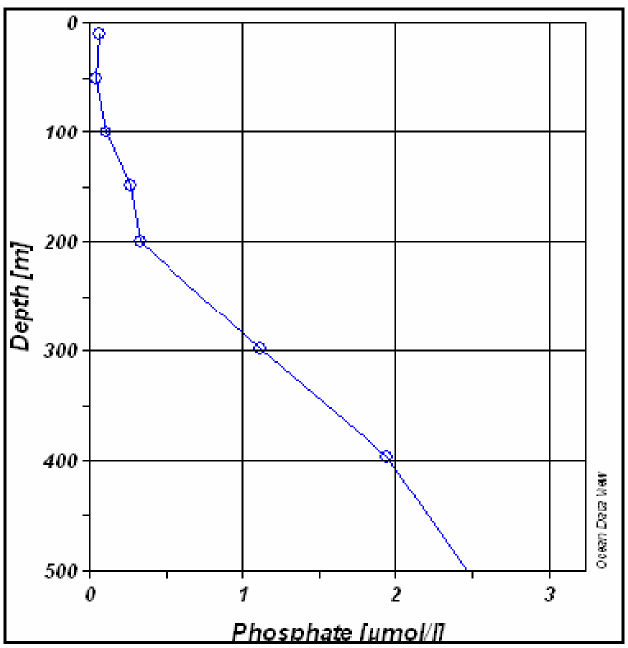


Figure 3-15: Phosphate Concentration as a Function of Depth at a Station West of O‘ahu
(21.18°N, 158.55°W) (Source: Makai Ocean Engineering, 2005b)

Figure 3-16 shows the corresponding depth profile for dissolved oxygen concentrations. Unlike the nutrient concentrations shown in the previous figures, oxygen concentrations are lower below the thermocline. The relevant State water quality standard for dissolved oxygen concentration is 75% saturation. Figure 3-17 shows a nomograph of oxygen saturation as a function of temperature and salinity (Strickland and Parsons, 1968). The saturation point for the receiving waters at the Alternative 1 discharge location would be 6.63 mg/l. The measured concentration (Makai Ocean Engineering, 2005b) is 4.82 mg/l or 72.7% saturated. Thus, even the shallow receiving water is not always in compliance with State water quality standards. The return flow would be 24.5% saturated at its discharge temperature, but as it warmed to ambient temperature in the receiving water its saturation would increase to 31.7% because warmer water can hold less dissolved oxygen.

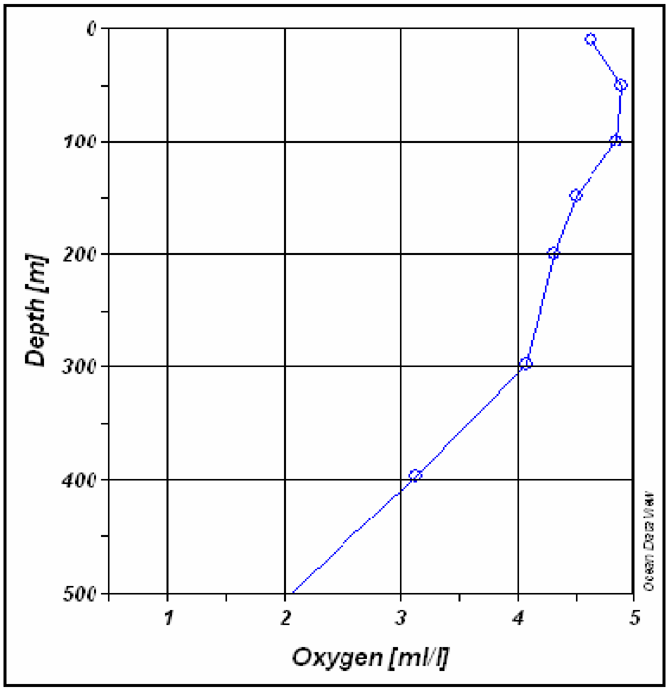


Figure 3-16: Dissolved Oxygen Concentration as a Function of Depth at a Station West of O‘ahu
(21.18°N, 158.55°W) (Source: Makai Ocean Engineering, 2005b)

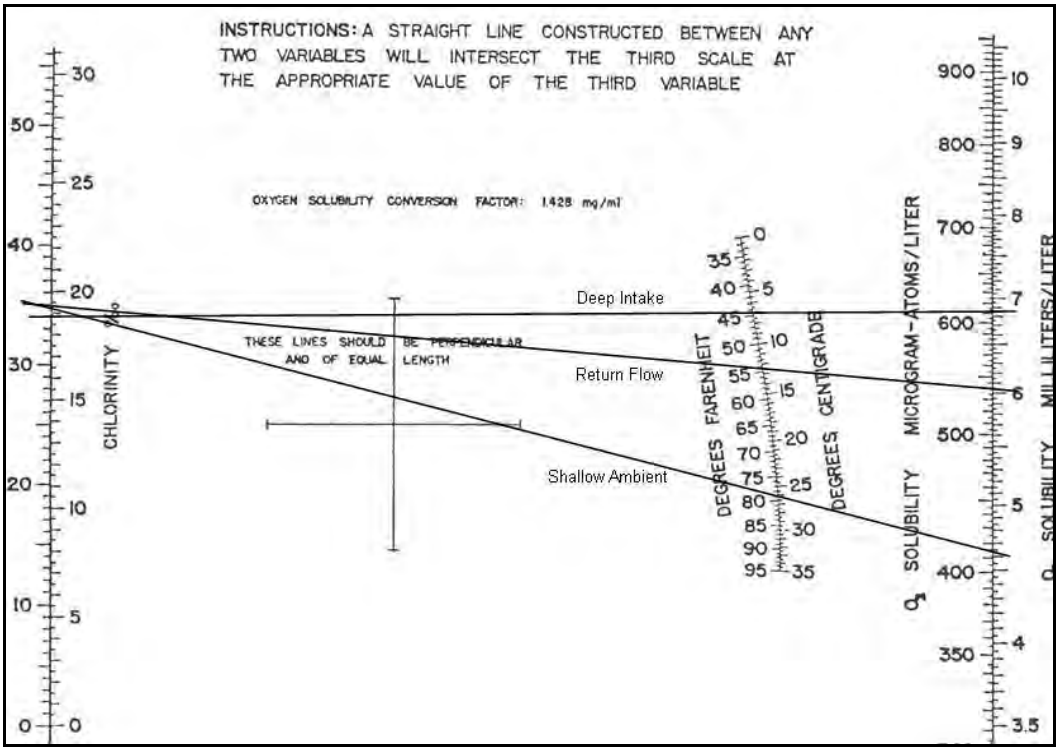


Figure 3-17: Dissolved Oxygen Saturation as a Function of Temperature and Salinity
(Source: Strickland and Parsons, 1968)

HSWAC Water Samples

In March of 2011, water samples were collected in triplicate at the location and approximate depth of the proposed intake. The results are displayed in Table 3-7. Parameters for which there are State water quality standards in wet, open coastal waters are designated with an asterisk.

Table 3-7: Water Quality at the Proposed HSWAC Intake Location

Parameter	*Sample 1 Depth = 538 m*	*Sample 2 Depth = 535 m*	*Sample 3 Depth = 536 m*	*Mean*
PO_4 (µg P/L)	69.75	69.75	69.44	69.65
NO_3+NO_2 (µg N/L)*	466.90	474.46	475.72	472.36
NH_4 (µg N/L)*	-	0.28	0.14	0.21
TP (µg P/L)*	70.06	71.30	70.37	70.58
TN (µg N/L)*	513.52	522.48	516.32	517.44
Turbidity (NTU)*	0.28	0.07	0.18	0.18
Salinity (0/00)*	34.186	34.178	34.183	34.182
pH*	7.70	7.71	7.74	7.72
Chl-a (µg /L)*	0.021	0.010	0.010	0.014
TSS (µg /L)	4.74	3.03	2.05	3.27
D.O. (mg/L)	1.50	1.58	1.52	1.53
D.O. (% saturation)*	15.2	16.0	15.4	15.5
Temp. (°C)*	6.9	6.4	6.2	6.5
BOD-5 (mg/L)	3.0	1.8	4.3	3.0
COD (mg/L)	154	112	105	124
Oil & Grease (mg/L)	<5.0	<5.0	<5.0	<5.0
TOC (mg/L)	2.16	1.26	1.36	1.59

Comparing these values with the standards shown in Table 3-6, it's clear that the deep ocean waters violate the standards for total nitrogen, nitrate+nitrite nitrogen, total phosphorus, and dissolved oxygen. Of these parameters, nitrate+nitrite nitrogen would require the greatest dilution to meet the applicable standard.

Sand Island WWTP Ocean Outfall Monitoring Data

As part of the monitoring program required for the NPDES permit for the Sand Island WWTP ocean outfall, a number of stations are routinely sampled, several of which are in close proximity to the potential HSWAC diffuser locations. Data collected from 2006-2011 were provided by HDOH. (See Figure 2-34 for locations of the Sand Island outfall monitoring stations and the alternative HSWAC facilities locations.) Sand Island Outfall Monitoring Stations C4, D4 and E4 are located offshore of Kaka‘ako Waterfront Park at nominal water depths of 60 feet, 150 feet and 300 feet, respectively. At each of these stations, water samples are collected near the surface, midway in the water column and close to the bottom.

The original data and the geometric means may be found in Appendix F. Original values shown as <1, essentially nondetectable, were arbitrarily converted to a value of 0.5.

Nevertheless, no parameter at any station exceeded the respective geometric mean criterion for wet open coastal waters and with only a single exception, there were no exceedances of the 10% or 2% criteria. The sole exception was ammonia-nitrogen at mid-depth at station E4 where there was one value of 16.00 µg N/L which exceeded the 15.00 µg N/L criterion for 2% of samples. There were 21 data points at this location so the one exceedance represented 4.8% of the samples.

Temperature Measurements

Because of the critical importance of the seawater intake temperature to HSWAC system engineering and economics, the temperature regime at the proposed intake location was exhaustively investigated. Existing data were analyzed, existing models were run, and sensors were deployed to collect new data. Some interesting relationships were seen between the water temperatures at 1,600 feet and tides and internal waves. Although reduction of temperature variability and its impact were important engineering considerations for the applicant's engineers, this temperature variability was not significant in terms of State water quality standards. Seawater temperature variations at 1,600 feet water depth in Māmala Bay were examined in four sources of data:

- The first data set (Hamilton et al., 1995) was collected as part of the Māmala Bay Study. This investigation consisted of deploying pressure sensors and thermistors at various depths and locations throughout Māmala Bay for a period of 1.5 years. The deepest and closest mooring relative to the preliminary proposed HSWAC intake location (named E4) was positioned approximately 3.7 nm southeast of that location in a water depth of 1,665 feet. The deepest thermistor attached to this mooring was at a water depth of 1,476 feet.
- The second source of data was a recent depth/pressure sensor deployment (named HSWAC1) in the general vicinity of the proposed HSWAC intake location at 1,600 feet water depth. The data were collected by Makai Ocean Engineering, Inc. (MOE), for a period of 11 days.
- The third source of data was based on a second deployment (named HSWAC2) that occurred immediately following the first MOE deployment and lasted for a period of 20 days.
- The fourth source of data was the Hawai‘i Ocean Time-Series (HOT) project. The HOT data represents a long-term data set consisting of cruise averages spanning 19 years. The data are collected about 62 miles north of O‘ahu. A cruise average is generated from a series of expendable bathythermograph (XBT) casts. The casts collect instantaneous temperature data through the water column between the surface and 3,048 feet depth. Each cruise averages five

days of data and the cruises are spaced about a month apart. The fact that the HOT data includes a wide range of depths means it includes data at the same depths as all the other data sets.

The locations of the first three stations are shown on Figure 3-18, and the results are discussed below.

Māmala Bay 1995 Study

The Māmala Bay study included 11 mooring stations positioned throughout Māmala Bay. Most sensors were deployed shallow (< 820 feet) with the exception of A4 and E4, which were deployed in 1,476 feet water depth (approximately 190 feet above the seafloor). The E4 sampling period was January 1994 to August 1995. The average temperature for this site was found to be 45.41°F, with a standard deviation of 0.68°F.

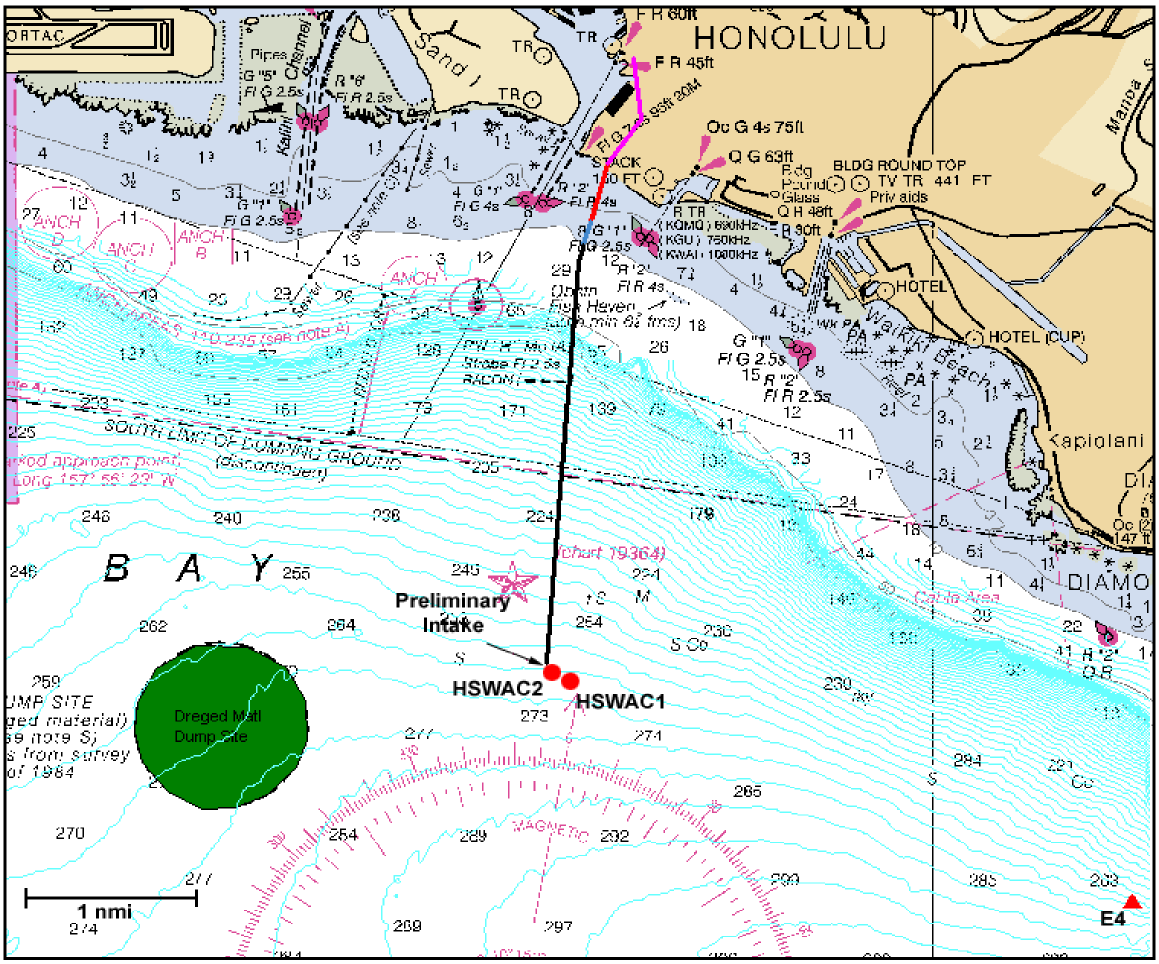


Figure 3-18: Temperature Time-Series Data Collection Sites in Māmala Bay
(Source: Makai Ocean Engineering, 2005a)

The preliminary HSWAC design intake temperature was established at 45°F. Based on bathymetry and existing temperature profile data, this placed the target intake at approximately 1,600 feet water depth. Using the data available from the Māmala Bay study (Hamilton et. al., 1995) and that of Noda (1982), the temperature at the 1,476 feet water depth was extrapolated to a depth of 1,600 feet. Taking the overall average for the Māmala Bay study data set gives an estimated average temperature at 1,600 feet water depth of 44.7°F.

MOE November 2004 11-Day Data Collection

In an attempt to gain a better understanding of the variation of subsurface water temperature at 1,600 feet in Māmala Bay, MOE deployed a temperature/pressure sensor approximately 3 nm seaward of Honolulu Harbor in 1,600 feet water depth (21-14.58276 ºN, 157-52.20180 ºW). The deployment location is labeled HSWAC1 on Figure 3-18. The sensor was deployed on November 27th and retrieved 11 days later on December 8th, 2004.

Table 3-8 provides descriptive statistics from the 11-day sampling period. The mean water temperature (45.01°F) was 0.31°F warmer than what was predicted for the 1,600 feet depth at the E4 mooring, as might be expected from sampling a much shorter time period than the 20-month time period for the E4 data.

Table 3-8: Descriptive Statistics for the HSWAC1 Sensor Located in 1,600 Feet Water Depth at the Proposed HSWAC Seawater Intake Location

HSWAC1 Stats (11-Days) °F	
Mean	45.01
Standard Deviation	0.67
Range	3.22
Source: Makai Ocean Engineering, 2005a	

Making direct comparisons between the HSWAC1 data and those collected in 1995 (Hamilton et al., 1995) is difficult because of the differences in collection times and water depths. Further analysis of these temperature data suggests that the difference in temperature variation between the two data sets (HSWAC1 versus E4) may not simply be due to sampling error (difference in sample sizes).

When MOE plotted the entire HSWAC1 data series an obvious pattern of periodicity in temperature fluctuations was observed (Figure 3-19). Furthermore, a strong correlation between pressure (water depth) and temperature is apparent. The most likely explanation is that there is a correlation between water temperature and tides. An observed episodic temperature periodicity of 12 hours and in some cases 24 hours was noted.

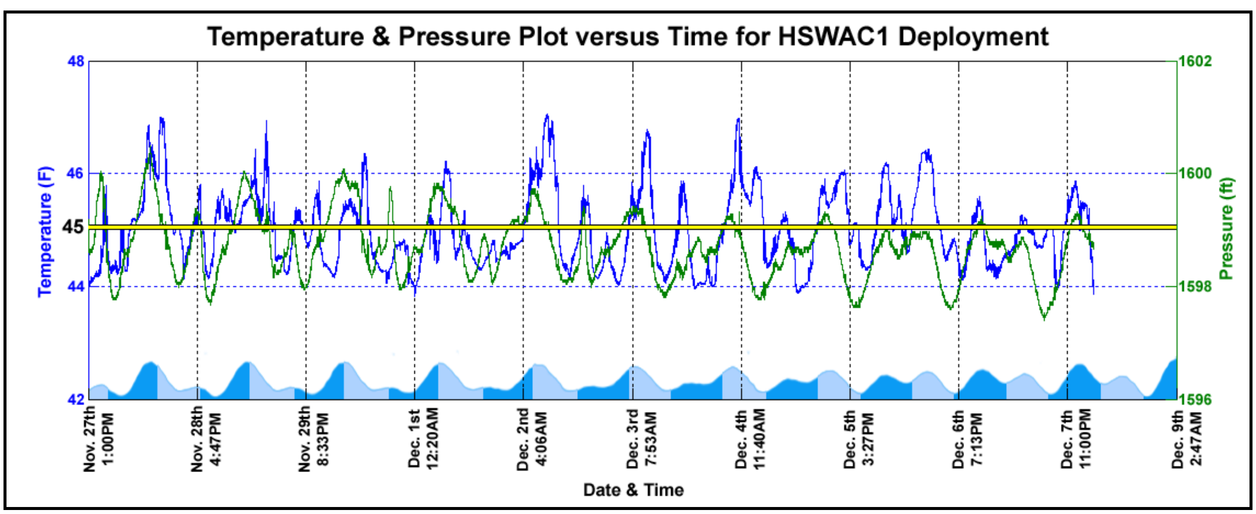


Figure 3-19: A Plot of the Temperature and Pressure Data Collected for an 11-day Period at the HSWAC1 Location

(The yellow bar represents the mean temperature, the blue line represents temperature and the green line represents pressure. Located just above the x-axis is the tidal profile for the periods identified.) (Source: Makai Ocean Engineering, 2005a)

In addition to measuring the temperature variation at 1,600 feet, a water column profile was also collected (Figure 3-20). It can be seen that the mixed layer extends to well below 200 feet in this profile, at this time of year.

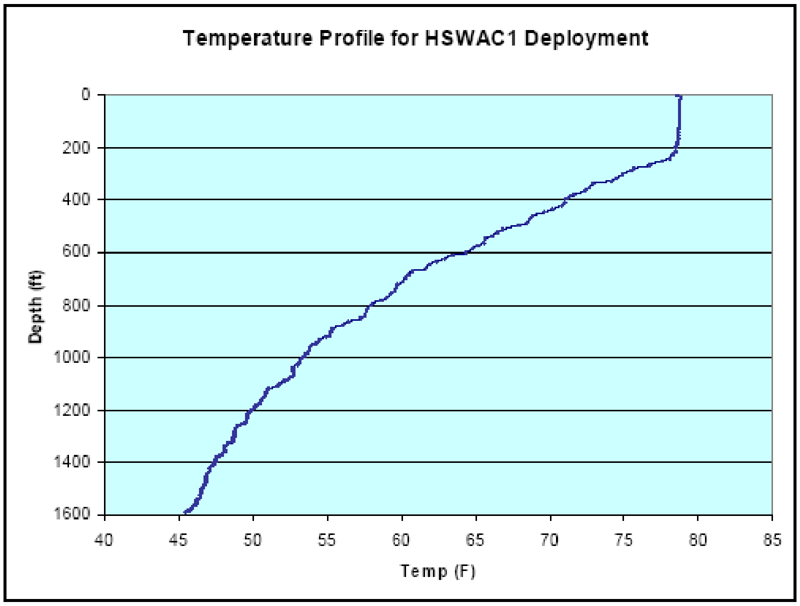


Figure 3-20: Temperature Profile for the HSWAC1 Deployment
(Source: Makai Ocean Engineering, 2005a)

MOE December 2004 20-Day Data Collection

Immediately following the MOE 11-day HSWAC1 deployment, the sensor was redeployed for 20 days at roughly the same location; 21-14.619 ºN, 157-52.309 ºW (HSWAC2 - see Figure 3-18). Table 3-9 provides descriptive statistics for the 20-day sampling period. The mean water temperature (45.2°F) was 0.19°F warmer than in the 11-day HSWAC1 deployment at essentially the same location.

Table 3-9: Descriptive Statistics for the HSWAC2 Sensor Located in 1,600 feet Water Depth at the Preliminary Intake Target

HSWAC2 Stats (20-Days) °F	
Mean	*45.20*
Standard Deviation	*0.59*
Range	*3.78*
Source: Makai Ocean Engineering, 2005a	

The 20-day HSWAC2 sampling period resulted in minimum and maximum temperature values which were greater than the HSWAC1 11-day sampling period but less than the E4 monthly sampling period. Combined, the 20-day HSWAC2 and 11-day HSWAC1 are still within the E4 minimum and maximum temperature ranges recorded for the months of November and December 1994.

Analytical Modeling

To further examine potential variability of water temperature in Māmala Bay, two numerical oceanographic models designed to model tides, internal waves, temperature, salinity, and bathymetry were reviewed. The University of Hawaiʻi – Mark Merrifield Model provided the most useful results.

University of Hawaiʻi – Mark Merrifield's Model
Dr. Mark Merrifield at the University of Hawaiʻi has published several papers on the dynamics of Māmala Bay. He also operates a Princeton-based model of the bay's dynamics including the tides, internal waves, temperatures, currents, etc. In general, his results show that Māmala Bay has large temperature excursions because of the tidal waves (not tsunami) hitting the island daily from the northeast.

If the bottom of the ocean were flat there would be no vertical excursion near the seabed, and therefore no temperature variations. However, the bottom slope drives the vertical variations. Temperature excursions can be reduced by: (1) looking for the smallest cross-slope surge, (2) going deeper for a smaller temperature gradient, or (3) locating the intake at a low bottom slope.

Considering the bathymetry of Māmala Bay, there are potentially economically feasible opportunities for locating the seawater intake where the bottom slope is lower. For instance, in Figure 3-21, location C has a lower slope than location A where HSWAC1 and HSWAC2 measurements were made, so one would expect a considerable lowering of the temperature fluctuations under the same surge conditions. Surge, however, increases toward Pearl Harbor, so the net effect of this potential move is unknown.

3.7.4.4 **Approach to Impact Analysis**

Methodology

Activities and substances that could affect water quality during construction and operation of the system were identified and the possibility of exceedances of regulatory standards evaluated. In particular, the potential water quality effects of the return seawater plume were evaluated with a USEPA-approved computer simulation.

Determination of Significance

A significant adverse effect would be an exceedance of regulatory standards.

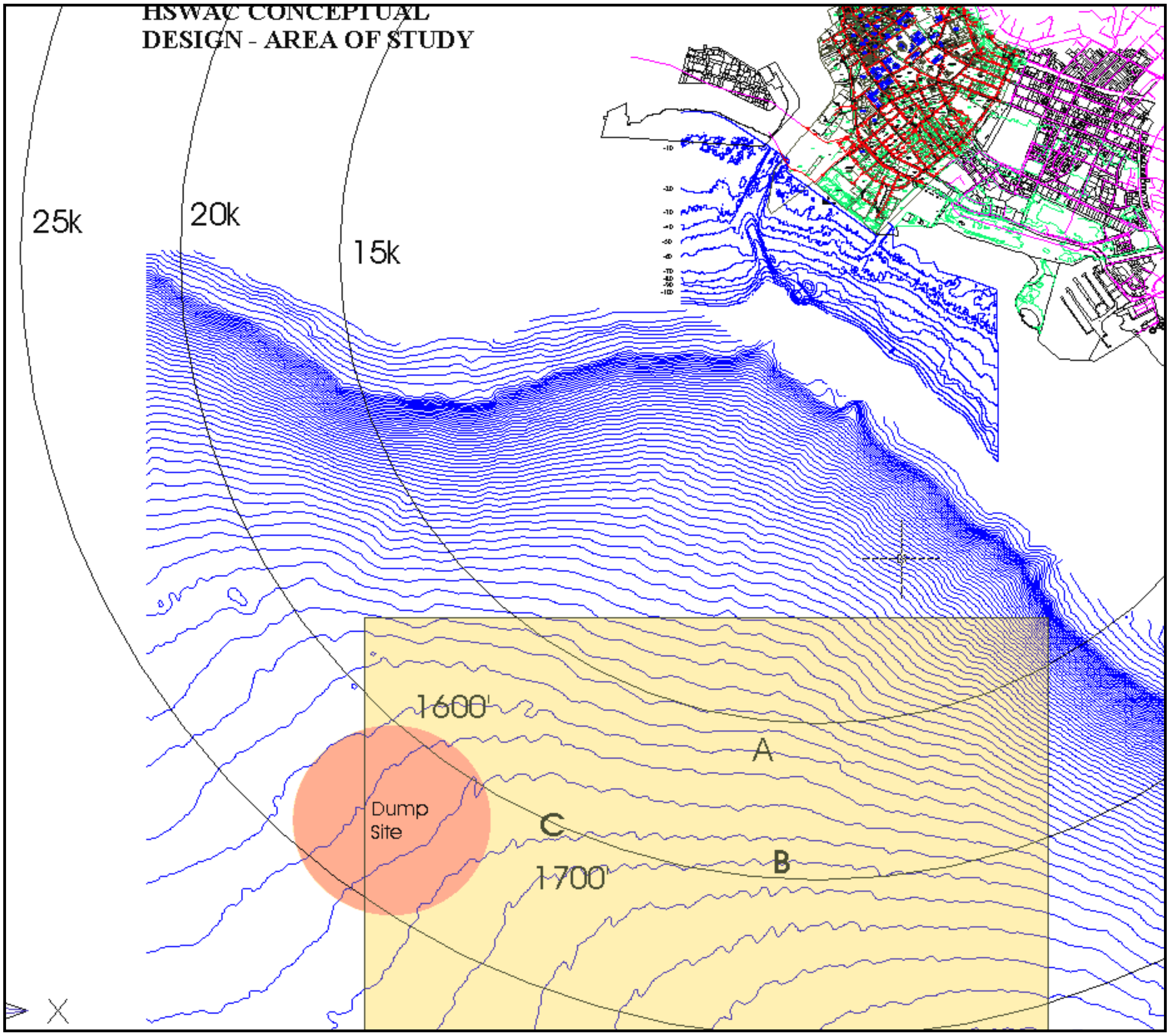


Figure 3-21: Alternative HSWAC Seawater Intake Locations Based on Bottom Slope

(Location C has a much lower slope than Location A where temperature data were collected. Location B is a potential 1,700 feet intake location. The radii are distances (in thousand [k] feet) from the assumed microtunnel breakout location.) (Source: Makai Ocean Engineering, 2005a)

3.7.4.5 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effect on marine water quality because there would be no construction or facilities offshore. Electricity would continue to be used for air conditioning all downtown buildings. This electrical demand generates cooling water that is disposed of into offshore marine waters, raising ambient temperatures.

Alternative 1

Under Alternative 1, marine water quality would be impacted during both construction and operation of the seawater pipelines. During construction and pipeline installation, sources of impacts would include construction vessel mooring, excavation and backfill of the microtunnel receiving pit at the offshore breakout point, emplacement of the deployment holdbacks if they are in the water rather than on land, deployment of the pipeline anchor collars on the seabed, and placement of piles to moor pipe strings in Ke‘ehi Lagoon.

During microtunneling, pressure on the slurry at the drill head balances the sea pressure. There is no excessive pressure that could lead to a blowout causing uncontrolled slurry release into the ocean. In the event there is a rupture, the pressure would immediately drop limiting slurry escape. There is no pressurized reserve capacity. If the rupture were behind the drill head, seawater would immediately inundate the tunnel causing the slurry to be pushed back to the jacking pit where it would be contained. There is no risk of the slurry escaping into the ocean in any significant quantity.

The microtunnel would emerge through the sheet piles into the receiving pit. Within the confined receiving pit, there could be an increase of turbidity when the microtunnel boring machine penetrates the sheet piles. Turbidity could result from disturbance of sediments or from release of drilling mud, if it is used in the terminal stages of boring. It is possible the contractor would not use drilling mud in the terminal stages of boring to avoid the release at breakout. In any event, the applicant’s construction specifications would require the complete isolation of the receiving pit from the surrounding waters using either sheet piles or a combination of sheet piles and silt curtains. Drilling mud, if used, or disturbed sediments would be contained within the confines of the receiving pit. The void between the microtunnels and the pipes would be grouted as drilling progresses to eliminate the possibility of drilling mud leaking through the sediments into the water column.

At the breakout location, a work platform, likely a barge or pile supported platform, would have to be present for an estimated period of seven to nine months. Due to the open ocean conditions offshore of Kaka‘ako, barges or work boats may be moored to pre-installed underwater mooring anchor piles. A similar underwater mooring was provided for the sunken *Ehime Maru.* The breakout point would be in a sand and rubble channel lacking coral reef development and installation of anchor piles or support piles would be done carefully to minimize turbidity generation. The temporary holdbacks, if in-water holdbacks are employed, would be installed in similar fashion.

At the breakout point, the receiving pit would be lined with sheet piling or a combination of sheet piling and silt curtains extending to the water surface, but some turbidity would be generated during placement of the sheet piling. BMPs would be employed to minimize turbidity in surrounding waters. Further, the work area in general is on an open coast exposed to high summer surf and storm surge. Much of the seafloor is covered with sediments deposited from previous dredging of Honolulu Harbor. These sediments are remobilized and resuspended during high wave energy events so the biological community is periodically exposed to high suspended sediment concentrations and turbidity.

As the pipeline is lowered to the seabed in the deployment process, it could be expected that impact of each anchor collar with the sea floor would result in suspension of a small amount of sediments. This also would be a brief transient series of events.

Turbidity from backfilling the receiving pit would be minimized by the isolation and containment described above. In addition, only pre-washed, 3/8-inch to 2-inch crushed basalt gravel would be used. Other sources of turbidity would include pile driving, if required to secure vessels offshore and pipe strings in Keʻehi Lagoon, and deployment of vessel anchors and pipe collars. These would be brief, transient effects. Once the containment structure is removed, the fill at the breakout pit would not affect water circulation, salinity or other physicochemical or water quality parameters. It would be inert. The material proposed for discharge would consist of clean gravel and concrete. It would not introduce, relocate, or increase contaminants.

During construction, turbidity generation would be the primary water quality concern. Turbidity is a characteristic of many coastal waters in Hawaiʻi. Turbidity can be caused by natural events such as storms, heavy rains and floods, which create fast running water that can carry particles and larger-sized sediment. In the coastal portion of the project area, turbidity is caused by runoff from the land during and after rainfall and resuspension of bottom sediments by waves and currents. Marine communities in the project area are adapted to occasionally turbid conditions because of the seasonal exposure of the area to large southern swells.

Construction effects on water quality would be direct, short term and adverse, but mitigable to less than significant. Mitigation measures proposed by the applicant would include careful placement of all anchors and piles, use of sheet piles/silt curtains to contain sediments mobilized in excavation of the breakout pit, and removal of all excavated materials for disposal on land. Impacts would be further minimized by implementing BMPs during construction, including:

- The employment of standard BMPs for construction in coastal waters, such as daily inspection of equipment for conditions that could cause spills or leaks,
- Cleaning of equipment prior to deployment in the water,
- Proper location of storage, refueling, and servicing sites, and
- Implementation of adequate spill response and storm weather preparation plans.

At the breakout point, there is a possibility of contaminants from the capped landfill under Kakaʻako Waterfront Park being mobilized and entering the water column. This would be a direct, short-term significant adverse effect. To minimize this possibility, as pipe is installed inside the microtunnel, the space between the pipe and the microtunnel wall would be grouted. This would mitigate the potential short-term impact to less than significant. The breakout pit would be capped with concrete after a short open period in which the surface-mounted pipelines are attached to the pipes inside the microtunnels. This also would be a short-term adverse impact mitigable to less than significant. All materials removed from the microtunnel and also materials removed from the piles before capping would be tested for contamination and disposed of or stored for reuse on land, as appropriate. As all potential sources of contaminant leaching arising from HSWAC construction would be capped with concrete there would be no direct, long-term adverse effects.

The applicant's mitigation measures for potential impacts from mobilizing contaminants in the microtunneling operation are:

- As pipe is installed inside the microtunnel from the cooling station to the breakout pit, the space between the pipe and the microtunnel wall would be grouted.
- All materials removed from the microtunnel and also materials removed from the piles before capping would be tested for contamination and disposed of or stored for reuse, as appropriate.

Water quality monitoring would be conducted during the construction period. Pursuant to Section 401 of the Clean Water Act, the applicant must obtain and comply with the conditions of a Water Quality Certification from the HDOH. The proposed action would also be accomplished in compliance with the conditions of the individual NPDES permit required by the HDOH.

Once operational, the HSWAC system would return slightly warmed (+9 to 13°F) deep seawater to relatively shallow depths. As the ambient condition of the unmodified deep source water is in violation of many of the State's water quality standards, so too would the return water be in violation of those standards (even though the source waters are classed "oceanic" and the receiving waters are classed "open coastal," with generally higher thresholds for violations). Parameters that would not meet standards for open coastal waters (wet coastline) include those for total nitrogen, nitrate+nitrite nitrogen, total phosphorus, dissolved oxygen and temperature modification. Consequently, a ZOM would have to be approved to permit these exceedances in a specified area. In order to ensure water quality standards would be met outside the ZOM, a diffuser system was designed for the end of the return seawater pipe. The design and operation of the diffuser are described in Section 2.4.2.

The primary objective of this modeling effort was to identify the level of dilution that could be achieved by the diffuser system in each of the current scenarios. The temperature difference between the discharge waters and the receiving waters was identified as a concern in scoping. Temperature, however, was not found to be the governing pollutant, and a dilution of only 13 would be required to satisfy water quality standards for temperature. Review of water quality data for the intake location (Table 3-7) showed that the governing pollutant for this discharge would be nitrate+nitrite nitrogen, where deep ocean measurements suggest the effluent stream would have a concentration of ~500 μg/l. To meet water quality standards, a dilution of 113 would be required.

The conclusions of the modeling exercise are reiterated here:

- The design of the diffuser facilitates substantial near-field initial mixing of the return water for all water current cases considered.
- The negative buoyancy of the plume dominates the discharge near-field behavior. Surfacing of the plume (at a low dilution) is not anticipated; after initial mixing, the plume would have a tendency to sink. This is considered desirable from a water quality standpoint, as this represents a general movement away from the photic zone where the nutrients could have biostimulatory effects.
- Some plume-seabed interaction is anticipated in the immediate vicinity of the diffuser; however, substantial initial dilution implies plume properties would be close to ambient when the plume encounters the seabed. Within a few meters from the centerline of the diffuser the dilution would be sufficient to meet water quality standards for temperature.
- Under low current conditions, port velocity of the diffuser would provide good initial mixing, but the weak ambient flow would allow considerable upstream intrusion of the plume. This is presumed to be acceptable, as the ZOM would not be directionally restricted. The required dilution of 113 for nitrate+nitrite nitrogen is reached within 525 feet of the diffuser centerline.
- Under high current conditions, the initially mixed plume would be rapidly advected away from the diffuser, and the plume dispersed rapidly by the turbulent energy associated with the high flow. The required dilution of 113 would be achieved within 16 feet of the diffuser centerline.

- Under mean current conditions the required dilution is reached within 285 feet of the diffuser centerline.

Operational effects on water quality would be direct, long-term, significant and adverse, but would be contained within a designated ZOM and therefore mitigable (from a regulatory perspective) to less than significant. CWA Section 316(a) allows that thermal discharge effluent limitations or standards established in permits may be less stringent than those required by applicable standards if the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife can be demonstrated. The modeling results summarized above indicate that thermal effects of the discharge would be highly localized and contained within a few meters of the diffuser centerline, allowing protection and propagation of fish. When the plume intersects the bottom, temperatures would be close to ambient, allowing protection and propagation of shellfish. Wildlife on the water would be unaffected by the negatively buoyant plume. A water quality and biological monitoring program (Appendix G) would be implemented to ensure that all terms and conditions of required permits are complied with.

As part of the CWA Section 401 Water Quality Certification process, the applicant produced an antidegradation analysis, which is included as Appendix H. To explore the capacity of the receiving waters to assimilate the HSWAC return seawater, data from the Sand Island WWTP Water Quality Monitoring program were analyzed. Table 3-10 summarizes the geometric means of results from the three stations nearest the proposed diffuser location and depths and compares their collective arithmetic mean with the respective geometric mean water quality criterion to determine the assimilative capacity of the water in the vicinity of the proposed diffuser location for each parameter. The depths shown are the assumed nominal sampling depths based on the water depth at the respective station.

Table 3-10: Sand Island WWTP Ocean Outfall Water Quality Monitoring Data Geometric Means (μg/L)

Station	*Depth (ft)*	*NO2+NO3*	*NH4*	*TN*	*TP*	*Turb*	*Chl*
C4 (surface)	1	1.67	1.01	92.97	6.94	0.25	0.18
C4 (mid)	20	1.19	0.89	89.64	6.78	0.23	0.19
C4 (bottom)	40	1.37	0.84	91.92	7.00	0.26	0.21
D4 (surface)	1	0.57	1.05	87.40	6.34	0.17	0.15
D4 (mid)	80	0.57	1.06	90.18	6.49	0.17	0.15
D4 (bottom)	160	0.91	1.34	94.41	6.66	0.24	0.21
E4 (surface)	1	0.52	1.31	90.48	6.75	0.18	0.13
E4 (mid)	165	0.72	2.04	86.63	6.82	0.19	0.17
E4 (bottom)	330	4.25	1.75	98.29	6.50	0.16	0.18
Mean (all stations and depths)		1.31	1.26	91.32	6.70	0.21	0.18
GM Criterion		5.00	3.50	150.00	20.00	0.50	0.30
% Capacity Remaining (all stations and depths)		73.86	64.14	39.12	66.51	58.92	41.57
Mean (surface and mid depths)		0.94	1.19	90.45	6.72	0.21	0.17
% Capacity Remaining (surface and mid depths)		81.21	65.92	39.7	66.39	57.87	41.94
% Capacity Remaining (E4 bottom)		15.00	50.00	34.47	67.50	68.00	40.00

Considering all stations and depths, the available assimilative capacity ranges from a low of 39.12% for total nitrogen to a high of 73.86% for nitrate+nitrite nitrogen. Removing Station E4 (bottom), which is at a depth often within the thermocline, increases the assimilative capacity for nitrate+nitrite nitrogen to over 81% in waters where the proposed HSWAC diffuser would be located.

Water quality, as determined by these parameters, substantially exceeds that necessary to protect all existing or designated uses despite the input of pollutants from a number of nearby sources. Several regulated and unregulated point sources of pollution discharge into Māmala Bay. Most prominent are the three WWTP outfalls (Sand Island, Fort Kamehameha, and Honouliuli). Sewage has been pumped into the ocean offshore of Kewalo and Sand Island since the 1930s. The early inputs were all raw sewage released in shallow water (not exceeding 20 feet in depth). The actual points of release varied through time as different pipes were constructed and used. The multitude of perturbations that occurred in shallow water from these early sewage inputs continued until the construction of the present Sand Island WWTP ocean outfall in 1978 (Brock, 1998). The closest major point source of pollutants to the proposed site of the HSWAC seawater return diffuser is the diffuser for the Sand Island WWTP deep ocean outfall, which lies about two miles west. The monitoring data described above show no significant effect on waters near the proposed HSWAC diffuser. Because of the spatial separation and the relative densities of the two discharge plumes no interaction is expected. The Sand Island wastewater discharge is a positively buoyant plume that tends to rise toward the surface and be affected by wind driven surface currents, whereas the HSWAC discharge plume would be negatively buoyant and tend to sink seaward down the slope.

Once operational, the HSWAC system would have an indirect beneficial effect. Up to 84 million gallons/yr of wastewater discharge to Māmala Bay would be eliminated by HSWAC operations. This would reduce the load to the Sand Island Sewage Treatment Plant, and could reduce the potential for exceeding the capacity of the plant with subsequent discharges that do not meet water quality standards.

A final water quality issue is the potential effects of the HDPE pipes themselves. HDPE is a petroleum-based plastic used for piping and containers for consumer products. Piping applications include drainage, sewage and potable water. Also known as plastic #2, HDPE is the second most used bottle plastic behind polyethylene terephthalate (PET or plastic #1). HDPE can be found in milk jugs, detergent bottles, medicine bottles, motor oil bottles, shampoo bottles, frozen juice containers, coffee containers and baby bottles. A 2006 study found that HDPE drainage pipes leached volatile organic carbons (VOCs) that could contaminate groundwater. Volatile organic compounds are hydrocarbons (excluding methane) that are capable of forming oxidants (particularly ozone) by reactions with nitrogen oxides in the presence of sunlight. Major sources of VOCs are vehicles, solvents and process industry emissions. The HDPE pipes would have limited exposure to sunlight. Additionally, HDPE pipes in the HSWAC system would carry cold seawater rather than freshwater. The low temperature and the tendency of microbiological biofilms to form on structures in seawater would both retard diffusion of VOCs from the pipes. VOCs are ubiquitous in the marine environment; some, including formaldehyde, are produced and utilized *in situ* by phytoplankton. All are subject to bacterial degradation. Quantities potentially leaching from the HSWAC pipes and passing the air-water interface would be miniscule and insignificant compared with those from vehicular emissions. The HDPE pipes would be virtually inert in seawater and would have no effect on water quality.

In summary, Alternative 1 would have potentially significant, direct, short-term and long-term, adverse effects mitigable to less than significant. Potential violations of State water quality standards would be limited to within an approved ZOM. The actual effects would be monitored during construction and operation of the system. A long-term, indirect beneficial effect would result from reducing the quantity of wastewater generated in cooling towers in customer buildings and disposed of through the Sand Island outfall.

Alternative 2

The potential effects of Alternative 2 would be essentially identical to those of Alternative 1. While the respective breakout points are different, the precautions and mitigation measures to be employed during construction and operation would be the same for Alternative 2 as for Alternative 1.

Alternative 3

The breakout point and receiving pit for Alternative 3 would be the same as for Alternative 1 and the impacts and mitigation measures also would be the same. Under Alternative 3, however, the diffuser would terminate at a depth of 300 feet, rather than the 150 feet of Alternatives 1 or 2. As can be seen from Table 3-10, the ambient concentration of nitrate+nitrite nitrogen (the parameter requiring the greatest dilution to comply with State water quality standards) at 300 feet is substantially higher than the concentration at 150 feet. While this means that, on average, the macronutrient concentrations of the discharge would be closer to those of the receiving waters, the capacity of the receiving waters at 300 feet deep to assimilate the discharge without exceeding water quality standards is much less than at 150 feet deep. As noted above, the receiving waters in the vicinity of the shallower discharge depth have an available capacity of 76.6%, while the waters in the vicinity of the deeper discharge depth have only 15.0% available capacity. Hence, a larger ZOM would be required for the deeper discharge. Considering the ambient concentration at the diffuser depth, a dilution factor of 621 would be required for nitrate+nitrite nitrogen. CORMIX modeling of the deep discharge of Alternative 3 showed that, under the worst case maximum discharge rate and minimum current flow, appropriate dilution would not occur until 8,056 feet from the diffuser centerline.

In summary, Alternative 3 would have a short-term (construction-phase), potentially significant, direct, adverse effect mitigable to less than significant. Water quality monitoring during construction would identify operations creating adverse effects to water quality and allow changes to be made. During operations, Alternative 3 would have less adverse long-term effects on water quality than Alternatives 1 and 2 considering that return seawater discharge nutrient concentrations would be closer to ambient nutrient concentrations. From a regulatory perspective however, the higher ambient nutrient concentrations at the depth of the diffuser in Alternate 3, compared to the depth of the diffuser in Alternatives 1 or 2, would require a larger ZOM to assimilate the nutrients of the return seawater. As for all of the action alternatives, a long-term, indirect beneficial effect would result from reducing the quantity of wastewater generated in cooling towers in customer buildings and disposed of through the Sand Island outfall.

Alternative 4 (Preferred Alternative)

The breakout point and receiving pit for Alternative 4 would be the same as for Alternative 1 and the impacts and mitigation measures for the construction phase also would be the same. Under Alternative 4 the diffuser would terminate at a depth of 423 feet, rather than the 150 feet of Alternatives 1 and 2 or the 300 feet of Alternative 3, on a section of relatively steep slope which begins above the diffuser and extends several hundred feet below the diffuser.. The rationale for selecting this location was to move the diffuser to a depth below that where corals were observed in the route surveys and minimize the potential for biostimulation of phytoplankton or benthic algae. To characterize the baseline water quality at the final diffuser depth, three sets of measurements were considered. The first was data collected by University of Hawaii scientists at Station Aloha, north of Oʻahu. The second was a NOAA compilation of all historic water quality data from Māmala Bay and other locations along the southern coast of Oʻahu. The third was from samples collected on a recent University of Hawaiʻi oceanographic cruise. In the latter case, the applicant arranged for the collection and analysis of water samples from the locations of the upper and lower ends of the Alternative 4 diffuser location. The nitrate+nitrite nitrogen data from those locations are summarized in Table 3-11 below.

As can be seen in these site-specific data from a single day and frequently in the extended time-series of the other two data sets, in the proposed depth range, the diffuser would sometimes straddle the interface between the bottom of the mixed layer and the top of the thermocline. Concentrations of nitrate+nitrite nitrogen are sometimes quite different at the depths of the two ends of the diffuser. While this means that the macronutrient concentrations of the discharge would be more similar to those of the receiving waters, the ambient conditions of the receiving waters could be considered, especially at the depth of the deeper end of the diffuser, in violation of State water quality standards. This complicates estimation of the "ambient" concentration, the assimilation capacity of the receiving waters, and design of a ZOM.

Table 3-11: Nitrate+Nitrite Nitrogen Concentrations at the Locations of the Top and Bottom of the Proposed Diffuser

Location	***Depth (Feet)***	***NO2+NO3 (µg/L)***
Diffuser - Top	0	2.52
	50	1.26
	100	1.40
	150	1.58
	200	1.40
	200	1.40
	225	1.40
	250	1.40
	300	1.68
	325	1.26
	325	1.26
Diffuser - Bottom	0	1.26
	50	1.12
	100	1.40
	150	1.40
	200	1.40
	250	1.40
	300	2.45
	350	2.66
	400	2.76
	425	7.78
	425	8.39

The applicant is working with the regulatory agencies (HDOH and USEPA) to appropriately characterize the assimilation capacity over the depth range of the diffuser by using a blended or depth-averaged ambient concentration to account for variability in the depth of the thermocline. The applicant's proposed ZOM is based on the site-specific data in Table 3-11. From the recent data collected by the University of Hawaii, the nitrate+nitrite nitrogen concentration at 330 feet deep is 1.26 µg/L. The assimilation capacity of the receiving waters is thus 74.8%. Based on the CORMIX modeling at 300 feet, the distance from the centerline of the diffuser to a point where dilution is adequate to meet State water quality standards is 313 feet. Accounting for dilution to both sides of the centerline and adding an adequate safety factor to account for inherent inaccuracies in the CORMIX model, it appears that a 2,000-foot wide ZOM would be adequate at the top of the ZOM, which would begin 1,000 feet from the shallow end of the diffuser. In other words, the ZOM would extend 1,000 feet in three directions from the shallow end of the diffuser.

A similar calculation can be made for the bottom of the ZOM. In this case however, it is necessary to account for the vertical fluctuation in the depth of the top of the thermocline. Over time, there will be a range of assimilation capacities at the depth of the bottom of the diffuser, depending on the depth at which the thermocline begins, and at any given time there will be a gradient of assimilation capacities from where the thermocline intersects the diffuser to the bottom of the diffuser. Consequently, to define a reasonable "ambient" concentration of nitrate+nitrite nitrogen at the bottom of the diffuser and calculate an assimilation capacity, and to construct an appropriate width of the ZOM at the bottom of the diffuser, an average concentration through the depth range from 200 to 450 feet deep was used. From the recent data generated from the samples taken at the proposed location of the bottom of the diffuser, that average concentration is 3.18 µg/L. That yields an assimilation capacity of 36.4%, somewhat less than half that at the top of the diffuser. Considering again the CORMIX modeling results, accounting for dilution to both sides of the diffuser, and applying an adequate safety factor, the width of the ZOM at its deep end would be 7,000 feet. In other words, the ZOM would extend 3,500 feet in three directions from the deep end of the diffuser. Connecting the top and bottom extents of the ZOM results in a trapezoidal area of 490.7 acres.

In summary, as for Alternative 3, Alternative 4 would have a short-term (construction-phase), potentially significant, direct, adverse effect mitigable to less than significant. Water quality monitoring during construction would identify operations creating adverse effects to water quality and allow changes to be made. During operations Alternative 4 would have less adverse long-term effects on water quality than the other three alternatives considering that the return seawater discharge nutrient concentrations would be most similar to ambient nutrient concentrations. From a regulatory perspective, however, the higher nutrient concentrations at the depth of the diffuser in Alternate 4 would require a larger ZOM to assimilate the nutrients of the return seawater, compared to the diffuser depths of the other action alternatives. The return seawater discharge would be closer to ambient water quality conditions under Alternative 4 than any of the other alternatives. As for all of the action alternatives, a long-term, indirect beneficial effect would result from reducing the quantity of wastewater generated in cooling towers in customer buildings and disposed of through the Sand Island outfall.

3.7.5 Marine Biota

Various factors control the variety, distribution, and abundance of marine life in the Hawaiian islands, including geographic isolation, subtropical climate, storm waves, and human-caused pollution and development. This section describes the existing marine biological resources in the areas around the proposed seawater intake and return pipelines and in the proposed Keʻehi Lagoon staging area.

Since planning for the HSWAC project began, the applicant commissioned a number of marine biological surveys, assessments and reports. Early work was focused on identifying marine communities in the shallow region of the project area to aid pipe routing and siting of the receiving pit and diffuser. The results of this work were presented in the DEIS. Comments on the DEIS received from the USEPA, NMFS and USFWS requested more quantitative data along the entire preferred pipe route. Consequently, the applicant commissioned three additional surveys, one at diver accessible depths from the proposed location of the receiving pit to about 120 feet (Appendix E) a second survey quantifying the coral population at the receiving pit (Appendix O) and a third by submersible to the proposed intake depth (Appendix I). Excerpts from these surveys are included in Section 3.7.5.1. Additional information regarding pelagic communities along the proposed pipeline route may be found in Section 3.7.5.2.

Certain marine biota and habitats are protected by the Federal Endangered Species Act of 1973 (16 U.S.C. §§ 1531-1544, as amended) (ESA), Hawaiʻi's Endangered Species Law (Chapter 195D HRS), the Marine Mammal Protection Act (16 U.S.C. §§ 1361-1421h, as amended) (MMPA), and the Migratory Bird Treaty Act (16 U.S.C. §§ 703-712, as amended) (MBTA). Protected species are discussed in Section 3.7.5.3. Protection of essential fish habitat and coral reefs is afforded by the Magnuson-Stevens Fishery

Conservation and Management Act (16 U.S.C. §§ 1801-1882, as amended) (Magnuson-Stevens Act or MSA) and Executive Order (EO) 13089 Coral Reef Protection, respectively. An assessment of impacts to EFH was completed and appears in its entirety in Appendix J. A summary of that assessment may be found in Section 3.7.5.4. Additionally, coral reefs are special aquatic sites afforded unique restrictions and considerations under Section 404 (b) (1) of the Clean Water Act.

The marine areas in the proposed pipeline corridor have been subjected to municipal waste dumping, sewage discharges, dredged material dumping, and other waste disposal activities. Furthermore, the nearshore area is maintained in an early successional stage by seasonal high surf events, occasional storm surge, and near the Honolulu Harbor entrance channel, dragging of barge tow cables on the bottom. The marine surveys done in the pipeline corridor (Appendices E and I) confirm the historic adverse effects of these perturbations.

3.7.5.1 **Benthic Communities**

Benthic communities, or the benthos, are made up of marine organisms that live on or near the seafloor. They may burrow in the seafloor, attach themselves to the bottom, or crawl or swim about within the bottom waters. Where sunlight reaches the seafloor, the benthos includes plants and plant-like organisms such as seaweeds, which become anchored to the bottom. Among the common animals that live on the seafloor are clams, crabs, lobsters, starfish, and worms. In tropical and subtropical waters, corals form an important part of the benthic community and provide habitat for other organisms. Bottomfish are fish that have adapted to life on and near the seafloor. Barnacles, clams, oysters, and various snails and worms are among the animals that begin life as zooplankton, but upon reaching maturity sink to the seafloor and become part of the benthos.

The greatest known diversity of marine species exists in benthic communities, especially in coral reefs. The benthic environment includes the intertidal shore; the shallow subtidal shelf; the deep abyssal plains; and isolated ecosystems such as certain coral reefs, seamounts, and deep-sea trenches. The substratum may vary considerably, with distinct differences between hard-bottom and soft-bottom communities. The type of bottom affects the nature of the community that lives there. Beyond that single physical factor, species diversity is maintained by biological mechanisms— competition, predation, larval recruitment, and biological structuring of the substratum—and/or physical mechanisms, such as nutrients, light, waves, and currents (Thorne-Miller and Catena, 1991).

The Māmala Bay study completed in the early 1990s looked at both water quality and benthic ecosystems in the bay. The historical account of major perturbations affecting the Māmala Bay benthos provided by Grigg (1995) is useful in understanding conditions in the bay today. The paragraphs below are excerpted from Grigg's report.

> *The effects of both point and non-point sources of pollution on coral reef ecosystems in Māmala Bay were studied at three levels of biological organization: the cell, the population and the community. The results show a uniform lack of negative environmental impact. Calcification and growth show no relation to point or non-point sources of pollution within the bay, nor do species abundance patterns, diversity or community structure. Changes in water quality caused by rainfall and wave events are too small and too short-lived to affect coral reef ecosystems in the bay.*

> *The lack of environmental impact of point and non-point pollution on coral reef ecosystems in Māmala* Bay *in 1993-94 has not always been the case. Prior to 1977, most of the sewage discharged into Māmala* Bay *was untreated. In that year, sewage treatment was upgraded from raw to advanced primary and the outfall terminus was moved from a depth of 13 m [43 feet] to a depth of 73 meters [240 feet], and 2,743 meters [9,000 feet] offshore. In 1975, an extensive*

survey was conducted that ranged between 4 km [2.5 mi] to the east of the outfall and 13 km[8 mi] to the west of the outfall at Sand Island at depths between 5 and 20 m [16 and 66 feet]. In 1975, a large zone of impact existed around the old outfall, extending 2 km [1.25 mi] to the east and 4 km [2.5 mi] to the west, in which corals were either absent or severely depressed in abundance. The bottom area within 1 km [0.6 mi] of the outfall was completely dominated by Chaetopterus, a tube building polychaete that built thick (up to 0.5 m [1.6 feet] high) mounds or bioherms. Within the mounds, up to 100,000 nematodes/m^2 [9,300/ft^2] were found. Other species favored within the zone of impact were the algae, Ulva sp., sponges and the urchins Echinothrix diadema and Tripneustes gratilla. The urchins were exceedingly abundant and succeeded in bioeroding and excavating virtually all living corals within the 6 km [3.7 mi] range. This accounts for the lack of old colonies of P. lobata noted in the survey conducted in Māmala Bay in 1993-94.

By 1977, virtually the entire area within 6 km [3.7 mi] had been reduced to a flat hard plane of calcium carbonate with a benthic community dominated by species favored by the raw sewage. This community presumably replaced a normal coral reef ecosystem living in the area before the outfall was built in 1955. As such it represented a large scale phase shift in community structure (Hughes, 1994).

In 1978, one year after the outfall had been diverted into deeper water, another survey of the area was made (R.W. Grigg, unpublished observations). At this time, all of the dominant species present in the zone of impact were now absent or very rare. The Chaetopterus bioherms had vanished. Urchins of both species were rare. Sponges and Ulva were absent. Another phase shift had occurred. The bottom was a hard pan barren limestone substratum with an abundance of cobbles and rubble and thin layers of sand. No coral recruitment was observed.

Then in 1982, huge waves generated by Hurricane Iwa devastated the entire coast of Māmala Bay (Borg et al, 1992). Anecdotal observations by R.W. Grigg, Gordon Tribble, Roger Pfeffer and many others, revealed that most of the reefs all across the bay, particularly those dominated by Porites compressa, the finger coral, were heavily disturbed. Many reefs formerly supporting 60 to 100% coral cover were reduced to rubble. The only areas to "survive" were those where high relief existed and P. lobata was the dominant species. This explains the results of the 93-94 survey, that show that relative high coral cover exists only in high relief areas. By virtue of the complex morphology in high relief areas, they were little affected by scour and abrasion caused by transport and reworking of coralline rubble that occurs even during normal high waves every summer.

Then in 1992, Māmala Bay was again hit by hurricane force waves, this time produced by Hurricane Iniki. Like Hurricane Iwa, waves from this storm were reported to be 25 feet [7.6 m] or larger. In Hurricane Iwa, 30 foot [9.0 m] waves were reported by the missile destroyer Goldsborough as it was leaving Pearl Harbor on November 23, 1982. Five crewmen were injured, one fatally, by waves that hit the ship (Chiu et al, 1983). The effects of Iniki were similar to those of Iwa in terms of scour and abrasion, however, coral breakage was not nearly as severe as with Hurricane Iwa since much of the vulnerable coral had already been heavily disturbed and little recovery had occurred. The dominant species to "weather" both storms was P. lobata and did so most successfully in areas of high relief.

In low relief areas in 1992, scour and abrasion were severe and the successional process was set back (Dollar, 1993). Piles of rubble were transported and reworked along the bottom. Only in areas relatively free of carbonate rubble was there any evidence of substantial recovery and this

> *was due to the recruitment and regrowth of P. meandrina since 1982. During the Māmala Bay 1993-94 survey, all low relief stations were dominated by this pioneer species.*
>
> *In summary, a historical perspective is necessary to interpret and understand the existing patterns of distribution and abundance of coral ecosystems in Māmala Bay. At the present time (1993-94), these ecosystems are virtually unaffected by both point and non-point sources of pollution in the bay. Distribution patterns appear to be related primarily to the effects of past episodic and severe storm events in 1982 and 1992. Today, the effects of these past intense and short lived physical events override the cumulative effects of long-term but slow biological processes such as recruitment, regrowth and succession. However, in the absence of intense future storms, biological processes should eventually return the ecosystem to a more mature successional stage. Unless significant changes occur in the nature of existing sources of point and non-point source pollution, neither are expected to affect the long-term recovery of coral reefs in Māmala Bay (Grigg, 1995).*

Since the 1993-94 surveys no major hurricanes have affected this coast, but the typically large surf experienced along this coast in summer months continues to inhibit coral recruitment by scour and abrasion. Figure 3-22 depicts the nearshore benthic habitat in the project area prepared by visual interpretation from remote sensing imagery collected by the National Oceanic and Atmospheric Administration (NOAA).

While this map is coarse in scale, the general features agree well with dive surveys completed specifically for the HSWAC project. According to the NOAA interpretations, progressively seaward from shore are areas of macroalgae dominance, uncolonized pavement, scattered coral/rock in unconsolidated sediments, sand, and again macroalgae dominated habitat.

As noted above, the applicant commissioned three recent benthic surveys that quantitatively assessed the entire proposed pipeline route from the location of the proposed receiving pit to the location of the proposed intake. These are summarized as shallow and deep surveys in the following sections.

Shallow Water Marine Biological Surveys

Early marine biological studies in support of the HSWAC project were focused on qualitatively examining the shallow water communities fronting Kaka‘ako Waterfront Park with the objective of delineating the major ecological zones or biotopes present as well as to determine the degree of development of the communities in these biotopes. This work was done to find possible pipeline alignments that would have the least environmental damage within the general constraints given by construction methodologies that were being considered at that time. These methodologies included possibly placing the pipeline in a trench dug across the shallow reef areas or use of microtunneling beneath much of the shallow reef area, thereby avoiding direct disturbance to the marine communities present mauka (landward) of the breakout point. Because of the presence of coral reefs, microtunneling became the method of choice and at least three different locations were considered for the seaward breakout point. However, as with all marine construction work, there are limitations and constraints with any method of choice; in the case of microtunneling, the distance at which such tunneling can be performed is limited due to substratum type and as distance increases, the ability to keep the tunneling within the desired alignment becomes more difficult.

In completing the initial qualitative marine biological work, Brock (2005) used several methods, which included towing a diver behind the support vessel. Where water clarity would permit, this diver made observations from the surface and verbally reported these observations to personnel on the vessel who noted these comments and also marked the location of these observations using a hand-held GPS. This exercise allowed a rough delineation of benthic communities and ecological zonation in the path of the diver. Other than towing a diver behind the support vessel, all underwater work was completed using self-contained diving gear. Coral community development was assessed by determining species present and estimating their cover on the bottom. Photographs were taken of representative sections of the substratum. Despite having preliminary pre-selected locations for possible pipeline alignment, much of the shallow water fronting Kakaʻako Waterfront Park at depths ranging from 2 to 20 m was examined for determining the geographic extent of the biotopes (or ecological zones) found in this study.

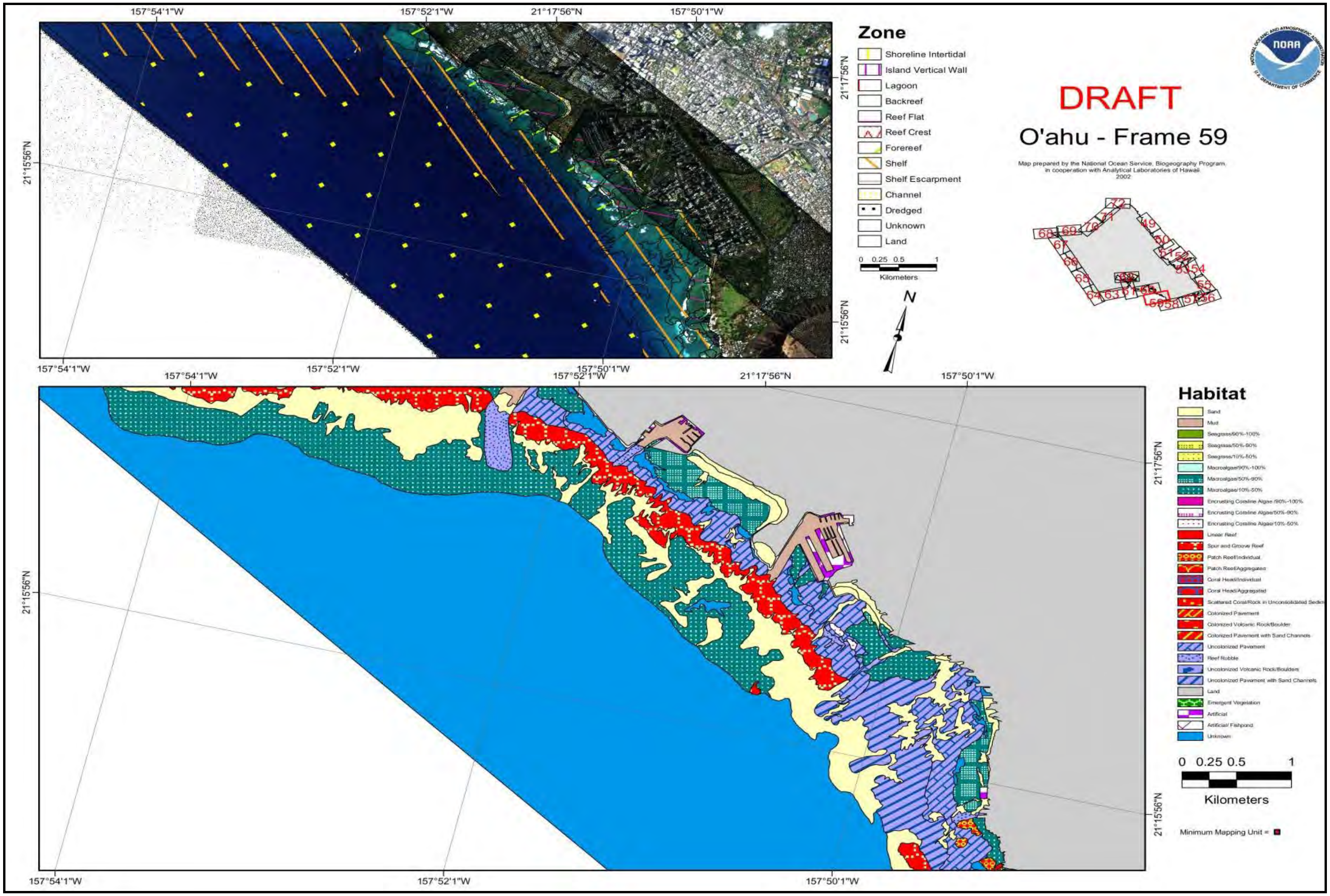


Figure 3-22: NOAA Interpretative Benthic Habitat Map for the HSWAC Project Area
(Source: NOAA, 2002)

The early work noted four major biotopes present in the study area offshore of the Kaka‘ako Waterfront Park; these are the biotope of scoured limestone, the biotope of scattered corals, the biotope of dredged rubble, and the deep offshore biotope of sand. As noted above, the applicant proposed microtunneling beneath the shallow reef platform to avoid impact to the marine resources present on the platform. Thus all of the biotope of scoured limestone as well as almost all of the biotope of scattered corals would be avoided. The pipes would emerge from the microtunnel approximately 547 m (1,796 feet) offshore in a sand covered limestone channel where coral cover is very low. The general characteristics of the three most seaward biotopes examined in the early qualitative study through which the proposed HSWAC pipeline would pass are described below.

The Biotope of Scattered Corals

This biotope is situated seaward of the biotope of scoured limestone from about 160 feet to over 330 feet from the shoreline, at depths commencing in 13 to 20 feet and ending in depths from about 40 to 60 feet. This biotope is the most common feature of the Kaka‘ako limestone platform and occupies a band about 1,100 feet in width, and about 3,000 feet in length between the Honolulu Harbor entrance channel and the abandoned sewer line near the Kewalo Basin entrance channel. Thus, the biotope encompasses about 75 acres. However, the proposed microtunnel for the HSWAC pipeline would pass beneath most of this biotope, emerging at the seaward edge of the biotope in a natural channel cut in the limestone about 1,796 feet from the shoreline.

The smooth limestone of the shallower, more inshore areas transitions to a series of limestone ridges (or spurs) separated by channels (or grooves). The spurs may rise as much as 5 feet above the general substratum and are separated by sand/coralline rubble-filled channels. These spurs and grooves have a general orientation that is perpendicular to shore and the ridges or “spurs” are from 6 to 49 feet in width and have lengths up to about 200 feet. Channels are from 3 to about 33 feet in width and are up to 130-160 feet in length.

Along the shallower inner reaches of this biotope corals are scattered. With increasing depth (i.e., 26 to 40 feet) coral cover increases, and in some areas ranging from 220 to 1,600 ft^2, cover may approach 75%, although such areas are not found within the project footprint. A gross overall mean estimate of coral cover in this biotope is 5%. Corals are commonly seen on the ridges that lie above the sand-scour that occurs during periods of high surf. Common corals include cauliflower coral (*Pocillopora meandrina*), lobate coral (*Porites lobata*), rice corals *(Montipora verrucosa, M. patula*), as well as other less dominant species (*Porites compressa, Montipora verrilli, Pavona varians, Leptastrea purpurea, Porites rus,* and others). Most of the other invertebrates and fishes seen in this area are all species common to Hawai‘i’s reefs. Diurnally-exposed macroinvertebrates seen include the pearl oyster or pa (*Pinctada margaritifera)*, octopus or he‘e (*Octopus cyanea*), sea cucumbers (*Holothuria atra, H. edulis, Actinopyge mauritana*), starfishes (*Linckia multifora, L. diplax, Acanthaster planci*), cone shells (*Cone imperialis, C. leopardus, C. lividus, C. ebraeus, C. miles* and *C. distans*), cowry (*Cypraea maculifera*), spindle shell (*Latirus nodus*), Christmas tree worm (*Spirobranchus gigantea*), polychaete (*Loimia medusa*), boring bivalve (*Arca ventricosa*), mantis shrimp (*Gonodactylus* sp.), occasional ula‘papa (*Paribaccus antarcticus*), and small xanthid crabs. Fishes commonly seen include surgeonfishes (manini - *Acanthurus triostegus*, na‘ena‘e - *A. olivaceus*, pualo - *A xanthopterus,* palani - *A. dussumieri*, maikoiko - *A leucoparieus*, ma‘i‘i‘i - *A. nigrofuscus,,* kole - *Ctenochaetus strigosus*, lau‘ipala - *Zebrasoma flavescens,* kala - *Naso unicornis*, umaumalei - *N. lituratus*, kihikihi - *Zanclus cornutus*, lauwiliwili - *Chaetodon miliaris*, *C. multicinctus*, *C. ornatissimus,* lauhau - *C. quadrimaculatus,* lauwiliwili nukunuku‘oi‘oi - *Forcipiger flavissimus*, mamo - *Abdufeduf abdominalis,* piliko‘a - *Paracirrhites arcatus*, toby - *Canthigaster jactator*) and damselfishes (*Chromis hanui, C. vanderbilti, C. agilis*). Fish species of commercial importance that are seen include moano - *Parupeneus multifasciatus* and *P. pleurostigma*, weke - *Mulloidichthys flavolineatus*, roi - *Cephalopholis argus*, po‘opa‘a - *Cirrhitus pinnulatus,* rarely the omilu

- *Caranx melampygus*, opelu - *Decapterus pinnulatus*, palukaluka - *Scarus rubroviolaceus*, and uhu – *Chlorurus spilurus* and *Scarus sordidus.*

Montipora patula and *M. verrilli* are among the corals proposed by NMFS for listing under the ESA. These two species are indistinguishable genetically or micro-morphologically, but *M. verrilli* is only found in an encrusting form whereas *M. patula* may be encrusting or plate forming. For purposes of listing, NMFS considers them a single species. According to NMFS, it has a very restricted range, centered in the main and Northwestern Hawaiian Islands (NWHI), although the International Union for the Conservation of Nature (IUCN) reports the species from other western Pacific and South Pacific islands. It is sometimes common with a statewide mean cover of 3.3%. *M patula* is the fourth most abundant coral in Hawaiʻi (Brainard, et. al., 2011).

<u>*The Biotope of Dredged Rubble*</u>

Seaward of the spur and groove formations that are common elements of the biotope of scattered corals, the ridges become less obvious often sloping seaward and coalescing with sand and rubble floors of adjacent channels thus creating a relatively open bottom largely covered with coralline rubble. Much of this rubble appears to be quite angular and ranges from several centimeters to about 0.75 m in diameter, but the majority of it is small. This coral rubble is what remains from the dredging activities in Honolulu Harbor and these tailings were deposited in the area probably from about 1920 through about 1960. With sufficient material, the old seaward face of the limestone platform fronting Kakaʻako Waterfront Park was extended seaward, probably adding anywhere from 10 to 40 m to the outer edge of the platform. This biotope is recognizable at depths from about 9 to 12 m and extends seaward sometimes as a relatively steep slope or otherwise as a gentle slope from 20 to 60 m in width and at its deepest point is found at depths up to about 24 to 29 m where a sand/rubble bottom is encountered. The distance between the most obvious spur and groove formations with reasonable coral cover to the top of the more offshore rubble slope ranges from 20 to over 50 m.

In the zone of coral rubble dredge tailings, benthic and fish communities are not well developed. The relatively unstable nature of the substratum does not promote coral growth; most corals seen in this biotope (zone) are small. Corals seen include cauliflower coral (*Pocillopora meandrina*), antler coral (*Pocillopora eydouxi*), lobate coral (*Porites lobata*), and rice corals (*Montipora capitata* and *M. patula*). Corals are best developed on the larger pieces of limestone. Mean coral cover in this biotope is less than 0.1% (overall mean estimated cover is 0.01% in this biotope) and species commonly seen include cauliflower coral (*Pocillopora meandrina*), lobate coral (*Porites lobata*), rice corals (*Montipora capitata* and *M. patula*) and less frequently antler coral (*Pocillopora eydouxi*).

Fishes observed in this area are usually small, either juveniles or species that do not attain large sizes (gobies, some labrids, etc.) probably due to the lack of shelter. Where larger limestone/dead coral pieces or metal/concrete debris are present, the fish communities are better developed probably due to the shelter afforded by these materials. Most fishes encountered in this biotope are around available shelter; species commonly seen include the moano (*Parupeneus multifasciatus*), lauwiliwili (*Chaetodon miliaris*), butterfly fish (*Chaetodon kleini*), mamo (A*budefduf abdominalis*), aloʻiloʻi (*Dascyllus albisella*), dartfish (*Ptereleotris heteroptera*), pilikoʻa (*Paracirrhites arcatus*), toby (*Canthigaster jactator*), puhi laumilo (*Gymnothorax undulatus*), ʻoʻopu hue (*Arothron hispidus*), alaʻihi (*Sargocentron xantherythrum*), surgeonfishes (pualo - *Acanthurus blochi*, *A. xanthopterus*, palani - *A. dussumieri*) maʻiʻiʻi (*A. nigrofuscus*), kala holo (*Naso hexacanthus*), kala lolo (*N. brevirostris*), humuhumu lei (*Sufflamen bursa*), humuhumu mimi (*S. fraenatus*) and wrasses, the aʻawa - *Bodianus bilunulatus*, hinalea ʻiʻiwi - *Gomphosus varius*, small wrasses - *Macropharyngodon geoffroy*, *Pseudocheilinus octotaenia*, *P. evanidus*, *Oxycheilinus bimaculatus* as well as the ʻomaka - *Stethojulis balteata* and hinalea lauwili - *Thalassoma duperrey*.

Commonly seen diurnally-exposed macroinvertebrates in this biotope include sea urchins (*Echinothrix diadema*, *E. calamaris*, *Diadema paucispinum*, *Tripneustes gratilla*), boring bivalve (*Arca ventricosa*), rock oyster (*Spondylus tenebrosus*), sponges including *Mycale armata*, *Suberites zeteki*, *Chondrosia chucalla*, *Spirastrella coccinea*, *Tethya diploderma*, *Mycale cecilia*, *Halichondria coerulea*, *Iotrochota protea*, *Halichondria dura* and *Tedania macrodactyla*, sea cucumbers (*Holothuria atra*, *H. hilla*, *H. verrucosa*), polychaete (*Loimia medusa*), he‘e (*Octopus cyanea*) and cushion starfish (*Culcita novaeguineae*).

The Biotope of Sand

Below and seaward of the rubble slope, the substratum flattens out and is composed of sand and coral rubble. Offshore (within 100 m of the rubble slope and to the east of the proposed pipeline alignment) are several mounds of coral/limestone rubble rising up to 5-8 m above the surrounding substratum that probably represent one or more barge loads of dredge tailings. The diversity of life on the sand/rubble plain seaward of the 20 m isobath is not well-developed and was not examined in the 2005 preliminary description of biotopes present in the vicinity of the proposed HSWAC pipeline alignment due to diver bottom time constraints using conventional diving gear.

Recent Shallow Water Surveys

Comments received from the regulatory community on the DEIS (noted above) pointed out the necessity of carrying out quantitative studies in the proposed HSWAC pipeline alignment from the microtunnel receiving pit (where the pipes come to the surface of the seafloor) on down to the deep seawater intake at 540 m depth. Concerns addressed herein include the quantitative studies carried out from the breakout point of the pipes to depths between 120 and 150 feet. To meet this objective two shallow water surveys were conducted (Appendix E and Appendix O).

To specifically quantify the scale of anticipated coral impacts associated with construction of the proposed offshore receiving pit, a detailed survey of corals within the footprint of the receiving pit was completed on October 1, 2013 (Appendix O). GPS was used to mark the corners of the proposed 12.2 m by 12.2 m (40 ft by 40 ft) offshore receiving pit and outline the receiving pit footprint. Divers photographed all coral colonies observed within the footprint of the receiving pit. A marine biologist identified the taxa of the coral colonies that were observed during the survey and recorded their sizes and growth forms. A total of 29 coral colonies were observed within the 148.6 m^2 (1,600 ft^2) footprint of the proposed receiving pit. *Pocillopora meandrina* and *Porites lobata* were the most common corals observed and comprised 55% and 34% of the total coral, respectively, within the pit footprint. There were also single colonies of *Montipora capitata*, *Montipora patula*, and *Porites lutea*. Of the 29 total coral colonies, there were 15 corals with diameters larger than 10 cm. (3.9 in.). The total live coral cover within the receiving pit footprint is 0.3% equating to a total area of 0.43 m^2 (4.63 ft^2) within the 148.6 m^2 (1,600 ft^2) footprint area.

For the “Shallow Water Marine Biology Survey” (Appendix E), transects were established to quantify biota present. Relative to the general configuration of biotopes present, the studies show that from the base of the rubble slope where the sand/rubble plain commences, the slope becomes and remains gradual to a depth of 75- 80 feet at which point the slope again increases and remains this way to the 130 feet isobath (the depth limit of this study). As shown below, the substratum on both the initial or shallower slope as well as the slope present at 23-24 m is composed primarily of rubble, which continues from the 23-24 m isobath to the 40 m isobath. This rubble substratum appears to be largely composed of dredge tailings, which continue to depths below the diffuser. Thus in summary the relatively flat biotope of sand (above) is sandwiched between the biotope of dredged rubble both on the mauka (landward) and makai (seaward) sides in the vicinity of the proposed HSWAC pipeline route. Figure 3-23 shows the extent of the biotopes in the project area and the locations of sampling stations.

General results of this survey indicated that along the western part of the limestone platform that fronts all of Kakaʻako Waterfront Park, the biotope of scattered corals terminates in a series of limestone ridges (or "spurs") and channels (or "grooves"). Coral communities are relatively well-developed on the limestone ridges. The channels or grooves may have a veneer of sand and rubble; in a seaward direction the limestone spurs merge into the surrounding deeper sand/rubble substratum; further seaward, this sand and rubble veneer merges with the rubble substratum comprising the biotope of dredged rubble. The dredged rubble is obvious, being angular and sharp-edged rather than rounded and smooth as is most naturally-derived coralline reef rubble. The proposed exposed portion of the HSWAC pipeline route was selected to avoid areas of coral and thus would emerge from the microtunnel in a natural channel and continue seaward across areas having little marine community development as explained below.

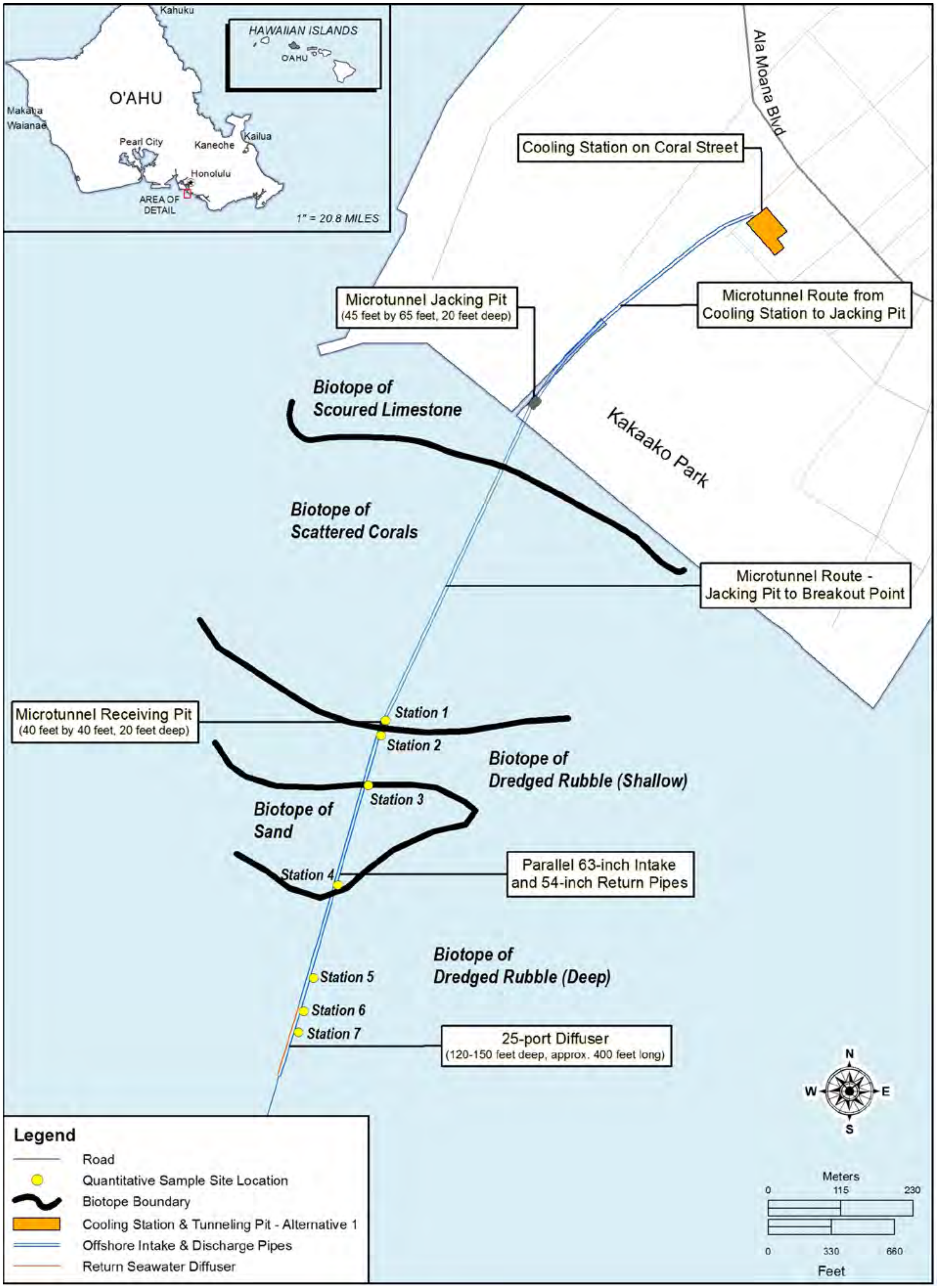


Figure 3-23: Biotopes and Sampling Locations for the Shallow Water Marine Biology Survey

The first station for quantitative sampling was established at a point that would be in the middle of the shoreward boundary of the receiving pit. One 4 x 25 m transect commenced at this point and sampled from a compass heading of 120° (Transect A, to the east) and the second 25 m line commenced at the same point but sampled at a compass heading of 270° (Transect B, to the west). The middle of the channel where the proposed receiving pit would be located is shown in Figures 3-24 (looking seaward down the channel) and Figure 3-25 (looking shoreward up the channel).

Figure 3-24: Photo Taken from the Center of the Proposed Receiving Pit at Station 1
(Depth 9.5m on 24 August 2011 looking in a seaward direction down the channel.)

The proposed location of the receiving pit is close to the seaward edge of the biotope of scattered corals in the spur and groove formation that is well-developed in this area. The overall mean coral cover on Transect A is estimated at 4.3% and on Transect B it is 10.7%. Coral cover is estimated to be 15% on the eastern spur and 21% on the western spur limestone ridges adjacent to the channel floor of the proposed receiving pit location. However, since transects also incorporated the channel floor where coral cover is close to zero, the mean cover was less. As found in the coral survey of the receiving pit (Appendix O) a total of 29 coral colonies exist within the receiving pit footprint, 15 of which were greater than 10 cm and none greater than 30 cm. The total coral cover in the receiving pit was found to be 5.17 ft^2, or 0.32%, with a live tissue cover of 4.63 ft^2, or 0.29%. Based on proposed construction methodologies, which may extend beyond the configuration of the receiving pit footprint, minor adjustments to the receiving pit location may be necessary to minimize impacts to coral on the eastern and western spurs. Figure 3-26 is an example of one of the larger *Porites lobata* colonies on the eastern spur; a more common spacing and size of colonies on the eastern spur is seen in Figure 3-26.

Figure 3-25: Photo Taken From the Center of the Proposed Receiving Pit at Station 1
(Depth 9.5m on 24 August 2011 looking towards shore.)

Figure 3-26: Photo Taken on the Limestone Ridge East of the Proposed Receiving Pit
(Taken on 24 August 2011 showing the typical coral cover in the vicinity of Transect A [Station 1]. Depth ~ 8.5m.)

Due to the locally high diversity/cover coral community in proximity to the proposed receiving pit, a second station was established 24 m (80 feet) seaward of the receiving pit (as measured from the center of the pit) situated at the midline of the proposed pipeline alignment at a depth of 33 feet. This station is again in the middle of the same channel at a point where the two limestone ridges (to the east and west of the channel) merge with the biotope of shallow dredged rubble. Transect C sampled marine communities present to the east (compass heading 120°) and Transect D sampled those to the west (compass heading 270°). This station sampled emergent limestone, sand and coralline rubble; where the limestone substratum continues to be present, some corals are found but mean cover is only 3.2% and the fish community was not well developed (mean number of species/transect = 10, mean number of individuals/transect = 27 individuals, mean standing crop = 31 g/m^2). The relatively poor development in the coral community may be related to scour and abrasion that probably impacts this area during high surf events. Considering that the C and D transects included sampling of the spur ridges east and west of the proposed pipeline route, which would be precisely installed at this location in the channel with low coral occurrence, actual coral impacts would be less than what may be suggested by transects C and D. To accurately represent coral community conditions within the area of impact of the proposed pipeline route, quadrats C-23m and D-24m should be omitted.

The third station was established at a depth of 45 feet in an area of transition (or ecotone) from the biotope of shallow dredged rubble to the biotope of sand; the 4 x 25 m transects sampled to the east (compass heading 100°) and west (compass heading 270°) of this point. Again, coral cover and mean colony sizes were less than found in shallower water probably related to the lack of appropriately-scaled hard substratum available for settlement and growth. As with the previous station, where emergent limestone substratum is encountered, corals are present. The eastern transect (Transect E) crossed one area of hard substratum, which was sampled, but such substratum is rare in the area. Figure 3-27 shows the common substratum (a mix of dredge tailings and sand) present in the area sampled at this station.

Figure 3-27: Photo of a "Dart" Marker Placed West of the Center of the Proposed Pipeline Alignment on Transect F (Station 3)

(13.7m deep 10 August 2011)

The fourth station was established on the midline of the proposed pipeline alignment at a depth of 60 feet. Transect G (compass heading 120°) sampled to the east and Transect H (compass heading 270°) sampled to the west. The two transects sampled different substrata types; to the east, the 4 x 25 m transect was situated on dredge tailings which were colonized by some coral (Figure 3-28) and where larger pieces of limestone were encountered, more coral was seen. Overall mean coral cover on Transect G (to the east) was 0.9% and to the west on Transect H, which sampled an area of sand, no corals were sampled in the five, one square meter quadrats. Figure 3-29 shows the sand substratum at Transect H where little hard substratum is present. The fish communities sampled on Transects G and H were not well-developed, with a mean number of species = 4, 7 individuals, and standing crop = 5.5 g/m^2 which is probably related to the lack of appropriately scaled shelter space. Where shelter space is available small reef fishes may be present.

Figure 3-28: Photo Taken on Transect G (Station 4) Showing the Rubble Substratum Present in the Area
(Photo date 10 August 2011, depth 18m.)

Figure 3-29: Photo Showing Sand Substratum Present at Transect H (Station 4) on 10 August 2011
(Depth 18m)

Figure 3-23 shows the approximate boundaries in the vicinity of the proposed HSWAC pipeline route of the major biological zones (or biotopes) identified in this study. Between the proposed location of the receiving pit where the HSWAC pipeline would emerge from the substratum and the proposed terminus of the outfall diffuser at 150 feet most of the exposed pipeline passes through the biotope of dredged rubble. To the east of the proposed pipeline alignment, the biotope of dredged rubble appears to be a near-continuous feature from about 12 m to 46 m in depth. This rubble has probably covered considerable areas that were composed of limestone, sand and coral. Viewing videotapes from a remotely operated video camera shows that the dredged rubble is a near continuous feature along the proposed pipeline route from about 80 feet to at least 200 feet. Because the quantitative data collected at Transects I (90 feet), J (115 feet) and K (130 feet) were similar these stations are considered together.

Transect I was carried out on a rubble substratum (Figure 3-30) where mean coral cover was 2.5%. Besides dredge tailings, much old debris is also present as well as modern refuse. As found elsewhere in this study, where larger pieces of dredged limestone are encountered, corals and other biota are found. Development of most coral reef species is minimal and this is reflected in the quantitative data collected at this and the other two deep transect sites.

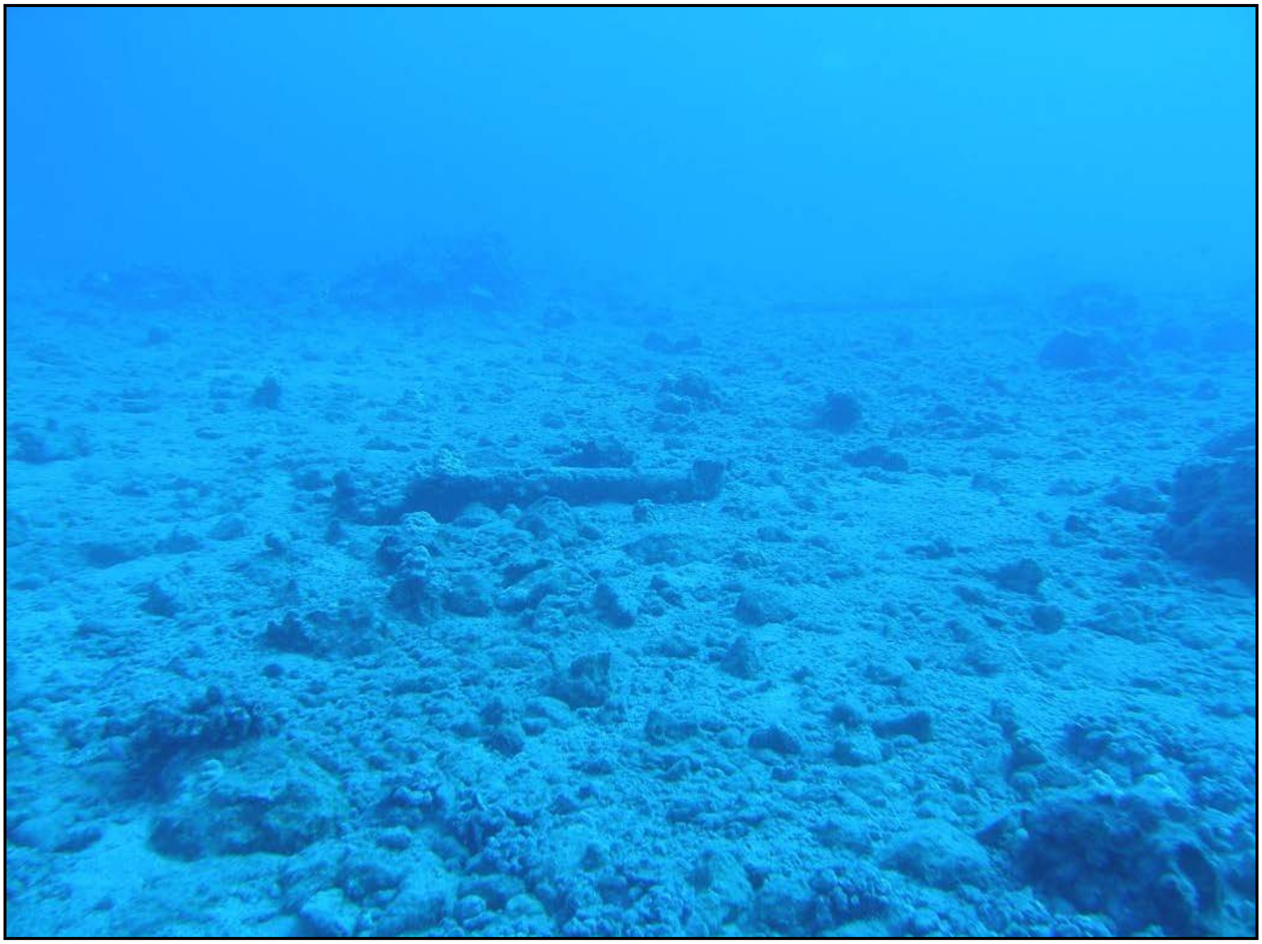


Figure 3-30: Photo of Typical Coralline Rubble Substratum Present at Transect I (Station 5)
(Note the metal debris (pipe) in the background, 10 August 2011, depth 27m.)

Transect J was located on substratum at a depth of 115 feet, again on the midline of the proposed pipeline alignment. Mean coral cover at this location was 0.6% and again the photographs show that the benthic community at this location appears to be depauperate.

Transect K was again situated on the midline of the proposed pipeline route at a depth of 130 feet. As with the two preceding transects, the benthic and fish communities are poorly developed. Additional photographs may be found in Appendix E.

Table 3-12 summarizes information from the shallow-water transect surveys concerning the size, density and biomass of coral reef organisms observed. With increasing depth there are general trends of decreasing numbers of coral species, decreasing coral cover, and decreasing coral colony size. Seaward of the receiving pit (biotope scattered corals), along the proposed pipeline route, the average coral size was approximately 5 cm. Trends for invertebrates are not as clear, but the greatest numbers of species and individuals were seen in the shallowest transects and the fewest in the ecotone between the biotopes of dredged rubble and sand. Fish numbers, species and biomass were much higher in the shallowest transects than at greater depths.

Table 3-12a: Summary of Size, Density and Biomass of Coral Reef Organisms found in Appendix E

Measure		***Biotope***				
		Scattered Corals	***Dredged Rubble (Shallow)***	***Ecotone Between Dredged Rubble and Sand***	***Sand***	***Dredged Rubble (Deep)***
Mean Number of Coral Species		4.5	5.0	2.5	1.0	2.0
Mean Coral Cover (%)		7.5	3.2	1.0	0.5	1.1
Mean Colony Size (cm)	Pl	13.1	10.2	4.5-	3.1-	4.0
	Mc	5.9	9.3	2.7-	3.8	4.5-
	Mp	14.2	8.8	-	-	-
	Pm	11.7	10.9	5.5-	-	-
	Pd	-	10.0	-	-	-
	Pe	-	25.0	21.0	-	-
Mean Number of Invertebrate Species		2.0	1.0	0.5	1.0	1.3
Mean Number of Invertebrate Individuals		8.5	5.0	0.5	5.0	2.3
Mean Number of Fish Species		28.0	10.0	10.5	4.0	4.7
Mean Number of Fish Individuals		127.5	26.5	40.5	6.5	13.3
Mean Fish Biomass (g/m^2)		123.5	30.5	11.7	5.5	1.9

Pl = *Porites lobata*; Mc = *Montipora capitata*; Mp = *Montipora patula*; Pm = *Pocillopora meandrina*; Pd = *Pavona duerdeni*; Pe = *Pocillopora eydouxi*; Lp = *Leptastrea* sp.; Ls = *Leptoseris* sp.

Table 3-12b: Coral Colony Sizes from Receiving Pit (biotope scattered corals) to 40 m depth
Source: Appendix E, Tables 1 and 2.

Transects	**Pipeline Route Survey (10–40m), Coral Colony No. in Size Class (cm)**					Total No.
	0<2	**2<5**	**5<10**	**10<20**	**20<40**	
C*	1	4	7	1	1	14
D*	0	4	1	2	2	9
E	4	19	3	3	1	30
F	0	1	0	0	0	1
G	3	24	3	2	0	32
H	0	0	0	0	0	0
I	0	12	14	6	0	32
J	2	7	8	0	0	17
K	16	5	0	0	0	21
Total No.	**26**	**76**	**36**	**14**	**4**	156
*quadrats C-23m and D-24m outside of impact area and thus omitted						
Receiving Pit Count	**0**	**0**	**4**	**15**	**10**	29

Keʻehi Lagoon

Keʻehi Lagoon was originally a large shallow reef and subtidal area no more than 1-2 m deep that extended more than two miles off the mouths of Kalihi and Moanalua Streams. The three seaplane runways that make up much of Keʻehi Lagoon today were dredged from shallow areas during and after WWII. More than 16 million cubic yards of dredged material was removed from the runways and a mooring basin, and deposited along the shore to form the area of Honolulu International Airport. The lagoon was again substantially altered during the 1960s and 1970s. The Keʻehi Lagoon Marina was completed in 1963. From 1972 to 1975, the Reef Runway of the Honolulu International Airport was constructed offshore of the lagoon. About 1,240 acres of reef were covered with fill. Circulation channels were dredged resulting in alleviation of stagnant conditions that had been created by the initial seaplane runway dredging.

A comprehensive description of the biota of Keʻehi Lagoon is contained in B.P. Bishop Museum (1999). The authors sampled benthic biota and made observations of fish at five stations in the lagoon as part of a study of nonindigenous marine species introductions into Oʻahu harbors. All prior marine biological studies of Keʻehi Lagoon were reviewed and compared with their sampling results. The closest station to the proposed HSWAC staging area was their Station 18, across the Kalihi Channel near the Keʻehi Marina. Heavy fouling was seen on dock surfaces. The water was turbid and the bottom covered with muddy sediment.

The most common types of biota were arthropods (45 species), annelid worms (31 species) and sponges (21 species). Seventeen reef fish species were observed, as was one coral, *Leptastrea purpurea* (crust coral), which is a common, wide-ranging species, presumably seen on the dock structures. In total, 19 species of algae, one flowering plant, 148 invertebrates and 17 fish species were seen. Among the animals seen, filter feeders and detritus feeders predominated. The numbers and types of organisms seen throughout the lagoon in the Bishop Museum study were similar to those recorded in earlier studies following creation of the Reef Runway. Of the five harbors studied, Keʻehi Lagoon had the highest percentage of introduced or possibly introduced (cryptogenic) species at 33%.

The Deep Benthos

The types of animals present and their abundance in the deep sea around Hawaiʻi are determined by Hawaiʻi’s geographic isolation, water chemistry, temperature and pressure, current speeds, lack of light, and bottom habitat quality. In the deep sea around Hawaiʻi, only about 35% of the species seen from research submersibles are native (indigenous) to Hawaiʻi (Chave and Malahoff, 1998). Of the sponge, coral and echinoderm species present, 45% occur at depths of 15-400 meters, 15% at 400-800 meters, and 12% at 800-2,000 meters. Twenty-eight percent of these species range widely from depths of 40 to 2,000 meters. However, sessile benthic species are usually distributed in zones. Glass sponges, crinoids and most gorgonians are generally found at depths greater than 300 meters. The number of benthic fish species has been found to decrease logarithmically with depth. The greatest numbers of species inhabit depths between 15 and 200 meters, the fewest 2,000 meters. Crustaceans seem to follow the same distribution pattern (Chave and Malahoff, 1998).

Below 130 meters, only a few, if any, stony corals occur. Non-reef-building corals and other animals obtain their food from the plankton, smaller animals, or dead animal and plant material. Filter-feeding is a relatively common strategy, with areas swept by faster currents, such as ridges, banks and pinnacles, being favored. Because of low light intensity and limited food sources, depths below 500 meters are sparsely populated. Estimates of density are 0.05 animals per square meter (Chave and Malahoff, 1998).

At deep-sea depths, temperature is low, inhibiting metabolic processes. In addition, dissolved oxygen concentrations are low and pressures are high, further restricting life forms. Typical deep-sea animals include sponges, cnidarians including gorgonians, some of which are Management Unit Species (MUS) under the *Fishery Ecosystem Plan for the Hawaii Archipelago* (WPRFMC, 2005), echinoderms including sea stars, deep-sea urchins, and sea cucumbers, brittle stars, basket stars, and crinoids (sea lilies), crustaceans including barnacles, crabs, and shrimp, and mollusks including sea snails and octopus. Typical fish include deep-sea sharks, rays, chimaeras, deep-sea mackerels and eels.

In late 2010, the applicant became aware that the University of Hawai‘i’s Hawai‘i Undersea Research Laboratory (HURL) had surveyed a portion of the HSWAC route using one of its submersibles. The dive was made to recover a side-scan sonar glider that was lost during a previous bathymetric survey in the immediately vicinity of the HSWAC intake pipe route. After recovering the lost glider, the HURL team continued surveying the HSWAC route. The entire dive was videotaped, beginning with arrival of the submersible at the seafloor. The videotapes, 5.8 hours in duration, covered roughly the lower 1.89 km (6,205 feet) of the proposed pipeline alignment from 500 m to about 558 m deep. The applicant’s consultant reviewed the videotapes and produced a report of findings. A summary of that report follows.

The approximate area examined is 10,700 m^2 along about 3.57 km. More than 99 percent of the substratum viewed was sand. Scattered tailings were seen, probably originating from former Honolulu Harbor dredging operations. Hard substratum (limestone or basalt) was extremely rare, making up an estimated 0.3 percent of the bottom. Anthropogenic debris, primarily metal, made up an estimated 0.5 percent of the bottom. There were 419 sightings of organisms in 42 taxa. Most organisms were found on or adjacent to hard substratum. Exceptions were glass rope sponges, panaeid shrimps, squids and the jellynose eel. The most abundant species seen was the sea star *Brisinga* sp. (170 individuals). Second most abundant was the glass rope sponge (45 individuals), followed by small unidentified fishes (27 individuals).

The above effort illustrated the usefulness of the HURL submersibles in surveying the deep benthos and after discussions with resource and regulatory agency personnel, the applicant arranged for additional dives to characterize the deep benthos along the actual intake pipe route from about 200 meters deep to the intake depth. HURL was contracted in 2011 to conduct two dives that began at 540 m and extended up to a depth of 250 meters. Data from these dives and the two previously noted shallower dives made in 2009 also along the proposed HSWAC intake pipe route were combined in a report, which is contained in Appendix I. The following paragraphs summarize the salient conclusions of that report.

All organisms observed on the videos from these dives were counted and identified to the lowest taxonomic level using VARS (Video Annotation and Reference System) developed by the Monterrey Bay Aquarium Research Institute. The data, which included substrata information, depths, locations, and environmental factors, were extracted and imported into ArcGIS.

A total of 1,741 biological observations were recorded from the four dives. Organisms were observed along the entire length of the surveyed pipe route. A total of 159 different “organism types” along with 2 algae types were identified. Some organisms were identified only generally, while others could be identified to species. A depth range analysis indicated that animal types/species could be segregated into 3 depth zones: 50-200 m, 200-400 m, and 400-550 m (Figure 3-30). These zones, labeled 1, 2, and 3 starting with the shallowest, coincided with noticeable differences in substrata composition and slope (Figure 3-31).

The upper part of zone 1 was characterized by hard substratum consisting of carbonate bedrock mixed with sediment pockets, pebbles, cobbles, boulders, and manmade debris such as discarded tires, trash, and metal objects. Many of the cobbles and boulders appeared to be dredge spoil deposits. The slope was fairly gradual from 50m down to a depth of 110 m where a break-in-slope occurred. From that depth to 200 m, zone 1 could be characterized as a steep, primarily carbonate bedrock habitat. The break-in-slope is a well-known old reef feature that is believed to have drowned during the last glacial melt phase approximately 20,000-30,000 years ago.

Zone 2 was characterized by a transition from primarily carbonate bedrock to sediment covered by pebbles, cobbles, boulders, and manmade debris. The more gradual slope between 200-400 m presumably allowed for increased deposit of sediment, while the majority of the larger grain sizes (i.e., cobbles and boulders) were clearly dredge spoil deposits that are likely masking a smaller amount of natural landslide debris. The large amount of dredge spoil is primarily responsible for the high backscatter return throughout most of this zone. Manmade objects were numerous and included trash, shipwrecks, discarded vehicles, miscellaneous metal debris, and a small amount of disposed ordnance. This zone could be considered as highly disturbed habitat.

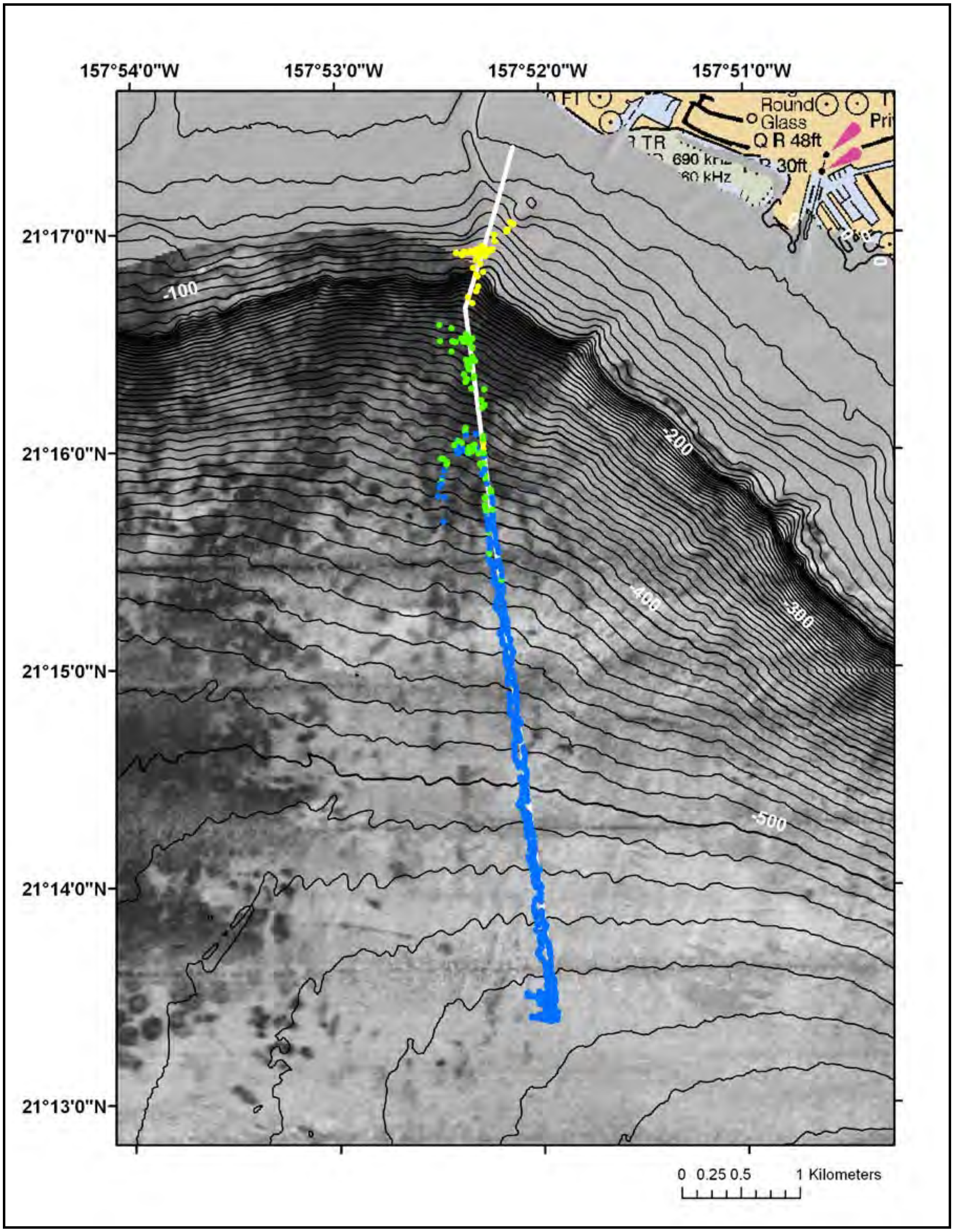


Figure 3-31: The Location of Animal Records Obtained from the Dive Video
(Following a depth range analysis, animal types/species were segregated into 3 zones: zone 1 [50-200m, yellow dots], zone 2 [200-400m, green dots], and zone 3 [400-550m, blue dots].)

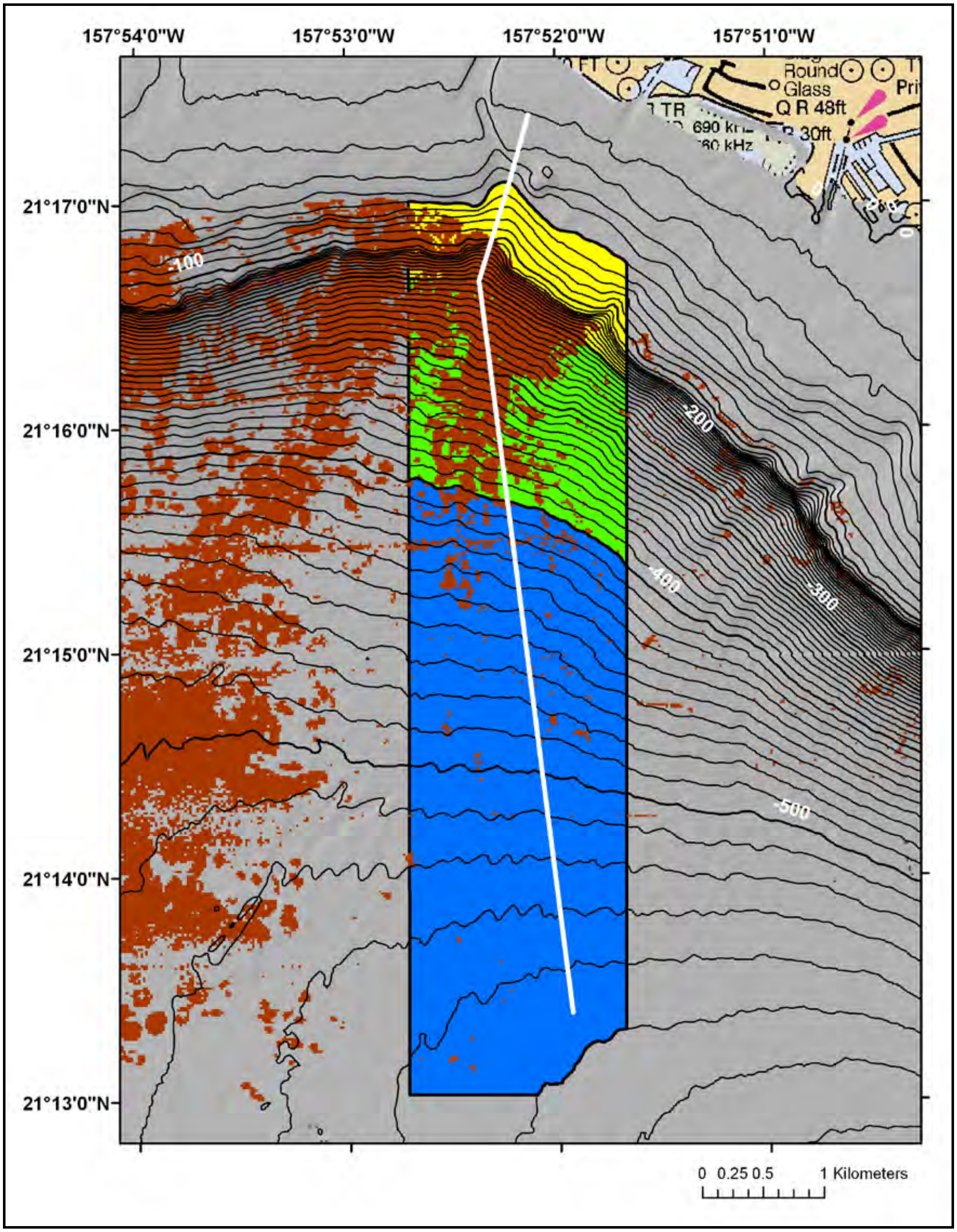


Figure 3-32: Three Habitat Zones Shown in Relationship to Multibeam Backscatter Values Greater than 187 (Red Areas)

Zone 1 = yellow, zone 2 = green, and zone 3 = blue) Note the upper part of zone 1 was outside of the backscatter data coverage, but from submersible observations, consists primary of hard substratum similar to its lower half and zone 2.

The substratum in zone 3 was primarily rippled sediment with pebbles, occasional cobbles, boulders, and blocks, and a considerable number of manmade objects. The slope was far more gradual than either of the other two zones with virtually no exposed bedrock present. Large blocks and boulders that were occasionally encountered were believed to be natural landslide debris. Dredge spoil was far less prevalent than that observed in either zone 1 or 2. However, a significantly larger amount of disposed ordnance was encountered, which included small World War I-II era chemical weapons (M1 30 lb and MK47 100 lb bombs), both large artillery and small mortar projectiles, an aerially-deployed rocket, and a small number of 500 lb bombs with their shipping collars still attached. With the exception of the rocket and 500 lb bombs, all of the ordnance was clearly old and highly corroded. Other manmade debris included vehicles, airplane debris, large pieces of unidentified metal framing, 55 gal drums, and piles of what appeared to be discarded fuses. Similar to zone 2, the habitat in zone 3 has clearly been highly disturbed.

In addition to differences in substrata, the 3 zones differed significantly with regard to light intensity and water quality. Off the coast of Oahu, down-welling natural light reaches a depth of approximately 300 m. Zone 1 was therefore mesophotic, zone 2 was transitional between mesophotic and aphotic, and zone 3 was aphotic. Pressure, while changing from 90 to 817 psi, is generally not considered a major factor in structuring marine communities above 500m. Salinity was relatively constant for all zones, ranging between 34.0 and 35.1 ppt. However, temperature and dissolved oxygen dropped 11-16°C and 1.7-2.9 ml/l, respectively, between 50 and 550 m. In general, zone 1 consisted of relatively warm, lit, oxygenated water in contrast to zone 3 which consisted of cold, dark, poorly oxygenated water typical of depths below 400m throughout Hawaiʻi and the rest of the Pacific. The differences in substrata, light intensity, and water quality are most likely the factors responsible for the changes in species composition along the pipe route.

Identifications of organisms and densities within the three depth zones may be found in Appendix I, but the broad conclusions are repeated here. In zone 1, a total of 551 organisms were counted, yielding an estimated density of 766 per hectare. Twenty-three organism types were identified, 13 of which were fishes. Among the organisms seen in this zone was a well-known mesophotic scleractinian coral, *Leptoseris* sp. In order to put these observations into context, HURL database records were extracted to determine the total number of different organism types ever identified from submersible video in the main Hawaiian Islands for each of the three depth zones. HURL has documented 447 different organism types within 50-200m, with fishes being the most abundant (242), followed by cnidarians (66), sponges (20), and urchins (19). Only 5.1% of all organism types from the database were observed along the HSWAC pipe route within zone 1. Two of the 66 cnidarians in the HURL database were observed. In comparison to other 50-200 m areas HURL submersibles have been in the main islands, zone 1 of the pipe route has a very low number of species.

In zone 2, a total of 297 animals were counted for an estimated density of 148 per hectare. Even though the overall density was significantly lower than in zone 1, the number of different organisms (55) recorded in zone 2, was significantly higher than that of zone 1. Similar to zone 1, fishes predominated with 26 types, followed by cnidarians (9), crabs (5), and urchins (4). No shallow reef fishes or invertebrates were observed in this zone. The HURL database for zone 2 depths contains 592 different organism types within 200-400m, with fishes being the most abundant (198), followed by cnidarians (181), crabs (35), seastars (33), and sponges (26). Only 9.3% of all organism types from the database were observed along the HSWAC pipe route within zone 2. Only 9 of 181 cnidarians (5%) in the HURL database were observed. In comparison to other 200-400m areas HURL submersibles have been in the main islands, zone 2 of the pipe route again has a very low number of species.

In zone 3, a total of 1,483 organisms were counted, yielding an estimated density of 510 organisms per hectare. One hundred different types of organisms were recorded in zone 3, which is almost double the number of zone 2. As with the other zones, fishes had the greatest number of species (40), followed by cnidarians (22), urchins (7), shrimps (6), sea stars (6), sponges (5), and crabs (5). In terms of density, fishes were the most numerous group, followed by cnidarians, shrimps, and sea stars. The HURL database for zone 3 depths contains 415 different organism types within 400-550m, with cnidarians being the most abundant (145), followed by fishes (106), sponges (27), sea stars (27) and urchins (22). Approximately 24% of all organism types from the database were observed along the HSWAC pipe route within zone 3, which included 15% of the cnidarians.

Approach to Impact Analysis

Avoidance and minimization of impacts to coral communities was a major project planning criterion. The most straightforward method of pipe installation is cut and cover, or trenching. This potential methodology was dismissed early in project planning in favor of a trenchless technology for pipe installation from the shoreline to a breakout point. The respective alternative breakout points were selected to be in areas of sand and rubble bottom.

The Clean Water Act Section 404(b)(1) Guidelines provides the framework for USACE evaluations of DA permit applications involving a discharge of dredged or fill material in waters of the U.S. The fundamental precept is that DA permits must not authorize discharges of dredged or fill material into waters of the U.S. unless it can be demonstrated that such a discharge would not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern. Additionally, DA permits may only authorize the least environmentally damaging practicable alternative determined by the USACE. Special aquatic sites, including coral reefs, are recognized as possessing unique and important ecological values that should not be degraded or destroyed. In general, practicable alternatives which avoid and/or minimize discharges into special aquatic sites are presumed to have less adverse impacts unless demonstrated otherwise.

Methodology
The methodology to characterize the marine benthos offshore of Kaka‘ako Waterfront Park began with a review of previous survey reports of the area and similar habitats throughout the islands to understand the physical and chemical factors shaping the community structure. Subsequently, experienced marine biologists surveyed the area. First, rapid qualitative surveys were done by towing divers behind a small boat to define the types and extent of habitats or biotopes present. Then more quantitative surveys were done using transect lines and SCUBA gear and an inventory survey of the defined receiving pit. Finally, for portions of the route inaccessible to divers, videos from submersibles were collected and analyzed.

The net effects to substratum and specifically to coral resources in the shallow water region from the receiving pit to approximately 300 feet were quantified for each action alternative as follows.

- Adverse effect at receiving pit:
  - Calculate area of receiving pit (total loss of coral)
  - Calculate coral losses
- Adverse effect of collars placed from the receiving pit to approximately 300 feet deep:
  - Calculate collar footprint by collar type (from engineering drawings)
  - Calculate number of collars needed by type (from engineering data)
  - Calculate substratum covered in each biotope based on collar type, distance between collars and route
  - Estimate coral loss from substratum covered
- Adverse effect on corals from operational discharge in the ZOM:
  - Estimate area of subambient temperature based on CORMIX modeling
  - Assume complete mortality of corals in zone of subambient temperature
  - Estimate coral loss from area of subambient temperature and coral cover
- Sum substratum and coral losses from all three sources
- Potential beneficial effect of collars and pipes:

- o Estimate potential coral recruitment opportunities on artificial substratum of proposed structures

The results of these calculations are summarized in Table 3-15 at the end of this section.

Impacts to deep water species were quantified based on the footprint of collars (by type) beyond the diffuser and the frequency of organisms in three depth zones seen in the videos of the route collected from submersibles.

Quantitative data on biota in Ke‘ehi Lagoon were sourced from a publication summarizing surveys conducted by the Hawaii Biological Survey of the B.P. Bishop Museum (1999).

Determination of Significance
The criterion for significance is whether or not there would be substantial decreases in coral cover or coral community function, i.e., would there be more than minimal decreases in coral aquatic resource functions or services. For the proposed action this will be determined by the loss of greater than 0.1 acre of coral cover and/or the loss of coral colonies 100 cm or greater in size. There is less to distinguish and/or compare the alternatives in their potential effects in deeper waters. Potential entrainment effects would be identical and substrata creation would be very similar. Ultimately, the criterion of significance in deep water would be the potential for the return seawater discharge to adversely affect mesophotic ecosystems.

Impacts

No Action Alternative
The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effects on benthic communities including coral reefs as there would be no marine construction of facilities.

Alternative 1
Alternative 1 would have a short-term (construction phase), direct, adverse effect on benthic biota due to excavation and backfilling of the receiving pit, emplacement of pipe collars on the bottom, and anchoring of vessels and pipe strings (in Ke‘ehi Lagoon). Applicant proposed and DA permit special conditions, if issued, would minimize adverse effects to the maximum extent practicable to ensure less than significant effects. In the longer-term (operational phase), benthic biota in the immediate vicinity of the diffuser, including corals, may be significantly adversely affected, although corals are scarce at the Alternative 1 diffuser location. The indirect long-term effect of the increased hard substratum provided by the pipes and collars would be expected to provide increased opportunities for coral growth.

In the proposed Ke‘ehi Lagoon staging area piles would be driven into the substratum to anchor floating strings of pipes as they are formed. Epibenthic and infaunal organisms, primarily algae, filter feeders and detritus feeders, in the footprint of the pipes would be damaged or destroyed. Approximately 40 pipe piles of 20-inch diameter would be used to secure the pipe strings. Thus, a total bottom area of about 173 square feet would be directly impacted. This is about 0.00036% of the total Ke‘ehi Lagoon area of 1,116 acres. A corresponding percentage of the ecological services provided by this ecosystem would be lost, albeit temporarily, while the piles are in place. Once the pipe strings begin to be positioned in the lagoon, the bottom beneath the pipes would be shaded, inhibiting primary production from benthic macroalgae. Shading would increase incrementally over time as an increasing number of pipe strings are floated into place. The maximum area to be shaded would vary slightly by alternative due to the length of discharge pipe needed, but the range would be from 3.19 acres under Alternative 1 to 3.39 acres under Alternative 4. Most of the shading would be caused by the larger diameter and much longer intake pipe, which would be approximately the same length under all alternatives. The shaded area would constitute less than 0.3%

of the lagoon bottom under any of the alternatives. While this would temporarily reduce overall primary productivity in the lagoon a small amount during staging, the presence of the piles and pipe strings would offer temporary substratum for sessile benthic organisms and shelter for fish. There would be no chemical discharges to the lagoon associated with storage of the floating pipes. Small work boats and possibly barges would access the site and position the pipe strings. Vessel operations would be conducted in accordance with all regulations concerning pollution prevention and discharges.

Microtunneling would have no anticipated direct effects on benthic resources. The shaft would be well below the biologically active layer of sediments near the surface of the seafloor. The microtunnel would emerge through the sheet piles into the receiving pit. Prior excavation of the receiving pit would have removed benthic resources from the area of the receiving pit.

To evaluate potential offshore impacts, a marine survey was conducted along the entire pipeline from the proposed location of the receiving pit to the proposed intake location. The results of the shallow portion of that survey are contained in Appendix E and Appendix O and the results of the deep portion are contained in Appendix I.

If the proposed HSWAC project proceeds there are both direct and indirect impacts that may occur to the marine communities in the affected area. Direct impacts are those associated with the construction of the pipeline and include those due to removal of substratum at the receiving pit as well as those due to placement of anchors, cables, etc. used in the construction of the receiving pit. Other direct impacts include those that would occur with the deployment of the collars on the surface of the substratum when benthic organisms in the footprint of each concrete collar are covered. Other potential impacts would occur from generation of turbidity during the construction and pipe deployment process, which may impact resident benthic and fish resources in the area. Impacts may also occur with the operation of the HSWAC system; of primary concern would be potential impacts that may occur with the discharge of return seawater with lower temperatures and oxygen concentrations as well as higher nutrient concentrations compared with ambient conditions in the receiving waters. The discharge water would impinge on benthic communities in the vicinity of the diffuser. These potential impacts are assessed using data from the quantitative studies summarized above and potential mitigation is proposed.

The proposed location of the receiving pit is in the middle of a sand channel; this pit would be 40 x 40 feet in plan view and would be constructed by driving sheet piling into the substratum and removing material from within this area to a depth of 20 feet. The current plan would utilize the sheet piles (or a combination of sheet piles and silt curtains, if feasible) to define the walls of the receiving pit to a point above the sea surface, thus containing most of the sediment generated by the excavation. Materials from within the structure would be removed using a clam shell dredge and transferred to a barge for transport to land. The excavated material would be disposed at a state approved upland location, potentially a landfill, following chemical analysis to determine suitable sites. Therefore, there would be no discharge of dredged material into waters of the U.S. Considering the low volume of excavated material the establishment of an upland containment facility would not be necessary. The proposed methodologies would minimize the possibility of high local turbidity loading and potential adverse impacts in surrounding waters and aquatic benthos. After completion of work at the receiving pit, the steel sheet piling would be cut off at or below grade and removed from the area. Similarly, to reduce the potential for anchor/line impact anchor locations would be selected which are free of or have little benthic community development. At the selected sites, piles would be driven into the substratum with a portion remaining upright and above the surrounding benthic communities. Vessels would be held in position using tautline moorings to these vertical anchor points, which would keep moorings off the substratum. Once work has been completed, these vertical moorings would be removed.

Direct Effects on Substrata and Benthos

The proposed receiving pit would occupy a substantial portion of the width of the sand channel. Benthic species located on the adjacent limestone ridges (to the east and west) could also be subject to impact. The greatest coral development in the proposed project area occurs at the seaward edge of the biotope of scattered corals in the spur and groove system present in the area. High coral cover varies along the reef edge but it approximately follows the width of the spur and groove formations. In the general area of the proposed receiving pit the width ranges from 40 to 80 m (131 to 262 feet), thus the mean width is 40+80/2 = 60 m (197 feet). Based on the most recent survey found in Appendix O, mean coral cover is 0.29% on the channel floor, which would be occupied by the receiving pit, whereas the adjacent limestone ridges possess mean coral cover estimated at 15-21%. The proposed footprint of the receiving pit contains 29 coral colonies, ranging 5-30 cm in size and averaging 14.3 cm in size, comprising 4.63 ft^2 (0.43 m^2) of live cover (see Appendix O) that would be directly affected by excavation of the pit. The applicant proposes to transplant corals larger than 10 cm in size, which would include 15 of the 29 colonies, comprising 3.68 ft^2 of the 4.63 ft^2 of coral cover affected. In addition, the selected marine contractor would perform a preconstruction survey to make minor adjustments to the location of the receiving pit to minimize the impact associated with the construction of the receiving pit. The survey would be used to minimize impacts to coral colonies within the pit footprint as well as adjacent coral resources. A report of the preconstruction survey and any proposed modifications to positioning of the receiving pit would be submitted to the Corps for approval prior to commencement of construction.

The proposed collar placement would cover substratum consisting mostly of sand and dredged rubble with scattered small coral colonies, with an average coral coverage of 1.1%. Coral colony sizes vary from 1-45 cm, with an overall average size of 5 cm. The proposed collar placement may crush coral colonies, with an estimated combined loss of 71 ft^2 (6.6 m^2). To minimize coral losses the applicant would conduct a pre construction survey to identify options to avoid colonies and the collars would be installed with the assistance of divers.

Turbidity is an issue relative to the construction of the receiving pit. In general, currents fronting Kakaʻako Waterfront Park roughly follow the tradewind flow and hence move water from the east towards the southwest (See also Laevastu et al., 1964; Bathen, 1978). Thus, any sediment generated by the construction/deployment of the HSWAC pipeline would probably have a greater impact on benthic communities present in a southwesterly direction rather than on communities in locations upcurrent (to the east). The receiving pit and the above grade portion of the proposed pipeline route would be located at the seaward edge of the biotope of scattered corals where the highest coral diversity and cover occurs. If turbidity is generated in this shallow area, most of it would be carried to the southwest in the biotopes of dredged rubble and sand, which both have low diversity and cover of corals, thus reducing potential adverse effects.

Sedimentation has been implicated as a major environmental problem for coral reefs. Increases in turbidity may decrease light levels resulting in a lowering of primary productivity. Perhaps a greater threat would be the simple burial of benthic communities that may occur with high sediment loading. Many benthic species including corals are capable of removing sediment settling on them, but there are threshold levels of deposition where cleaning mechanisms may be overwhelmed and the individual colony becomes buried. Dollar and Grigg (1981) studied the fate of benthic communities at French Frigate Shoals in the NWHI following the accidental spill of 2,000 tons of kaolin clay. Those authors found that after two weeks there was no damage to the reef corals and associated communities; damage was observed when organisms were actually buried by the clay deposits for a period of more than two weeks. Similarly, coral communities along the southern shoreline of Lanai Island were exposed to prolonged high turbidity due to a series of high rainfall events (29 January 2002 - 7.75 inches, 12-13 May 2002 - 4.10 inches, 14-17 October 2002 - 13.10 inches). The high turbidity conditions persisted for an 18-

month period (up to August 2003) due to unusually poor coastal circulation. Despite the prolonged period of extreme turbidity in permanently marked transects, mortality in the monitored coral communities was low (grand mean across all stations: April 2002 - 1.1%, May - 0.7%, November - 0.6% with no subsequent mortality). Mortality was restricted primarily to one species, the cauliflower coral (*Pocillopora meandrina*). These data are a testimony to the resiliency of these communities in the face of this natural perturbation (Brock, 2011).

The HSWAC pipeline would be constructed in sections at an off-site staging and assembly area proposed to be located at Sand Island and in the adjoining waters of Keʻehi Lagoon and floated to the site for final deployment on the seafloor. The shallow portion of the exposed pipeline considered here is that part of the system from the breakout point at the receiving pit down to 300 feet deep. This section of the pipeline would be 3,453 feet in length and would carry both the 63-inch HDPE intake pipe as well as the 54-inch HDPE seawater return discharge pipe to a depth of 150 feet. This pair of pipes would be held in place on the substratum using a series of concrete combination (Type A) collars, which cradle both pipes. From 150 feet deep to 300 feet deep, only the 63-inch intake pipe would be carried by single concrete collars (Type B). These collars are simply gravity anchors, many of which in the shallow section considered here would be further secured to the bottom using 20 in diameter steel pipe piles that would be driven through sleeves in the collars using a percussion hammer. Once in place the upper portions of the steel pipes would be filled with tremie concrete. In total from the breakout at the receiving pit to 300 feet depth, 90 combination collars and 102 single collars would be deployed to hold the system in place. Considering collar footprint, collar spacing, collar placement within various biotopes and the percent coral cover in the respective biotopes, there would be a total potential loss of 6.5 m^2 (70ft^2) of coral. This loss does not include loss that may occur from anchors or by divers assisting in the deployment process where anchors and/or divers trample or break coral as well as other resident benthic species. Since the deployment strategy would utilize a gradual sinking of the entire length of the pipeline with collars attached commencing from the shallow end and ending with the deep end, losses due to anchors and/or divers assisting with the deployment in the shallow section from the breakout point to the end of the discharge diffuser would be expected to be minimal.

The presence of the HSWAC pipes from the breakout point seaward would create an elevated artificial hard substratum as well as vertical relief and shelter space in an otherwise relatively featureless sand and rubble bottom habitat. Previous biological studies of marine community development around similar pipes and deployment methods (Smith et al., 2006) have noted the development and persistence of a considerably diverse, high biomass fish community along pipes. In one case, a sewage outfall was constructed by tunneling beneath much of the limestone reef platform with trenching seaward of this, finally emerging at an approximate 26 m (85 feet) depth, close to the eastern edge of the Pearl Harbor Entrance Channel (approximately 8.7 km [5.4 miles] west of Kakaʻako Waterfront Park). The Pearl Harbor sewage disposal pipe continues seaward across a sand and rubble substratum similar to that found fronting parts of Kakaʻako Waterfront Park. Past studies of fish communities on these deeper sand areas have found fish community standing crops in the 0.2 to ~2 g/m^2 range; following pipe deployment at Pearl Harbor, the resident fish community standing crop was 126 g/m^2 (Smith et al., 2006) which is an increase of 63 times over predeployment standing crops. These types of results may be the result of attraction and aggregation of fish from the surrounding areas, or a new structure may open new niches for colonization. Regardless, the deployment of the HSWAC pipelines would be expected to enhance local fish communities to an unknown extent.

Each of the 90 concrete combination collars and 102 single collars proposed for deployment over the 1,052 m (3,453 feet) distance between the receiving pit and the 300 foot depth would have an estimated surface area of 313 ft^2 or 29.1 m^2 and 181 ft^2 or 16.8 m^2 respectively that would potentially be available for recruitment by benthic species once the collars have been deployed. Concern has been voiced regarding the recruitment of benthic species (especially corals) to both concrete and the HDPE pipe that would be used for both intake and discharge in this proposed system. Comments were received on the DEIS stating that neither concrete nor the HDPE pipe are suitable surfaces for the recruitment of corals due to the antifouling properties of each. Published studies have shown that concrete structures provide a surface that is preferred by many coral reef species colonizing hard substrata (including corals). Preference in substratum types found that both natural dead coral and concrete received the greatest recruitment (both in terms of the diversity of species as well as their abundance) and survival of recruits was better relative to other tested substrata (e.g., metal and tires; Fitzhardinge and Bailey-Brock, 1989). Other studies have found that corals will settle on natural and artificial substrata within four months of immersion (Birkeland et al., 1982; Harriott and Fisk; 1987; Sammarco and Carleton, 1982; Wallace, 1985; Wallace and Bull, 1982).

The HDPE pipe would also provide a substratum that would be situated well above the substratum and away from much of the sand scour that occurs across the flat limestone in the shallows during periods of high surf. It has been demonstrated that HDPE pipe can be a suitable substratum for recruitment of corals and other sessile benthic organisms. Figure 3-33 is a photograph of one of the HDPE pipes at the Natural Energy Laboratory of Hawaii at Keāhole Point, Hawaiʻi and corals have been successful at recruiting to and growing on this HDPE pipe. This photograph was taken in 2008 and the pipe pictured was deployed about twelve years earlier. Thus, the HDPE pipe to be used in the proposed HSWAC system would likewise be expect to provide opportunities for the recruitment and growth of benthic species.

In waters around Oʻahu, a relevant example of benthic community response to inputs of high concentrations of inorganic nutrients at depths above the thermocline is the Mokapu deep ocean outfall for the Kailua WWTP. Brock (Appendix L) prepared a literature review of the effects of high nutrient concentrations on corals and summarized the empirical evidence from a monitoring program around the Mokapu outfall. In addition to discharging at a depth comparable to the proposed Alternative 1 discharge depth, the effluent receives secondary treatment so organic matter in the wastewater is largely broken down to inorganic forms, similar to what is present in the deep ocean water that the HSWAC system would discharge. Differences between the two are that wastewater discharge is essentially fresh water, which has very deleterious effects on corals, and that despite the wastewater treatment process there is still a significant amount of particulate material in that effluent. The nitrate+nitrite nitrogen concentrations in the Mokapu discharge are approximately 16,600 times greater than in the receiving waters and approximately 32 times what would be in the HSWAC discharge. The results of the monitoring study may be summarized as follows: There is a high-biomass, diverse fish community around the outfall; the coral cover within about 15 m of the outfall is reduced by about half of that at greater distances; and algae at the diffuser depths were all encrusting coralline species. The lowered coral cover around the diffuser may be attributable to the low salinity of the wastewater discharge. On the diffuser, the most abundant coral species is the lobe coral (*Porites lobata*), comprising 99% of the cover. This species also dominates the cover (92%) at the proposed location of the HSWAC diffuser under Alternative 1. This comparison suggests that the nutrient concentrations associated with the proposed HSWAC discharge may have minimal negative impacts on the dominant coral species present in the area.

Figure 3-33: Photo of an HDPE Coldwater Pipeline at the Natural Energy Laboratory of Hawaii at Keāhole Point, Hawai'i, Showing Coral Development

Considering the exposed surface areas of the collars and the pipes under Alternative 1, the total surface area available for potential benthic recruitment between the breakout point at the receiving pit and 300 feet deep would be 13,661 m^2 (147,043 ft^2). In summary, deployment of the proposed HSWAC system may provide a significant increase in available hard surfaces for the potential recruitment and growth of benthic species such as corals.

The 1.37 m diameter seawater return pipe would be deployed with and lie adjacent to the 1.60 m diameter intake pipe. The seawater return pipe would run from the shaft breakout and 580 m seaward to a depth of 46 m (150 feet). The seawater return pipe would be constructed of the same material (HDPE) using the same techniques as the intake pipe, but would have a smaller diameter (1.37 m) relative to the intake pipe. This is possible because the return flow would be under pressure. The temperature of the return seawater would vary between 53°F and 58°F depending on system demand. Under Alternative 1, the seawater return pipe would terminate in a 25-port diffuser that commences at a depth of 120 feet and ends at 150 feet. The applicant has proposed the delineation of a ZOM around the diffuser. Computer simulations using CORMIX software were used in determining the boundaries of the ZOM where a dilution factor of 113 is necessary to meet water quality standards for nitrate+nitrite nitrogen at the ZOM boundary.

The rationale for establishing a ZOM around a discharge into an aquatic environment is made in recognition by regulatory agencies that at and surrounding the diffuser a discharge may exceed water quality standards for the receiving water. A ZOM allows for a variance in the concentration of constituents that exceed allowed ranges within a defined area, but at the ZOM boundary the constituent concentrations should be in compliance with applicable standards due to dilution. Thus, granting the establishment of a ZOM infers that the regulatory community recognizes that some area would be impacted by the applicant's activity. The applicant must implement a monitoring program to document that water quality and biological conditions at and outside of the ZOM boundary are not being adversely affected.

The HSWAC return seawater would be colder than the receiving water, with a lower concentration of dissolved oxygen and a higher concentration of dissolved nutrients. The physical properties of the discharge water could have an adverse impact on the resident marine communities. Higher nutrient concentrations could serve to stimulate phytoplankton and/or benthic algal production. If dissolved oxygen concentrations were significantly below ambient, this could serve to inhibit species that require higher dissolved oxygen content in the water, and lower temperatures could stress or cause the elimination of species that cannot tolerate the lower temperatures in the area immediately around the discharge diffuser. Species susceptible to the lower temperatures would be those that are sessile, such as corals. While nutrient loading represents an inherent risk, Hawaiian corals have not displayed significant adverse reactions to increased nutrient loading from discharges of treated sewage wastes in marine habitats with reasonable currents and mixing (Grigg, 1994) such as those found in Mamala Bay. In contrast, studies of coral growth (or carbonate accretion) find decreases in growth of the same species subject to lower mean water temperatures (Grigg, 1981; 1982). Therefore, water temperature is the parameter of primary concern with respect to potential impacts to corals resident in the area of the HSWAC diffuser. Low temperatures could impose the greatest impact to sessile species such as corals. The minimum temperature of the discharge water is 11.7°C (or 53°F) and the surrounding ambient water temperature at the diffuser is 25°C (or 77°F). The CORMIX model found that ambient temperatures are attained within less than one-half meter of the centerline of the diffuser under high natural current flow. Under worst-case low current flow, ambient temperatures are attained within 12.2 m (or 40 feet) from the diffuser centerline. Under average current flow conditions ambient temperature is attained within about one meter of the diffuser centerline.

Based on the above CORMIX results there should be no discernible biological impact due to temperature at a distance greater than 12.2 m from the diffuser centerline. To estimate how much coral this might affect several assumptions were made. First, from the CORMIX model, it was assumed that the maximum calculated distance from the centerline of the diffuser to the distance at which discharged water reaches ambient conditions is 12.2 m (40 feet) and that the lowest discharge temperature would be 11.7°C. It was further assumed that the ZOM would form an envelope around the entire diffuser and the diffuser length is 76 m (250 feet). The area of sub-ambient temperature would then be 2,450 m^2 (26,362 ft^2). The diffuser is in the biotope of deep dredged rubble, which has a mean coral cover of 1.1%. Assuming that the lower temperatures within the ZOM would be the primary source of mortality to corals and that all corals within the area of reduced temperature would die, the estimated potential loss of coral cover would be about 27 m^2 (291 ft^2). However, the temperature of the discharge water would be in the range of 11.6 to 14.4°C (53 - 58°F) at the diffuser, and would increase with distance from the diffuser as a result of mixing that would occur within the ZOM, so this may be an overestimate of the potential coral loss.

Historically, it has been recognized that the distribution of coral reef communities is restricted to low latitudes where water temperatures are relatively warm. Field observations and laboratory experiments established 16°C (60.8°F) as a thermal stress threshold for most reef corals (Mayor, 1915). More recent laboratory studies in Hawaii have indicated that individual hermatypic (reef-building) corals do not persist at temperatures below 18°C (64.4°F) (Jokiel and Coles, 1977; Coles and Jokiel, 1978). Corals may respond to anomalously low temperatures in a manner similar to how they respond to anomalously high temperatures: by bleaching. Reef-building corals have an obligate symbiotic relationship with single-celled algae known as zooxanthellae. The algae contribute to the relationship by using dissolved nutrients and sunlight to produce carbon through photosynthesis. When bleaching occurs, the corals expel a high percentage of the algae and remaining algae may lose much of their photosynthetic pigments. This effect may be reversible if the cause of the bleaching is removed in a reasonable amount of time. Persistent exposure to temperatures below the thermal threshold (which may vary with species and preconditioning) would result in mortality.

Winter sea surface temperatures at Midway Atoll in the Papahānaumokuākea Marine National Monument, where many Hawaiian coral species flourish, are as low as 17.8°C (64°F). Thus, some of the corals in the ZOM may adapt to the lower temperatures. It should also be realized that under normal or average current flow, ambient temperatures are attained only about one meter away from the centerline of the diffuser; assuming average current conditions and using the lowest discharge temperature (here 11.7°C), the maximum affected area is 156 m^2 (1,679 ft^2) and the estimated potential loss of coral is calculated to be 1.7 m^2 (18.5 ft^2).

The HSWAC return seawater discharge would constitute, in effect, a permanent region of upwelling. Upwelling brings a surplus of dissolved inorganic nutrients from deep to shallow water which can increase zooxanthellae densities by a factor of two or three (Buchheim, 1998). Consequently, within the ZOM, cold water temperatures may inhibit coral growth and/or survival, but outside this zone, the nutrient supplements may enhance coral growth through increased densities of zooxanthellae.

The CORMIX modeling showed that the concentration of the deep water constituent requiring the greatest dilution to meet State water quality standards, nitrate+nitrite nitrogen, would meet those standards at the Zone of Mixing boundary. The design of the diffuser facilitates substantial near field initial mixing of the return water for all current cases considered. The negative buoyancy of the plume dominates the discharge near-field behavior. After initial mixing the plume would have a tendency to sink. This is considered desirable from a water quality standpoint, as this represents a general movement away from the photic zone where the nutrients could have biostimulatory effects. Some plume-seabed interaction is anticipated in the immediate vicinity of the diffuser; however, with substantial initial dilution, plume properties would be close to ambient when the plume encounters seabed implying a phase shift toward algal dominance would be unlikely.

If a ZOM were approved, the benthic and fish resources that would remain and/or recruit to the area within the ZOM would be those that can tolerate the physical conditions found within the ZOM. Theoretically, species from deeper benthic communities could colonize the ZOM.

In summary, anticipated impacts to coral aquatic resources would occur from the excavation and backfilling of the micro-tunneled pipeline receiving pit, seafloor mounted pipeline collar placement, and water quality changes within the zone of mixing of the return water discharge. The area of potential direct coral loss would occur between the receiving pit and approximately 3,500 linear ft. of seafloor seaward to a water depth of approximately 300 ft. (the depth limit of observed mesophotic corals) over an area of approximately 95,000 ft^2 (2.2 acre). Within the total area of potential impact, scattered individual coral colonies are estimated to occupy between 0.2 to 1.1% of the seafloor, with measured coral colonies ranging from 1 to 30 cm (scattered deep water plate/encrusting mesophotic corals were estimated between 30-45 cm). The total estimated area of potential coral loss under Alternative 1 would be 94.5 ft^2 (0.002 acre).

The HDPE pipes and concrete collars from the receiving pit to the end of the diffuser may provide a benefit by adding 11,619 m^2 (125,068 ft^2) of surfaces for the recruitment of benthic species including corals. If coral recruitment occupies ~25% of this substratum as it does on the HDPE pipes at Keāhole Point, Hawaii, then potential coral cover may be 2,905 m^2 (31,267 ft^2) of coral. Assuming a "worst case" scenario of only 2.5% coral cover on the pipeline, the estimated cover would be 291 m^2 (3,127 ft^2) of coral.

Working in areas where there are few corals present would minimize the effects of constructing Alternative 1 on coral communities. Construction effects on corals, primarily turbidity, would be direct, short-term, and adverse, but with the mitigation measures described above for water quality, mitigable to less than significant.

Once operational, the HSWAC return seawater discharge may have direct, long-term adverse effects on coral communities near the diffuser. The pipe structure (anchor collars and pipes) may provide direct long term beneficial effects by providing artificial substrate for benthic community recruitment and growth and vertical relief for enhancement of fish populations.

Effects of the pipeline at greater depths are evaluated in Appendix I and key portions are included here. The HSWAC pipe would be expected to have three different types of impacts on the animals living between 50-550m along the pipe route:

(1) Perturbation to benthic species in each zone during installation.
(2) Entrainment of benthopelagic animals in zone 3 at the 540m intake location.
(3) Addition of a long-term, hard man-made ridge substratum to each zone.

An evaluation of the first type of impact can be made by considering the dimensions of the pipe footprint to the observed densities of animals. There would be two types of weights in contact with the substratum between 50-550m, Type B (142 units) and Type C (762 units). Type B weights are 4.826m long by 0.61m wide, yielding a benthic footprint of 2.942m^2. Type C weights are 3.251m long by 0.254m wide creating a footprint of 0.826m^2. Table 3-13 provides the number of weights that would be deployed in each zone and Table 3-14 provides the total weight footprints for each zone.

Table 3-13: The Number of Weights and Area Covered in Each Deep Water Biological Zone

	Wt Type	***50-200m***	***210-400m***	***401-550m***	***Total***
Number of Weights	B	136	6		142
	C		275	487	762
	Total	136	281	487	904
Bottom Area Covered (m^2)	**Wt Type**	**50-200m**	**210-400m**	**401-550m**	**Total**
	B	400.1	17.7		417.8
	C		227.2	402.3	629.4
	Total	400.1	244.8	402.3	1047.2

The footprints in hectares can be obtained by simply moving the decimal places of the area values in Table 3-13 four places to the left. The numbers of each organism that the weights would potentially land on can then be calculated by multiplying this value by their density per hectare. Table 3-14 provides the results of this analysis.

Table 3-14: Types and Numbers of Organisms Potentially Impacted by the Deep Collars During Installation

Zone	*Group*	*Identification*	*# Impacted*
1	Cnidarians	Leptoseris sp.	2
	Sponges	Pseudoceratina sp.	21
		Unidentified	1
	Urchins	Asterotomatidae cf.	3
	Fishes	Unidentified	1
2	Fishes	Symphysanodon maunaloae	1
3	Cnidarians	Kophobelemnon stelliferum	1
		Pennatulacea white	1
		Protoptilum sp.	1
	Ctenophores	Lyrocteis sp.	1
	Sponges	Regadrella sp.	1
	Sea stars	Brisinga panopla	3
	Shrimps	Plesionika sp.	2
		Benthesicymus laciniatus	1
	Fishes	Hymenocephalus antraeus	1
		Malacocephalus boretzi	1
		Chlorophthalmus proridens	1
		Macrouridae	1
		Synagrops sp.	1

All values were rounded to the closest whole number so the summed total for each of zones 1, 2, and 3 were 31, 4, and 21, respectively. For the entire length of pipe from 50-550m, the total number of all organisms estimated to be impacted by the pipe collars is therefore 56.

Entrainment

The second type of projected impact, entrainment of animals at the intake site, cannot be adequately addressed from only the results of this survey. Nevertheless, the animals recorded in zone 3 do provide data relevant to this issue. At the intake, the pipe curves upward placing the opening approximately 3 meters above the substratum. Most truly pelagic animals do not come this close to the seafloor on a regular basis and therefore entrainment would be unlikely. The animals most at risk are benthopelagic, a term used to describe a community that associates with the seafloor but is generally found in the water column from several to sometimes up to 100 meters above it. Often, this community exhibits a diurnal migration pattern, moving upslope (or shallower over flat substrata) at night and returning downslope or deeper during the day. One such community is known to spend daylight hours at the depth where the intake is located and is referred to as a deep scattering layer, backscatter layer or mesopelagic boundary layer. The composition of this community near the intake is unknown, but likely consists of the same general animal groups as backscatter layers investigated elsewhere. The community typically consists of small, actively swimming adult as well as larval phases of fishes, squids, and crustaceans that provide prey for nocturnal predators who feed further up the slope.

Entrainment of backscatter layer animals by the pipe would likely reflect their vertical migration patterns, occurring more often during the day and less often at night. Benthopelagic animals observed during the daytime submersible dives included small, unidentified fishes, myctophids (i.e., lantern fishes), macrourids, particularly *Hymenocephalus antraeus*, and several species of shrimp, particularly *Plesionika sp.*, and *Heterocarpus ensifer*. The small sizes of these animals would preclude effective filtering at the intake. Entrainment of small fishes and shrimps occurs almost daily at the NELH facility on the Big

Island and may simply have to be considered an unavoidable consequence of bringing up cold water from these depths.

The applicant prepared an analysis showing that impingement and entrainment of all life stages of fish and shellfish would be reduced at least 90% from what would be expected if the intake were located at typical shallow cooling water intake depths (CWA Section 316(b) Track II demonstration; See Appendix N). More specifically, the expected entrainment of marine biota would be reduced from 93% to 100% for different taxonomic groups with an overall reduction rate of 98% from other locations around Oahu or surface waters to the proposed location of the HSWAC intake.

Creation of New Substrata

The third type of expected impact is the long-term effect of the pipe and collars as artificial substrata. In essence, the pipe and collars would create the equivalent of a relatively low, continuous, very porous ridge several meters high that is oriented perpendicular to the prevailing east-west current flow. As such, it is reasonable to expect some small degree of current acceleration along the top of the pipe and in the spaces between the weights, which would likely attract filter-feeding invertebrates as well as small planktivorous fishes that would use the structure for shelter against predation. Based on the substrata and animal surveys described above, the effect of this new ridge feature on the communities along the pipe route would be expected to be zone dependent. For example, the pipe would likely have the least effect on zone 1 where hard bedrock and boulder substrata already predominate and the break-in-slope already provides substantial vertical relief. Based on a diameter of 63 in, the pipe would add an estimated 0.42 ha of hard surface. It is reasonable to expect it would be eventually colonized by species already present such as *Pseudoceratina sp.* and *Leptoseris sp.* on the top of the terrace where the additional height off the bottom may reduce sedimentation events. Small reef fishes observed there may also find shelter around the weights. However, the expected impact of the pipe in this zone would be relatively minor because the pipe would not be providing a substantial increase in the proportion of hard substratum present.

The pipe would provide a more significant change to the substratum composition in zones 2 and 3 where there is less bedrock, more sediment, and more gradual slopes. With the exception of single polyp scleractinians and a benthic ctenophore, *Lyrocteis sp*, the dredge spoil deposits found in zone 2 were not colonized by attached invertebrates. Furthermore, these loose piles of deposits do not seem to be providing shelter to small fishes. As a result, this zone had by far the lowest density of both fishes and invertebrates in comparison to the other zones. The most concentrated observations of animals were made around a large man-made structure that had numerous cavities clearly being used by a variety of fishes. For lack of other more suitable options, the pipe and weights in zone 2 may attract small fish species as well as bottomfish such as *E. carbunculus* and *E. coruscans*. The estimated increase in hard surface area the pipe alone would provide is 0.92 ha, so the increase in species abundance and diversity would likely be modest.

In zone 3, the pipe would provide a structure quite different than that currently found at those depths along the route. Without man-made debris, the substratum in this zone would be predominantly sediment with small pebbles. The dumping of man-made debris, particularly metal objects such as ordnance and framework, has provided the majority of hard substratum found at these depths. It follows that the density of hard substratum filter-feeders such as *Brisinga panopla* and *Regadrella sp*, is undoubtedly much higher than it was prior to human perturbation. Most of these hard objects were relatively small, whereas the pipe alone would provide 2.11 ha of continuous hard surface. Assuming the pipe material is suitable for colonization by attached as well as unattached invertebrates, the pipe route should experience an increase in the number of hard substratum specialists including deep water corals, anemones, and sponges. Given that the total amount of similar habitat within depths of 400-550m south of Honolulu and Pearl Harbor is over 9,779 ha, the increase in hard substratum by the pipe should be insignificant to the community as a whole.

Effects on Coral Reef Ecological Functions and Services

Coral reefs provide a variety of ecological functions and services including functions associated with their physical structure, biotic function, biogeochemical function, information services and social and cultural services. Physical structure functions refer to the capacity of solid reef structures to protect the shoreline through dissipation of wave forces. In Keʻehi Lagoon there are isolated corals, but the bottom is mud, silt and sand. The ecosystem there does not provide this function. Similarly, offshore of Kakaʻako at depths beyond the location of the proposed receiving pit, the bottom also includes unconsolidated sediments with scattered small coral colonies. The area is characterized by movement of sediments and rubble under conditions of high surf, which accounts for it remaining in an early successional stage. The spur and groove formations adjacent to and inshore of the proposed location of the receiving pit do provide this service. The receiving pit location was selected and the procedures for installation of the pipes were developed in an effort to minimize direct or indirect effects to inshore reef structures, as described above. Direct physical effects would be limited to drilling a small number of holes for installation of holdbacks and moorings. After pipeline installations are complete, these fixtures would be cut off at the seafloor, or removed and the pit capped to match original seafloor contours. The structural integrity of the reef would not be compromised. Excessive turbidity could result in smothering of coral colonies and weakening of the reef structure. As described above, however, the receiving pit would be completely contained and turbidity generation from activities outside the pit would be minimal. Significant impacts on physical structure services are not expected from any of the proposed activities.

Biotic functions include such things as maintenance of habitats and biodiversity, biological productivity, and energy transfer between ecosystems. The 29 small coral colonies (averaging 14 cm in size) currently residing within the receiving pit area would be destroyed or transplanted elsewhere, resulting in a loss of up to 5 ft^2 of coral cover. Additionally, the proposed collar placement may destroy an estimated 71 ft^2 of colonies ranging in size from 1-45 cm, with an average size of 12 cm. The actual coral losses associated with the proposed collar placement would most likely be less than the conservative estimate considering that a preconstruction survey would be conducted to avoid corals where possible, the collars would be installed with the assistance of divers. The receiving pit and pipeline cumulatively would remove approximately 76 ft^2 of coral colonies averaging 13 cm and scattered across approximately 3,500 ft of the pipeline route. Considering the small colony sizes and the degree of separation between the scattered colonies within the predominantly loose sand and rubble substrate of the seafloor, the anticipated scale of impact to functions is expected to be relatively minor. The ZOM is estimated to result in a loss of approximately 19 ft^2 of coral cover with colony sizes estimated to range between 1-15 cm and averaging 4 cm. However, the degree of potential impacts associated with the ZOM is not certain and may be greater. The hard substratum represented by the concrete cap on the receiving pit, the concrete collars and the HDPE pipe would provide a stable, hard substratum for potential recruitment of sessile invertebrates and structure for fish populations. As the community on the structures grows, it would create a reservoir from which recruitment to other habitats may occur. As diversity increases so too may community resilience. An increase in potential biotic functions may occur from the presence of the HSWAC submarine facilities.

Biogeochemical functions include such things as nitrogen fixation, carbonate/calcium budget control, waste assimilation, sand production and sedimentation. Organisms primarily responsible for these types of services, including algae, sea urchins, parrotfish, etc. are not abundant in the pipeline corridor. The presence of the HSWAC structures in the water column is anticipated to increase the density and diversity of benthic invertebrates and fish in the vicinity. As ecosystem productivity increases, biogeochemical services would also be expected to increase. The long term effect of the HSWAC structures on biogeochemical services is expected to be positive.

Information services refer to storage of records of environmental conditions such as pollution or climate change within the growth forms of long-lived organisms. In the pipeline corridor, the marine community is kept in an early stage of succession due to periodic physical stresses from waves and surge that suspend sediments and mobilize abrasive dredge tailings. No more than minimal impacts are anticipated from the proposed project. The HSWAC marine structures may present a much more stable substratum for recruitment and growth than the bottom in either of the two biotopes that would be crossed.

Social and cultural services include such things as recreational and commercial fishing, other recreation such as snorkeling and SCUBA diving, and provision of aesthetic, cultural, religious or spiritual values. Currently, the proposed pipeline corridor offers little of these services. Fishing effort is extremely low because fish density is low. The biotopes of dredged rubble and sand provide little visual interest. This is in contrast to the mouth of the Kewalo Basin entrance channel where an abandoned sewer pipe and area of high coral cover are frequently visited by groups of recreational SCUBA divers and snorkelers. It is anticipated that the HSWAC structures would increase both fishing effort and in-water recreational interest due to development of an enhanced epibenthic community and an increase in fish density and diversity.

Alternative 1 would have less than significant short-term (construction phase), direct, adverse effect on benthic biota due to excavation of the receiving pit, placement of pipe collars on the bottom, and anchoring of vessels and pipe strings (in Keʻehi Lagoon). In the longer-term (operational phase), benthic biota in the immediate vicinity of the diffuser, including corals, may be significantly adversely affected, although corals are scarce at the Alternative 1 diffuser location. The applicant proposes to transplant all coral colonies greater than 10 cm in the proposed receiving pit. The indirect long-term effect of the increased hard substratum provided by the pipes and collars may provide benefits to ecological functions and services of the ecosystem.

<u>Alternative 2</u>

Direct Effects on Substrata and Benthos

The proposed breakout point for Alternative 2 would be in a sand patch with 0.0% coral coverage followed by the biotope of scattered corals. The size of the receiving pit and the operations associated with its creation would be the same for both Alternatives 1 and 2. Therefore, under Alternative 2 the affected area would be 148.6 m^2 (1,600 ft^2). Under Alternative 2, the distance from the receiving pit to 300 feet deep would be 4,200 feet, as compared to 3,453 feet under Alternative 1. The Alternative 2 alignment, which exposes the pipes to greater lateral stress than the other alternatives, results in a greater number of Type A combination collars and Type B single collars per unit length than either of the other alternatives. The total number of Type A and Type B collars needed for Alternative 2 is 202 and 82 respectively. Each Type A collar would occupy a footprint of 76 ft^2 (7.06 m^2) and each Type B collar 32 ft^2 (2.97 m^2) so the total area in contact with the seafloor between the receiving pit and 300 ft deep would be 1,670 m^2 (17,976 ft^2). Under Alternative 2 the biotope of scattered corals gives way to the biotope of dredged rubble that is interrupted by a narrow band of relatively high coral cover frequented by recreational divers. The mean coral cover is about 49%, with comparatively complex and well developed coral structure occurring at depths from about 52 feet to 62 feet. The biotope is 150 feet wide where the pipe alignment for Alternative 2 would cross. Crossing this area of high coral cover increases the quantity and quality of coral loss under Alternative 2. Considering that Alternative 2 would be more environmentally damaging and would result in other potential conflicts, this alternative was not preferred relatively early in the planning process. Consequently, quantitative marine surveys did not include the Alternative 2 route. Total coral cover lost due to the receiving pit and collar deployment would result in an estimated 55 m^2 (584 ft^2). This is about 6 times the estimated coral cover lost from the receiving pit to the diffuser under Alternative 1.

The additional 747 feet of pipeline alignment from the receiving pit to 300 feet deep under Alternative 2 would create more artificial substratum than under Alternative 1. Table 3-15 summarizes the substratum that would be created by the collars and pipes under the four action alternatives. In the shallow zone from the receiving pit to the 300 feet deep, Alternative 2 would create 160,239 ft^2 of artificial substratum, whereas Alternative 1 would create only 125,068 ft^2.

Under Alternative 2, the diffuser would be 345 feet long, rather than the 250 foot length under Alternatives 1 and 3. This would necessitate a larger ZOM and there would be a larger area of sub-ambient temperature. The total maximum area impacted by decreased temperatures under Alternative 2 assuming average flow conditions would be 214 m^2 (2,301 ft^2). Given a mean coral cover of 0.001% this would result in an estimated potential loss of coral cover in the Alternative 2 ZOM of .002 m^2 (.023 ft^2). As for Alternative 1, the plume would be negatively buoyant and the nutrient concentrations would be close to ambient when the plume encounters the bottom so a phase shift to an algal dominated community would not be expected.

In summary, anticipated impacts to coral aquatic resources would occur from the excavation and backfilling of the micro-tunneled pipeline receiving pit, seafloor mounted pipeline collar placement, and water quality changes within the zone of mixing of the return water discharge. The area of potential direct coral loss would occur between the receiving pit and approximately 4,200 linear ft. of seafloor seaward to a water depth of approximately 300 ft. (the depth limit of observed mesophotic corals) over an area of approximately 115,080 ft^2 (2.6 acre). Within the total area of potential impact, coral occurrence is mostly scattered individual colonies estimated to occupy between 0 to 5% of the seafloor. However, the pipeline would cross a band of spur and groove reef with relatively well developed coral communities having estimated cover coverage of 50%. The total estimated area of potential coral loss under Alternative 2 would be 583.6 ft^2 (0.013 acre).

Entrainment

The location of the intake would be the same under all alternatives and therefore the potential entrainment effects would be the same for Alternative 2 as for Alternative 1.

Creation of New Substrata

Alternative 2 covers the most shallow water substratum because the route angles sharply through the nearshore area from the receiving pit to the diffuser and is much longer than the Alternative 1 route, which proceeds directly offshore, essentially perpendicular to the bathymetric contours. Alternative 2's relatively greater shallow-water length and exposure to cross swells would necessitate more than double Alternative 1's number of Type A collars; they would be more closely spaced than under any of the other alternatives. Consequently, Alternative 2 would create the greatest amount of artificial substratum of the action alternatives in the shallow region between the receiving pit and the diffuser (see Table 3-15).

Effects on Coral Reef Ecological Functions and Services

The adverse and beneficial effects to coral reef ecological functions and services would be similar to Alternative 1. However, the estimated losses of natural coral resources would be six times that of Alternative 1. Additionally, the quality, and hence degree of functions and services, of the affected coral community under Alternative 2 is greater than any of the other action alternatives.

Alternative 2 would have potentially significant, direct, short-term and long-term, adverse effects on benthic habitats and communities with the short term effects mitigable to less than significant. In shallow water from the receiving pit to the diffuser, the indirect long-term effect of the increased hard substratum provided by the pipes and collars may be beneficial. The applicant proposes to transplant all coral colonies greater than 10 cm in the proposed receiving pit. Effects in deeper water beyond the diffuser would be essentially the same as for Alternative 1, although a portion of the Alternative 2 offshore route would diverge from that of the other alternatives.

<u>Alternative 3</u>

Direct Effects on Substrata and Benthos

Alternative 3 follows the same alignment as Alternative 1. The potential effects of Alternative 3 would be similar to those of Alternative 1 with the exception that additional hard surfaces would be created and additional bottom area would be covered in the depth range of 150-300 feet because the discharge pipe in that range would be deployed in tandem with the intake pipe. In this depth range, Type A anchor collars would be substituted for the Type B collars used in Alternative 1 to the end of the diffuser at 300 ft deep. The difference in the footprints of the two types of collars is 44.3 ft^2, so an additional 4,488 ft^2 of bottom surface would be directly affected.

The breakout pit under Alternative 3 would be in the same location as under Alternative 1, and the estimate of potential lost substratum and coral cover is also the same: 148.6 m^2 (1,600 ft^2) and 0.43 m^2 (4.63 ft^2), respectively with the average colony size of 14.3 cm.

Under Alternative 3, the distance from the receiving pit to 300 ft deep would be 3,453 feet, the same as Alternative 1. The total area in contact with the seafloor from the receiving pit to 300 ft deep would be 1,355.5 m^2 (14,592 ft^2). In comparison to Alternative 1, Alternative 3 would cover an additional 417 m^2 (4,488 ft^2) of substratum. Total coral cover lost due to collar deployment between the receiving pit and the end of the diffuser for Alternative 3 would thus be estimated at 7.6 m^2 (81 ft^2).

CORMIX modeling of the Alternative 3 discharge showed that under average current flow ambient temperatures would be attained within 3.3 feet (1 m) from the diffuser centerline. The length of the diffuser under Alternative 3 is the same as under Alternative 1, so the area of sub-ambient temperature would be the same as Alternative 1 at 156 m^2 (1,679 ft^2) and the estimated potential loss of coral is calculated to be .37 m^2 (4.0 ft^2) As for Alternative 1, the plume would be negatively buoyant and the nutrient concentrations would be close to ambient when the plume encounters the bottom so a phase shift to an algal dominated community would not be expected.

In summary, anticipated impacts to coral aquatic resources would occur from the excavation and backfilling of the micro-tunneled pipeline receiving pit, seafloor mounted pipeline collar placement, and water quality changes within the zone of mixing of the return water discharge. The area of potential direct coral loss would occur between the receiving pit and approximately 3,500 linear ft of seafloor seaward to a water depth of approximately 300 ft (the depth limit of observed mesophotic corals) over an area of approximately 95,000 ft^2 (2.2 acre). Within the total area of potential impact, scattered individual coral colonies are estimated to occupy between 0.2 to 1.1% of the seafloor, with measured coral colonies ranging from 1 to 30 cm (scattered deep water plate/encrusting mesophotic corals were estimated between 30-45 cm). The total estimated area of potential coral loss under Alternative 3 would be 90 ft^2 (0.002 acre).

Entrainment

The location of the intake would be the same under all alternatives and therefore the potential entrainment effects would be the same for Alternative 3 as for Alternative 1.

Creation of New Substrata

Compared to Alternative 1, the larger surface area of the more numerous Type A collars necessary under Alternative 3 would result in creation of an additional 21,400 square feet of artificial hard substrate in the depth range of 150-300 feet (see Table 3-15).

Effects on Coral Reef Ecological Functions and Services

The adverse and beneficial effects to coral reef ecological functions and services would be similar to Alternative 1. The estimated construction-related losses of natural coral resources would be slightly greater (1.0 m^2 coral cover of colonies averaging 2.5 cm) than Alternative 1. However, the long term adverse effects to the coral community associated with the return seawater discharge would be expected to be less considering the lower coral abundance, smaller colony sizes, and more similar ambient water quality conditions at the 300 ft discharge depth. Mesophotic corals were identified by the deep water survey at the diffuser depth of Alternative 3, which may be adversely effected by the return seawater discharge.

In summary, Alternative 3 would have less than significant direct, short-term, and potentially significant but mitigable to less than significant long term adverse effects on benthic habitats and communities. While the diffuser under Alternative 3 would be in deeper water than under either Alternative 1 or 2, the deep water survey identified mesophotic corals at the depth of the Alternative 3 diffuser and these could be affected by the return seawater discharge. The indirect long-term effect of the increased artificial hard substratum provided by the pipes and collars may provide some ecological benefit.

<u>*Alternative 4 (Preferred Alternative)*</u>

Direct Effects on Substrata and Benthos

Alternative 4 follows the same alignment as Alternatives 1 and 3. Similar to Alternative 3, both the discharge pipe and the intake pipe would be deployed in tandem. Therefore the potential effects of Alternative 4 on coral resources from the receiving pit to 300 ft deep would be the same as those of Alternative 3.

The breakout pit under Alternative 4 would be in the same location as under Alternative 1, and the estimate of lost substratum and coral cover would also be the same: 148.6 m^2 (1,600 ft^2) and 0.48 m^2 (4.63 ft^2), respectively, with an average colony size of 14.3 cm.

Under Alternative 4, the distance from the receiving pit to 300 ft deep is the same as Alternates 1 and 3. The number of Type A collars is the same as for Alternative 3. The total area in contact with the seafloor due to the concrete collars from the receiving pit to 300 ft deep would be 1,356 m^2 (14,592 ft^2). Note that no scleractinian corals were observed at depths below 300 ft, which is consistent with the limits generally found for coral habitats. As a result, estimates of coral cover loss for all action alternatives are based on the footprint of the receiving pit and pipe collars found from the receiving pit to 300 ft deep. Results from the deep water marine biology survey along the proposed route indicate a lack of coral below 92 m so there would be no anticipated loss of coral in the ZOM under Alternative 4 due to operations. As for Alternative 1, the plume would be negatively buoyant and the nutrient concentrations would be close to ambient when the plume encounters the bottom so a phase shift to an algal dominated community would not be expected. At the depth of the diffuser under Alternative 4, photosynthetically active radiation is very low, so the possibility of a phase shift favoring development of an algal dominated community is the lowest of the action alternatives.

In summary, anticipated impacts to coral aquatic resources would occur from the excavation and backfilling of the micro-tunneled pipeline receiving pit and from seafloor mounted pipeline collar placement. No impacts to corals are anticipated from the zone of mixing of the return water discharge considering that it would occur at a depth below coral occurrence. The area of potential direct coral loss would occur between the receiving pit and approximately 3,500 linear ft. of seafloor seaward to a water depth of approximately 300 ft. (the depth limit of observed mesophotic corals) over an area of approximately 95,000 ft^2 (2.2 acre). Within the total area of potential impact, scattered individual coral colonies are estimated to occupy between 0.2 to 1.1% of the seafloor, with measured coral colonies ranging from 1 to 30 cm (scattered deep water plate/encrusting mesophotic corals were estimated between 30-45 cm). The total estimated area of potential coral loss under Alternative 4 would be 86.1 ft^2 (0.002 acre).

Entrainment

The location of the intake would be the same under all alternatives and therefore the potential entrainment effects would be the same for Alternative 4 as for Alternative 1.

Creation of New Substrata

The effects of new substrata from Alternative 4 would be the same as for Alternative 3 for depths from the receiving pit to 300 feet.

Effects on Coral Reef Ecological Functions and Services

The total losses in coral would be less than any other action alternative. The adverse and beneficial effects to coral reef ecological functions and services would be similar to Alternative 1. However, the potentially significant long term adverse effects to the coral community associated with the return seawater discharge would be eliminated under Alternative 4 considering the lack of corals found at the diffuser depth (326 to 423 ft). Additionally, the ambient water quality conditions at the 423 ft diffuser depth of Alternative 4 would be the most similar to that of the return seawater discharge than any of the other alternatives.

Alternative 4 would have a less than significant direct, short-term and long-term, adverse effect on benthic habitats and communities. The diffuser under Alternative 4 would be below the depths at which mesophotic corals were observed in the route surveys, so the effect on benthic biota would be less than significant at this deeper location. The indirect long-term effect of the increased hard substratum provided by the pipes and collars may provide beneficial effects.

Comparison of Substrata Effects of the Action Alternatives

Table 3-15 summarizes the surface areas of benthic substratum potentially covered by the concrete collars and the areas of new substratum created by the collars and pipes for the action alternatives. Alternative 1 covers only about one-sixth of the area of substratum of Alternative 2. Alternative 3 and Alternative 1 share the same alignment to 300 ft depth with Alternative 3 having the greater number of the larger Type A collars, so Alternative 3 covers more substratum than Alternative 1. Alternative 2 would cover the greatest amount of substratum of the action alternatives between the receiving pit and 300 ft deep.

The four action alternatives differ in the area of substratum covered, but also in the amount of coral cover along the alignments. Table 3-15 summarizes the estimated area of live coral cover that would be lost for each alternative along each alignment from the receiving pit to 300 ft deep from the analyses above. Coral cover lost at the receiving pit would be the same for Alternatives 1, 3 & 4. Alternative 2, following a different alignment than the other Alternatives has a different coral loss profile as can be seen in Table 3-15. There are differences among the action Alternatives 1, 3 & 4 in coral cover lost due to the quantity of Type A collar used. Alternative 2 would affect the highest coral cover due to the alignment passing through a biotope of 49% coral coverage, tighter collar spacing and a longer alignment to 300 ft depth. Alternative 4 would potentially affect the least amount of coral cover because the ZOM would be below depths where coral is found.

Table 3-15 also summarizes the surface area of new substratum created by the collars and pipes. The calculations of substrate created by the HSWAC structures assume all exposed surfaces of the collars and pipes have some biological value, even though the pipe undersides may be less favorable for coral recruitment. From a holistic perspective of ecological function, however, the undersides of the pipes would also provide usable artificial habitat for sessile and motile invertebrates. The extent to which the artificial substrate created by the proposed action would result in coral recruitment and sustainable growth, and the degree of potential ecological benefit, is unknown.

The relative lengths of the alternative routes to the diffuser and intake, and consequently the length of pipes in the system, determines the amount of substratum created by the pipes themselves. Alternative 1, having the shortest route to the diffuser would use the least amount of pipe and therefore provide the least amount of new substratum. Alternative 2, with its different alignment and tighter collar configuration, would create the most substratum.

Table 3-15: Coral Loss and Substratum Changes by Action Alternative

Facility/Resource	***Parameter***	***Alt. 1***	***Alt. 2***	***Alt. 3***	***Alt. 4***
% Coral Coverage per Biotope	Biotope: Scattered Corals	0.3%	5.0%	0.3%	0.3%
	Shallow Dredged Rubble	1.1%	0.01%	1.1%	1.1%
	High Coverage		49.0%		
	Sand	0.7%	0.0%	0.7%	0.7%
	Deep Dredged Rubble (1)	1.1%	0.001%	1.1%	1.1%
	Deep Water Zone 1	0.2%	0.2%	0.2%	0.2%
Type A Pipe Collars	Biotope: Scattered Corals	5	23	5	5
	Shallow Dredged Rubble	15	32	15	15
	High Coverage		11		
	Sand	33	10	33	33
	Deep Dredged Rubble (1)	37	126	37	37
	Deep Water Zone 1			102	102
Type B Pipe Collars	Deep Water Zone 1	102	82		
Collars Type A & B Total		192	284	192	192
Substratum Covered by Pit		1,600	1,600	1,600	1,600
Substratum Covered by Collars (sq ft) (Type A = 76 sf) (Type B = 32 sf)	Biotope: Scattered Corals	380	1,748	380	380
	Shallow Dredged Rubble	1,140	2,432	1,140	1,140
	High Coverage		836		
	Sand	2,508	760	2,508	2,508
	Deep Dredged Rubble (1)	2,812	9,576	2,812	2,812
	Deep Water Zone 1	3,264	2,624	7,752	7,752
Covered Substratum Total		11,704	19,576	16,192	16,192
Coral Cover Lost from Receiving Pit to 300' depth	Biotope: Scattered Corals	5.7	167.4	5.7	5.7
	Shallow Dredged Rubble	12.2	0.2	12.2	12.2

(sq ft)	High Coverage		409.6		
	Sand	17.9	0.0	17.9	17.9
	Deep Dredged Rubble (1)	31.9	0.1	31.9	31.9
	Deep Water Zone 1	7.7	6.2	18.3	18.3
	Zone of Mixing	19.0	0.023	4.0	0.0
Lost Coral Cover Total		94.5	583.6	90.0	86.1
Substratum Created by Collars (sq ft)	Type A (313 sq ft)	28,170	63,226	60,096	60,096
	Type B (181 sq ft)	18,462	14,842		
Collar Substratum Total		46,632	78,068	60,096	60,096
Substratum Created by Pipes	Sq ft	78,436	82,171	99,836	99,836
Created Substratum Total	Sq ft	125,068	160,239	159,932	159,932
Average Coral Colony Size by Biotope (cm)	Biotope: Scattered Corals	14.3		14.3	14.3
	Dredged Rubble (shallow)	7.9		7.9	7.9
	Sand	3.2		3.2	3.2
	Dredged Rubble (deep) (1)	4.2		4.2	4.2
	Deep Water Zone 1	37.5		37.5	37.5
Maximum Coral Colony Size by Biotope (cm)	Biotope: Scattered Corals	30		30	30
	Dredged Rubble (shallow)	24		24	24
	Sand	15		15	15
	Dredged Rubble (deep)	15		15	15
	Deep Water Zone 1	45		45	45
Notes:	1) Shallow dredged rubble & sand biotope data averaged with ecotone biotope data				
	2) Omitted data from transect A & B in favor of receiving pit coral census data				
	3) Eliminated Quadrats 23M & 24M from transects C&D. (quadrats on spurs)				
	4) Alt 2 data is qualitative only (from 2008 survey; no coral size data available)				

3.7.5.2 **Pelagic Communities**

The organisms living in pelagic communities may be drifters (plankton) or swimmers (nekton). The plankton includes larvae of benthic species; therefore, a pelagic species in one ecosystem may be a benthic species in another. The plankton consists of plant-like organisms (phytoplankton) and animals (zooplankton) that drift with the ocean currents with little ability to move through the water on their own. The mostly one-celled phytoplankton float in the photic zone where they obtain sunlight and nutrients, and also serve as food for the zooplankton and some larger marine animals. Zooplankton consists of many kinds of organisms, ranging from single-celled heterotrophic plankton to jellyfish up to 6 feet wide, which live in both surface and deep waters of the ocean. Crustaceans make up about 70% of all zooplankton. While some zooplankton float freely throughout their lives, many spend only the early part of their lives as plankton. As adults some become strong swimmers and join the nekton, while others settle and attach themselves to the seafloor to become part of the benthos.

The nekton consists of animals that can swim freely and purposefully in the ocean. They are strong swimmers and include fish, squids, sea turtles, and marine mammals. Most species of nektonic animals live near the sea surface where food is plentiful, but others live in the deep ocean. Fish are the most important nekton, with over 13,000 species of fish living in the ocean. Squids are free-swimming mollusks that live in both surface and deep waters. Nektonic mammals, including porpoises and whales, remain in the ocean for their entire lives. Other marine mammals, such as the Hawaiian monk seal, spend time on land.

It is thought that pelagic systems are controlled primarily by physical factors, including temperature, nutrients, amount of light in the surface waters, and disturbances in the water structure. The latter occurs when winds and other atmospheric conditions drive changes in the circulation patterns and mixing of ocean waters. As a result, there are vertical changes in the temperature and nutrient distribution, which in turn affect the vertical distribution of species. There is no clear evidence of biological factors controlling species diversity in these ecosystems, but species interactions have not been well studied (Thorne-Miller and Catena, 1991).

Much of what is known about the biology of the deep ocean waters surrounding the Hawaiian Islands is based on limited information gleaned from studies on sport and commercial fisheries. Pelagic and deep seafloor (benthic) ecosystems occur in the deep open waters beyond the neritic shallow-water zone around all the islands and on, and above, the seafloor at depths greater than 660 ft. Pelagic ocean waters are exposed to swells, currents, and winds from all directions, generally beyond the sheltering effects of the islands. Deep currents and eddies are also associated with this zone. Sunlight is absent on the deep seafloor. Basalt and carbonate rock substrata are common on slopes with sediments prevalent on flatter surfaces. Bottom sediments surrounding O‘ahu are composed largely of muds washed as organic matter (detritus) from the adjacent islands, and sand and gravel of shallow-water origin.

Phytoplankton are the only abundant plants in the pelagic zone; living plants are rare or absent on the deep seafloor. Zooplankton, fishes, squids, sea turtles, marine mammals, and various seabirds forage in neritic or pelagic waters. At depths in excess of 330 ft, many benthic organisms live where there is little or no light and maintain themselves on detritus and planktonic organisms in the water column.

In review of the DEIS, a concern was raised about effects of entrainment of organisms in the mesopelagic boundary community and compliance with CWA Section 316(b), so additional background information is included here and effects of the HSWAC system on this community are summarized below. (See also Appendix N.) The mesopelagic boundary community off the coast of the Hawaiian Islands, and O‘ahu in particular, was first defined by Reid et al. (1991) and is now known to consist of at least 23 species of fish, 12 families of squid, and crustaceans. The majority of these organisms are considered micronekton, which range from 2-10 cm in size and are between plankton and larger nekton in terms of swimming ability, meaning they swim actively but are still affected by currents (Brodeur and Yamamura, 2005). The micronekton are primarily composed of cephalopods (squid and octopi), crustaceans (large euphausiids, decapods [shrimp], and mysids), and fish (myctophids, gonostomatids, and bathylagids) (Pakhomov and Yamamura, 2010).

Micronekton play a crucial role in the marine ecosystem. Micronekton serve as a link between zooplankton and higher trophic levels as they are a major prey item for tuna, billfish, and spinner dolphins (Lammers et al., 2006). In addition, mesopelagic micronekton are responsible for the majority of the Hawaiian zooplankton consumed in Hawaiian coastal waters (Clark, 1973; Benoit-Bird and Au, 2006). As one of the most important consumers of zooplankton, the mesopelagic boundary community becomes a major contributor to the biological pump through its diel migration by transporting organic material from epipelagic waters to the deeper, mesopelagic waters (Roger and Grandperrin, 1976; Hidaka et al., 2001).

The diel migration of the mesopelagic boundary community is characterized by a daytime layer along the slopes of islands at depths that range from 200 to 700m, but is usually between 400 and 700m, and consists of extensive diel vertical and horizontal migrations from its daytime depth to epipelagic waters at night (Lammers et al., 2006). Off the leeward coast of Oahu, the mesopelagic boundary community generally forms one layer at 400m or deeper during the day (at densities of up to 1,800 animals/m^3) and migrates to shallow waters (traveling up to 11 km round-trip) to form multiple aggregations at night (Benoit-Bird et al., 2001; Benoit-Bird and Au, 2006). The typical horizontal portion of the diel migration of mesopelagic boundary organisms is approximately 1.8 km each way towards and away from shore. The timing of these migrations is conserved regardless of the year, season, and across the various Hawaiian Islands, although the phase of the moon does have some influence on the timing and extent of the migration (Benoit-Bird et al. 2001; Drazen et al., 2011).

The composition, distribution, and movement of the mesopelagic boundary community around the Hawaiian Islands are not well understood. The majority of such studies only used trawling for sampling the mesopelagic boundary community, which is effective in identifying species and estimating the community's general distribution, but is severely limited in its spatial scope and overall inclusiveness (due to net avoidance). The inherent patchiness of the mesopelagic boundary community, especially at night when much of the sampling occurred for logistical reasons, also results in biased density estimates from trawling (Benoit-Bird et al., 2001). Additionally, different types of nets and mesh sizes sample differentially for various components of the mesopelagic boundary community, meaning some organisms are highly underestimated or even missed completely (Brodeur and Yamamura, 2005). Most mesopelagic boundary community studies were also limited to the upper 200m of the water column due to logistical and technological limitations (Benoit Bird and Au, 2003; 2006). Therefore, the mesopelagic boundary community's composition and distribution during the day at depth remain ill-defined.

The following is a brief synopsis of relevant findings from key mesopelagic boundary layer studies conducted in Hawaiian waters in chronological order. Young (1995) used a combination of nighttime trawling and daytime submersible video to identify the species of cephalopods found in the Hawaiian mesopelagic-boundary region off the leeward and windward coasts of Oʻahu. The most common squid was *Abralia trigonura*. Several transects were conducted with a submersible, resulting in a total of 19 *A. trigonura* sightings and eight probable sightings. A 15 min transect that was performed with the submersible at 10 m above the 435 m ocean bottom at a speed of 0.5 m/s (total distance covered was 450 m) had 18 of the 27 total *A. trigonura* sightings (14 sightings and 4 probable sightings). However, an earlier transect at that same site 3-4 m above the ocean floor did not result in squid sightings. A total of six possible sightings of *A. trigonura* were made during another transect at 430-470 m, 10-100 m above the seafloor. A single sighting was made at 505 and 565 m, at 85 and 25 m above the bottom, respectively. Only one was found within 1 m of the bottom (550 m). *A. trigonura* were not observed by submersible during transects over seafloor bottoms of 535-540 and 270-275 m while traveling 2-3, 10, and 50 m above the bottom. One other species of squid was observed by submersible. *Nototodarus hawaiiensis* was sighted a total of 13 times, 12 of which were between 345 and 400 m depth, and one of which was at 500 m. These squid were always solitary and resting on the bottom or swimming 10-20 cm above the bottom. A single large female octopus (*Haliphron atlanticus*) was observed barely moving at 270 m, just a few centimeters above the seafloor. One other octopus (*Tremoctopus* spp.) was also observed swimming slowly approximately 5 m above the seafloor at 340 m depth (Young, 1995). These results demonstrate the heterogeneity and patchiness associated with the mesopelagic boundary community.

Acoustic sampling performed by Benoit-Bird et al. (2001) with a modified echo sounder off the leeward coast of O‘ahu resulted in mesopelagic density estimates of zero to 1,800 organisms/m^3 for 20 sampling locations in inshore waters (20-50 m depth, 1-1.3 km from shore) and 20 locations in offshore waters (175-200 m depth, 2.8-3 km from shore) at night from July 5-30, 1999. The mean density for the measured water column varied from zero to 23 organisms/m^3. From November 10-15, 1999, transects were also conducted parallel to the Kona coast of the Big Island of Hawai‘i approximately 1.0-1.3 km and 2.8-3.0 km from the shore. There, the density estimates ranged from zero to 700/m^3, with the mean density for the measured water column ranging from zero to 15 organisms/m^3. While these density estimates were only calculated at depths of 200 m and above at night, they still provide an indication of possible densities at the mesopelagic layer at depth during the day, as the organisms migrate from the shallow waters where they were observed in this study to deeper waters during the day.

Benoit-Bird and Au (2003) examined the degree of patchiness of the mesopelagic boundary community with a modified echo sounder off the coasts of three Hawaiian Islands, including O‘ahu. Only the top 156 m were measured at night along this series of transects in 2000 and 2001 due to depth limitations of the acoustics equipment. Large differences in distribution and organism density were found for the mesopelagic boundary community among the different locations. Two transects (north and south) were conducted off the Waianae coast of O‘ahu. Overall mesopelagic organism density was lower for the southern transect than for the northern transect, and it was found that the low-density region (southern transect) exhibited small (tens of meters) discrete patches that were clearly distinguishable against a background density of zero. Locations with high densities (northern transect) tended to form boundary-community layers. While this study was conducted off the leeward coast of Oahu, and not the southern coast, it demonstrates the variation in distribution and density of the mesopelagic boundary community in different areas along the same shoreline, with lower densities and a higher degree of patchiness found further to the south of the Waianae coast. Lammers et al. (2006) also found substantial temporal and spatial variation for the mesopelagic boundary community among transects at seven sites in the NWHI and one site off the Waianae coast of O‘ahu.

Benoit-Bird and Au (2006) used a video camera system along with echo sounders to fully quantify the mesopelagic boundary community throughout its diel migration off the leeward coast of O‘ahu. The camera system was able to image micronekton to a depth of 600m with a sampling volume of 575 liters per frame, which captured 5 to 10 mesopelagic animals per frame at night and 0.4 mesopelagic animals per frame during the day, on average. At night, the mesopelagic boundary layer was never detected when the bottom depth was less than 22.7 m or closer than 0.5 km from the shoreline. Only one mesopelagic boundary layer was observed in the study area during the day, from 6 to 11 km offshore and at depths of 400 m or deeper. This mesopelagic boundary layer did not extend into water with a bottom depth shallower than 570 m and was composed of 86% myctophids, 12% shrimp, and 2% hatchetfish.

Current knowledge regarding the mesopelagic boundary community in Hawaiian waters, as relevant to the proposed HSWAC project, is summarized by the above studies. A substantial amount of spatial and temporal heterogeneity in the mesopelagic boundary community occurs among different study sites. Data concerning the distribution and density at which they are found during the day is severely limited, but is likely site specific as it is affected by topographic and biological bottom influences, as well as tidal advection and mesoscale eddies (Young, 1995). Specific to O‘ahu, the data available demonstrate a lower mesopelagic boundary community density to the south along the Waianae coast on the leeward side than to the north in epipelagic waters at night, which would likely translate to lower overall densities during the day once those organisms migrate to lower depths during the day. Additionally, the one mesopelagic boundary layer found during the day with the new camera system used by Benoit-Bird and Au (2006), also off the leeward coast of Oahu, did not extend into water with a bottom depth shallower than 570 m.

The proposed site for the HSWAC intake pipe is approximately 4.68 miles (7.5 km) offshore from Honolulu at a depth of 1,740 feet (530 m). The pipe would be 1.6 m in diameter and would rest in a series of collars situated 0.8 to 1.4 m above the seafloor. Video was collected along the final 1,891 m of the proposed pipeline at depths from 500 m to 550 m from a manned submersible in October 2010. The approximate area examined was 10,700 m^2 along a track approximately 3.57 km in length along the seafloor. Most of the footage appeared to cover a field of about 3 x 3 m. The species and associated abundance of organisms nearby in the same ecological zone as organisms present on the proposed pipeline alignment were also examined by viewing all of the video obtained of the ocean bottom during the submersible dive. It is important to note that identification of organisms is tentative due to varying image quality. In terms of organisms considered typical of the mesopelagic boundary community, their observed presence in the submersible videotape was limited. Approximately 27 shrimp (22 unknown panaeid and 5 *Heterocarpus laevigatus*), 3 cephalopods (2 squid, 1 octopus), and 38 possible mesopelagic boundary community fishes (unidentified fish categorized as 4 cm or less [27] and greater than 4 cm [11]) were found. That is a total of 68 possible mesopelagic boundary community organisms observed over a 3.57 km length track covering an area of approximately 10,700 m^2. For a very rough approximation of the density of possible mesopelagic boundary organisms from this data, the 3m by 3m camera viewing area is assumed along the 3,570 m track to obtain a volume of 32,130 m^3 for a rough density estimate of 0.002 possible mesopelagic boundary organisms/m^3, far less than the density of mesopelagic boundary organisms encountered by other camera and submersible-based studies of mesopelagic boundaries in Hawaiian waters. These estimates would not be expected to change significantly as this community has been said to be relatively constant seasonally and annually.

For comparison purposes, the Natural Energy Laboratory of Hawaiʻi Authority (NELHA) at Keāhole Point, Hawaiʻi was also examined. Ocean water has been drawn from similar depths through three separate pipe systems at depths from 548 m (1,800 feet) to 915 m (3,000 feet) since 1981-82, and problems with excessive entrainment and impingement of organisms have not been encountered. This is especially important in regard to mesopelagic boundary community organisms, as the relatively slow swimming speeds of micronekton put them at risk of entrainment near intake pipes. It is unlikely, then, that the high-density mesopelagic boundary layer described in the studies summarized above has been encountered by the NELHA facility with an intake pipe at a depth comparable to that proposed by the applicant. However, the intake velocities of the NELHA pipes are all around 0.35 ft/s, an order of magnitude less than the proposed HSWAC intake velocity, so some larger, more vigorous swimming organisms could be expected to be entrained in the HSWAC intake.

In conclusion, the substantial variation in distribution of the mesopelagic boundary layer in Hawaiian waters as described by the studies summarized above, and especially the observed daytime limit to water with a bottom depth deeper than 570 m for one of the few daytime mesopelagic boundary layers studied (Benoit-Bird and Au, 2006), means a mesopelagic boundary layer is not necessarily present at the proposed site of the HSWAC intake pipe. In addition, the extremely low number of observed members of that community by the submersible at that specific site and the absence of an entrainment/impingement problem with the similar pipe system at NELHA indicate that the proposed intake pipe would not have a significant impact on the mesopelagic boundary community.

Approach to Impact Analysis

Methodology
A qualitative assessment was made of the response of nekton and plankton to changes in water quality during construction and operation. In the construction phase the primary concern is turbidity. In the operations phase the primary concerns are the return seawater plume and entrainment of organisms in the intake. The analysis of potential effects of the seawater return relies on the applicant's computer modeling of the water quality effects of the seawater return. An entrainment analysis was prepared based on the expected densities of pelagic organisms from numerous literature sources.

Determination of Significance
A significant effect for pelagic organisms would be depletion or restoration of a population or permanent change in abundance of suitable habitat.

Impacts

No Action Alternative
The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effects on pelagic communities because there would be no offshore construction or facilities.

Alternative 1
Alternative 1 would have a less than significant, direct, short-term adverse effect on nekton as a result of the turbidity generated in the vicinity of the construction operations. It's likely that some of these organisms would avoid turbid areas while others would be attracted to displaced or exposed benthic organisms as a supplemental food source. Less than significant indirect adverse effects would be experienced in adjacent areas to the extent nekton are displaced. In turbid areas, light available to phytoplankton would be temporarily reduced; filter feeding zooplankton may ingest particulate matter.

Once the system is operational, there would be a less than significant, long-term direct effect on nekton. Habitat within the ZOM may be avoided by nekton favoring higher water temperatures. Supplemental nutrients introduced to the euphotic zone in the return seawater plume may stimulate phytoplankton productivity. Because the seawater return plume is negatively buoyant it would tend to sink and flow downslope to aphotic depths where photosynthesis cannot occur. Because of the time lag between nutrient uptake and growth or reproduction, any response by the phytoplankton community would likely occur at some distance from the source of the nutrients and be diluted by the effects of mixing and advection by ocean currents. The increased phytoplankton productivity may not be expressed as increased biomass depending on the response of higher trophic levels. Filter feeding organisms may graze the phytoplankton down and population response may be seen at a higher trophic level, including fish populations. Depending on the nature of the response the less than significant indirect effect could be adverse or beneficial.

One of the primary environmental concerns to arise from any proposed ocean intake system is entrainment, or the incidental trapping of marine organisms in the intake pipe flow. The marine biota classes most susceptible to entrainment include phytoplankton, zooplankton (including larvae), micronekton, and small fish (Myers et al., 1986). Because the intake would be located well below depths to which light penetrates in the ocean, a functional phytoplankton community is not present. The very small amount of chlorophyll (0.014 µg/L) that was detected in the samples taken at the intake location likely represents degradation products of phytoplankton sinking from the euphotic zone. Entrainment of phytoplankton would not be a concern at the intake depth.

Of the biota classes susceptible to entrainment, fish larvae would be of particular concern. The proposed depth of the intake pipe (~544 m) is comparable in terms of possible interaction with marine larvae with that typically assumed for an OTEC cold water intake (1000 m), for which it was determined that the entrainment of larvae and eggs (except for coral) in Hawaiian waters would be unlikely, of low significance, and not a regulatory priority (Coastal Response Research Center, 2010). Most fish eggs are extremely buoyant and can be found in the neuston layer (top 1 m). For example, Hirota (1977) found that tuna larvae are more abundant in the neuston layer than from 1-200 m, that fish larvae found at depths from 1-200 m are generally mid-water species, and that very few fish larvae occur between 200-1000m in the mid-Pacific. Therefore, the proposed intake pipe is much deeper than the typical vertical distribution of fish larvae and any danger of entrainment posed by the intake pipe can be considered negligible.

The distribution of larvae of other marine organisms, such as coral and crustaceans, has more variability depending on the organism in question and its life strategy. For most coral and crustacean larvae, however, the larval recruitment process starts with planktonic larvae that then settle onto the seafloor and achieve their first benthic life stage. Some larvae are fully developed upon release and settle within hours, while others require substantial development (or even fertilization, like corals) before settlement occurs, which can range from days to months. The composition of crustacean larvae approximately 7.5 km offshore of Honolulu - the proposed location of the intake pipe - is unknown, but according to Smith and Parnell (1995), larval traps at a 50 m depth off Sand Island, Oʻahu in water with a bottom depth of 72 m primarily collected bivalve, gastropod, polychaete, and ascidian larvae. Coral larvae generally remain in the upper 5 m, but their horizontal distribution after release is not well understood (Hodgson, 1985). In conclusion, most marine larvae remain in the top five meters of the ocean prior to settling, hundreds of meters above the proposed intake pipe. It is possible, albeit doubtful given all the chemical and tactile cues necessary to initiate settlement, for the occasional larvae to be entrained by the intake pipe during the actual release or settlement process; however, the lack of "parent" reefs and general paucity of organisms near the proposed intake makes entrainment of larvae (especially coral larvae) during actual release or settling improbable.

Zooplankton are weak swimmers that tend to flow with the current, and are therefore also subject to entrainment. Often categorized according to size, generally as microzooplankton and macrozooplankton, zooplankton also play a major role at the base of the marine food web. Microzooplankton are heterotrophic and mixotrophic organisms less than 200 μm in size (e.g., ciliates, dinoflagellates, foraminiferans, copepod nauplii and some copepodites, and some meroplanktonic larvae) that are major consumers of phytoplankton (Calbet and Landry, 2004), thereby forming the link between phytoplankton and copepods (Calbet, 2008), and are key components in marine biogeochemical cycles and the microbial loop (Sherr and Sherr, 2002). Microzooplankton are not expected to occur below the euphotic zone (200 m), so no microzooplankton are expected to be entrained at the proposed intake pipe location.

Macrozooplankton include temporary (meroplankton) and permanent (holoplankton) members of the zooplankton community that are between 200 μm and 2,000 μm in size (visible to the naked eye) and include such organisms as copepods, arrowworms, decapod shrimp, ctenophores, siphonophores, amphipods, mysids, tunicates, ostracods, and cladocerans (Peterson, 1969). Macrozooplankton are found below the euphotic zone, but at a lower abundance. Observations by Noda et al. (1981) showed that there is an approximate tenfold difference between zooplankton surface samples and those from 600-1000 m off Kahe Point. The estimated biomass of macrozooplankton in surface waters off Kahe Point was obtained by Myers et al. (1986) by converting their mean dry weight for the upper 200 m from two separate cruises to near-surface zooplankton carbon according to Wiebe et al. (1975) to obtain 1.3 mg C/m^3. After factoring in the proposed flow rate for the HSWAC system, this would result in 170.68 kg C/year of entrained macrozooplankton. In contrast, only 34.14 kg C/year of macrozooplankton would be entrained at depths from 700-1000 m (a depth ecologically similar to that of the proposed intake pipe) according to the reported average macrozooplankton biomass of 0.26 mg C/m^3 by Uchida (1983).

Micronekton are the next largest size class to be considered susceptible to possible entrainment. They range from 2-10 cm in size and are between plankton and larger nekton in terms of swimming ability, meaning they swim actively but are still affected by currents (Brodeur and Yamamura, 2005). The micronekton are primarily composed of cephalopods (squid and octopi), crustaceans (large euphausiids, decapods [shrimp], and mysids), and fish (myctophids, gonostomatids, and bathylagids) (Pakhomov and Yamamura, 2010). As major consumers of zooplankton, and primary prey items themselves for tuna, billfish, and spinner dolphins (Lammers et al., 2006), micronekton are a crucial link between zooplankton and higher trophic levels (Clark, 1973 and Benoit-Bird and Au, 2006). Micronekton are a primary component of the mesopelagic boundary community. Therefore, the results of acoustic sampling performed by Benoit-Bird et al. (2001) with a modified echo sounder off the leeward coast of Oahu to measure mesopelagic boundary community organism density are used as a proxy to estimate entrained micronekton. Mesopelagic boundary community organism density ranged from zero to 1,800 organisms/m^3 for 20 sampling locations in inshore waters (20-50 m depth, 1-1.3 km from shore) and 20 locations in offshore waters (175-200 m depth, 2.8-3 km from shore) at night from July 5-30, 1999. The mean density for the measured water column varied from zero to 23 organisms/m^3. These density estimates were calculated for the top 200 m at night, but they indicate possible densities at the depth of the proposed intake pipe as the organisms migrate there from these shallower waters. In contrast, a submersible video transect conducted at the actual site of the proposed intake pipe resulted in a total of 27 shrimp (22 unknown panaeid and 5 *Heterocarpus laevigatus*), 3 cephalopods (2 squid, 1 octopus), and 38 possible mesopelagic boundary community fishes (unidentified fish categorized as 4 cm or less [27] and greater than 4 cm [11]). That is a total of 68 possible mesopelagic boundary community organisms observed over a 3.57 km length track covering an area of approximately 10,700 m^2. For a very rough approximation of the density of possible mesopelagic boundary organisms from this data, the 3m by 3m camera viewing area is assumed along the 3,570 m track to obtain a volume of 32,130 m^3 for a rough density estimate of 0.002 possible mesopelagic boundary organisms/m^3, far less than the density of mesopelagic boundary organisms measured by the acoustic sampling methodology described above or by other camera and submersible-based studies of mesopelagic boundary communities in Hawaiian waters. For comparison purposes, the mesopelagic boundary organism density at the depth of the output pipe off the leeward coast of Oahu (and at the proposed depth of the intake pipe since these organisms have a diel migration between the two depths) is assumed to be the median of the range given as zero to 23 organisms/m^3, or 11.5 organisms/m^3. At this density, 262,589 micronekton organisms/year would be entrained in the intake pipe for the HSWAC system.

Other, larger fish were also observed during the submersible video transect. Once fish reach a certain size, they are generally able to avoid entrainment due to the associated increase in swimming speed. However, for a more conservative estimate, all other observed fish (except jellynose eels, which can reach 6 feet in length and are not expected to be entrained) are included for a total count of 80 organisms, which corresponds to an increase in concentration of 0.0003 organisms/m^3, which is an additional 39,388 possible entrained organisms/year.

Such estimates of low entrainment rates are consistent with the lack of problems associated with entrainment at the Natural Energy Laboratory of Hawai‘i at Keāhole Point, Hawai‘i. Ocean water has been drawn through three separate pipe systems at depths from 548 m (1,800 feet) to 915 m (3,000 feet) since 1981-82, and problems with excessive entrainment and impingement of organisms have not been encountered.

In summary, Alternative 1 would have a less than significant, direct, short-term, adverse effect on nekton as a result of the turbidity generated in the vicinity of the construction operations. Less than significant indirect adverse effects would be experienced by pelagic biota in adjacent areas to the extent nekton are displaced. In turbid areas, light available to phytoplankton would be temporarily reduced; filter feeding zooplankton may ingest particulate matter. Once the system is operational, there would be a less than significant, long-term, direct, adverse effect on nekton due to potential entrainment.

Alternative 2
Alternative 2 would have similar effects as Alternative 1, as the intake location is common to all action alternatives and the ZOM is at the same depth in Alternative 1 as in Alternative 2.

Alternative 3
Alternative 3 would have similar short term effects as Alternative 1, as the intake location is common to all action alternatives. During the operation of the project, Alternative 3 would be expected to have less impact than Alternatives 1 and 2 considering the deeper diffuser location. However, a less than significant, long term direct, potentially adverse, effect on nekton would be expected. There would be less of difference of water quality conditions between the diffuser seawater return discharge and ambient conditions as well as a greater tendency of habitat within the ZOM to be avoided by nekton favoring higher water temperatures in Alternative 3 than in Alternatives 1 and 2. Also to the extent phytoplankton activity is less at greater depths due to lower light levels, response by the phytoplankton community would be less in Alternative 3 than Alternatives 1 and 2 due to the greater depth of the ZOM for Alternative 3.

Alternative 4 (Preferred Alternative)
Alternative 4 would have similar short term effects as Alternative 1, as the intake location is common to all action alternatives. During the operation of the project, Alternative 4 would be expected to have less impact than Alternatives 1, 2, and 3 considering the deeper diffuser location and absence of coral resources. However, a less than significant, long term direct, potentially adverse, effect on nekton would be expected. There would be less of difference of water quality conditions between the diffuser seawater return discharge and ambient conditions than any of the other alternatives, although the ZOM would be much larger in Alternative 4. Also, to the extent phytoplankton activity is less at greater depths due to lower light levels, response by the phytoplankton community would be less in Alternative 4 than the other Alternatives.

3.7.5.3 **Protected Species and Habitats**

Protected species include those listed as endangered or threatened under the ESA. In addition, all marine mammals are protected under the MMPA, and migratory birds (including seabirds) are protected under the Migratory Bird Treaty Act (MBTA). Protected (and proposed) species of marine mammals, sea turtles, and migratory birds in Hawai‘i are identified below. Additional descriptions are provided for those species that could potentially interact with the HSWAC system. In addition, NMFS has proposed a number of coral species for listing under the ESA, including one (*Montipora patula*) found in the proposed project area. Potential impacts to that species are also evaluated below.

Marine Mammals

Stock assessment information presented below for both listed and non-listed marine mammal species comes primarily from NOAA’s *U.S. Pacific Marine Mammal Stock Assessments: 2006* (Carretta et al., 2006) and the draft 2007 updates (Carretta et al., 2007) available on NMFS’ Office of Protected Resources web site. Information about the humpback whale comes primarily from NOAA’s *Alaska Marine Mammal Stock Assessments* (Angliss and Outlaw, 2007).

The most recent information on cetacean abundance in Hawaiian waters is the report by Barlow (2003) that summarizes the results of a NOAA survey conducted in August-November 2002. Two NOAA research vessels surveyed the entire exclusive economic zone (EEZ) around the Hawaiian Islands along parallel transects spaced 53 mi apart (outer EEZ stratum) and 26.4 mi apart within 87 mi of the main Hawaiian Islands (MHI) (main island stratum). Both visual observations and acoustic detections were employed. Twenty-four species of cetaceans were seen, including two species (Fraser’s dolphin and sei whale) that previously had not been documented to occur in Hawaiian waters. The most abundant large whales were sperm whales and Bryde’s whales. The most abundant delphinids were rough-toothed dolphins and Fraser’s dolphins. Dwarf and pygmy sperm whales and Cuvier’s beaked whales were estimated to be quite abundant. Accurate estimates of abundance for migrating whales were not possible as the survey did not take place during periods of their highest abundance in Hawaiian waters. Nevertheless, abundance estimates were possible for 21 other species. The overall density of cetaceans was low, especially for delphinids. The precision of density and abundance estimates was generally low for all species due to the small number of sightings. Table 3-16 summarizes the sightings data, calculated abundances and densities, and the coefficients of variation (CV) from Barlow (2003).

Table 3-16: Estimated Abundances of Cetaceans in the Hawai‘i EEZ from 2002 Research Cruises

Species	***Main Island Stratum***		***Outer EEZ Stratum***		***Overall***		
	#Sightings	***Abundance***	***#Sightings***	***Abundance***	***Abundance***	***Individuals /km^2***	***CV***
Offshore spotted dolphin	6	4931	2	5329	10260	0.0042	0.41
Striped dolphin	1	508	10	9877	10385	0.0042	0.48
Rough-toothed dolphin	7	3860	7	16044	19904	0.0081	0.52
Bottlenose dolphin	5	525	4	2738	3263	0.0013	0.6
Risso’s dolphin	2	594	3	1757	2351	0.001	0.65
Fraser’s dolphin	0	0	1	16836	16836	0.0069	1.11
Melon-headed whale	0	0	1	2947	2947	0.0012	1.1
Pygmy killer whale	1	817	0	0	817	0.0003	1.12
False killer whale	0	0	1	268	268	0.0001	1.08
Short-finned pilot whale	7	3131	7	5715	8846	0.0036	0.49
Killer whale	0	0	2	430	430	0.0002	0.72
Sperm whale	2	56	16	7026	7082	0.0029	0.3
Pygmy sperm whale	0	0	2	7251	7251	0.003	0.77
Dwarf sperm whale	0	0	3	19172	19172	0.0078	0.66
Unidentified beaked whale	1	330	0	0	330	0.0001	1.05
Blaineville’s beaked whale	0	0	1	2138	2138	0.0009	0.77
Cuvier’s beaked whale	0	0	2	12728	12728	0.0052	0.83
Longman’s beaked whale	0	0	1	766	766	0.0003	1.05
Bryde’s whale	0	0	8	493	493	0.0002	0.34
Sei whale	1	77	0	0	77	0	1.06
Fin whale	0	0	2	174	174	0.0001	0.72
Spinner dolphin	3	2036	1	768	2804	0.0011	0.66
Delphinids	32	16403	39	62709	79112	0.0323	
Beaked Whales	1	330	4	15632	15962	0.0065	
Source: Barlow 2003							

<u>*Endangered Marine Mammals*</u>

Endangered marine mammals in the Hawaiian Islands include six cetaceans and one pinniped. The cetaceans include the humpback whale (*Megaptera novaeangliae*), the sperm whale (*Physeter macrocephalus*), the northern right whale (*Eubalaena glacialis*), the blue whale (*Balaenoptera musculus*), the fin whale (*B. physalus*), and the sei whale (*B. borealis*). The pinniped is the Hawaiian monk seal (*Monachus schauinslandi*). In addition, the Hawaiian Insular False Killer Whale (*Pseudorca crassidens*) is currently proposed for listing as endangered.

Most of these species occur very far offshore or in other habitats far from the proposed HSWAC project area. The listed marine mammals that could occur in the project area include the humpback whale, and the Hawaiian monk seal. The sections below summarize available information on the biology and population status of these species. The Hawaiian Insular False Killer Whale may also occur in the project area. The USACE has completed formal ESA Section 7 consultation with NOAA concerning potentially affected species, culminating in NOAA issuance of its Biological Opinion on September 13, 2012 (Appendix M).

Humpback Whale (Megaptera novaeangliae)

The International Whaling Commission (IWC) first protected humpback whales in the North Pacific Ocean in 1965. Humpback whales were listed as endangered under the ESA in 1973, and are consequently considered “depleted” and “strategic” under the MMPA. Strategic stocks are those that have a level of human-induced mortality that exceeds the number of animals that can be safely removed from the stock without interfering with that stock’s ability to reach or maintain its optimum sustainable population level. Humpbacks are also protected by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Critical habitat has not been designated for this species, but the Hawaiian Islands Humpback Whale National Marine Sanctuary affords some protections in Hawaiian waters. Recently the IUCN removed the humpback whale from its Red List of species at high risk of extinction due to its increased population, now estimated to be at least 60,000 and growing at 5% per year.

Humpback whales are found in all the world’s oceans. Photo-identification and genetic analysis show three separate stocks of humpbacks within the U.S. EEZ in the North Pacific Ocean that migrate annually (Calambokidis, et al., 1997). The Central North Pacific stock migrates between temperate/polar waters near British Columbia and southeast Alaska to warmer tropical waters around the Hawaiian Islands during the winter/spring months (November-April) to breed and calve. These whales are commonly found within the nearshore waters of Oʻahu during the months of October through May and are known to breed, give birth, and rear their young during this period. While in Hawaiʻi the whales favor shallow (~100 fathoms [fm]) nearshore areas. Humpback whales occur off all eight MHI, but are found in the highest density in the shallow waters of the “four-island” region of Kahoʻolawe, Molokaʻi, Lānaʻi, and Maui; the northwestern coast of the island of Hawaiʻi (Big Island), and the waters around Niʻihau, Kauaʻi, and Oʻahu (Wolman and Jurasz, 1977; Herman et al., 1980; Baker and Herman, 1981). The whales are generally found in shallow waters shoreward of the 600 feet depth contour (Herman and Antinoja, 1977), although Frankel et al. (1989) reported some vocalizing individuals up to 12.4 mi off South Kohala on the west coast of the Big Island over bottom depths of 4,593 feet. Typically mother and calf pairs prefer shallow water less than 600 feet deep (Glockner and Venus, 1983). When present in Hawai’i, humpback whales are regularly seen within the proposed project area.

Little to no feeding occurs in the winter breeding grounds, and the whales live off blubber reserves and may lose up to 20% of their body weight during a winter fasting period. During the summer and fall, the whales frequent polar waters to feed on small schools of fish and krill (Caldwell and Caldwell, 1983).

The primary natural predators of humpback whales are killer whales, and large oceanic sharks. Potential anthropogenic threats to humpbacks may include ship strikes, entanglement with fishing gear, and exposure to high levels of sound, including sonar. Concern about habitat is growing due to the increasing number of whale watching boats observing humpbacks in Alaska and Hawaiʻi.

Hawaiian Monk Seal (Monachus schauinslandi)

The Hawaiian monk seal (HMS) is one of the two extant species of the genus *Monachus*, one of the most primitive genera of seals. The Mediterranean monk seal (*Monachus monachus*) is critically endangered with fewer than 600 individuals left in the wild. The Caribbean monk seal (*Monachus tropicalis*) was last seen in 1952 and declared officially extinct in 1996. The HMS was listed as endangered under the ESA in 1976, and is one of the most endangered marine mammal species in the U.S. The HMS is endemic to the Hawaiian Archipelago, and is the only endangered marine mammal that exists wholly within the jurisdiction of the United States. The HMS is characterized as a strategic stock under the MMPA.

The six major reproductive sites are French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll. Small populations at Necker Island and Nihoa Island are maintained by immigration, and a growing number of seals are found throughout the MHI.

In 2006, the minimum population estimate for the HMS was 1,214 individuals (based on enumeration of individuals of the subpopulations in the NWHI, extrapolation of counts for Nihoa and Necker, and estimates of minimum abundance for the MHI) (Carretta et al., 2006). The best estimate of the total population size was 1,247.

The NMFS collects information and data for HMS sightings in the MHI, but the only complete systematic survey of seals in the MHI was performed in 2000 and 2001. Aerial surveys estimated a minimum abundance of 52 seals in the MHI but reports of seals have increased recently, and as of 2005 the total number of identifiable seals in the MHI was 77 (Baker and Johanos, 2004; Carretta et al., 2006).

Population trends for HMS are determined by the highly variable dynamics of the six main reproductive sub-populations in the NWHI. The sub-population of HMS on French Frigate Shoals has shown the most change in population size, increasing dramatically in the 1960s-1970s and declining in the late 1980s-1990s. From 1989-2005 beach counts at French Frigate Shoals declined 73%. In the 1960s-1970s the other five sub-populations experienced declines. However, during the last decade the number of HMSs increased at Kure Atoll, Midway Atoll, and Pearl and Hermes Reef, while the sub-populations at Laysan Island and Lisianski Island remained relatively stable. At the species level, however, demographic trends over the past decade have been driven primarily by the dynamics of the largest subpopulation at French Frigate Shoals. This population is experiencing an increasingly unstable age distribution resulting in an inverted age structure. This age structure indicates that recruitment of females and pup production is decreasing. In the near future, total population trends for the species will likely depend on the balance between continued losses at French Frigate Shoals, and gains at other breeding locations including the MHI. The recent sub-population decline at French Frigate Shoals is thought to have been caused by male aggression, shark attack, entanglement in marine debris, loss of habitat, and low juvenile survival rate due mainly to food limitation. The HMS is assumed to be far below its optimum sustainable population, and the overall population has declined approximately 3.8% per year since 1998 (Carretta et al., 2006).

HMS are brown or silver in color, depending upon age and molt status, and can weigh up to 600 lb. Adult females are slightly larger than adult males. It is thought that monk seals have a life expectancy of 30 years, but most do not reach their full life potential. HMS spend time in and out of the water, but stay on land for about two weeks during their annual molts. HMS are nonmigratory, but recent studies show that their home ranges may be extensive (Abernathy and Siniff, 1998). Counts of individuals on shore compared with enumerated sub-populations at some of the NWHI indicate that HMS spend about one-third of their time on land and about two thirds in the water (Forney et al., 2000). HMS feed on a wide variety of teleosts, cephalopods, and crustaceans indicating that they are highly opportunistic feeders (Rice, 1964; MacDonald, 1982; Goodman-Lowe et al., 1999).

The HMS population is influenced by human-caused mortality in the NWHI and to a larger extent in the MHI. The MHI is home to 1.2 million people, while less than 100 people inhabit the NWHI. Vessel grounding, damage or destruction of the reef, release of marine debris, and oil spills threaten the HMS habitat and have a higher chance of occurring in the MHI. Hookings of HMS by fisherman are also a cause of injury or death, as is vessel traffic, which is high in the MHI (Carretta et al., 2006).

Non-listed Marine Mammals

Marine mammals not listed as threatened or endangered under the ESA that have been observed in the central Pacific region are listed in Table 3-17. These species are protected under the MMPA.

Table 3-17: Marine Mammals Not Listed as Threatened or Endangered Under the ESA but Observed in the Central Pacific Ocean

Common Name	***Scientific Name***
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
Rough-toothed dolphin	*Steno bredanensis*
Risso’s dolphin	*Grampus griseus*
Bottlenose dolphin	*Tursiops truncatus*
Pantropical spotted dolphin	*Stenella attenuata*
Spinner dolphin	*Stenella longirostris*
Striped dolphin	*Stenella coeruleoalba*
Melon-headed whale	*Peponocephala electra*
Pygmy killer whale	*Feresa attenuata*
False killer whale	*Pseudorca crassidens*
Killer whale	*Orcinus orca*
Pilot whale, short-finned	*Globicephala macrorhynchus*
Blainsville’s beaked whale	*Mesoplodon densirostris*
Cuvier’s beaked whale	*Ziphius cavirostris*
Bryde’s whale	*Balaenoptera edeni*
Pygmy sperm whale	*Kogia breviceps*
Dwarf sperm whale	*Kogia simus*
Minke whale	*Balaenoptera acutorostrata*
Dall’s porpoise	*Phocoenoides dalli*
Fraser’s dolphin	*Lagenodelphis hosei*
Longman’s beaked whale	*Indopacetus pacificus*
Northern elephant seal	*Mirounga angustirostris*
Northern fur seal	*Callorhinus ursinus*

Although false killer whales currently are not listed as “threatened” or “endangered” under the ESA, nor as “depleted” under the MMPA, in September 2009, a petition was submitted to NMFS to list the Hawaiian insular false killer whale stock as an endangered species under the ESA. NMFS completed a status review and issued a proposed rule to list them as endangered (75 FR 70169, November 17, 2010). The insular false killer whale stock is not considered “strategic;” however, the current estimate of mortality and serious injury does not include additional unidentified animals that may have been false killer whales (blackfish) and were taken within the insular stock range, and the status of this stock is likely to change once methods have been developed to prorate these additional takes. The false killer whale is a large member of the dolphin family. False killer whales are found worldwide mainly in tropical and warm-temperate waters (Stacey et al., 1994). They prefer waters deeper than 1,000 meters. They are top predators and eat fish and squid primarily. In the North Pacific, this species is well known from southern Japan, Hawaii, and the eastern tropical Pacific. There are six stranding records from Hawaiian waters (Nitta 1991; Maldini et al. 2005). One on-effort sighting of false killer whales was made during a 2002 shipboard survey of waters within the EEZ around Hawaiʻi (Barlow, 2006). Smaller-scale surveys conducted around the MHI show that false killer whales are also encountered in nearshore waters (Baird et al., 2008; Mobley et al., 2000).

An insular stock around the Hawaiian Islands has been identified. Genetic analyses of tissue samples collected within the Indo-Pacific indicate restricted gene flow between false killer whales sampled near the MHI and false killer whales sampled in all other regions (Chivers et al., 2007, 2010). The recent update from Chivers et al. (2010) included additional samples and analysis of 8 nuclear DNA (nDNA) microsatellites, revealing strong phylogenetic patterns that are consistent with local evolution of haplotypes that are nearly unique to the separate insular population around the MHI.

Recent satellite telemetry studies, boat-based surveys, and photo-identification analyses of false killer whales around Hawaiʻi have demonstrated that the insular and pelagic stocks have overlapping ranges, rather than a clear separation in distribution. Insular false killer whales have been documented as far as 112 km from the MHI, and pelagic stock animals have been documented as close as 42 km to the islands (Baird et al., 2008; Baird, 2009; Baird et al., 2010; Forney et al., 2010). Based on a review of new information (Forney et al., 2010), the 2010 stock assessment report recognized a new, overlapping stock structure for insular and pelagic stocks of false killer whales around Hawaii: unless stock identity can be confirmed through other evidence (e.g., genetic data), animals within 40 km of the MHI are considered to belong to the insular stock; animals beyond 140 km of the MHI are considered to belong to the pelagic stock, and the two stocks overlap between 40 km and 140 km from shore.

For the purposes of this EIS, only the Hawaiʻi insular stock has relevance. In the 2010 stock assessment report, the Hawaiʻi insular stock's population size was estimated at 123 (coefficient of variation, or CV=0.72), based on a mark-recapture study of photo-identification data from 2000-2004 (Baird et al., 2005). The minimum population estimate is the number of distinct individuals identified in this population during the 2002-2004 studies, 76 individuals (Baird et al., 2005). The current population trend is believed to be declining, and no data are available on current or maximum net productivity rates for this species in Hawaiian waters. NMFS' Biological Opinion (Appendix M) does not consider this species.

<u>*Sea Turtles*</u>
In addition to endangered whales and the HMS, listed sea turtles occur in the project area. All species of sea turtles are listed under the ESA as either endangered or threatened, and five species of sea turtles occur in the region. Two are considered endangered: the leatherback (*Dermochelys coriacea*) and the hawksbill (*Eretmochelys imbricata*). The other three are considered threatened: the green (*Chelonia mydas*), the loggerhead (*Caretta caretta*) and the olive ridley (*Lepidochelys olivacea*), although the breeding populations of Mexico olive ridley turtles are currently listed as endangered. The green turtle is listed as threatened under the ESA throughout its Pacific range, except for an endangered population nesting on the Pacific coast of Mexico.

Leatherbacks have the most extensive range of any living reptile and have been reported circumglobally from latitudes 71°N to 42°S in the Pacific and in all other major oceans. The diet of the leatherback turtle generally consists of cnidarians (i.e., medusae and siphonophores) in the pelagic environment. They lead a completely pelagic existence, foraging widely in temperate waters except during the nesting season, when gravid females return to beaches to lay eggs. Typically, leatherbacks are found in convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters.

The loggerhead turtle is a cosmopolitan species found in temperate and subtropical waters and inhabiting continental shelves, bays, estuaries, and lagoons. Major nesting grounds are generally located in warm temperate and subtropical regions, generally north of 25°N or south of 25°S latitude in the Pacific Ocean. For their first several years of life, loggerheads forage in open ocean pelagic habitats. Both juvenile and subadult loggerheads feed on pelagic crustaceans, mollusks, fish, and algae. As they age loggerheads begin to move into shallower waters, where, as adults, they forage over a variety of benthic hard and soft bottom habitats.

The olive ridley is one of the smallest living sea turtles (carapace length usually between 24 and 28 inches) and is regarded as the most abundant sea turtle in the world. Since the directed take of sea turtles was stopped in the early 1990s, the nesting populations in Mexico seem to be recovering, with females nesting in record numbers in recent years. The olive ridley turtle is omnivorous, and identified prey include a variety of benthic and pelagic items such as shrimp, jellyfish, crabs, snails and fish, as well as algae and sea grass.

Hawksbill turtle populations in the Pacific have declined, primarily due to the harvesting of the species for its meat, eggs and shell, as well as the destruction of nesting habitat. Hawksbills have a relatively unique diet of sponges.

Green turtles in Hawaiʻi are genetically distinct and geographically isolated, which is uncharacteristic of other regional sea turtle populations. Both nesting and foraging populations of green turtles in Hawaiʻi appear to have increased over the last 20 years. In Hawaiʻi, green turtles nested historically on beaches throughout the archipelago, but now nesting is restricted for the most part to beaches in the NWHI. More than 90% of the Hawaiian population of the green turtle nests at French Frigate Shoals. Satellite tagging of these animals indicates that most of them migrate to the MHI to feed and then return to breed.

While hawksbill turtles are relatively rare, green turtles are very common in Māmala Bay, and despite the volume of vessel traffic are often seen close to shore and in harbors and marinas. NMFS' Biological Opinion (Appendix M) considers only green and hawksbill turtles as likely to occur in the project area.

<u>*Migratory Birds*</u>

Thirty-nine species of migratory seabirds are known to occur in the Hawaiian Island chain (Table 3-18). Twenty-two of these species breed in Hawaiʻi. The foraging range of some of these species is estimated to be between 98 and 300 miles. Seabirds (e.g., red-footed boobies (*Sula sula*), masked boobies (*Sula dactylatra*), white-tailed tropicbirds (*Phaethon lepturus*), red-tailed tropicbirds (*Phaethon rubricauda*), sooty terns (*Sterna fuscata*), brown noddies (*Anous stolidus*), and others from the colonies located at Kaʻula, Niʻihau, Kauaʻi, and Oʻahu) may be observed foraging in the coastal pelagic waters that surround all of these islands.

Migratory shorebirds and waterbirds are also relatively common (Table 3-21) in the Hawaiian Islands, although within the project area the number of species present is limited and appropriate nesting, foraging or other useful habitat is absent.

Table 3-18: Migratory Birds in the Hawaiian Islands

Scientific Name	*Common Name*	*Status*
Migratory Seabirds		
Phoebastria albatrus	Short-tailed Albatross	Vo E
Phoebastria nigripes	Black-footed Albatross	Bi
Phoebastria immutabilis	Laysan Albatross	Bi
Fulmarus glacialis	Northern Fulmar	Vo
Pterodroma phaeopygia	Hawaiian Petrel	Bes E
Pterodroma externa	Juan Fernandez Petrel	Vo
Pterodroma cervicalis	White-necked Petrel	Vo
Pterodroma inexpectata	Mottled Petrel	Vo
Pterodroma hypoleuca	Bonin Petrel	Bi
Pterodroma nigripennis	Black-winged Petrel	Vo
Bulweria bulwerii	Bulwer Petrel	Bi
Puffinus carneipes	Flesh-footed Shearwater	Vo
Puffinus pacificus	Wedge-tailed Shearwater	Bi
Puffinus griseus	Sooty Shearwater	Vr
Puffinus tenuirostris	Short-tailed Shearwater	Vo
Puffinus nativitatis	Christmas Shearwater	Bi
Puffinus newelli	Newell's Shearwater	Be T
Oceanodroma leucorhoa	Leach Storm-Petrel	Vr
Oceanodroma castro	Band-rumped Storm-Petrel	Bi
Oceanodroma tristrami	Tristram Storm-Petrel	Bi
Phaethon lepturus	White-tailed Tropicbird	Ri
Phaethon rubricauda	Red-tailed Tropicbird	Bi
Sula dactylatra	Masked Booby	Ri
Sula leucogaster	Brown Booby	Ri
Sula sula	Red-footed Booby	Ri
Fregata minor	Great Frigatebird	Ri
Stercorarius pomarinus	Pomarine Jaeger	Vr
Larus atricilla	Laughing Gull	Vo
Larus Philadelphia	Bonaparte Gull	Vo
Larus delawarensis	Ring-billed Gull	Vo
Larus argentatus	Herring Gull	Vo
Larus glaucescens	Glaucous-winged Gull	Vo
Sterna antillarum	Least Tern	Vo
Sterna lunata	Gray-backed Tern	Bi
Sterna fuscata	Sooty Tern	Bi
Anous stolidus	Brown Noddy	Ri
Anous minutes	Black Noody	Res
Procelsterna cerulean	Blue-gray Noddy	Ri
Gygis alba	White Tern	Ri
Migratory Waterbirds		
Dendrocygna bicolor	Fulvous Whistling-Duck	Ri
Branta bernicla	Brant	Vo
Brantacanadensis	Canada Goose	Vo
Anas crecca	Green-winged Teal	Vr
Anas platyrhynchos	Mallard	Vo
Anas acuta	Northern Pintail	Vc
Anas querquedula	Garganey	Vo
Anas discors	Blue-winged Teal	Vo

Table 3-18: Migratory Birds in the Hawaiian Islands

Scientific Name	***Common Name***	***Status***
Anas clypeata	Northern Shoveler	Vc
Anas americana	American Wigeon	Vr
Aythya collaris	Ring-necked Duck	Vo
Aythya afinis	Lesser Scaup	Vr
Gallinula chloropus sandvicensis	Hawaiian Moorhen	Be E
Anas uyvilliana	Hawaiian Duck	Be E
Himantopus mexicanus knudseni	Hawaiian Black-necked Stilt	Be E
Fulica alai	Hawaiian Coot	Be E
Migratory Shorebirds		
Egretta caerulea	Little Blue Heron	Vo
Nycticorax nycticorax	Black-crowned Night-Heron	Ri
Pluvialis squatarola	Blue-bellied Plover	Vr
Pluvialis dominica	Lesser Golden-Plover	Vc
Charadrius semipalmatus	Semipalmated Plover	Vo
Tringa flavipes	Lesser Yellowlegs	Vr
Heteroscelus incanus	Wandering Tattler	Vc
Numenius tahitiensis	Bristle-thighed Curlew	Vr
Limosa lapponica	Bar-tailed Godwit	Vo
Arenaria interpres	Ruddy Turnstone	Vc
Calidris alba	Sanderling	Vc
Calidris mauri	Western Sandpiper	Vo
Calidris minutilla	Least Sandpiper	Vo
Calidris melanotos	Pectoral Sandpiper	Vr
Calidris acuminate	Sharp-tailed Sandpiper	Vr
Calidris alpine	Dunlin	Vr
Philomachus pugnax	Ruff	Vo
Limnodromus griseus	Short-billed Dowitcher	Vo
Limnodromus scolopaceus	Long-billed Dowitcher	Vr
Gallinago gallinago	Common Snipe	Vo
Phalaropus tricolor	Wilson Phalarope	Vo

Source: U.S. Fish and Wildlife Service 2001, unpublished tables
Symbols for Status:
E*=Endangered;* ***T****=Threatened;* ***Be****=Breeder, species breeds only in Hawai‘i;* ***Bes****=Breeder, Species also breeds elsewhere, Hawaiian subspecies breeds only in Hawai‘i;* ***Bi****=Breeder, Hawaiian also breeds elsewhere;* ***Res****=Resident, indigenous species, Hawaiian subspecies is endemic;* ***Ri****=Resident, indigenous species, Hawaiian form is not endemic;* ***Vo****=Visitor, occasional to frequent migrant to Hawai‘i;* ***Vr****=Visitor, regular migrant to Hawai‘i in small numbers.*

ESA-listed Birds

There are three ESA-listed species of seabirds that occur in the central Pacific region. The short-tailed albatross (*Phoebastria albatrus*) is an endangered species found primarily around the Pacific Rim. It is occasionally seen in the central Pacific on Midway Island at the northern end of the NWHI. It has never been sighted south of Kaua‘i, and it would be a major ornithological event were it to be seen in Māmala Bay.

The second ESA-listed seabird species in Hawai‘i is the endangered Hawaiian petrel (*Pterodroma phaeopygia*). The species is known to breed only within the MHI. Its nesting sites are currently restricted to elevations above 7,200 feet where vegetation is sparse and the climate is dry. Nesting colonies are found on Maui and Kaua‘i, but there are no known nesting sites on O‘ahu. Nesting takes place between

March and November. During the remainder of the year these birds forage far out to sea and would not be expected to occur in Māmala Bay.

There is also one listed threatened seabird in Hawaiʻi: Newell's shearwater (*Puffinus auricularis newelli*). This species nests only in the MHI. It was once widespread, but is now reduced to a few remnant breeding colonies on Molokaʻi, Hawaiʻi, and mainly on Kauaʻi because of loss of nesting habitat and predation by introduced species. It does not currently nest on Oʻahu and would not be expected to forage in Māmala Bay.

There are four endangered waterbirds that occur on Oʻahu: Hawaiian moorhen (*Gallinula chloropus sanvicensus*), Hawaiian duck (*Anas wyvilliana*), Hawaiian coot (*Fulica alai*), and Hawaiian black-necked stilt (*Himantopus mexicanus knudseni*). These waterbirds may overfly the project area, but their nesting and foraging areas are in wetlands. The closest waterbird habitat to the project area is in Pearl Harbor.

Corals Proposed for Listing

NMFS has proposed 59 coral species that occur in the Pacific Ocean for listing under the Endangered Species Act, seven as endangered and 52 as threatened. Of those species, three occur in Hawaiʻi. Two, *Montipora patula* and *M. flabellata* occur around Oʻahu. *Montipora patula* and *M. verrilli* are indistinguishable genetically or micro-morphologically, but *M. verrilli* is only found in an encrusting form whereas *M. patula* may be encrusting or plate forming. For purposes of listing, NMFS considers them a single species. According to NMFS, the species has a very restricted range, centered in the main and Northwestern Hawaiian Islands (NWHI), although the International Union for the Conservation of Nature (IUCN) reports the species from other western Pacific and South Pacific islands. In Hawaiʻi, it is sometimes common with a statewide mean cover of 3.3%. *M patula* is the fourth most abundant coral in Hawaiʻi (Brainard, et. al., 2011).

Several marine biological surveys of the HSWAC project area were completed. In characterizing the marine communities in nearshore waters off Kakaʻako Waterfront Park, four biotopes were seen. Progressing seaward from the nearshore area, the following four biotopes are present:

- The biotope of scoured limestone,
- The biotope of scattered corals,
- The biotope of dredged rubble, and
- The biotope of sand.

M. patula was seen only in two of these biotopes, the biotopes of scattered corals and dredged rubble. One colony of *M. patula* was found in the proposed footprint of the HSWAC receiving pit in the biotope of dredged rubble.

Approach to Impact Analysis

The USACE has completed formal ESA Section 7 consultation with NOAA concerning potentially affected species; culminating in NOAA issuance of its Biological Opinion on September 13, 2012 (Appendix M). The impact analysis in this section follows that used by NMFS in constructing its Biological Opinion.

Methodology

NMFS' analysis began by summarizing a description of the proposed action. No interrelated or interdependent actions were identified. The action area was then defined as "For all work, other than pile driving, the action area is estimated to be the in-water area within 50 yards (46 m) of project activities, and the down-current extent of any plumes that may result from mobilized sediments or discharges of wastes or toxic chemicals such as fuels and lubricants associated with the machinery used for this activity. During the proposed pile driving, the action area is extended seaward out to 4,700 meters from the proposed marine receiving pit, to include the waters that may be ensonified by pile-driving noise capable of eliciting behavioral response in ESA-listed marine species." Following that, the status of species likely to be adversely affected and the environmental baseline were summarized. The effects of the proposed action were then evaluated by identifying potential stressors, evaluating exposure and organisms' responses to them, and characterizing the resultant risk to individuals and the respective species.

The stressors identified in NMFS' Biological Opinion included the following:

1. Exposure to elevated noise levels;
2. Entrainment;
3. Collision with vessels;
4. Direct impact by heavy equipment;
5. Disturbance from human activity and equipment operation;
6. Loss or degradation of sheltering and forage habitat;
7. Exposure to Elevated turbidity; and
8. Exposure to wastes and discharges.

Determination of Significance
Degree to which the proposed project would affect ESA-listed species or their habitat.

USACE determined that the proposed action would be likely to adversely affect humpback whales (*Megaptera novaeangliae*), Hawaiian monk seals (*Monachus schauinslandi*), green sea turtles (*Chelonia mydas*), and hawksbill sea turtles (*Eretmochelys imbricata*), but would not be likely to affect, or have no effect on, the remaining ESA-listed marine species in the region.

Impacts

No Action Alternative
The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effects on protected marine species because there would be no marine construction or system operation.

Alternative 1
The paragraphs below discuss potential effects of the above stressors and NMFS' conclusions relative to their significance, in the order the stressors are presented above.

Once the pipes are laid on the bottom, securing the shallow anchor collars with piles would begin. Noise from this operation could affect species protected under the MMPA or the ESA. Under the ESA, all Federal agencies (e.g., the USACE) must ensure that any actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify its designated critical habitat. Both endangered marine mammals and endangered and threatened sea turtles may occur in the ROI and USACE determined that the proposed action is likely to adversely affect green and hawksbill sea turtles, humpback whales, and Hawaiian monk seals. No critical habitat exists in the ROI.

Under the MMPA, "take" includes harassing, hunting, capturing, or killing, or attempting to do any of those things. Harassment is defined as any act of pursuit, torment, or annoyance which:

- Has the potential to injure a marine mammal or stock in the wild (Level A), or
- Has the potential to disturb a marine mammal or stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B).

Construction noise can be an "incidental" take. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 et seq.) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review. An authorization shall be granted if NMFS finds that the taking would be small, have a negligible impact on the species or stock(s), would not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses, and that the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth. NMFS has defined "negligible impact" in 50 CFR 216.103 as "...an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

Pile driving would be required for both sheet piles around the receiving pit and pipe piles to secure the collars in shallow water. Consequently, the applicant submitted an application for an Incidental Harassment Authorization (IHA) under the MMPA. The IHA was approved on August 21, 2012. The IHA specified the following BMPs for implementation during in-water work:

1. Limit work to daylight hours so the BMPs can be carried out.
2. Constant vigilance shall be kept for the presence of Federally-listed species
3. When piloting vessels, vessel operators shall alter course to remain at least 100 yards from whales, and at least 50 yards from other marine mammals.
4. Reduce vessel speed to 10 knots or less when piloting vessels in the proximity of marine mammals.
5. Marine mammals should not be encircled or trapped between multiple vessels or between vessels and the shore.
6. If approached by a marine mammal, put the engine in neutral and allow the animal to pass
7. All in-water work shall be postponed when whales are within 100 yards, or other marine mammals are within 50 yards. Activity may commence only after the animal(s) depart the area.
8. Should protected species enter the area while in-water work is already in progress, the activity may continue only when that activity has no reasonable expectation to adversely affect the animal(s).
9. Do not attempt to feed, touch, ride, or otherwise intentionally interact with any protected species.

In addition to NMFS - recommended BMPs, the following exclusion zone, shut down and soft start practices shall be implemented:

10. Establishment of Exclusion Zones. Before any pile driving, a clearly marked exclusion zone of 100 yards from the pile driver for all marine mammals would be established. The exclusion zone would be marked by buoys for easy monitoring. One biological observer per pile driver barge would survey the exclusion zone to ensure that no marine mammals are seen within the zone 30 minutes before pile driving begins and during pile driving operations. If marine mammals were found within the safety zone, pile driving would be delayed until they move out of the area.
11. Shut Down. If a marine mammal is seen approaching or within the exclusion zone, pile driving operations would be shut down until the animal has left the exclusion zone or 15/60 minutes (pinniped/cetacean) have passed without the animal being seen.
12. Soft Start. Although marine mammals would be protected from harassment by establishment of an exclusion zone, mitigation may not be 100 percent effective at all times in locating marine mammals. In order to provide additional protection to marine mammals near the project area allowing marine mammals to vacate the area, thus further reducing the incidence of harassment from startling marine mammals with a sudden intensive sound, a "soft start" would be implemented. Under a soft start, pile driving would be initiated at an energy level less than full capacity (i.e., approximately 40-60 percent

energy levels) for at least 5 minutes before gradually escalating to full capacity. This would minimize harassment of, although not expected, any marine mammals that are undetected during safety zone monitoring.

In its Biological Opinion, NMFS concluded that: "Based on the expected source levels and proposed mitigation measures, NMFS expects that no marine mammals would be exposed to sound intensity at or above the level required for the onset of PTS [permanent threshold shift]." Further, regarding humpback whales: "…NMFS expects that humpback whale TTS [temporary threshold shift] is improbable, and that any impact on hearing sensitivity would recover rapidly after exposure to the sound ends. NMFS further expects that behavioral responses in the form of mild alert and startle responses, avoidance of the project area, and brief or minor modification of vocal behaviors are the most probable humpback whale responses to exposure to the in-water sounds of pile driving, with no measurable impacts expected to occur on their ability to forage, shelter, navigate, reproduce, and avoid predators and other threats such as vessels.

With regard to effects on Hawaiian monk seals, NMFS concluded that "…TTS would be improbable for exposed Hawaiian monk seals, and that any impact on hearing sensitivity would recover rapidly after exposure to the sound ends. NMFS further expects that behavioral responses in the form of mild alert and startle responses, avoidance of the project area, and alteration in diving patterns are the most probable Hawaiian monk seal responses to exposure to the in-water sounds of pile driving….no measurable impacts [are] expected to occur on their ability to forage, shelter, navigate, reproduce, and avoid predators and other threats such as vessels."

With regard to effects on sea turtles, NMFS concluded that "…TTS is improbable, and that any impact on hearing sensitivity would recover rapidly after exposure to the sound ends. NMFS further expects that behavioral responses in the form of mild alert and startle responses, avoidance of the project area, and alteration in swimming and diving patterns are the most probable responses of green and hawksbill turtles that are exposed to the in-water sounds of pile driving….no measurable impacts [are] expected to occur on those turtles' ability to forage, shelter, navigate, reproduce, and avoid predators and other threats such as vessels."

Operation of the intake may result in entrainment of marine organisms, the second identified stressor. CWA Section 316(b) requires the USEPA to ensure that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts associated with impingement and entrainment of organisms in intake pipes.

The owner or operator of a new cooling water intake structure must comply with the requirements of CWA Section 316(b). Two options for compliance, Track I or Track II, are available. The applicant is pursuing Track II, which requires demonstration that the technologies employed would reduce the level of adverse environmental impact from the cooling water intake to a level comparable to what would be achieved under Track I. Track II requirements would be met if it the deep ocean intake would entrain at least 90% less than what would be entrained in a comparable shallow water intake. The applicant prepared an entrainment analysis based on the best available information about what is likely present at the intake depth off Oʻahu. That analysis may be found in Appendix N. The analysis began with a search of the available scientific literature regarding the concentrations in shallow and deep water around Hawaiʻi of various types of organisms that potentially could be entrained in the intake. The types of organisms analyzed included fish eggs and larvae, other types of larvae including those of corals and crustaceans, zooplankton of several size categories, phytoplankton, micronekton including typical mesopelagic boundary community organisms and larger fish. The conclusions of that analysis were that entrainment of marine biota would be reduced from 93% to 100% for different groups of organisms, and that Track II requirements would therefore be met by the proposed intake structure. To further quantify the likely entrainment effects of a shallow-water intake, the applicant obtained data from HECO's entrainment monitoring program for its three Oʻahu generating stations that have seawater cooling water intakes. Data on numbers of larval fish entrained per unit volume and total biomass entrained per unit volume were obtained and used to calculate what would constitute 90% reductions in those parameters. The HECO monitoring program was then used by the applicant as a model to propose an HSWAC entrainment monitoring program that would generate numbers that could be compared with the HECO shallow-water results.

As noted above, current USEPA regulations are designed to control the impact of shallow water intakes (surface water sources) in rivers, bays and over the continental shelf. Deep ocean intakes are a relatively new development that does not present the risks to resident aquatic communities that shallow intake structures do. Experience with deep ocean intakes has been gained at the Natural Energy Laboratory of Hawaiʻi (NELH) at Keāhole Point on the Big Island. NELH has the largest seawater supply system with regards to size and capacity, and employs the deepest large diameter pipeline in any ocean throughout the world. NELH has three deep seawater pipelines. Installed in 1987, NELH's 40-in pipeline pumps 5,000 gallons/minute of 43°F water to the surface from a pipeline 2,010 feet deep. The offshore pipe length is 6,284 feet. Also installed in 1987, an 18-in pipeline extends offshore to a length of 6,180 feet, and pumps 3,000 gallons/minute from 2,060-ft deep. NELH's largest pipeline, 55-in diameter, more recently came on line. This pipeline extends offshore 10,247 feet, and intakes water at a depth of 3,000 feet. Overall, NELH does not have issues with impingement or entrainment, organisms clogging the pumps, or with fouling delivery pipes.

At NELH, a half inch mesh intake screen box covers the 40-in sump, and the filter is checked every four to six months. Usual findings include small fish (2-4 in), shrimp, and invertebrates. The total volume of organisms found in the filter after four to six months varies from a half to one gallon. The 18-in system has a stainless steel mesh over the intake with a mesh size of 3/8 in-1/2 in. NELH has not experienced impingement issues with this pipeline.

If fish are entrained in the pipeline they usually die before they reach the surface due to changes in atmospheric pressure that cause their swim bladders to burst. Invertebrates, however, are unaffected by the pressure change and can live if entrained in the pipeline. NELH does not filter the deep seawater before it enters the heat exchangers. The heat exchangers have never been opened or serviced, and have not been fouled or ever required cleaning.

Because all of the action alternatives incorporate the same intake location, the potential effects of impingement and entrainment would be the same for all of these alternatives. All of the action alternatives would utilize the following approaches to reduce entrainment (and impingement):

- The intake location is approximately five miles offshore at a depth of about 1,750 feet. The euphotic zone (zone of photosynthetic light) does not extend to this depth. At the intake depth biological productivity is much less than at shallower depths and the lower density of organisms reduces the potential for impingement and entrainment.
- The maximum velocity of the intake (approximately 5 feet/sec. or 3.4 miles per hour) would limit entrainment of macroorganisms.
- Variable speed pumps would be used which would provide for greater system efficiency and reduced flow requirements (and associated entrainment).

Some monk seals and sea turtles could dive to the depth of the HSWAC intake. According to the Recovery Plan for the Hawaiian Monk Seal (NMFS, 2007), adult male monk seals have been observed to dive to below 500 meters, so an adult male monk seal could conceivably reach the intake depth. Females and pups dive shallower than adult males and would not be expected to reach such depths. The question then is could an adult monk seal escape the intake suction. The intake flow, at the mouth of the pipe, is moving at 3.4 mph, and the speed decreases further out in the cone of influence. It is reported that true seals, such as monk seals, can reach speeds of 14-24 mph (Oregon Coast Aquarium, n.d.), a speed at which they could easily extract themselves from the influence of the intake.

The applicant consulted with NMFS representatives about potential entrainment of protected species. In consideration of a screened intake, NMFS was concerned about the size of the screen openings. To maintain adequate flow rates, the screen openings would have to be fairly large, possibly large enough for seals to get their heads stuck in the screen. Smaller holes would restrict flow and clog faster due to fouling. Restricted flow across the screen would require pumps to operate harder, increasing costs and reducing system efficiency. It would also increase the suction effect at the screen because the water would have to move faster through the constriction in order to maintain desired flow volumes. It is likely that the presence of a screen could increase the probability of a seal becoming impinged (pinned against the screen) by the inflow, as compared to being able to freely swim out of the inflow of an open-ended intake. Fouling organisms on the screen also could entice seals to investigate the intake more closely than they may have otherwise. For these reasons, NMFS does not object to the lack of a screen on the intake and believes the risk of a monk seal being entrained in the open intake is discountable.

While the most common sea turtle in the project area, the green turtle, is not known to dive to the intake depths (Rice and Balazs, 2008), leatherback turtles do dive to such depths (Eckert, et al., 1986). Leatherback sea turtle extended cruising speeds have been measured at 6.26 mph (Eckert, 2002) and brief bursts can be expected to exceed that. It is thus likely that a leatherback turtle could also extract itself from the influence of the intake.

In conclusion, in the unlikely event that a Hawaiian monk seal or sea turtle entered the cone of influence of the HSWAC intake, their swimming capability would be more than adequate to escape entrainment (Oregon Coast Aquarium, n.d.; Eckert, 2002). Based on the NELH experience, it is likely that some small quantity of smaller-sized fish and invertebrates would be entrained and impinged on the screen at the cooling station. This would constitute a direct, long-term adverse, but less than significant effect. The applicant has not proposed any measures to mitigate for the anticipated impacts due to the entrainment and impingement of organisms.

In its Biological Opinion (Appendix M), NMFS concludes that “Based on habitat preferences and diving abilities, NMFS considers it discountable that green or hawksbill sea turtles as well as humpback whales would encounter the intake. However, Hawaiian monk seals are known to dive to and forage at depths equal to or greater than the planned intake’s depth….Based on the best information available, NMFS considers it likely that the presence of a screen could increase the probability of a seal becoming impinged (pinned against the screen) by the inflow, as compared to being able to freely swim out of the inflow of an open-ended intake. NMFS also believes that fouling organisms on the screen could entice seals to investigate the intake more closely than they may have otherwise. NMFS expects that exposure to inflow would discourage seals from closer approach, and that based on the maximum expected flow velocity, as well as monk seal swimming speed and agility, any monk seal that might encounter the in-flow would be able to swim away from the open intake. Thus, NMFS considers that the risk of monk seal entrainment in the intake is discountable….”

The third and fourth stressors identified by NMFS are collision with vessels and direct impact by heavy equipment. Potential impacts due to construction activities would be as follows. Under Alternative 1, work at the breakout point would span about seven to nine months, so there would be obstructions (platform, vessels, etc.), at least intermittently, in shallow water for that duration. It would be unlikely for a whale to enter waters that close to the shore in Kakaʻako, but even if that were to happen, the slow movement of work vessels would not present a hazard and the submarine structures (sheet piles, mooring piles, etc.) would be readily apparent. It is more likely that sea turtles would pass through the area, but again, turtles could easily avoid stationary structures or slowly moving vessels. The NMFS has determined the risk of collisions between action-related vessels and protected species to be discountable, based on the expectation that the vessels would be operated in accordance with BMPs that require vessel operators to watch for and avoid protected marine species and to operate at reduced speeds.

Deployment of the seawater pipes would extend the work area much farther seaward for a shorter period of time. Installation of the intake and return pipes would preferably occur in winter when ocean conditions along the southern shores of O‘ahu are calmer than at other times of the year. However, winter is also when humpback whales migrate into Hawaiian waters to breed and calve. The volume of vessel traffic in Māmala Bay makes the habitat less attractive to whales than more isolated coastal areas, but humpbacks still occur in the area. Offshore project activities would be done from stationary or very slowly moving vessels decreasing the risk of a collision between a project vessel and a humpback whale. Most of the pipeline installation work would be done close to, or on the sea floor rather than in the water column. Installation would be limited in duration to about 24 hours. The rate of descent and the speed at which the pipe and collars intersect the bottom would be less than 0.5 mph, or roughly the speed of a very slow walk. There is a concern, however, about a juvenile or adult whale striking a partially deployed pipe during the critical hours when the pipe is being sunk into place. A lookout system such as a picket line of tender vessels would be positioned around the work area during the deployment operation to minimize this risk, as well as to temporarily secure the area from other vessel traffic.

To reduce or eliminate potential adverse effects to protected marine species from vessel and construction operations, the following NMFS-recommended BMPs would be followed during in-water activities such as boat operations or diving.

1. Constant vigilance would be kept for the presence of Federally-listed species,
2. When piloting vessels, vessel operators would alter course to remain at least 100 yards from whales, and at least 50 yards from other marine mammals and sea turtles,
3. Vessel speed would be reduced to 10 knots or less when piloting vessels in the proximity of marine mammals,
4. Vessel speed would be reduced to 5 knots or less when piloting vessels in areas of known or suspected turtle activity,
5. Marine mammals and sea turtles would not be encircled or trapped between multiple vessels or between vessels and the shore,
6. If approached by a marine mammal or turtle, vessel operators would put the engine in neutral and allow the animal to pass,
7. Unless specifically covered under a separate permit that allows activity in proximity to protected species, all in-water work would be postponed when whales are within 100 yards, or other protected species are within 50 yards. Activity would commence only after the animal(s) depart the area,
8. Should protected species enter the area while in-water work is already in progress, the activity may continue only when that activity has no reasonable expectation to adversely affect the animal(s), and
9. Project personnel would not attempt to feed, touch, ride, or otherwise intentionally interact with any protected species.

Risks to protected species from entanglement in markers, buoys or moorings would also be minimized through implementation of appropriate mitigation measures, such as the following.

1. Mooring systems would be designed to keep the lines as tight as practicable, with the intent to eliminate the potential for loops to form.
2. Mooring lines would each consist of a single line per anchor. No additional lines or material capable of entangling protected species would be attached to a mooring line or to any other part of the deployed system.

3. Mooring systems would be designed to keep gear off the bottom, such as by use of a mid-line float where appropriate, with the intent to eliminate scouring of corals or entanglement of the line on the substratum.
4. Proposals for permanent or long-term deployments would include an inspection and maintenance program to reduce the likelihood of failures that may result in loose mooring lines lying on the substratum or hanging below a drifting buoy.
5. Mooring systems, including those used for temporary markers, would be completely removed from the marine environment immediately at the end of project construction, or the mooring's service life. The only exceptions to this rule would be mooring anchors such as eyebolts that are epoxied into the substratum and which pose little or no risk to marine life.

With implementation of appropriate mitigation measures, the NMFS has determined that "…disturbances from human activity and equipment operation would be infrequent and non-injurious, resulting in insignificant affects on marine mammals and sea turtles."

The sixth stressor identified by NMFS was loss or degradation of sheltering and forage habitat. Construction of the pipelines could impact potential forage habitat of ESA-listed species. However, epibenthic life would likely re-colonize damaged areas and become established on the surfaces of the new structures after construction is complete. NMFS concluded that "…the loss or degradation of sheltering and forage habitat due to the construction of the pipeline would be relatively small in scope and temporary in duration."

The seventh stressor identified by NMFS was increased turbidity. Isolation of the receiving pit would minimize construction-related turbidity, but it is likely that some turbidity would be generated during construction and protected marine species may temporarily avoid turbid areas. The NMFS has determined that "…it is unlikely that any sea turtles or marine mammals would approach close enough to the work area to be exposed to project-related elevated turbidity….we expect that exposure to elevated turbidity would have insignificant impacts on sea turtles and marine mammals…"

The final stressor identified by NMFS was wastes and discharges. Construction and vessel wastes could entangle marine life or expose protected species to toxic chemicals. The applicant and their contractors would adhere to State and Federal regulations regarding discharge of toxic wastes and plastics during construction and operation of the system. Consequently, NMFS determined "…that exposure to construction-related wastes and discharges would result in insignificant effects on sea turtles and marine mammals…"

Once the HSWAC system is operational, a plume of return seawater would originate at the diffuser and be advected downslope. It is possible that marine mammals or sea turtles would pass through the plume. Marine mammals and sea turtles have a much greater tolerance to temperature extremes than do corals. Marine mammals in particular are known to forage below the thermocline. Evolutionarily, marine mammals have developed the physiological adaptation of thermoregulation which, combined with their efficient insulation (i.e., the blubber layer), allows their distribution range to extend from warm equatorial waters to the coldest high latitudes (Perrin et al., 2002). The leatherback sea turtle, known to dive to 3,000 feet also has thermoregulatory adaptations such as a counter-current heat exchange system, high oil content, and large body size which allow them to maintain a core body temperature higher than that of the surrounding water and tolerate colder water temperatures (NMFS OPR, n.d.). In any event, if the temperature in the vicinity of the return seawater discharge were unsuitable for a mammal or sea turtle for any reason, such highly motile animals would be expected to leave the area. To the extent that the elevated dissolved inorganic nutrient concentrations in the artificial upwelling created by the discharge stimulated benthic algae downstream of the diffuser, turtle foraging habitat could be enhanced. No further impacts of the return seawater on protected marine species would be expected.

In summary, NMFS' Biological Opinion concludes that of the eight potential stressors identified above, only the potential impacts of noise to humpback whales, Hawaiian monk seals, green turtles and hawksbill turtles are not discountable or insignificant. NMFS further concludes in their Biological Opinion that the risk of the expected exposure to pile driving noise from the HSWAC project of reducing the likelihood of survival and recovery of any of these species is negligible.

In the Biological Opinion, NMFS established the following non-discretionary Reasonable and Prudent Measures that USACE shall implement:

1. USACE shall reduce impacts on ESA-listed marine species and their habitats through the employment of BMP and conservation measures.
2. USACE shall monitor and report to NMFS any take of ESA-listed marine species that results from the proposed action.

Similarly, in the Biological Opinion, NMFS established the following non-discretionary Terms and Conditions:

1. To meet reasonable and prudent measure 1 above, USACE shall ensure that the applicant and/or their contractors comply fully with the BMP and conservation measures identified in the Administrative Draft EIS, the HSWAC Mitigation Plan, and the Mitigation Plan outlined in the Proposed IHA.
    a. All workers associated with this project, irrespective of their employment arrangement or affiliation (e.g. employee, contractor, etc.) shall be fully briefed on the required BMP and conditions, and their requirement to adhere to them for the duration of their involvement in this project.
    b. The USACE shall periodically inspect the off-shore project site to ensure that appropriate BMP and conservation measures are in place or enacted.
    c. The USACE shall ensure that the applicant establishes and complies with appropriate protected species exclusion zones around pile driving.
    d. The USACE shall ensure that no vibratory pile driving takes place between December 1 and March 31.
2. To meet reasonable and prudent measure 2 above, USACE shall ensure that the applicant and/or their contractors comply fully with the monitoring and reporting plans identified in the Administrative Draft EIS, the HSWAC Mitigation Plan, and the Mitigation Plan outlined in the Proposed IHA.
    a. The USACE shall ensure that the applicant performs acoustic monitoring at the onset of both pile driving types (impact and vibratory) to ensure that the acoustic estimates used in the consultation are appropriate.
    b. The USACE shall ensure that the applicant reports the preliminary results of acoustic monitoring in a timely manner so that NMFS and USACE can confirm the efficacy of the exclusion zones for the protection of marine mammals, or to adjust them as necessary.
    c. USACE shall ensure that the applicant employs vessel-borne protected species observers as described in the IHA.
    d. In addition to compliance with the monitoring and reporting requirements set forth in the IHA, the USACE shall require the applicant to:
        i. Document and immediately report to the USACE all protected species interactions, such as any observation of humpback whales within the 4,700-meter exclusion zone around sheet pile driving, any humpback whales or monk seals within the 1,000-meter exclusion zone around pipe pile driving, and any sea turtles within the 46-meter zone around pipe pile driving.
        ii. Report any dead or injured sea turtles to the Sea Turtle Stranding Hotline at 808-983-5730.

e. USACE would in turn report interactions to NMFS Protected Resources Division (PRD) at 808-944-2233/2242 and by e-mail to *Donald.Hubner@noaa.gov* and *Patrick.Opay@noaa.gov*. Notification of an injurious protected species interaction shall be done within 24 hours. Weekly notification of NMFS PRD shall suffice for non-injurious protected species interaction reports.

f. The USACE shall track all incidences of take in a manner that would allow them to recognize the potential for exceeding the level of take authorized in this ITS, and so that corrective measures might taken to prevent an exceedance. g. Within 180 days of the completion of project construction, the USACE shall submit a report to NMFS. That report shall include: 1) The dates and times of site visits, with the name and title of the inspecting person, the findings of the inspection, and any corrective measures taken to ensure compliance with the required BMP and conservation measures; 2) The results of acoustic monitoring; and 3) The results of protected species monitoring efforts.

With respect to potential effects on migratory birds, it is unlikely that Hawaiian petrels would forage in Māmala Bay because there are no nesting colonies on O‘ahu and the species forages far out to sea. No impacts to this listed species would be expected from the proposed project. Several other species of migratory birds use coastal and offshore waters for foraging activities, and local troll fishermen use them as guides to target fish such as marlin, mahimahi, and tuna. Typically, these birds work waters much farther from shore than those in the project area; however, if they did occur in the project area, they could easily avoid collisions with the slow-moving or stationary work vessels. Turbidity generated by construction activities could obscure forage fish to the extent they stay within the turbid waters; however, it's more likely fish would avoid a plume of turbid water. No significant adverse effects would be expected to migratory birds. The HSWAC project would not affect waterbird nesting or foraging habitat as there are no wetlands in the project area.

In summary, Alternative 1 would have a potentially significant, direct, short-term, adverse effect mitigable to less than significant on protected species by modifying their behavior during construction. In particular, construction noise may cause behavioral modifications in marine mammals and sea turtles. Mitigation measures included in both the IHA and the Biological Opinion would minimize effects on individuals and these species.

The coral species proposed for listing by NMFS were not considered in the Biological Opinion. A finer scale survey of the footprint of the proposed receiving pit location of the preferred alternative found one colony of *M. patula* that would be directly affected by excavation of the receiving pit. This was an encrusting form 26-30 cm in size. Depending on the preconstruction survey results the receiving pit location may be altered, which may avoid the M. patula colony. Other colonies which may exist in adjacent areas, are not expected to be affected by the excavation. However, there is the potential that colonies may be inadvertently affected by vessel anchoring and/or turbidity generation during construction. *M. patula* was found in the biotope of dredged rubble, through which the pipelines would pass. This biotope extends to a depth of 29 meters along the preferred pipeline route. There would be 15 concrete collars from the receiving pit to the 29 meter depth, each covering 76 square feet (7.06 square meters). The estimated amount of coral cover to be lost beneath the footprint of the collars is 12.5 square feet (1.16 square meters). It is unknown whether *M. patula would be affected*. The potential impacts to *M. patula* would be the same under Alternatives 1, 3 and 4 (preferred alternative) because they all would employ Type A collars within the biotope which *M. patula* may occur. In conclusion, it is anticipated that the proposed project may result in minimal adverse effects to *M. patula*, but is not likely to jeopardize its continued existence.

Alternative 2
The potential effects of Alternative 2 on protected species would be the same as those described for Alternative 1. However, the potential impacts of Alternative 2 to *M. patula* would likely be greater than those of the other alternatives because Alternative 2 would employ many more Type A collars through the depth range where *M. patula* may occur.

Alternative 3
The effects of Alternative 3 would be the same as those described for Alternative 1.

Alternative 4 (Preferred Alternative)
The effects of Alternative 4 would be the same as those described for Alternative 1.

3.7.5.4 **Essential Fish Habitat**

The USACE completed an EFH assessment for the HSWAC project; it is contained in Appendix J and was used to initiate consultation with the NMFS under the MSA. A summary of the conclusions of the assessment by alternative is presented in this section.

The MSA defines EFH as those waters and substrata necessary to fish for spawning, breeding, feeding, or growth to maturity. "Waters," when used for the purpose of defining EFH, include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include historical areas of use where appropriate. Substrata include sediment, hard bottom, underlying structures, and associated biological communities. Regional Fishery Management Councils are responsible for identifying and describing EFH for each Federally-managed species, minimize to the extent practicable adverse effects on such habitat caused by fishing and non-fishing activities, and identify other actions to encourage the conservation and enhancement of such habitat.

The designation of EFH by the Western Pacific Regional Fishery Management Council (WPRFMC or the Council), which has responsibility for the EEZ around Hawai‘i and other U.S. flagged island areas in the Pacific, was based on groups of species managed under its five former fishery management plans (FMP): pelagics, bottomfish and seamount groundfish, precious corals, crustaceans, and coral reef ecosystems. These species-based plans have been superseded by archipelago-based fishery ecosystem plans (FEP), but the EFH and habitat areas of particular concern (HAPC) designations have not changed.

The Council identified HAPC within EFH for all FMPs (Table 3-19). In determining whether a type or area of EFH should be designated as a HAPC, the area had to meet one or more of the following criteria:

- The ecological function provided by the habitat is important,
- The habitat is sensitive to human-induced environmental degradation,
- Development activities are or will be stressing the habitat type, or
- The habitat type is rare.

Table 3-19: Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) for all Western Pacific FMPs

FMP	*EFH (Juveniles and Adults)*	*EFH (Eggs and Larvae)*	*HAPC*
Pelagics	*Water column down to 1,000 m	*Water column down to 200 m	Water column above seamounts and banks down to 1,000 m
Bottomfish and Seamount Groundfish	[1]Bottomfish: Water column and bottom habitat down to 400 m Seamount Groundfish: (adults only) water column and bottom from 80 to 600 m, bounded by 29°-35°N and 171°E-179°W	[1]Bottomfish: Water column down to 400 m Seamount Groundfish: (including juveniles) epipelagic zone (0 to 200 m) bounded by 29°-35°N and 171°E-179°W	[1]Bottomfish: All escarpments and slopes between 40 and 280 m, and three known areas of juvenile ōpakapaka habitat Seamount Groundfish: not identified
Precious Corals	Keāhole Point, Makapuu, Kaena Point, Westpac, Brooks Bank, 180 Fathom Bank deep-water precious corals (gold and red) beds and Milolii, Au‘au Channel and S. Kaua‘i black coral beds	Not applicable	Makapuu, Westpac, and Brooks Bank deep-water precious corals beds and the Au‘au Channel black coral bed
Crustaceans	*Lobsters: Bottom habitat from shoreline to a depth of 100 m *Deep-water shrimp: The outer reef slopes at depths from 300-700 m	*Water column down to 150 m *Water column and associated outer reef slopes from 550-700 m	All banks with summits less than 30 m No HAPC designated for deep-water shrimp
Coral Reef Ecosystems	*Water column and benthic substrata to a depth of 100 m	*Water column and benthic substrata to a depth of 100 m	All MPAs identified in FMP, all PRIA, many specific areas of coral reef habitat (see FMP)

(Source: WPRFMC, 2009) Notes: All areas are bounded by the shoreline and the outer boundary of the EEZ, unless otherwise indicated. * Denotes EFH and HAPC potentially impacted by the proposed project. [1] Bottomfish EFH will be modified soon to define three new complex EFH designations within the 0-400 m depth range for shallow, mid-water, and deep-water species. Bottomfish HAPC also will be modified so that the depth range is replaced with seven discrete areas around the main Hawaiian Islands, none of which would be impacted by the proposed project.

Approach to Analysis

The ROI for EFH is the same as that for protected marine species. Because of the general paucity of life-stage specific information about Federally-managed marine species in the Western Pacific Region, EFH was designated as broadly as possible. Essentially every part of the water column and seafloor from the shoreline to the 200-mile limit of the EEZ is EFH for one species or another. A subset of EFH is Habitat Areas of Particular Concern (HAPC). HAPC are specific areas that are essential to the life cycle of Management Unit Species (MUS). At least one or more of the following criteria established by NMFS must be met for HAPC designation: (1) the ecological function provided by the habitat is important; (2) the habitat is sensitive to human-induced environmental degradation; (3) development activities are, or would be, stressing the habitat type; or (4) the habitat type is rare. It is possible that an area can meet one HAPC criterion and not be designated an HAPC. The WPRFMC used a fifth criterion, not established by NMFS, in HAPC designation of areas that are already protected, such as wildlife refuges (WPRFMC, 2005). Potential effects to EFH include modifications to either the water column or the seafloor in the ROI.

Methodology

The potential effects of the HSWAC project to the seafloor are described in Section 3.7.2 and potential effects to the water column are described in Section 3.7.4. The discussion below summarizes the conclusions of the USACE's EFH assessment (Appendix J).

Determination of Significance

Pursuant to 50 CFR 600.910(a), an "adverse effect" on EFH is defined as any impact that reduces the quality and/or quantity of EFH. In the context of the proposed action, a significant adverse effect on EFH would be one that permanently reduces the quality and/or quantity of a relatively large area of habitat considering the availability of the habitat type affected, reduces quality and/or quantity of the ecological function of the area in question, or reduces the quality and/or quantity of a rare or particularly sensitive habitat type.

Impacts

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effects on EFH because there would be no construction or facilities operation in the marine environment.

Alternative 1

The applicant selected the proposed location of the receiving pit (or "breakout point") for Alternative 1 to avoid coral reefs or coral-dominated communities. This breakout point would become a temporary pit (40 by 40 feet and 20 feet deep) in the biotope of dredged rubble where corals are sparse. The locations of the anchors or piles to be used to tension the pipes during deployment also would be selected to avoid corals.

Sheet piles or a combination of sheet piles and silt curtains to protect the adjacent ecosystem would surround the seafloor at the excavation site, but the excavation of the breakout pit would destroy any infaunal organisms resident in the removed sand. Once the connections between the surface-mounted pipes and the microtunneled pipes are complete, the breakout pit would be backfilled with crushed basalt gravel (pre-washed to ensure fines are not introduced). Tremie concrete would be used to cap the filled pit (to be even with surrounding bottom contours) and for filling and capping the piles that would be driven to hold the collars in place in shallow water. From the location of the receiving pit to the end of the diffuser, 91 Type A pipe collars would be used. Each of these collars would cover 76 ft^2 of substratum, but would provide an exposed surface of about 313 ft^2.

Both the concrete and HDPE pipe are expected to provide stable substrata suitable for the settlement and growth of corals and other sessile benthic species. Further, the vertical relief afforded by the collars would be greater than found on existing hard substratum in the pipeline corridor. This greater vertical relief would provide separation of recruiting corals and other invertebrates from the potential scour caused by the movement of sand and rubble during periods of high surf in the project area. Therefore, the presence of the pipes and collars may result in some benefit to EFH.

Marine structures are well known to attract and concentrate fish, although whether this represents only attraction or an actual increase in biomass production has been the subject of debate and is reviewed by Pickering and Whitmarsh (1997). The addition of material to increase the vertical relief in otherwise barren areas is well-known and usually takes the form of artificial reefs. Artificial reefs in Hawaiian waters may serve to increase fish standing crops to more than 0.2 lb ft^{-2} (Brock and Norris, 1989). The HSWAC pipelines would be expected to enhance resident fish populations to an unknown extent. Recruitment and growth of an epibenthic coral community on the structures is likely to attract and support growth of associated fish populations by providing additional food, shelter from predation, and shelter from tidal currents.

Receiving pit to diffuser construction:

Based on the Coral Survey of Appendix O, the proposed receiving pit location is dominated by sand with scattered small individual coral colonies, which occupy an estimated 0.32% of the seafloor. The proposed construction would affect a total of 29 coral colonies, ranging in size from 5-30 cm, with the average size being 14 cm. A total of 0.43 m^2 (4.6 ft^2) of coral cover would be removed. However, the spur ridges adjacent to the proposed receiving pit footprint have a much more developed coral community. Following completion of construction, the receiving pit would be backfilled and capped with concrete to match original seafloor contours. Coral communities are expected to recruit and eventually occupy the receiving pit footprint following construction. The applicant proposes to transplant the 15 coral colonies greater than 10 cm as described in Appendix O. The marine contractor selected to install the seawater pipe structures would perform a detailed preconstruction survey of the conditions at the receiving pit and along the pipeline alignment. Based on the preconstruction survey, minor adjustments to the location of receiving pit and concrete collars may be proposed to avoid coral colonies and/or minimize the potential for inadvertent impacts to surrounding coral colonies.

Combination collars (Type A) covering 6,916 ft^2 would be deployed from the receiving pit to the end of the diffuser at a depth of 150 feet. Under Alternative 1, this would, in its entirety, take place in the biotope of dredged rubble, where live coral cover is a very sparse 1.1% and colony sizes average 4.6 cm. Assuming some additional coral loss by construction operations (vessel anchors, etc.), it is estimated that cumulatively less than 100ft^2 of living coral would be destroyed.

Deep-water pipeline collars:

Based on the relatively low numbers of coral reef organisms (and coral reef ecosystem MUS) observed during the submersible survey from 50-200 m depth, along with the prevalence of natural bedrock and dredge spoil deposits as hard substratum, the impact of the pipe on the coral reef EFH is expected to be minimal. Many of the organisms that were observed were associated with large substrate features, such as outcrops and boulders, which the applicant intends to avoid during installation of the pipe.

Overall, the proposed pipeline collars would cover 14,427 ft^2 of substrate, but the collars would create 155,257 ft^2 of new elevated surface and the pipes themselves would create an additional 408,125 ft^2 for potential colonization by sessile benthic organisms.

Benthic and fish communities are poorly developed on the rubble slope or sand/rubble bottom, and the deployment of the pipe would have a short-term, direct, adverse effect on these communities. Direct loss to fish populations is not expected. The proposed intake location is approximately five miles offshore at a depth of about 1,755 feet, while the euphotic zone (zone of photosynthetic light) typically does not extend beyond the first 330 feet of depth. The intake depth biological productivity is much less than at shallower depths and the lower density of organisms reduces the potential for impingement and entrainment. The relatively low maximum velocity of the intake (approximately 5 ft/sec. or 3.4 miles per hour) is expected to minimize potential entrainment of macro-organisms. The applicant's planned use of variable speed pumps would enable adjustment of flow to the minimum needed to match system requirements.

Construction effects:

Effects from construction activities are expected, primarily in the form of temporarily altered water quality, primarily turbidity, in the immediate vicinity of the breakout pit. The type of sediment being excavated (primarily sand) is expected to sink relatively quickly. By isolating the receiving pit within sheet piles or a combination of sheet piles and turbidity curtains, the applicant plans to confine effects of the work so as to mitigate impacts on adjacent coral reef habitat. Working in an area where there are relatively few corals present minimizes the effects of constructing Alternative 1 on coral communities. There would be a direct, short-term effect on nekton as a result of the turbidity generated in the vicinity of the construction operations – some of these organisms would avoid turbid areas while others would be attracted to displaced or exposed benthic organisms. In addition, light available to phytoplankton would be temporarily reduced and filter feeding zooplankton may ingest particulate matter with increased turbidity. Indirect effects may be experienced in adjacent areas to the extent nekton are displaced.

System operation:

Once operational, the HSWAC return seawater discharge would impact water quality and marine biota within a defined ZOM located in the biotope of sand. Under worst case conditions, the applicant estimates that ambient water quality standards would be met within about 150 feet of the diffuser. Within 10 feet from the centerline of the diffuser, the applicant estimates that the dilution would be sufficient to meet water quality standards for temperature. Cold water temperatures within the proposed ZOM may inhibit coral growth and/or survival if the temperature at the sea bottom is reduced below thermal thresholds. Outside this zone, nutrient supplements may enhance coral growth through increased densities of zooxanthellae as a result of bringing increased dissolved inorganic nutrients found in deep water. However, the extent and degree of adverse and/or beneficial affects of the proposed return seawater discharge at this depth (120-150 ft) is unknown. Therefore, adverse affects on corals in the area affected by the return seawater plume would likely result, meaning that HSWAC operations would have a direct, long-term adverse affect on EFH in the ZOM. This may be offset to some extent by the artificial hard substrate and vertical relief that would be provided by the structures (anchor collars and pipes).

The operation of the completed system would create a relatively low-velocity current at the elevated deep-water intake at a bottom depth of approximately 535 m, which could potentially entrain pelagics (juveniles and adults) and deep-water shrimp MUS.

In summary, Alternative 1 would have short-term, direct and indirect, less than significant adverse effects on EFH. The seawater return discharge may have a potentially significant but mitigable to less than significant direct long term adverse effect on EFH; however, long term indirect effects may be beneficial overall.

<u>Alternative 2</u>

The effects of Alternative 2 would be similar to those described for Alternative 1, with one major exception. The proposed breakout point under Alternative 2 would be in the biotope of dredged rubble, as under Alternative 1; however, unlike the conditions offshore of the Alternative 1 breakout point where dredged rubble gives way to sand bottom further offshore, seaward of the Alternative 2 breakout point is a narrow area of relatively high coral cover frequented by recreational divers. The mean coral cover in that area is about 49%, corals are complex and developed and highly valued by recreational divers, occurring at depths from about 52 feet to 62 feet. The area of increased coral cover is 150 feet wide where the proposed pipe alignment for Alternative 2 crosses it. Due to an alignment that exposes the pipeline to more physical stress, approximately double the number of Type A collars per unit length would be installed for Alternative 2 as for Alternative 1, with a total of about 11 collars in this region, each covering 76 ft^2 of substratum. This would result in about 410 sf of live coral being destroyed in this short section of the route. Additional live coral would be impacted relative to Alternative 1 because more collars would be installed at depths typically colonized by coral, although a biotope of sand and rubble extends seaward where the mean coral cover is 0.001% beyond the depths of the narrow biotope of high coral cover.

The pipeline collars under Alternative 2 would cover 21,377 ft^2 of substratum. The collars would create 150,984 ft^2 of artificial substratum and the pipes themselves would create an additional 423,653 ft^2 for potential colonization by sessile benthic organisms. However, the emplacement of the collars supporting the pipes would affect more live coral due to direct impacts under Alternative 2 than under Alternative 1.

In summary, Alternative 2 would result in potentially significant but mitigable to less than significant short and long term direct adverse effects. However, the short term indirect effects of coral losses may be potentially significantly adverse. Long term indirect effects of the structures would be expected to provide benefits to EFH.

Alternative 3

The effects of Alternative 3 would be the same as those described for Alternative 1, with one major exception. The diffuser would terminate at a depth of 300 feet, rather than at a depth of 150 feet. As for Alternative 1, the concrete and HDPE pipe would provide settlement and growth opportunities for corals and other sessile benthic species. Overall, the proposed pipeline for Alternative 3 would cover 18,901 ft^2 of substratum. The collars would create 168,589 ft^2 of substratum and the pipes themselves would create an additional 429,854 ft^2.

The placement of the collars supporting the pipes would affect more live coral under Alternative 3 than under Alternative 1 because Type A collars would be used for the length of pipeline from the receiving pit to the end of the diffuser. Because the end of the diffuser would be located an additional 1,537 feet further seaward under Alternative 3, it would require use of 102 more Type A collars and 102 fewer Type B collars. The installation of more Type A collars would result in an additional 7,676 ft^2 of substratum being covered and the reduction of Type B collars would result in 3,201.7 ft^2 less substratum being covered, for a total of 4,474.3 ft^2 of additional substratum being covered for Alternative 3 than for Alternative 1.

Once operational, the HSWAC return seawater discharge would impact water quality and marine biota within a defined ZOM located in the biotope of sand. There is the potential for presence of mesophotic corals down to the depth of the Alternative 3 diffuser, which may be adversely affected.

In summary, Alternative 3 would have short-term, direct, less than significant adverse effects on EFH and long term potentially significant adverse direct effects on the EFH. Short term indirect effects to the EFH would be less than significant. Long-term indirect effects may be beneficial due to the presence of the structures.

Alternative 4 (Preferred Alternative)

The effects of Alternative 4 would be the same as those described for Alternative 1, except that the diffuser would terminate at a depth of 423 feet, rather than at a depth of 150 feet. As for Alternative 1, the concrete and HDPE pipe would provide opportunities for settlement and growth of corals and other sessile benthic species. Overall, the proposed pipeline for Alternative 4 would cover 20,541 ft^2 of substratum, but the collars would create 173,473 ft^2 of substratum and the pipes themselves would create an additional 430,498 ft^2.

The footprint of the collars supporting the pipes would affect more substratum under Alternative 4 than under Alternative 1 because the larger Type A collars would be used for the entire pipeline alignment from the receiving pit to 300 foot depth. With the diffuser to be located an additional 1,909 feet further seaward under Alternative 4, it would require use 138 more of the larger Type A collars and 138 fewer of the smaller Type B collars. The installation of more Type A collars would result in a net increase of 6,114 ft^2 of additional substratum being covered for Alternative 4 than for Alternative 1.

Once operational, the HSWAC return seawater discharge would impact water quality and marine biota within a defined ZOM located in the biotope of sand. The lack of coral at the greater proposed depth for the diffuser under Alternative 4 (423 feet) means coral growth and/or survival would not be expected to be inhibited by cold water temperatures within the discharge plume. Additionally, the return seawater would be closer to ambient water quality conditions than any of the other alternatives. Therefore, the anticipated adverse effects on corals in the area affected by the return seawater plume under Alternative 1 are not expected under Alternative 4. Impacts to corals would be the least under Alternative 4.

In summary, Alternative 4 would have short-term, direct, indirect and long term direct, less than significant adverse effects on EFH. Potential long-term indirect effects may provide benefits to EFH.

EFH Consultation
Based on the complete analysis in Appendix J, the USACE has determined that the applicant's proposed construction and operation of the HSWAC system under any of the action alternatives "may adversely affect" EFH. USACE consolidated its EFH consultation with the environmental review procedures required by the National Environmental Policy Act (NEPA).

The Conservation Recommendations provided by NMFS in the EFH consultation process may be found in Appendix J and are summarized as follows:

1. Gather additional biological information and analyze in greater detail the available science to allow determination of the holistic effects of the return water discharge, particularly from nutrients, to the nearshore marine community including EFH.
2. Evaluate how public use of resources within the project footprint would be affected by project construction and operations.
3. Ensure that a detailed mitigation plan consistent with the 2008 Rule for Compensatory Mitigation for Losses of Aquatic Resources is appropriately developed and implemented.
4. Condition the permit with specific and detailed monitoring requirements that would trigger project modification to reduce impact if adverse impacts are detected during operations.
5. Prior to and/or during construction implement the following avoidance and minimization measures:
    a. Avoid conducting in-water nearshore construction operations during periods when heights of the front of waves exceed five feet to minimize risk of uncontrolled movement of equipment.
    b. Ensure that all materials and structures such as the pipeline, anchor systems, silt curtains, are installed/placed on sand bottom or non-coral covered substrate to avoid to the greatest extent possible coral or macro-invertebrates being crushed and /or abraded.
    c. Implement BMPs, such as silt curtains, as specified in the Hawaiʻi Department of Health Water Quality Certification to minimize turbidity from construction activities including dredging, dewatering, sheet pile driving, and installation of pipes.

Additional quantitative biological surveys of the project area and an inventory of coral resources within the proposed receiving pit were conducted to augment previous surveys and are described in Chapter 3.7.5.1. The return water discharge pipe of the new preferred alternative (Alternative 4) would terminate at a water depth of 423 feet to minimize potential water quality related impacts to nearshore marine communities, including coral resources. The anticipated impacts of the return water discharge on aquatic resources are described in Chapters 3.7.4.5, 3.7.5.1., and 3.7.5.2. Anticipated affects of the proposed project on public use resources are evaluated in

Chapter 3.3. The DA permit, if issued, would be conditioned to ensure that adverse impacts to aquatic resources, including EFH, are avoided and minimized to the maximum extent practicable.

3.8 TERRESTRIAL RESOURCES

3.8.1 Definition of the Resource and the Region of Influence

Terrestrial resources are defined to include topography, geology and soils; climate and air quality; groundwater and surface water, and terrestrial biota. The ROI includes the area around the cooling station site and the Sand Island staging area.

3.8.2 Topography, Geology and Soils

3.8.2.1 Existing Conditions

The Kaka‘ako Peninsula lies on the Honolulu coastal plain, an emerged fossil reef formed approximately 120,000 years ago (MacDonald and Abbott, 1970). Within the project area coral reefs and eroded volcanic material have formed a wedge of sedimentary rock and sediments, referred to as caprock, which rests on the underlying volcanic rock. Caprock is composed predominantly of coral-algal limestone interlaid with clays and muds. The ocean-side fronting Kaka‘ako Waterfront Park is underlain by a coral layer between 5 and 20 feet below mean sea level (MSL). Soft lagoonal deposits made up of sand, silt, and clay are found above the ancient reef, and are especially prominent in a buried stream channel which extends below Ala Moana Boulevard between Keawe and Ohe Streets to the ocean. Soft alluvial soils within the channel area extend to depths of 50 to 65 feet below sea level. These deposits are covered by 5 to 10 feet of dredged coral fill (Okamoto, 1998).

According to the soil survey maps published by the United States Department of Agriculture, Soil Conservation Service (1972), surface soils in the Kaka‘ako area are described as fill land. Fill land generally consists of materials dredged from the ocean and from other sources.

The topography of the project area (cooling station and distribution route) is generally flat (less than 5% slope) with elevations 5 to 15 feet above MSL. An exception is the large mound located in Kaka‘ako Waterfront Park near the proposed cooling station. This mound was originally formed as a debris mound between 1927 and 1977 when the area was an incinerator landfill and was 400 feet wide by 1,700 feet long and 15 to 55 feet in elevation (Okamoto, 1998). The mound was resculptured in conjunction with the development of the park. At its highest point the mound is currently 53 feet in elevation (Okamoto, 1998).

The alternative cooling station sites are located on the southern coastal plain of O‘ahu. Prior to being reclaimed in the late nineteenth and early twentieth centuries, the Kaka‘ako area consisted of mudflats and marshes adjacent to Honolulu Harbor. The general geology of the area, consisting of lagoonal deposits underlain by coralline sediments and alluvial deposits overlying basaltic bedrock, reflects changing depositional environments associated with rising and falling sea levels. During the Waipio Stand of the Sea, sea level fell to 60 feet or more below the present level and streams flowed out of the Ko‘olau Mountains and into the Pacific Ocean carving out deep alluvial channels in the vicinity of Honolulu. One of these buried channels is likely present in the vicinity of the site. Based on readily available geologic information, a buried channel may run roughly from the corner of Keawe Street and Ala Moana Boulevard through the corner of Ilalo and Coral Streets and then continue south.

The anticipated subsurface conditions in the vicinity of the cooling station alternative sites are described as follows. The sites are located in a reclaimed area. Subsurface conditions in this area are generally anticipated to consist of variable amounts of fill material at the surface underlain by lagoonal deposits, coralline sediments, alluvial deposits, and basaltic bedrock. The lagoonal deposits are anticipated to consist of loose sandy silt, silty sand, and silty gravel. Coralline sediments underlying the lagoonal deposits are anticipated to consist of medium dense sand and gravel with layers of cemented coralline material and/or coral ledges. The coralline sediments are anticipated to be underlain by basaltic bedrock at depths of approximately 100 to 150 feet below existing grades. It is anticipated that variable amounts of alluvial deposits may be encountered. These alluvial deposits may be interbedded with, or be present in place of, the lagoonal deposits.

The proposed Sand Island staging area is on fill land reclaimed from the lagoon by dredging of the seaplane runways.

3.8.2.2 **Approach to Impact Analysis**

Terrestrial portions of the system would be constructed in highly urbanized areas with impact mitigating conditions mandated by local authorities. In addition, dewatering and testing of excavated materials for reuse or disposal would take place at upland sites in accordance with Federal and State regulations. Potential impacts and appropriate mitigation measures are described below.

Methodology

Construction operations were evaluated for their potential impact to topography, geology and soils. The project area is relatively flat and there are no significant geological resources, so the focus was on soil erosion from construction sites. Processing, evaluation and disposition of the excavated materials would be done by a contractor, which has not yet been selected. However, major aspects of this operation would be established in contract specifications and so the assessment below proceeds on the basis of a most likely scenario.

Determination of Significance

A significant adverse effect in terms of soil erosion would occur if there were a regulatory violation. Likewise, a significant adverse effect of the spoils disposition process would be a direct regulatory violation such as inadequate erosion control or an indirect effect creating a risk to human health or safety, or potential ecological damage.

3.8.2.3 **Impacts**

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term direct adverse effect on topography, geology or soils because there would be no construction under this alternative. No generation of spoils under this alternative would preclude the possibility of direct or indirect effects from that source.

Alternative 1

The cooling station site for Alternative 1 is flat and level; it is currently used for at-grade parking. As noted above, adverse effects to topography or geology would not occur, but soil erosion control would be an issue. To implement the project would require obtaining a grading, grubbing, and stockpiling permit from the City and County of Honolulu. Obtaining this permit would require a project-specific erosion control plan. With implementation of the erosion control plan, direct adverse effects to soils would not occur, nor would indirect effects of runoff and sedimentation.

Excavation of the cooling station sump, the shoreline jacking pit, the offshore receiving pit, the microtunnels, the upper few feet from the emplaced pipe piles, and the distribution system trenches would all generate spoils requiring dewatering, testing and disposition. The applicant’s intent is to beneficially reuse all non-contaminated spoils; however, contamination from some of these sources may be evident after testing. The results of the applicant's Phase 2 environmental site assessment indicate that historic landfill materials (including ash and debris consistent with material from the incinerator landfill site) would be encountered during excavation of surface soils at the shoreline jacking pit location, and that limited petroleum contamination may be encountered during excavation at the cooling station. The applicant has prepared and the State of Hawaiʻi has accepted an Environmental Hazard Management Plan (EHMP) (Appendix D) that specifies testing requirements for the excavated materials and disposal requirements for contaminated spoils. Implementation of the EHMP would eliminate the potential for adverse effects from these sources.

All holding areas would be lined to prevent fluids from leaching into the ground and transportation of spoils from one location to another would be done in lined and covered trucks. No holding areas would be established inland of the State's Underground Injection Control line to avoid potential leaks in areas above potable groundwater aquifers.

Excavated materials from each of the sources would be segregated so that uncontaminated spoils could be beneficially reused as construction fill or, lacking a market for them, disposed of at the PVT Land Company, LTD construction and demolition materials landfill where they could be used for interim cover. The PVT landfill operates in accordance with Chapter 342H, Hawaii Revised Statutes and Title 11 Administrative Rules Chapter 58.1 Solid Waste Management Control, which preclude disposal of hazardous or toxic materials at the landfill.

The contractor may opt to remediate petroleum contaminated spoils rather than ship them to an approved disposal site. This would be done in accordance with HAR 11-58.1-42, Remediation Facilities. Both a permit and a leachate management plan would be required and the selected site could not be located in an area susceptible to flooding, in wetlands, close to potable water supplies, near a fault area or any other unstable location. Locations around the reef runway at Honolulu International Airport previously have been used for this purpose, and presumably could be so used again.

With implementation of the above measures, Alternative 1 would have no direct or indirect, short-term or long-term adverse effect on topography, geology or soils or adverse indirect effects on air quality, water quality, human health and safety, or ecological systems.

<u>Alternative 2</u>

The effects of Alternative 2 would be similar to those described for Alternative 1. The Alternative 2 cooling station site is also flat, level and paved. The nearshore jacking pit, however, would not be required under Alternative 2 and thus the most likely source of contaminated spoils would be avoided.

<u>Alternative 3</u>

The effects of Alternative 3 would be the same as described for Alternative 1. The cooling station location would be the same under those alternatives.

<u>Alternative 4 (Preferred Alternative)</u>

The effects of Alternative 4 would be the same as described for Alternative 1. The cooling station location would be the same under those alternatives.

3.8.3 Climate and Air Quality

3.8.3.1 Climate

<u>Existing Conditions</u>

The climate of the project area is characterized by abundant sunshine, persistent tradewinds, and moderate and constant temperature and humidity. The average temperature recorded at the Honolulu International

Airport ranges from 70°F in the coolest month to 84°F in the warmest month (with extremes of 52°F and 96°F). The average amount of annual rainfall varies greatly with location. For example, the yearly average is 18.3 inches at the airport but 152.1 inches in Mānoa Valley (DBEDT, 2003). The project site is located in an area that would likely have a climate similar to that at the airport. Insolation (incoming solar radiation) in the project area is approximately 1,840 British thermal units (Btu)/ft^2-day (DBEDT, 2005).

Approach to Impact Analysis

Greenhouse gases are gases that trap heat in the atmosphere by absorbing infrared radiation. Without this natural greenhouse effect, the average surface temperature of the Earth would be about 60°F colder (U.S. Global Change Research Program [USGCRP], 2009). Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in GHG emissions from human activities. The climate change associated with this global warming is predicted to produce negative environmental, economic and social consequences across the globe.

Greenhouse gas emissions occur from natural processes and human activities. Water vapor is the most important and abundant GHG in the atmosphere. However, human activities produce only a very small amount of the total atmospheric water vapor. The most common GHGs emitted from natural processes and human activities include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The main source of GHGs from human activities is the combustion of fossil fuels, including crude oil and coal. Examples of GHGs created and emitted primarily through human activities include fluorinated gases (hydro fluorocarbons and per fluorocarbons) and sulfur hexafluoride.

Each GHG is assigned a global warming potential (GWP). The GWP is the ability of a gas or aerosol to trap heat in the atmosphere. The GWP rating system is standardized to CO_2, which has a value of one. For example, CH_4 has a GWP of 21, which means that it has a global warming effect 21 times greater than CO_2 on an equal-mass basis (Intergovernmental Panel on Climate Change [IPCC], 2007). To simplify GHG analyses, total GHG emissions from a source are often expressed as a CO_2 equivalent (CO_2e). The CO_2e is calculated by multiplying the emissions of each GHG by its GWP and adding the results together to produce a single, combined emission rate representing all GHGs. While CH_4 and N_2O have much higher GWPs than CO_2, CO_2 is emitted in such higher quantities that it is the overwhelming contributor to CO_2e from both natural processes and human activities.

Recent observed changes due to climate change include rising temperatures, shrinking glaciers and sea ice, thawing permafrost, a lengthened growing season, and shifts in plant and animal ranges. International, national, and state organizations independently confirm these findings (IPCC, 2007; USGCRP, 2009).

Predictions of long-term environmental impacts due to global climate change include sea level rise, changing weather patterns with increases in the severity of storms and droughts, changes to local and regional ecosystems including the potential loss of species, and a significant reduction in winter snow pack.

Federal agencies are, on a national scale, addressing emissions of GHGs by reductions mandated in Federal laws and EOs, most recently EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management.* Several states have promulgated laws as a means to reduce statewide levels of GHG emissions. The Council on Environmental Quality (CEQ) published *Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions* in February 2010 (CEQ, 2010). The guidance outlines ways in which Federal agencies can improve their consideration of the effects of GHG emissions. In a NEPA context the intent is to estimate the GHG emissions that would be generated by each project alternative. However, one of the major benefits of the HSWAC system would be a reduction of fossil-fueled electricity demand and its associated production of greenhouse gases so the analysis of the net benefits of the entire HSWAC system was based on available system planning information and industry and HECO-specific production data. The calculations are provided in Appendix C.

An indirect effect of climate change is sea level rise. The potential effects of proposed GHG emissions on sea level are by nature global and cumulative, as individual sources of GHG emissions are not large enough to have an appreciable effect on climate change or sea level. Therefore, the impact of sea level rise on project facilities is discussed focuses on the net reduction in GHG emissions as a consequence of the action alternatives.

Operations of the HSWAC system would substantially reduce the amount of electricity needed for air conditioning in the downtown area. According to the applicant, the proposed project would reduce the annual emissions from fossil fuel consumption by the following estimated amounts[13]:

- Carbon Dioxide (CO_2) Emissions - 83,000 tons/year
- Volatile Organic Compounds (VOC) Emissions - 5 tons/year
- Carbon Monoxide (CO) Emissions - 28 tons/year
- Particulate Matter under 10 microns (PM_{10}) Emissions - 19 tons/year
- Nitrogen Oxides (NO_x) Emissions - 169 tons/year
- Sulfur Oxides (SO_x) Emissions - 165 tons/year

Methodology
The applicant's calculation in the context of cumulative impacts can be found in Section 3.9.2 of this EIS. Because this EIS evaluates the effects of construction and installation of components of the seawater system, including the cooling station, the effects identified below are restricted to those related to the seawater portions of the proposed action.

Determination of Significance
A long-term net increase in production and emission of greenhouse gases would constitute a significant adverse effect.

Impacts

No Action Alternative
The No Action Alternative would have no direct or indirect, short-term or long-term adverse effect on climate because there would be no change in current greenhouse gas emissions.

Alternative 1
Alternative 1 would have a less than significant, short-term, direct adverse effect on climate due to the greenhouse gases emitted as a result of construction vehicles and equipment. Beneficial effects would result once the entire HSWAC system becomes operational.

Alternative 2
Alternative 2 would have the same effects on climate change as Alternative 1.

Alternative 3
Alternative 3 would have the same effects on climate change as Alternative 1.

Alternative 4 (Preferred Alternative)
Alternative 4 would have the same effects on climate change as Alternative 1.

[13] Calculations of these amounts are described in Appendix C.

3.8.3.2 **Air Quality**

Existing Conditions

Ambient concentrations of air pollutants are regulated by both national and State ambient air quality standards (AAQS) (Table 3-20). As shown in the table, national and State AAQS have been established for particulate matter (PM), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone, and lead. Particulate matter includes dust, soot, smoke, and liquid droplets. The State also has a standard for hydrogen sulfide.

Table 3-20: Summary of State of Hawai'i and National Ambient Air Quality Standards

Pollutant (all units in $\mu g/m^3$ unless otherwise noted)	*Averaging Time*	*Maximum Allowable Concentration*		
		National Primary [a]	*National Secondary* [b]	*State of Hawai'i* [c]
Particulate Matter (≤10 microns)	Annual 24 Hours	150	- 150	50 150
Particulate Matter (≤2.5 microns)	Annual 24 Hours	15 35	15 35	- -
Sulfur Dioxide	Annual 24 Hours 3 hours 1 Hour	0.03 ppm 0.14 ppm - 75 ppb	- - 0.5 ppm -	80 365 1300 -
Nitrogen Dioxide	Annual 1 hour	53 ppb 100 ppb	53 ppb -	70 -
Carbon Monoxide	8 Hours 1 Hour	9 ppm 35 ppm	- -	5,000 10,000
Ozone	8 Hours 1 Hour	0.075 ppm 0.12 ppm	0.075ppm 0.12 ppm	- 100
Lead	Rolling 3 Month Average Quarter	0.15 -	0.15	- 1.5
Hydrogen Sulfide	1 Hour	-	-	35

[a] Designated to prevent adverse effects on public health. Source: 40 CFR Part 50

[b] Designated to prevent adverse effects on public welfare, including effects on comfort, visibility, vegetation, animals, aesthetic values, and soiling and deterioration of materials. Source: 40 CFR Part 50.

[c] Designated to protect public health and welfare and to prevent significant deterioration of air quality. Source: HAR 11-59-1

Sulfur oxides, which include SO_2, are colorless gases emitted primarily by power plants, refineries and volcanic activity. Nitrogen dioxide is a brownish, highly corrosive gas with a pungent odor that is formed from nitrogen oxides emitted during combustion of fossil fuels by electric utilities, industrial boilers, and vehicles. Carbon monoxide is a colorless, odorless, and tasteless gas produced by the incomplete combustion of fossil fuels, primarily motor vehicles. Ozone is formed in the atmosphere by a chemical reaction of nitrogen oxides and volatile organic compounds in the presence of sunlight. Although an ozone layer in the upper atmosphere shields the earth from harmful ultraviolet radiation, high ozone levels at ground level can cause harmful effects to humans and plants. Lead is a naturally occurring substance that has been used extensively in paint and gasoline. Hydrogen sulfide is a colorless malodorous gas with the smell of rotten eggs, mainly associated with sewage or volcanic emissions.

The national AAQS are stated in terms of primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect public health with an "adequate margin of safety." National secondary standards define levels of air quality necessary to protect public welfare from "any known or anticipated adverse effects of a pollutant." The State AAQS are designed "to protect public health and welfare and to prevent the significant deterioration of air quality." The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects.

The HDOH operates a network of nine air quality monitoring stations at various locations on O‘ahu. Each station monitors certain air quality parameters. The closest monitoring station to the project area is located at 1250 Punchbowl Street, which is within the project area. An air pollutant emission summary for downtown Honolulu at this station for the years 2004 to 2006 is shown in Table 3-21. There were no exceedances of the standards for the measured parameters.

The project area is an attainment area for all national and State AAQS. Although CO measurements taken at the monitoring stations suggest that concentrations are in compliance with the State standards, CO concentrations near congested intersections could exceed the State AAQS at times.

Approach to Analysis

Methodology
Construction operations associated with the seawater portion of the HSWAC system were assessed for their potential to adversely affect air quality.

Determination of Significance
Impacts to air quality would be considered significant if an alternative would generate emissions that may result in air pollutant concentrations above the Federal or State Ambient Air Quality Standards (AAQS), contribute to pollutant concentrations already above the AAQS, or interfere with AAQS attainment.

Impacts

No Action Alternative
The No-Action Alternative would have no direct or indirect, short-term or long-term, adverse effects on air quality because there would be no construction.

Alternative 1
For a project of this nature there are two potential types of air pollutant emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust and (2) exhaust emissions from on-site construction equipment. There also could be direct, short-term adverse impacts from slow-moving construction equipment traveling to and from the project site and from delivery of large materials on slow moving trucks. Air emissions would occur at the Sand Island staging area and offshore, as well as at the cooling station site.

O‘ahu and the proposed project location are in attainment of AAQS. The impact from Alternative 1 would be an increase in pollutants from operation of construction vehicles and equipment. However, construction vehicles and equipment are not considered major stationary sources, and there are no standards or criteria set for non-stationary equipment. Based on this information, exhaust emissions during construction of the proposed project would not have significant impacts on air quality. BMPs for mitigation of fugitive dust would be undertaken at the cooling station location and wherever earth moving takes place. Specific mitigation measures would be established as conditions of construction permits, but typical mitigation measures include watering the exposed surfaces, covering dirt being transported and keeping offsite roadways clean. USEPA-recommended mitigation measures include the following.

Fugitive Dust Source Controls:

- Stabilize open storage piles and disturbed areas by covering and/or applying water or chemical/organic dust palliative where appropriate. This applies to both inactive and active sites, during workdays, weekends, holidays, and windy conditions.
- Install wind fencing and phase grading operations where appropriate, and operate water trucks for stabilization of surfaces under windy conditions.
- When hauling material and operating non-earthmoving equipment, prevent spillage and limit speeds to 15 mph. Limit speed of earth-moving equipment to 10 mph.

Table 3-21: Annual Summaries of Ambient Air Quality Measurements in Downtown Honolulu

Pollutant	***Average Time***	***SAAQS ($\mu g/m^3$)***	***NAAQS ($\mu g/m^3$)***	***Maximum Concentration ($\mu g/m^3$)***			***Number of Exceedances SAAQS***			***Number of Exceedances NAAQS***		
				2004	***2005***	***2006***	***2004***	***2005***	***2006***	***2004***	***2005***	***2006***
CO	1 hr	10,000	40,000	2736	3876	2850	0	0	0	0	0	0
	8 hrs	5,000	10,000	1496	1610	1226	0	0	0	0	0	0
PM_{10}	24 hrs	150	150	36	64	25	0	0	0	0	0	0
	Annual	50	50	13	15	13	0	0	0	0	0	0
$PM_{2.5}$	24 hrs	---	65	10	45	10	---	---	---	---	---	0
	Annual	---	15	4	4	3	---	---	---	---	---	0
SO_2	3 hrs	1,300	1,300	56	75	43	0	0	0	0	0	0
	24 hrs	365	365	25	23	15	0	0	0	0	0	0
	Annual	80	80	1	1	1	0	0	0	0	0	0
Source: HDOH, 2004-2006												

Mobile and Stationary Source Controls:

- Reduce use, trips, and unnecessary idling from heavy equipment.
- Maintain and tune engines per manufacturer's specifications to perform at the USEPA certification levels and to perform at verified standards applicable to retrofit technologies. Employ periodic, unscheduled inspections to limit unnecessary idling and to ensure that construction equipment is properly maintained, tuned, and modified consistent with established specifications.
- Prohibit any tampering with engines and require continuing adherence to manufacturer's recommendations.
- If practicable, lease newer and cleaner equipment that would meet the most stringent of applicable Federal or State standards.
- Utilize USEPA-registered particulate traps and other appropriate controls where suitable to reduce emissions of diesel particulate matter and other pollutants at the construction site.

Administrative Controls:

- Identify where implementation of mitigation measures is rejected based on economic infeasibility.
- Prepare an inventory of all equipment prior to construction and identify the suitability of add-on emission controls for each piece of equipment before groundbreaking. (Suitability of control devices is based on: whether there is reduced availability of the construction equipment due to increased downtime and/or power output, whether there may be significant damage caused to the construction equipment engine, or whether there may be a significant risk to nearby workers or the public.)
- Utilize cleanest available fuel engines in construction equipment and identify opportunities for electrification. Use low sulfur fuel (diesel with 15 parts per million or less) in engines where alternative fuels such as biodiesel and natural gas are not possible.

The overall project will have a longterm indirect beneficial effect on air quality by reducing following emissions:

- Carbon Dioxide (CO_2) Emissions - 83,000 tons/year
- Volatile Organic Compounds (VOC) Emissions - 5 tons/year
- Carbon Monoxide (CO) Emissions - 28 tons/year
- Particulate Matter under 10 microns (PM_{10}) Emissions - 19 tons/year
- Nitrogen Oxides (NO_x) Emissions - 169 tons/year
- Sulfur Oxides (SO_x) Emissions - 165 tons/year

In summary, Alternative 1 would have a less than significant, short-term, direct adverse effect on air quality during project construction and a longterm indirect beneficial effect on air quality.

Alternative 2
The effects of Alternative 2 on air quality would be as described for Alternative 1.

Alternative 3
The effects of Alternative 3 on air quality would be as described for Alternative 1.

Alternative 4 (Preferred Alternative)
The effects of Alternative 4 on air quality would be as described for Alternative 1.

3.8.4 Water Resources

The subsections below describe the surface water and groundwater resources in the ROI for the Federal action.

3.8.4.1 Surface Waters

Existing Conditions

There are no streams within the ROI. The runoff from Kaka'ako Waterfront Park is collected by a storm drain system and routed to the Keawe Street open channel or Kewalo Basin.

Coastal waters in the vicinity of the project site are Class A marine waters according to HDOH Water Quality Standards. Class A waters are to be protected for recreational and aesthetic enjoyment.

Approach to Impact Analysis

Methodology

Potential effects of the proposed action on marine water quality are described above. This section describes potential effects on terrestrial surface waters. As there are no surface water resources in the ROI, the potential for non-point source runoff from construction sites through storm drains is examined.

Determination of Significance

Violation of State water quality standards or permit conditions designed to minimize the potential effects of dewatering effluents and construction storm water runoff would constitute a significant adverse effect.

Impacts

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effects on surface waters because there would be no construction under the No Action Alternative.

Alternative 1

Alternative 1 would have no direct or indirect, short-term or long-term, adverse effects on surface waters because there are no surface waters in the vicinity of proposed construction activities. Alternative 1 would require a grading, grubbing, and stockpiling permit from the City and County of Honolulu. Obtaining this permit would require a project-specific soil erosion control plan. With treatment of dewatering fluids as described below and the erosion control plan, no adverse effects to surface waters would occur as a result of the proposed project. The construction contractor would be required to comply with Section II (Storm Water Quality) of the City's Rules Relating to Storm Drainage Standards.

Alternative 2

The potential effects of Alternative 2 would be the same as for Alternative 1.

Alternative 3

The potential effects of Alternative 3 would be the same as for Alternative 1.

Alternative 4 (Preferred Alternative)

The potential effects of Alternative 4 would be the same as for Alternative 1.

3.8.4.2 Groundwater

Existing Conditions

Ground water in the project area is anticipated to be found at or near sea level. Because of the proximity of the sites to the ocean and harbors, it is anticipated that groundwater levels would fluctuate with tidal changes. Rainfall landward of the sites may also affect groundwater levels.

The project area is underlain by the Nuʻuanu Aquifer System, which is part of the Honolulu aquifer sector on the island of Oʻahu (Mink and Lau, 1990). This system includes an unconfined basal aquifer in sedimentary non-volcanic lithology. The groundwater in this aquifer is designated as currently used and has a moderate salinity (1,000 to 5,000 mg/l of chloride), and high total dissolved solids concentration. Close to the ocean the chloride level may reach 15,000 mg/l (equivalent to seawater). The groundwater is classified as neither drinking water nor ecologically important, replaceable, and with a high vulnerability to contamination. In the project area this aquifer is further underlain by a lower aquifer of the same system, the Honolulu Basal Aquifer, Nuʻuanu System. The aquifer is confined in flank compartments. The aquifer is currently being used as a drinking water source. The groundwater has a low salinity (250 to 1,000 mg/l chloride) and is classified as being irreplaceable with a low vulnerability to contamination.

In 1977, the Underground Injection Control (UIC) Line was established by the State of Hawaiʻi as part of the Federal Safe Drinking Water Act (SDWA) to protect the quality of the State's underground sources of drinking water from pollution by subsurface disposal of spent fluids. The UIC Line separates aquifers or portions of aquifers that supply public or private drinking water from exempt aquifers (aquifers or portions of aquifers that do not supply drinking water and can accept spent fluids). The UIC program established rules regulating the location, construction, and operation of all injection wells. Injection wells on Oʻahu are permitted only seaward of the UIC Line. The UIC line in the project vicinity runs along King Street (HDOH, 1984). There are numerous injection wells for waste discharge into the caprock in central Honolulu, including those for thermal effluent, car-wash return, and rainwater. Pollutants in these discharges do not reach the Southern Oʻahu Basal Aquifer due to upward artesian pressure in this aquifer.

Approach to Impact Analysis

Methodology

Construction plans for the seawater portion of the HSWAC system were evaluated for potential interactions with groundwater. Regulatory requirements for disposal of construction dewatering effluent were reviewed.

Determination of Significance

A significant effect would be one that changes contamination levels of groundwater or substantially changes demand on potable water resources.

Impacts

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term adverse effect on groundwater because there would be no construction under this alternative.

Alternative 1

Under Alternative 1, construction of the cooling station foundation and excavation of the jacking pit near the shoreline would require dewatering and appropriate treatment before discharge. Groundwater levels would be affected by tidal fluctuations due to the proximity to the shore, and the total quantity of water to be removed is currently unknown. However, the ROI for the Federal action lies seaward of the UIC line where the uppermost aquifer is considered less valuable than deeper potable aquifers.

Under Alternative 1, the dewatering effluent would be discharged under a National Pollutant Discharge Elimination System (NPDES) general permit. BMPs would be used to remove suspended particulates and meet all other permit requirements prior to discharge. Treatment may include settling ponds or tanks, filtration systems, or both. The method of treatment and disposal would be determined by the contractor after selection by the applicant, and so cannot be specified with certainty at this time. In any event, water would be tested to ensure that discharges would not exceed the limits for general water quality parameters and toxic contaminant parameters specified in the permit. Effects on groundwater levels would be temporary and extremely localized. Treatment as necessary of the extracted water before discharge would eliminate potential effects on the marine environment.

Alternative 1 would have a direct, short-term, but less than significant adverse effect on groundwater as a result of dewatering operations during construction.

Alternative 2
The effects of Alternative 2 on groundwater would be the same as for Alternative 1.

Alternative 3
The effects of Alternative 3 on groundwater would be the same as for Alternative 1.

Alternative 4 (Preferred Alternative)
The effects of Alternative 4 on groundwater would be the same as for Alternative 1.

3.8.5 **Terrestrial Biota**

3.8.5.1 **Existing Conditions**

Vegetation within the ROI consists of maintained plantings such as roadway medians, shoulders, and ruderal (weedy) patches.

According to records maintained by the Hawai‘i Natural Heritage Program (NHP, 2003), no sightings of Federal or State threatened or endangered species have occurred in the ROI.

White terns (fairy terns; *Gygis alba*) may be present in the ROI. The white tern population on O‘ahu was listed as threatened by the State of Hawai‘i in 1986 (Hawai‘i Administrative Rules, Title 13, Part 2, Chapter 124). This listing was presumably based on its limited distribution and small population size. Although the white tern is a common seabird that nests on many islands throughout the tropical and subtropical Pacific, Atlantic, and Indian Oceans (Harrison et al., 1983), including the NWHI, white terns were first documented on O‘ahu in 1961 according to Vanderwerf (2003).

White terns are found scattered throughout urban and suburban areas of Honolulu on the southern shore of O‘ahu where a total of 694 adult white terns and 221 nests were observed from October 2001 through January 2003 (Vanderwerf, 2003).

3.8.5.2 **Approach to Analysis**

The focus of this EIS is the potential effects of the HSWAC system on waters of the U.S., and terrestrial biological resources within the ROI are limited.

Methodology

The presence of unique, rare or protected terrestrial biological resources in the ROI was investigated. As noted above, resources potentially at risk in the ROI were limited to white terns.

Determination of Significance

A significant adverse effect would be disturbance to a white tern nest such that development of eggs or young was negatively affected.

3.8.5.3 Impacts

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term, adverse effect on terrestrial biota because there would be no construction under this alternative.

Alternative 1

Alternative 1 would have no direct or indirect, short-term or long-term, adverse effect on terrestrial biota. Although white terns are tolerant of people and noise, Vanderwerf (2003) recommends that construction projects that could disturb the birds be conducted during fall and early winter when fewer white terns are breeding, and in ways that minimize disturbance. White terns would be surveyed prior to construction in the ROI. If any were nesting within 100 feet of construction activity, noise and visual barriers would be used to prevent any disturbance to the birds.

Alternative 2

The effects of Alternative 2 would be the same as those of Alternative 1.

Alternative 3

The effects of Alternative 3 would be the same as those of Alternative 1.

Alternative 4 (Preferred Alternative)

The effects of Alternative 4 would be the same as those of Alternative 1.

3.9 CUMULATIVE IMPACTS

For purposes of this cumulative analysis, the HSWAC distribution system portion of the project is considered along with the seawater system.

3.9.1 Archaeological, Historical and Cultural Resources

None of the action alternatives would have any direct short-term or long-term adverse effects on known archaeological, historic or cultural resources and therefore would not contribute to cumulative adverse effects on these resources. All of the action alternatives would restrict uses of the construction areas at the ‘Ewa end of Kaka‘ako Waterfront Park and offshore of the park and a portion of Ke‘ehi Lagoon for a period of months during microtunneling, excavation of the breakout pit, assembly of the pipelines and pipeline installation. However, there would be no long-term use restrictions placed on any of these areas and no traditional or cultural uses would be affected as the area was formerly submerged lands and is now reclaimed fast land. It is possible that the State of Hawai‘i’s proposed interisland electrical cable could be routed close to the project area to make landfall within Honolulu Harbor. In that event, some restriction of uses in the area during cable installation would be likely, but that also would be a temporary situation. In the long-term, there would be no change to accessibility of the offshore area, nor would any traditional or cultural uses be restricted.

Implementation of any of the action alternatives could have a potential long-term beneficial impact to fishing as a result of marine community development on the HSWAC pipes and supporting structures. Cumulatively, this could help offset depletion of nearshore fisheries resources as has been experienced around O‘ahu in recent decades and enhance traditional fishing opportunities.

Installation of the freshwater distribution system would involve tunneling beneath and trenching in roadways in Kakaʻako and downtown Honolulu, and impacts to archaeological, architectural, and cultural resources are possible. With regard to the route of the distribution system under the four action alternatives, the only difference would be that under Alternative 2, the initial segment of the distribution system would be routed under Forrest Avenue and South Street, rather than under Keawe Street. The Keawe Street route has a high probability of finding cultural remains, but the Forrest/South route has a moderate probability of finding cultural remains. The remainder of the routes would be the same.

Historic architectural properties within the APE would not be significantly affected by any of the action alternatives. The proposed pipeline route would connect to three and pass near six of 72 historic properties in the APE; the total number includes register sites, register district properties, eligible properties, and historic properties. In all cases where connection to the HSWAC would occur, the distribution pipes would be connected to existing utility systems upon installation. There may be temporary alteration of the ground surfaces adjacent to these buildings as the pipeline trenching is conducted, but such alterations would be temporary and would be mitigated by restoring the ground surface and any landscaping. The HSWAC Project would not have any permanent physical or visual effects to historic buildings. Two register properties merit additional discussion; they are the Hawaiʻi State Capitol and Grounds, and Honolulu Hale and Grounds.

The preferred route of the distribution pipeline places one segment running from Richards Street along the pedestrian mall on the makai side of the Capitol building, within the grassy margin between the sidewalk and the ʻIolani Palace property. The current walkway is on what used to be a portion of Hotel Street, in use until the mid-1960s when construction of the Capitol began. On the ʻewa or west side of the Capitol building, the pipeline would penetrate the Capitol's structure beneath the reflecting pool, and extend into the underground parking area where it would be routed in two directions to serve other public and private customers.

First, a pipeline would extend east, along the ceiling to the vehicular entrance on Punchbowl Street. At the vehicular entrance, the pipeline would again be buried, and trenching for this installation would be done along one of the traffic lanes of the vehicular entrance, across Punchbowl Street, and down a traffic lane of the vehicular entrance to the Kalanimoku Building (state offices), which would also be included in the HSWAC distribution system. A second pipeline would extend mauka or north along the Miller Street corridor in order to serve the State Department of Education (DOE) building and the Queen's Hospital area. Like the Kalanimoku routing, the pipeline would be routed along the ceiling of the Capitol's underground parking garage, emerge on the Capitol grounds to go across Beretania Street, and then be installed along the Miller Street pedestrian mall on the side of the Department of Health (HDOH) building, in order to avoid Washington Place and its grounds. The pipeline would then cross over to provide service to the DOE building and then to Queen's Hospital. The Beretania and Miller Street pipeline installations would be carried out through trenching.

The Hawaiʻi State Capitol and Grounds are contributing properties to the Hawaiʻi Capitol Historic District, although they are not historic in age. The Capitol was constructed in the mid-1960s and dedicated in 1969. At the time of its construction, the entire parcel upon which it sits was excavated in order to accommodate both the capitol building and the underground parking areas. The entire area that would be impacted by the HSWAC installation was previously and extensively disturbed during construction of the Capitol building and associated parking areas. Any alterations due to trenching would be temporary and could be completely mitigated by replacing ground cover and landscaping. Insertion of the pipeline into the Capitol building would be below current ground surface, and not visible once it is in place. Consequently, it is believed that the HSWAC undertaking would have no effect on the State Capitol or grounds. Similarly, excavations along the Miller Street corridor beside the HDOH building, to the DOE building, and to the Queen's Hospital complex would have no effect on historic properties.

Honolulu Hale was originally constructed in 1929; the building and its grounds are contributing properties to the Hawaiʻi Capitol Historic District. Designed by renowned Hawaiʻi architects C.W. Dickey, Hart Wood and others. The California-Spanish style building was dedicated in 1929. The original building underwent a planned expansion in 1951 with the addition of two three-story wings on the mauka side of the existing structure. Through the 1960s, Hotel Street continued to exist as a vehicular route; its right-of-way overlaps with what is now a pedestrian walkway on the mauka side of Honolulu Hale, extending from Punchbowl Street towards the Frank F. Fasi Municipal Building, a 15-story office tower constructed to the east of Honolulu Hale and the Kalanimoku Building in 1975. At that time, the walkways and lawn areas between these government buildings were modified into the configuration seen today.

Honolulu Hale would be serviced by the HSWAC system and current routing shows the distribution pipeline going across the lawn area immediately mauka of the building, with open trenching being used to install the pipe. The HSWAC pipeline would be connected to existing utility systems and would not require any additional structures or appurtenances that would modify the appearance of Honolulu Hale or its grounds. There would be a temporary alteration to the grounds as trenching occurs but this would be mitigated through restoration of the ground surface and landscaping upon completion of excavations.

Using the data from previous archaeological reports, a map was developed illustrating areas of relative sensitivity for encountering subsurface cultural sites, including human burials, within the APE. Figure 3-34 shows the pipeline distribution routes for the action alternatives as they are assessed for the likelihood of encountering subsurface cultural sites. The green color indicates areas of expected low probability, the orange color corresponds to a moderate probability of finds, and red indicates an area of high probability of subsurface finds. Currently, most of the installation for the pipeline would be done through open trenching along existing roadways and sidewalks. The only exceptions to this would be short, trenched corridors that go from a main pipeline to an individual building, and the segment that traverses Ala Moana Boulevard, which would be done through microtunneling.

A number of segments of the distribution pipeline are deemed to be of low probability for finding subsurface cultural sites, as indicated by the record of previous finds and studies. These areas include portions of the Bishop, King, and Merchant Street corridors, as shown on Figure 3-34, and the entire Miller Street corridor between the State Capitol and the Queen's Hospital complex. In addition, trenching on the grounds of the Capitol and Honolulu Hale are deemed to be of low probability for finding subsurface deposits. In view of the multiple episodes of relatively recent construction in these areas, and the lack of any evidence for subsurface cultural deposits being present in these locations, it is believed that the HSWAC pipeline installations would have no effect on Honolulu Hale or the State Capitol and their grounds. The trenching for the pipeline segment between the cooling station and the makai side of Ala Moana Boulevard is also an area of low probability for subsurface finds since this is filled land, all excavation would take place within fill, and there is no history of prior finds in this part of Kakaʻako.

Areas of moderate probability of encountering subsurface cultural sites are shown on Figure 3-34 as including the following:

- Portions of Merchant and Bishop Streets on either side of the intersection;
- The portion of Alakea Street makai of the intersection with Queen Street;
- The portion of Richards Street from Hotel Street makai to the intersection with Merchant Street;
- The connecting trench to the U.S. Post Office, Custom House, and Court House;
- Pipeline segments through the Honuakaha section of Kakaʻako, from the intersection of Halekauwila and Punchbowl Streets makai to the intersection of Pohukaina and Punchbowl Streets, east along Pohukaina Street to Keawe Street, and makai on Keawe Street to the intersection with Auahi Street.

The area of high probability for encountering subsurface cultural sites is believed to be Keawe Street from its intersection with Auahi Street to Ala Moana Boulevard. The applicant's Preferred Alternative is to microtunnel under this segment to avoid contact with cultural remains as well as to eliminate impacts to traffic on Ala Moana Boulevard. The distribution system route for Alternative 2 would be microtunneled under Ala Moana Boulevard, but along a Forrest Avenue/South Street alignment, to minimize traffic impacts.

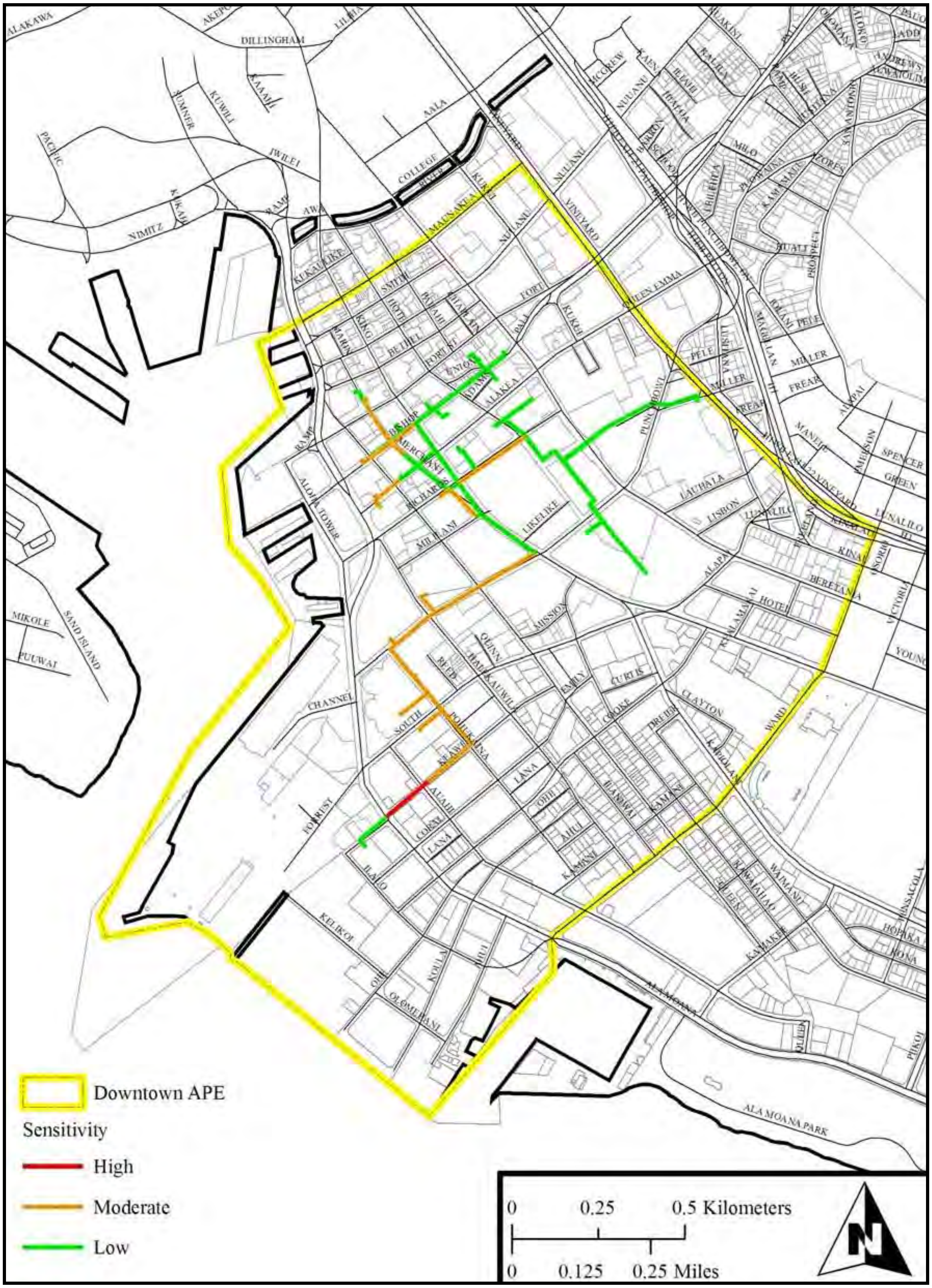


Figure 3-34: Distribution of Archaeological Probability Zones in the APE

Given the above information, the proposed HSWAC pipeline system may have an "adverse effect" on subsurface cultural sites that may be present in the portions of the APE that are deemed of moderate to high probability for encountering sites. In view of these facts, the applicant's consultant recommended that the areas of moderate and high probability for finding subsurface cultural sites undergo on-site archaeological monitoring during trenching done for the HSWAC. An archaeological monitoring plan has been prepared by the applicant and accepted by DLNR. With implementation of the measures specified therein, the proposed undertaking would have "no adverse effect" on significant historic sites.

Consulting parties in the CIA provided a great deal of information on Kakaʻako's past and the communities who lived there. They also identified several concerns with regard to the potential for finding or disturbing cultural sites during the HSWAC project, including the discovery of human burials. In general, consulting parties acknowledged that former burial locations are now largely unknown, thus it is difficult to predict where they might be encountered. One participant noted that in the old days people generally buried their dead "on the side of their house." Another participant also mentioned the previous find of numerous burials associated with Kawaiahaʻo Cemetery when Queen Street underwent improvements in the 1980s.

Participants in the CIA identified sacred places and precincts within the APE. A heiau (name unknown) was formerly in the vicinity of Point Panic, and a sacred pond (now filled in) was in the vicinity of Koula and Auahi Streets. The pond, according to the CIA participant, was a place for aliʻi to prepare for ritual sacrifices. These places and others were part of what one CIA participant called a Sacred Triangle that extended from Moanalua on the west to Mānoa on the east makai to the coral flats underlying ʻIolani Palace and nearby properties. This view of the landscape is still held by project participants and others; while they do not necessarily object to modern changes, they do not believe such change has eliminated the sacred and traditional realities of the landscape that they were taught to respect.

Based on the results of the historical, archaeological, and cultural impact studies, the applicant's consultant made the following recommendations to mitigate potential impacts. None of the architectural properties identified in this study would be adversely affected by installation of the HSWAC components, including the pipeline system. Nonetheless, Chapter 6E-10, HRS, requires that SHPD review and concur with any activity affecting historic properties owned by the State, particularly those on the Register. Currently, none of the privately-owned properties within the APE that are listed on the HRHP or NRHP would be affected by HSWAC activities. Should any such properties be included in future planning for the project, they may fall under the jurisdiction of Chapter 6E-10, HRS, which governs SHPD review of activities affecting privately-owned historic property on the HRHP. Thus, it was recommended by the applicant's consultant that SHPD be given the opportunity to review and concur with any portions of the HSWAC project that may affect privately-owned and State-owned historic properties on the HRHP. Finally, in order to ensure that no architectural properties are adversely affected by the HSWAC project, it was recommended by the applicant's consultant that any ground surfaces and landscaping associated with any historic building be restored to their original condition if they are disturbed by trenching or other activities.

With respect to archaeological resources, under any of the action alternatives, there is potential for encountering subsurface cultural sites within the APE, particularly during trenching for installation of the HSWAC distribution pipelines. A number of locations on the pipeline route have a low sensitivity of encountering subsurface sites; in these areas, the proposed undertaking would have no effect on significant archaeological sites, and the applicant proposes no further measures at this time.

Along pipeline segments deemed to be of moderate and high sensitivity for encountering subsurface sites, the proposed HSWAC pipeline system may have an "adverse effect" on such sites. Consequently, in areas of moderate and high sensitivity for finding subsurface cultural sites the applicant proposes to conduct on-site archaeological monitoring during trenching.

3.9.2 Built Resources and Human Uses

In the short-term, potential cumulative impacts of any of the action alternatives would be most likely to arise as a consequence of installation of the distribution system within the streets of Kaka‘ako and downtown, and be manifested as an increase in traffic congestion. In development of the preferred distribution system route, the applicant consulted HCDA and the City and County of Honolulu about projects with entitlements that could be under construction within the same time frame as installation of the HSWAC distribution system. Additionally, future projects that would require major street excavations in areas being considered for installation of the HSWAC distribution system were investigated. The greatest potential for future conflicts in use of street rights-of-ways is the proposed Honolulu rapid transit project. Once the proposed route for the rapid transit system was announced, it was compared with what was then the applicant’s preferred HSWAC route and conflicts were apparent along Halekauwila Street. Consequently, the HSWAC route was modified to avoid streets that would be used for the rapid transit route. With this route modification, potential cumulative impacts on the built environment would be minimized. Still, with project schedules in flux, other potential developments possibly coming on line, and emergency repairs being necessary at unpredictable times, cumulative effects on traffic in the ROI could be significant. The applicant intends to mitigate this to the extent possible by scheduling trenching where it would contribute least to cumulative traffic impacts considering the real time distribution of traffic obstructions.

Short-term cumulative impacts to human uses, specifically recreational uses, would be the same as described above for traditional and cultural uses. There would be short-term restrictions to uses of the offshore marine environment, but long-term opportunities for fishing and diving would be enhanced, possibly offsetting losses or deterioration of opportunities elsewhere.

Operations of the HSWAC system would substantially reduce the amount of electricity needed for air conditioning in the downtown area. According to the applicant, the proposed project would reduce the annual emissions from fossil fuel consumption by the following estimated amounts[14]:

- Carbon Dioxide (CO_2) Emissions - 83,000 tons/year
- Volatile Organic Compounds (VOC) Emissions - 5 tons/year
- Carbon Monoxide (CO) Emissions - 28 tons/year
- Particulate Matter under 10 microns (PM_{10}) Emissions - 19 tons/year
- Nitrogen Oxides (NO_x) Emissions - 169 tons/year
- Sulfur Oxides (SO_x) Emissions - 165 tons/year

Chillers currently in use by customers of the proposed project services would no longer be needed; refrigerants would be removed from the equipment and the possibility of their escape to the atmosphere would be eliminated.

In addition, SWAC reduces the amount of heat released to the environment (ocean and atmosphere). Electricity production is only about 32% efficient; the rest of the energy is rejected as waste heat (cooling water + stack gas losses + radiation and other minor losses). SWAC reduces thermal pollution of the environment by about 40% compared with conventional, electricity-powered air conditioning systems (see Appendix C for this calculation).

On a long-term basis, there would be a beneficial but negligible effect on climate change and its consequent effects such as sea level rise by the reduction of GHG emissions resulting from

[14] Calculations of these amounts are described in Appendix C.

implementation of any of the action alternatives. The proposed project is too small to have an appreciable influence over global trends. The facilities, however, would be susceptible to the same forces potentially affecting other coastal structures in Hawaiʻi. That is, as sea level rises, high waves, hurricanes, and tsunami will be able to penetrate further inland. In addition, the coastal groundwater table is likely to rise and perhaps extend above ground level, leading to flooding. The physical effects of sea level rise fall into five categories:

1. Marine inundation of low-lying developed areas including coastal roads,
2. Erosion of beaches and bluffs,
3. Salt intrusion into aquifers and surface ecosystems,
4. Higher water tables, and
5. Increased flooding and storm damage due to heavy rainfall.

Sea level rise is the product of (1) melting ice on Antarctica, Greenland, and among alpine glaciers, and (2) thermal expansion of seawater due to surface warming. Studies of both factors and satellite observations put the rate of rise at about 3.5 mm/yr. At the anticipated 50-year life span of the project, that would mean a 17.5 cm, or a little less than 7 inches, rise in sea level. Other estimates put the rise at 0.5 to 1.4 m by the end of the 21st century. That would mean that over the next 50 years, sea level could rise from about 0.28 to 0.78 m (~ 0.9 to 2.6 feet). The HSWAC system would employ a dry sump, direct connect type of cooling station, so the seawater circulation system would not be affected by changes in sea level of this magnitude. The cool water distribution system would also be a closed system, some of which would be installed beneath the water table. If the water table were to rise, more of the distribution lines would be under water, but unless a leak occurred, that would not be a concern. The distribution system would be pressurized and constantly monitored for leaks so intrusion of groundwater would be prevented. Direct effects of sea level rise on the HSWAC system during its anticipated life span would be negligible. Indirect effects could result in two ways. If the sea level rise were to incapacitate the electric utility, there would not be enough emergency power at the cooling station to run the auxiliary chillers and somewhat warmer water would have to be supplied to customers. Because sea level rise will occur gradually, however, it is highly likely that the electric utility would take the necessary actions to insure a reliable supply to its customers. A more unpredictable indirect effect could result from the potential for more and larger storm events. The HSWAC system would be designed and constructed to withstand extreme events, however, both the utility infrastructure and the customer buildings likely would be more susceptible to storm damage. With an electrical outage in the HSWAC service area, cooling water could still be delivered to customer buildings, but without electricity, downtown buildings would not be operational. Some cooling might still be desirable to inhibit damage from humidity and growth of mildew, but if windows have been broken, cooling would be ineffectual. In conclusion, it is likely that the HSWAC system would be less susceptible to storm damage than either the supporting electrical infrastructure or customer buildings, meaning that effects on surrounding elements of the built environment would be more likely to affect the capacity and need for cooling than a direct effect on the HSWAC system.

3.9.3 **Social and Economic Resources**

Any of the action alternatives would have beneficial effects on system customers, i.e., private sector building owners and government agencies, both of which are currently experiencing escalating utilities costs. In addition, building owners are experiencing increasing vacancies and decreasing rental rates while government agencies are being forced to trim budgets due to tax shortfalls. The cumulative effect of the HSWAC project would be to help alleviate the economic pressures on building owners arising from the current economic recession.

Cumulative effects on Oʻahu's electric rate payers would also be beneficial as implementation of the HSWAC project would eliminate about one year of HECO's projected load growth. This reduced need for expensive new electricity generation capacity would help to keep Oʻahu's electric rates lower for longer.

Hawai‘i’s unemployment rate, especially in the construction trades, has increased dramatically in the recession. HSWAC construction would help offset these losses for the approximately one-year period of construction. Over the long-term, implementation of the HSWAC project would benefit the local economy in terms of output, local spending, earnings, jobs and tax revenues. These benefits would cumulatively augment any other projects or actions with economic stimulus benefits undertaken during the life of the HSWAC project.

3.9.4 **Visual Resources**

Implementation of Alternatives 1, 3, or 4 would have no cumulative effect on visual resources. The only visible portion of the system would be the cooling station, which would be located at a site visible only from the immediately surrounding streets. The intention of the land owner is to develop immediately adjacent parcels so that ultimately, at most, only the narrow sides of the cooling station facing Keawe and Coral Streets would be visible. The cooling station under Alternative 2 would be located on Pier 1, an industrial setting characterized by aging warehouses and a container terminal. Erection of a new, modern building in this setting could be part of waterfront redevelopment that would improve the visual setting of the harbor as viewed from Kaka‘ako Waterfront Park or from vessels (including cruise ships) entering Honolulu Harbor.

3.9.5 **Natural Hazards**

Natural hazards could affect any of the action alternatives and the potential cumulative effects of a given incident would depend on a number of things including the nature of the natural hazard, its effects on the facility and its effects on the surrounding regional infrastructure. The cooling station site for Alternatives 1, 3, and 4 is within the designated flood zone, and facilities could also be affected directly or indirectly by an earthquake or tsunami. If the cooling station were rendered inoperable it would be likely that other coastal infrastructure would also be rendered inoperable. Such infrastructure would include electricity generating stations as well as customer buildings. In the case of a wide-spread power outage, customer buildings likely would remain unoccupied and cooling demands accordingly low. In the event of a localized power outage, the seawater and distribution pumps would operate for a time on emergency generators, but if the event were sustained and available fuel consumed, the system would cease to function. The power necessary to operate auxiliary chillers cannot be supplied from the emergency generators, so under outage conditions, cooling water would be supplied to customer buildings at a slightly higher temperature.

The Alternative 2 cooling station site is partly in a flood hazard zone and also would be susceptible to damage from a tsunami or earthquake.

3.9.6 **Marine Resources**

The project area has been subject to repeated historical discharges of dredged materials, regulated and unregulated, and that has in large measure determined the nature of the biotic community. In addition, Māmala Bay receives the discharges from numerous streams, canals and storm drains, which drain industrial, commercial and residential areas. Incinerator waste and other unburned waste were used to fill a section of shoreline. Treated and untreated domestic sewage has been dumped in the area for decades (Section 3.3.3.1). Anthropogenic debris, including discarded military munitions, litters the seafloor in the area (Section 3.7.2.1). Waves and currents resuspend sand and mobilize rubble, which scours the bottom keeping the benthic community in an early successional stage. Little solid substratum exists for recruitment by sessile benthic organisms and there is little shelter for fish.

For any of the action alternatives, in the area of the breakout pit, the soft bottom would be replaced by a concrete cap covering the connections between pipes in the microtunnel and the surface mounted pipes. The seafloor beneath each of the anchor collars would be covered. In all cases, however, the concrete would provide a more stable substratum for coral and other sessile benthic organism colonization than the existing unconsolidated bottom which is seasonally subject to scouring by rock and coral fragment movements associated with high surf events. The net effect of the HSWAC installation on marine resources is expected to increase coral colonization opportunities as well as increase vertical relief, which would likely provide benefits to fish production. Cumulatively, these beneficial effects would offset to a limited extent coral reef losses and fishery resource depletion around O‘ahu caused by other factors such as sediment runoff and increasing fishing effort. In a temporal sense, however, there would be a lag between completion of the seawater system installation and recruitment of benthic organisms and fish to and around the structures. Fish, being highly motile, would be expected to recruit to the structures first. Sessile invertebrates such as corals would recruit opportunistically, but coral cover would develop over a period of years.

At the depth of the seawater return discharge, historical influences have included disposal of debris and bottomfish fishing. A small area of the bottom around the diffuser could experience a phase shift wherein organisms typically found in deeper, colder water could prevail. The discharge would likely include some quantity of remains of entrained organisms, which would provide a food subsidy for other organisms in the vicinity, possibly including bottomfish.

Debris has also historically been disposed of at the depth and in the vicinity of the proposed intake location. Without this man-made debris, the substratum in this zone would be predominantly sediment with small pebbles. The dumping of man-made debris, particularly metal objects such as ordnance and framework, has provided the majority of hard substratum found at these depths. It follows that the density of hard substratum filter-feeders such as *Brisinga panopla* and *Regadrella sp*, is undoubtedly much higher than it was prior to human perturbation. Most of these hard objects were relatively small, whereas the pipe alone would provide 2.11 ha of continuous hard surface. Assuming the pipe material is suitable for colonization by attached as well as unattached invertebrates, the pipe route should experience an increase in the number of hard substratum specialists including deep water corals, anemones, and sponges. Given that the total amount of similar habitat within depths of 400-550m south of Honolulu and Pearl Harbor is over 9,779 ha, the increase in hard substratum by the pipe should be insignificant to the community as a whole.

To minimize the potential for the proposed activities to cause or promote the introduction or spread of aquatic invasive species, USACE would include the following as special conditions of the DA permit, if issued:

- To minimize the potential to cause or promote the introduction of spread of invasive species, prior to the start of in-water work, the applicant must thoroughly clean each vessel used for in-water work. The cleaning of each vessel must include appropriate steps to minimize the introduction or spread of invasive species from ballast water discharge, ballast sediments, and hull fouling.
- The applicant must thoroughly clean the remotely operated vehicle (ROV) used during pipeline deployment prior to each use in Hawai‘i waters. Following each use, the applicant must store the ROV dry.

3.9.7 **Terrestrial Resources**

With the respective proposed mitigation measures in place, none of the action alternatives would adversely affect living or nonliving terrestrial resources and thus would have no cumulative adverse effects.

3.10 COMPARISON OF THE ECONOMIC OPERATING PARAMETERS AND ENVIRONMENTAL EFFECTS OF THE ALTERNATIVES

Table 3-22 compares key economic operating parameters of the applicant's preferred alternative with those of the No Action Alternative. Table 3-23 summarizes the environmental effects of the action alternatives.

Table 3-22: Comparison of Economic Operating Parameters of the Preferred and No Action Alternatives

Parameter	***Applicant's Preferred Alternative***	***No Action Alternative (Conventional Cooling)***
Energy Consumption (kWh/yr)	22,800,000	100,300,000
Electrical Demand (kW)	8,400	23,100
Crude Oil (bbl/yr)	52,600	231,600
Potable Water Consumption (gallons/yr)	1,000,000	261,000,000
Sewage Generation (gallons/yr)	10,000	84,100,000
CO_2 Emissions (tons/yr)	24,900	109,700
Class 1 Ozone-Depleting Substances in Use	TBD	TBD
Cooling Tower Treatment Chemicals Used	TBD	TBD
Local Spending (over 26.5 years)	$476,300,000	$183,500,000
Output (over 26.5 years)	$806,700,000	$323,000,000
Earnings (over 26.5 years)	$246,800,000	$80,800,000
Jobs (full-time equivalent person-years over 26.5 years)	4,951	1,101
State Tax Revenues (over 26.5 years)	$39,000,000	$15,000,000

Table 3-23: Comparison of the Effects of the Action Alternatives

Resource	*Alternative 1*						*Alternative 2*						*Alternative 3*						*Alternative 4 (Applicant's Preferred)*					
	Direct		*Indirect*		*Cumulative*		*Direct*		*Indirect*		*Cumulative*		*Direct*		*Indirect*		*Cumulative*		*Direct*		*Indirect*		*Cumulative*	
	ST	*LT*	*ST*	*LT*	*ST*	*LT*	*ST*	*LT*	*ST*	*LT*	*ST*	*LT*	*ST*	*LT*	*ST*	*LT*	*ST*	*LT*	*ST*	*LT*	*ST*	*LT*	*ST*	*LT*
Cultural	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B
Archaeological	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Historic	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Harbors	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Shipping	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Navigation	SM	N	N	N	N	N	SM	N	N	N	N	N	SM	N	N	N	N	N	SM	N	N	N	N	N
Pipelines	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Outfalls	N	N	N	B	N	B	N	N	N	B	N	B	N	N	N	B	N	B	N	N	N	B	N	B
Dump Sites	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Recreation	L	N	L	B	L	B	S	S	L	B	L	B	L	N	L	B	L	B	L	N	L	B	L	B
Ocean Research	N	N	N	B	N	B	S	S	S	S	L	S	N	N	N	B	N	B	N	N	N	B	N	B
Comm. Fishing	L	N	L	B	N	B	L	N	L	B	N	B	L	N	L	B	N	B	L	N	L	B	N	B
Military Ops	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Potable Water	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B
Electricity	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B
Wastewater	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B	L	B	N	B	N	B
Solid Waste	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Noise	S	N	N	B	N	B	S	N	N	B	N	B	S	N	N	B	N	B	S	N	N	B	N	B
Haz/Toxics	SM	N	N	B	N	B	SM	N	N	B	N	B	SM	N	N	B	N	B	SM	N	N	B	N	B
Traffic	L	N	N	N	L	N	L	N	N	N	L	N	L	N	N	N	L	N	L	N	N	N	L	N
Health/Safety	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Socioeconomic	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Visual	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Natural Hazards	SM	SM	L	L	L	L	SM	SM	L	L	L	L	SM	SM	L	L	L	L	SM	SM	L	L	L	L
Mar. Geology	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N	L	N	N	N	N	N
Tides/Currents	L	N	N	N	N	N	L	N	N	N	S	N	L	N	N	N	N	N	L	N	N	N	N	N
Water Quality	SM	SM	N	B	N	B	SM	SM	N	B	N	B	SM	SM	N	B	N	B	SM	SM	N	B	N	B
Benthic Biota	L	S	L	B	L	L	SM	S	L	B	L	L	L	SM	L	B	L	L	L	L	L	B	L	L
Pelagic Biota	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Protected Spp.	SM	L	N	N	N	N	SM	L	N	N	N	N	SM	L	N	N	N	N	SM	L	N	N	N	N
EFH	L	SM	L	B	L	L	SM	SM	S	B	L	L	L	SM	L	B	L	L	L	L	L	B	L	L
Terres. Geology	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Climate	L	B	N	N	N	B	L	B	N	N	N	B	L	B	N	N	N	B	L	B	N	N	N	B
Air Quality	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B
Surface Water	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Groundwater	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B	L	N	N	B	N	B
Terres. Biota	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Notes: ST = Short-Term; LT = Long-Term; S = Potentially Significant Adverse Effect; SM = Potentially Significant Adverse Effect Mitigable to Less Than Significant; L = Less Than Significant Adverse Effect; N = No Effect; B = Beneficial Effect

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CHAPTER 4.
ENVIRONMENTAL MANAGEMENT ISSUES

4.1 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND MAINTENANCE OF LONG-TERM PRODUCTIVITY

The construction phase of the HSWAC project would have both positive and negative short-term impacts on several environmental resources. Marine habitats, communities, and productivity would be negatively affected by installation of intake and return pipes and appurtenant hardware. In the long-term, however, marine habitats, communities, and productivity would recover. The presence of the pipe structures would provide additional benthic habitat in a historically degraded area subject to seasonal impacts by high surf events. Construction of the cooling station and installation of the distribution system would be accompanied by noise, dust and some disruption of vehicular traffic flows. On the other hand, construction activities would result in direct, indirect, and induced employment opportunities with concomitant provision of personal income, increased corporate revenues, and increased government tax revenues. The negative short-term impacts associated with the construction activities would be necessary to realize the long-term benefits of the HSWAC project. These include reduction of petroleum imports, reduction of impacts to air and water quality associated with production of electricity, reduction of potable water use, reduction of wastewater generation, reduction in the use of ozone-depleting substances, as well as the economic benefits to be realized by HSWAC customers and O‘ahu rate-payers in general.

4.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible and irretrievable commitments of resources required to implement the HSWAC project include the human productivity expended in planning, constructing, and operating the system; much of the construction materials and hardware used in the system (although some could be recycled); the fuels and lubricants used in vehicles and equipment (some could be recycled); and the oil burned in producing electricity for those components of the system requiring it (pumps, auxiliary chillers, etc.).

4.3 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL OF THE ALTERNATIVES AND MITIGATION MEASURES

Energy in the form of petroleum would be required for construction vehicles and equipment, and for conversion into electricity for construction and operation of the HSWAC system. However, a major objective of the project is to reduce O‘ahu’s dependence on fossil fuels. Any of the action alternatives would save approximately 75% of the energy associated with operation of individual air conditioning systems in large downtown buildings compared to the No Action Alternative.

4.4 URBAN QUALITY, HISTORIC AND CULTURAL RESOURCES AND THE DESIGN OF THE BUILT ENVIRONMENT, INCLUDING THE RE-USE AND CONSERVATION POTENTIAL OF THE ALTERNATIVES AND MITIGATION MEASURES

The only portion of the HSWAC system potentially visible in the urban setting would be the cooling station, which under Alternatives 1, 3 or 4 would be hidden from mauka views to the ocean by an adjacent massive building. The design of the built environment in downtown Honolulu would not be negatively affected. Under Alternative 2, the cooling station would lie within an industrial harbor setting where views are currently obstructed by existing warehouses. Urban quality may be incrementally improved by reduction of waste heat from numerous downtown cooling towers. Known historic and cultural resources would be avoided, and appropriate mitigation measures would be employed should there be inadvertent discoveries of such resources during construction of the cooling station or installation of the distribution system. Any of the action alternatives would have a number of conservation benefits, including reductions in consumption of fossil fuels, electricity, and potable water. Refrigerant compounds from deactivated individual chiller units could be recycled.

4.5 CULTURAL RESOURCES AND CONSERVATION POTENTIAL OF THE ALTERNATIVES

The HSWAC project is not expected to affect known cultural resources. The approved archaeological monitoring plan would be implemented during construction. As appropriate, any discovered resources would be preserved, protected, salvaged, and/or documented. Should human burials be discovered the approved plan for dealing with remains would be implemented.

Based on available information, including the applicant's approved Archaeological Monitoring Plan, the USACE has made its determination of effect (per 33 CFR Part 325, Appendix C) and concluded the coordination required to fulfill its responsibilities pursuant to Section 106 of the National Historic Preservation Act. The USACE has determined that the proposed undertaking, with incorporation of the monitoring requirements of the applicant's approved archaeological monitoring plan as a condition of any issued DA permit, would result in "no historic properties adversely affected."

4.6 POSSIBLE CONFLICTS BETWEEN THE PROPOSED ACTION AND THE OBJECTIVES OF FEDERAL, STATE AND LOCAL LAND USE PLANS, POLICIES AND CONTROLS FOR THE AREA CONCERNED

The HSWAC project would not conflict with any Federal, State or local land use plan, policy or control, although variances would be sought for noise from night construction and shoreline setback during pipe staging. The project would further the objectives of numerous plans and policies, including the Hawai‘i State Plan, the Hawai‘i Coastal Zone Management Plan, the Hawai‘i Ocean Resources Management plan, the Kaka‘ako Community Development District Makai Area Plan and the City and County of Honolulu General Plan and Primary Urban Center Development Plan.

4.7 NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS AND CONSERVATION POTENTIAL OF THE ALTERNATIVES AND MITIGATION MEASURES

A major objective of the HSWAC project is to reduce the use of depletable natural resources (fossil fuels) by substitution of renewable natural resources (cold seawater). Implementation of the applicant's preferred alternative or any of the other action alternatives would result in significant savings of fossil fuels and potable water.

4.8 UNAVOIDABLE ADVERSE IMPACTS

Construction of the cooling station and installation of the distribution system would be accompanied by increased noise (Section 3.3.9), dust (Section 3.8.3) and traffic congestion (Section 3.3.11). Offshore construction would create turbidity at the receiving pit and where anchors impact the bottom (Section 3.7.4). Marine organisms within the footprint of the receiving pit would perish. Epifauna in the footprints of the collars would be crushed and infauna smothered (Section 3.7.5.1). Once operational, the system would impact water quality (Section 3.7.4) and marine biota within a defined ZOM (Section 3.7.5). The seawater return flows would be lower in temperature and dissolved oxygen concentrations and higher in dissolved inorganic nutrient concentrations. A ZOM would be sought to authorize an area in which adequate dilution could occur. Due to the very sparse coral cover in the vicinity of the microtunnel breakout point and along the seaward path of the pipes, construction activities would potentially affect a small number of living coral colonies.

4.9 MITIGATION MEASURES TO AVOID AND MINIMIZE ADVERSE IMPACTS

According to the applicant, impact mitigation for the HSWAC project began in earliest planning with the decision to use some form of trenchless technology to route pipes beneath the nearshore area and under major roadways. Planning and engineering design for the project also incorporated decisions about siting, routing, construction methods, etc., which had the effect of reducing the potential impacts of the project. For example, the decision to surface-mount the seawater pipes on concrete collars minimized the potential impacts to water quality and marine communities from laying the pipes directly on the seafloor. The proposed microtunnel breakout point was selected to avoid coral-dominated communities. The breakout point under any of the action alternatives would be within the biotope of dredged rubble where sand and rubble predominate and corals are very sparse.

Specific mitigation measures were developed to address unavoidable and avoidable potential impacts to archaeological, marine biological and terrestrial biological resources, navigation, recreation, utilities, marine and surface water quality, noise, air quality, and traffic. These are summarized in the following paragraphs.

Potential impacts to archaeological and cultural resources would be mitigated through implementation of an "Archaeological Monitoring Plan," which was approved by the Hawai'i State Historic Preservation Officer on November 10, 2008 (see Section 3.2).

Potential impacts to navigation would be mitigated by avoiding blockage of access to the residences on the island in Ke'ehi Lagoon; providing adequate space for canoe paddling around the pipe strings when deployed in the Ke'ehi Lagoon in-water staging area; deploying picket boats in the Ke'ehi Lagoon channel during tow-out of the completed pipe strings; using snag-resistant collars in shallow water to avoid potential interference with barge tow cables; and coordinating with the USCG for publication of a "Notice to Mariners" to alert mariners of the offshore construction activities (see Section 3.3.2).

Potential impacts to recreational resources and their use would be mitigated by minimizing the size of the area of Kaka'ako Waterfront Park used for construction activities and restoring any affected areas of Kaka'ako Waterfront Park and Sand Island State Park to prior or better condition after use (see Section 3.3.4).

To avoid potential utilities (Section 3.3.8), traffic (Section 3.3.11) and noise impacts of multiple construction projects occurring in the same area at the same time, the applicant would continue to participate in the City and State Utilities Coordinating Committee.

Soil erosion would be minimized by implementation of an Erosion Control Plan (Section 3.8.2). Dust generation and exhaust emissions would be minimized by implementing USEPA-recommended measures to control fugitive dust and mobile source emissions (Section 3.8.3.2).

Potential noise impacts to human receptors (Section 3.3.9) would be mitigated by adherence to State noise regulations for construction, which place limits on noise levels and exposure times, acquiring the appropriate permits and variances for construction operations, and adhering to any conditions attached to the permits or variances.

Potential noise impacts to marine mammal receptors (Section 3.7.5.3) would be mitigated by adherence to the conditions attached to the Incidental Harassment Authorization received from NMFS. These include BMPs for in-water work, an exclusion zone, shut down and soft start practices. Construction activities would cease if listed marine species are observed entering the active project construction site, and work would be allowed to resume only after the animal departs the construction site on its own volition. The Pacific Islands Regional Office of the NMFS would be notified of each such occurrence (Section 3.7.5.3). Other mitigation measures for potential impacts to protected species include vessel speed limits, establishment of safety zones, soft starts and seasonal restrictions while humpback whales are in Hawaiian waters.

Impacts to corals in the construction area would be minimized by using divers to assist with placing anchors or other equipment on the seafloor. The applicant prepared a proposed coral transplantation and monitoring plan designed to mitigate the specifically identifiable unavoidable losses to coral resources within the receiving pit (Appendix O).

To mitigate potential traffic impacts a variety of measures would be employed. The applicant would prepare and implement a Traffic Management Plan containing provisions for maintenance of pedestrian, public transportation and emergency vehicle movements; access to driveways; covering of trenches after working hours; community liaison; establishment of a website and hotline; and restrictions on times and dates of lane closures (Section 3.3.11).

A number of plans, BMPs, SOPs and training programs would be employed to minimize the potential impacts of spills or releases of hazardous or toxic materials on human health and safety or ecological systems from construction or operations. Excavated materials would be characterized and disposed of in accordance with Federal and State regulations. The following plans would be created and implemented: Environmental Hazard Management Plan, Facility Response Plan, Spill Prevention Control and Countermeasure Plan, Environmental Protection Plan, Contaminated Soil Management Plan, and Worker Health and Safety Plan. Additional institutional and engineering controls would be implemented during construction to mitigate potential impacts to children and Environmental Justice populations possibly residing near the shoreline jacking pit (see Section 3.3.10). A public notification plan would be implemented in the event of a spill or release of a toxic or hazardous substance. Other measures to ensure human health and safety would include using police escorts for oversized loads on public highways, enforcing OSHA regulations for worker safety, and implementing a worker Health and Safety Plan (Section 3.3.12).

A number of mitigation measures would be implemented to protect water quality during construction (Section 3.7.4). Turbidity impacts of pipeline installation would be minimized by implementing BMPs during construction, including:

- The employment of standard BMPs for construction in coastal waters, such as daily inspection of equipment for conditions that could cause spills or leaks,
- Cleaning of equipment prior to deployment in the water,
- Proper location of storage, refueling, and servicing sites, and
- Implementation of adequate spill response and storm weather preparation plans.

The offshore receiving pit would be contained within sheet piles or a combination of sheet piles and silt curtains to minimize turbidity. All soil removed from the tunnel, jacking pit and receiving pits would be processed appropriately and disposed of on land. Only washed granular or gravel backfill would be used.

The mitigation measures for potential impacts from mobilizing contaminants in the microtunneling operation are:

- As pipe is installed inside the microtunnel from the cooling station to the breakout pit, the space between the pipe and the microtunnel wall would be grouted.
- All materials removed from the microtunnel and also materials removed from the piles before capping would be tested for contamination and disposed of or stored for reuse, as appropriate.

BMPs would also be put into place for treatment of dewatering effluents in settling ponds, tanks or through filtration systems (Section 3.8.4.2).

Water quality monitoring would be conducted during the construction period. Pursuant to Section 401 of the Clean Water Act, the applicant would obtain and comply with the conditions of a Water Quality Certification from the HDOH. The proposed action is expected to meet the conditions of the CWA Section 402 NPDES permit required by the HDOH. To minimize impacts of the return seawater on the ambient receiving water quality a diffuser was computer-designed and optimized by the applicant. The design of the diffuser facilitates substantial near-field initial mixing of the return water for all water current cases considered. During operations, a water quality and marine biota monitoring program would be implemented by the applicant.

Potential impacts to terrestrial biota would be mitigated by noting for avoidance the location of the City's "Exceptional Trees" on construction plans and erecting noise and visual barriers for nesting white terns, if present (Section 3.8.5).

4.10 UNRESOLVED ISSUES (AND HOW SUCH ISSUES WILL BE RESOLVED OR OVERRIDING REASONS FOR PROCEEDING WITHOUT RESOLUTION)

The applicant's proposed method of compliance with CWA Section 316(b), which establishes requirements for screening and maximum intake velocities for cooling water intakes, is being evaluated by the U.S. Environmental Protection Agency (USEPA). The adequacy of the applicant's Proposed Coral Transplantation and Monitoring Plan (Appendix O) to appropriately mitigate losses to aquatic resources is also being evaluated by the USACE and would be resolved prior to issuance of a DA permit.

4.11 COMPLIANCE WITH FEDERAL LAWS, REGULATIONS AND EXECUTIVE ORDERS

The HSWAC project was evaluated for conformance with relevant Federal laws, regulations and executive orders and the results are presented in the following paragraphs.

National Environmental Policy Act

NEPA (42 U.S.C. 4321 et seq.) is the basic U.S. charter for protection of the environment. It establishes policy, sets goals, and provides means for carrying out the policy. NEPA is a procedural statute, requiring that Federal agencies consider the environmental effects of their actions when making decisions. NEPA procedures must ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing the NEPA. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment.

The Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508) provide guidance for implementing the procedural provisions of the NEPA and are binding on Federal agencies.

Preparation of this EIS and provisions for its public review are being conducted in compliance with the NEPA, Council on Environmental Quality Regulations, and USACE NEPA Implementation Procedures for the Regulatory Program (33 CFR Part 325, Appendix B).

Rivers and Harbors Act of 1899

Section 10 of the Rivers and Harbors Act of 1899 prohibits the unauthorized obstruction or alteration of any navigable water of the United States. Section 10 provides that the construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters is unlawful unless the work is authorized by USACE.

Because the proposed project would involve structures and work in or affecting navigable waters of the United States, it requires a DA permit from USACE. An application has been submitted and this EIS has been prepared to support a decision by USACE on the applicant's DA permit application.

Clean Water Act

The purpose of the Clean Water Act (33 U.S.C. 1251 et seq.) (CWA) is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The CWA establishes the basic structure for the regulation of pollutants into waters of the United States and quality standards for surface waters. Under the CWA, it is unlawful to discharge any pollutant from a point source into waters of the United States without obtaining a permit from the appropriate authority.

Section 404 of the CWA authorizes USACE to issue permits for discharges of dredged or fill material into waters of the United States, provided that the discharge complies with the 404(b)(1) Guidelines. Because the proposed project would involve the discharge of fill material into waters of the United States, it requires a DA permit from USACE under Section 404. This EIS has been prepared to support a decision by USACE on the applicant's DA permit application.

Under Section 401 of the CWA, a Federal agency may not issue a permit for an activity that may result in any discharge into waters of the United States until the applicant provides the agency with a Section 401 water quality certification from, or evidence of waiver by, the state where the discharge would originate. Accordingly, USACE may not issue a permit for the proposed project until the applicant provides USACE with a Section 401 water quality certification from, or evidence of waiver by, the State of Hawaiʻi, Department of Health. The Clean Water Act (CWA) Section 401 Water Quality Certification has not yet been approved by HDOH.

Section 402 of the CWA created the National Pollutant Discharge Elimination System (NPDES) program, which regulates point sources that discharge pollutants (other than dredged or fill material) into waters of the United States. In Hawaiʻi, the NPDES program has been delegated to the State of Hawaiʻi, Department of Health, which issues NPDES permits to ensure that the State's mandatory standards for clean water are met. The proposed discharge of return seawater into Māmala Bay triggers the requirement for the applicant to obtain a NPDES permit. In addition to other requirements, the NPDES permit would implement CWA Section 303(d), which addresses impaired waters, and CWA Section 316(b), which requires that the location, design, construction, and capacity of cooling water intake structures use the best technology available for minimizing adverse environmental impacts. Pursuant to CWA Section 316(b), an NPDES permit issued for the HSWAC project would require the use of the best technology available to minimize the potential for organisms to get pulled into the project's cooling system or trapped against screens at the front of the intake structure. The Clean Water Act (CWA) Section 402 NPDES permit has not yet been approved by HDOH.

Marine Protection, Research and Sanctuaries Act of 1972

The Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA) regulates the dumping of materials into ocean waters. Under Section 103 of the MPRSA, USACE is authorized to issue permits for the transportation of dredged materials for the purpose of disposal in the ocean where it is determined that the disposal would not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities.

Because the proposed HSWAC project would not involve any ocean disposal of dredged material, authorization under Section 103 is not required.

National Marine Sanctuaries Act

The National Marine Sanctuaries Act (16 U.S.C. 1431 et seq.), which is Title III of the Marine Protection, Research, and Sanctuaries Act of 1972, seeks to enhance both public awareness and conservation of the marine environment. Title III authorizes the Secretary of Commerce to designate marine sanctuaries for the purpose of preserving or restoring such areas for their conservation, recreational, ecological, or aesthetic values. Activities in a sanctuary authorized under other authorities are valid only if the Secretary of Commerce certifies that the activities are consistent with the purposes of Title III and can be carried out within the regulations for the sanctuary.

The proposed action would not affect any national marine sanctuary.

Coastal Zone Management Act of 1972

Under Section 307(c) of the Coastal Zone Management Program of 1972, as amended (16 U.S.C. 1456(c)), an applicant for a Federal permit to conduct an activity affecting land or water uses in the state's coastal zone must furnish a certification that the proposed activity will comply with the state's coastal zone management program. Under Section 307(c), USACE may not issue a DA permit until the state has concurred with the applicant's certification. The applicant has submitted a certification to the State of Hawaiʻi Office of Planning.

Endangered Species Act of 1973

The Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) (ESA) declares the intention of Congress to conserve threatened and endangered species and the ecosystems on which those species depend. Under Section 7 of the ESA, an agency must, in consultation with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS), take such action as necessary to ensure that any action it authorizes is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat. Endangered and threatened marine species in the project ROI are discussed in Section 3.7.5.3. No endangered or threatened terrestrial species are present in the project ROI (see Section 3.8.5).

Based on its Biological Assessment, USACE determined that the applicant's proposed action may adversely affect species listed as threatened or endangered under the ESA. Where potentially impacted, each species is under the jurisdiction of NMFS. Accordingly, pursuant to Section 7 of the ESA, USACE has consulted with the Protected Resources Division of NOAA's NMFS Pacific Islands Regional Office, which issued its Biological Opinion, including an Incidental Take Statement, dated September 13, 2012.

The Section 7 consultation history may be found in Appendix M and a summary, including the non-discretionary Terms and Conditions that USACE must comply with, may be found in Section 3.7.5.3.

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act, commonly referred to as the Magnuson-Stevens Act, requires Federal agencies to consult with NMFS on any action proposed to be authorized, funded, or undertaken by the agency that may adversely affect EFH. EFH in the project ROI is described in Section 3.7.5.4.

USACE has determined that the applicant's proposed action may adversely affect essential fish habitat. Accordingly, under the Magnuson-Stevens Act, USACE consulted with the Habitat Conservation Division of NOAA's NMFS Pacific Islands Regional Office. The history of the consultation may be found in Appendix J. NMFS' Conservation Recommendations are summarized in Section 3.7.5.4.

National Historic Preservation Act

The National Historic Preservation Act of 1966 (16 U.S.C. 470 et seq.) (NHPA) establishes preservation as a national policy and directs the Federal government to provide leadership in preserving, restoring, and maintaining the historic and cultural environment of the Nation. Under Section 106 of the NHPA, an agency with jurisdiction over a proposed undertaking or having authority to permit any undertaking must take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places. These resources are referred to as "historic properties." The agency must also afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the undertaking. Archaeological, historic and cultural resources in the Permit Area are described in Section 3.2.

In carrying out its Section 106 responsibilities, a Federal agency must consult with the State Historic Preservation Officer (SHPO) and with any Native Hawaiian organization that attaches religious and cultural significance to historic properties that may be affected by an undertaking.

USACE has completed consultation with SHPO pursuant to Section 106. USACE made a preliminary determination of "no historic properties adversely affected" and, based on SHPO's decision to allow the consultation period for USACE's request for concurrence to lapse, USACE has presumed concurrence with that determination.

Clean Air Act

Section 176(c) of the Clean Air Act requires that Federal agencies assure that their activities are in conformance with Federally-approved Clean Air Act state implementation plans for geographical areas designated as "nonattainment" and "maintenance" areas under the Clean Air Act. Hawai‘i does not have any geographic areas designated as nonattainment or maintenance areas. In addition, the activities proposed by the applicant would not exceed *de minimus* levels of direct or indirect emissions of a criteria pollutant or its precursors and are exempted by 40 CFR Part 93.153. Any later indirect emissions are generally not within the Corps' continuing program responsibility and generally cannot be practicably controlled by the Corps. For these reasons a conformity determination is not required for this permit action. Potential impacts of the HSWAC project on air quality are considered in Section 3.8.3.2.

Marine Mammal Protection Act

The Marine Mammal Protection Act of 1972 (16 U.S.C. 1361 et seq.) expresses the intent of Congress that marine mammals be protected and encouraged to develop in order to maintain the health and stability of the marine ecosystem. The Act imposes a perpetual moratorium on the taking of marine mammals and on the importation of marine mammals and marine mammal products without a permit from either the Secretary of the Interior or the Secretary of Commerce, depending upon the species of marine mammal involved.

Marine mammals that may be present within the project ROI are identified in Section 3.7.5.3. Because the noise from pile driving may affect marine mammals, the applicant has applied for an authorization to incidentally (IHA) take small numbers of marine mammals by harassment. This authorization from NMFS is commonly referred to as an Incidental Harassment Authorization.

The IHA was issued on August 21, 2012. It includes BMPs for in-water work as well as SOPs for establishment of a marine mammal exclusion zone, shut down, and soft start.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 U.S.C. 703-712) implements various treaties and conventions between the U.S. and Canada, Japan, Mexico and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing or possessing migratory birds is unlawful unless permitted by the Act’s implementing regulations. Migratory birds that may be present in the project ROI are identified in Section 3.7.5.3.

No taking, killing or possession of migratory birds would result from the proposed project. It is unlikely that Hawaiian petrels would forage in Māmala Bay because there are no nesting colonies on Oʻahu and the species forages far out to sea. No impacts to this listed species would be expected from the proposed project. Several other species of migratory birds use coastal and offshore waters for foraging activities, and local fishermen use them as guides to target fish such as marlin, mahimahi and tuna. Typically, these birds work waters much farther from shore than those in the project area; however, if they did occur in the project area, they could easily avoid the slow-moving or stationary work vessels. The HSWAC project would not affect waterbird nesting or foraging habitat as there are no wetlands in the project area.

Fish and Wildlife Coordination Act

A primary purpose of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) (FWCA) is to provide for more effective integration of fish and wildlife conservation within Federal water resources development. The FWCA requires Federal agencies to coordinate with the USFWS and relevant state wildlife resource agencies in order to help prevent the loss of and damage to fish and wildlife resources.

Through this NEPA process, USACE is coordinating with the USFWS and the State of Hawaiʻi, Department of Land and Natural Resources, Division of Aquatic Resources, with a view to the conservation of fish and wildlife resources by prevention of their direct or indirect loss or damage due to the applicant’s proposed activity.

The applicant responded to concerns of USFWS and DAR by (1) undertaking additional marine biological surveys of the entire pipeline route and quantitatively estimating losses of habitat, coral cover and other biota, including mesophotic organisms, (2) undertaking additional water quality surveys, (3) agreed to implement additional measures to avoid coral loss including using divers to guide emplacement of piles and anchors associated with construction of the receiving pit and pipeline deployment, (4) reexamined the feasibility and effects of screening the intake, and (5) prepared a coral transplantation and monitoring plan (Appendix O).

Toxic Substances Control Act

The Toxic Substances Control Act (15 U.S.C. 2601 et seq.) (TSCA) authorizes the administrator of the USEPA authority to regulate the manufacture, processing, distribution in commerce, use, or disposal of a chemical substance or mixture, which may present an unreasonable risk of injury to human health or the environment. The USEPA's authority includes total or partial bans on production, content restrictions, operational constraints, product warning statements, instructions, disposal limits, public notice requirements, and monitoring and testing obligations. The TSCA Chemical Substance Inventory is a database providing support for assessing human health and environmental risks posed by chemical substances. Hazardous or toxic substances that may be used or may be present in the project ROI are discussed in Section 3.3.10. Any substance listed on the TSCA Chemical Substance Inventory to be used in the HSWAC project would be subject to appropriate Federal and State regulations.

Noise Control Act of 1972 and Amendments of 1978

The Noise Control Act of 1972 (PL 92-574) and Amendments of 1978 (PL 95-609) as well as the USEPA's Subchapter G-Noise Abatement Programs (40 CFR 201-211) and local noise ordinances apply to construction and operation of the facilities.

Noise impacts are considered in Section 3.3.9. Federal and State noise regulations would apply to the construction and operation of the HSWAC facilities.

Resource Conservation and Recovery Act

Under the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 et seq.), Congress declares the national policy of the United States to be, whenever feasible, the reduction or elimination, as expeditiously as possible, of hazardous waste. Waste that is nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment. The RCRA defines waste as hazardous through four characteristics: ignitability, corrosivity, reactivity, or toxicity. Once defined as a hazardous waste, the RCRA established a comprehensive cradle-to-grave program to regulate hazardous waste from generation through proper disposal or destruction.

RCRA would apply to the handling of hazardous waste (see Section 3.3.10).

EO 11988, Floodplain Management

Executive Order 11988 requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities" for the following actions:

- acquiring, managing, and disposing of Federal lands and facilities,
- providing Federally-undertaken, financed, or assisted construction and improvements, and
- conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

Flood zones in the HSWAC project ROI are described in Section 3.6.2.2. A recent redrawing of flood zone boundaries placed the preferred location of the HSWAC cooling station in zone AE. For those activities which in the public interest must occur in or impact upon floodplains, the district engineer shall ensure, to the maximum extent practicable, that the impacts of potential flooding on human health, safety, and welfare are minimized, the risks of flood losses are minimized, and, wherever practicable the natural and beneficial values served by floodplains are restored and preserved.

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low- Income Populations

The purpose of this EO is to focus Federal attention on the environmental and human health effects of Federal actions on minority and low-income populations with the goal of achieving environmental protection for all communities. The EO directs Federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law. The order also directs each agency to develop a strategy for implementing environmental justice. The order is also intended to promote nondiscrimination in Federal programs that affect human health and the environment, as well as provide minority and low-income communities' access to public information and public participation.

The HSWAC project would not create human health effects, disproportionate or otherwise, on any human populations, including minorities or low-income populations. Human health and safety risks are described in Section 3.3.12.

EO 13045, Protection of Children from Environmental Health Risks and Safety Risks

The order applies to economically significant rules under E.O. 12866 that concern an environmental health or safety risk that the USEPA has reason to believe may disproportionately affect children. Environmental health risks or safety risks refer to risks to health or to safety that are attributable to products or substances that the child is likely to come in contact with or ingest (such as the air we breathe, the food we eat, the water we drink or use for recreation, the soil we live on, and the products we use or are exposed to). When promulgating a rule of this description, the USEPA must evaluate the effects of the planned regulation on children and explain why the regulation is preferable to potentially effective and reasonably feasible alternatives.

The HSWAC project would not create an environmental health or safety risk that may disproportionately affect children. Human health and safety risks are described in Section 3.3.12.

EO 13089, Coral Reef Protection

This EO recognizes the significant ecological, social, and economic values provided by the Nation's coral reefs and the critical need to ensure that Federal agencies are implementing their authorities to protect these valuable ecosystems. EO 13089 directs Federal agencies, including the USEPA and the USACE, whose actions may affect U.S. coral reef ecosystems, to take the following steps:

1. Identify their actions that may affect U.S. coral reef ecosystems,
2. Utilize their programs and authorities to protect and enhance the conditions of such ecosystems, and
3. To the extent permitted by law, ensure that any actions they authorize, fund, or carry out would not degrade the conditions of such ecosystems.

Pursuant to the requirement that all DA permits subject to Section 404 of the Clean Water Act comply with the applicable provisions of the 404(b)(1) Guidelines at 40 CFR Part 230, USACE will issue a DA permit only upon a determination that the applicant has taken all appropriate and practicable steps to avoid and minimize adverse impacts to waters of the United States, including coral reef ecosystems. Compensatory mitigation for unavoidable impacts to coral reef ecosystems may be required to ensure that the proposed project complies with the 404(b)(1) Guidelines or to ensure that it is not contrary to the public interest. Potential impacts to coral reefs are described in Section 3.7.5.1.

EO 13112, Non-Native Species

EO 13112 directs Federal agencies to "not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions." Invasive species are briefly considered in Section 3.9.6.

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CHAPTER 5.
PUBLIC INVOLVEMENT

5.1 ENVIRONMENTAL IMPACT STATEMENT NOTICE OF INTENT AND SCOPING MEETING

USACE published a Notice of Intent (NOI) to prepare a draft Environmental Impact Statement for this regulatory action in the Federal Register on February 17, 2009 (74 FR 7402-7404). The period for receipt of comments on the action extended until March 20, 2009. In addition to informing the public that USACE would be preparing an EIS to inform a decision on the permit application, the Federal Register notice announced a public scoping meeting, which was subsequently held on March 5, 2009. USACE also issued a Special Public Notice announcing the meeting, which was posted on the USACE Honolulu District website and mailed to interested parties.

5.2 DRAFT EIS AND RESPONSES TO COMMENTS RECEIVED

The Federal Register Notice of Availability of the Draft EIS was published on March 18, 2011. Appendix P contains the comments received on the DEIS. Table 5-1 summarizes substantive comments received on the DEIS and how they were addressed in the FEIS.

Table 5-1: Comments on the DEIS and How Addressed in the FEIS

DEIS Comment	*Response*
The document lacks a description of the occurrence of regular sightings of humpback whales within the proposed project area. (NOAA, NMFS, PIRO, PRD)	This information was added to Section 3.7.5.3.
The project may cause adverse impacts to marine mammals due to construction noise. (NOAA, NMFS, PIRO, PRD)	The applicant applied for an Incidental Harassment Authorization under the MMPA. Potential mitigation measures are identified in Section 3.7.5.3 and include time restrictions on noisy activities, safety zones monitored by observers, and soft starts to pile driving.
The document lacks information about archaeological sites and protections along the proposed routes for distribution pipelines. (OHA; DLNR)	The information has been added to the discussion of cumulative impacts in Section 3.9.1.
Discarded military munitions may be present in the proposed project area. The Hawai‘i Undersea Military Munitions Assessment (HUMMA) Study should be reviewed and findings incorporated in the FEIS. (USDOC NOAA NOS MBO RMD)	The HUMMA Study was reviewed and a summary of relevant findings was added to Section 3.3.3.
The project potentially violates CWA Sections 303(c)-(d). The proposed discharge location is listed as impaired for total nitrogen and chlorophyll-a. The project should avoid the discharge of nutrients that would further impair the water quality of Māmala Bay. (USEPA)	On July 3, 2012, the Hawai‘i Dept. of Health published an updated list of impaired waters in which the area of the proposed discharge was delisted for those parameters. The discussion in Section 3.7.4.2 was updated to reflect this change.

DEIS Comment	***Response***
The proposed HSWAC discharge may interact with the discharge from the Sand Island Wastewater Outfall. (USEPA)	The Sand Island Outfall is more than two miles away from the proposed HSWAC discharge. Water quality monitoring at stations between the two locations show no influence from the Sand Island Outfall. See Section 3.7.4 for more details. In addition, the Sand Island discharge plume is positively buoyant and tends to rise toward the surface while the HSWAC discharge plume would be negatively buoyant and would tend to sink, creating further separation between the two plumes. Finally, the FEIS contains a revised preferred location for the discharge diffuser which is roughly 100 feet deeper than the Sand Island Outfall, adding still more vertical separation between the respective plumes.
An antidegradation analysis will be required. (USEPA)	An antidegradation analysis was completed and may be found in Appendix H.
The FEIS should analyze the specifics of the *Friends of Pinto Creek vs. USEPA* opinion and its potential implications for the proposed project. (USEPA)	The proposed discharge from the HSWAC project is distinguishable from the discharge at issue in *Pinto Creek*. In *Pinto Creek*, the NPDES permit authorized a new source to discharge pollutants into a stream already exceeding its water quality standards for that pollutant. With respect to the HSWAC project, the State of Hawaiʻi, Department of Health, delisted the offshore portions of Māmala Bay where the proposed discharge would occur, and they are no longer identified as impaired. Consequently, unlike the *Pinto Creek* discharge, the proposed HSWAC discharge would return the seawater into a water segment that currently meets State water quality standards, and the regulations prohibiting discharges to impaired waters do not apply.
The FEIS should consider additional discharge alternatives. (USEPA)	Two additional alternatives were added to the FEIS, each with a deeper discharge location. See Sections 2.4.4 and 2.4.5 for descriptions of these alternatives.
The discharge would not meet State water quality standards for temperature or CWA 316(a). (USEPA)	Water quality standards would be met at the boundary of a proposed Zone of Mixing. Temperature is not the parameter requiring the greatest dilution to meet water quality standards and the discharge would meet water quality standards for temperature well within the boundaries of the proposed Zone of Mixing. The CORMIX model found that ambient temperatures would be attained within less than one-half meter of the centerline of the diffuser under high natural current flow. Under worst case low current flow ambient temperatures would be attained within 12.2 m (or 40 feet) from the diffuser centerline. Under average current flow conditions ambient temperature would be attained within about one meter of the diffuser centerline. See Section 2.4.2.4 for a description of diffuser operation and CORMIX modeling. The new preferred alternative location for the diffuser terminates about 225 feet deeper than proposed in the DEIS and the lower portion of the diffuser is frequently within the top of the thermocline. Consequently, ambient temperatures of the receiving waters vary greatly at these depths.

DEIS Comment	***Response***
The DEIS does not consider the potential discharge of toxic pollutants from the return seawater pipe. (USEPA)	The proposed discharge would consist of deep seawater. Nothing would be added to the cold seawater as it passes through the HSWAC system. No antifouling agents would be used in the seawater system. All components of the system are composed of metals with high resistance to corrosion in seawater (e.g., stainless steel or titanium) or inert plastics.
The project potentially violates CWA Section 316(b). The applicant should provide additional analyses to demonstrate compliance with either Track I or Track II requirements. (USEPA)	To demonstrate compliance with Track II requirements, the applicant prepared a comparison of entrainment of various biological taxa in the proposed intake with expected entrainment through a similar system at a shallow coastal location. Data collected in new deep and shallow water marine biological surveys of the HSWAC pipeline route and in published literature relevant to the proposed project area were used for the comparisons. In all cases the reduction of entrained biomass in the deep intake was more than 90%, demonstrating compliance with Track II. This analysis may be found in Appendix N to the FEIS and is summarized in Section 3.7.5.1.
The project potentially violates CWA Section 402. (USEPA)	Since publication of the DEIS, the Hawaiʻi Department of Health has delisted the outer portions of Māmala Bay as “impaired” for any water quality parameters and therefore a discharge can be permitted under Section 402. Under Alternatives 1, 2, and 3 the discharge would be into waters with all constituents in compliance with State water quality standards, i.e., having some assimilation capacity for additional loading. Alternative 4 would discharge in a depth range sometimes spanning the bottom of the mixed layer and the top of the thermocline. At those times, the bottom of the diffuser would be within the high nutrient regime of the thermocline, and there would be no assimilation capacity over that deeper portion of the diffuser. The applicant is working with the Hawaiʻi Department of Health to develop a blended measure of “ambient concentrations” of nitrate+nitrite nitrogen to reflect the variability of concentrations over the entire depth range of the Alternative 4 diffuser, which would ensure adequate assimilation capacity to permit a discharge under Section 402. Please see the discussion in Section 3.7.4.2.
The FEIS should consider the need for CWA Section 404 permits for the pipelines and anchor collars. (USEPA)	Because the proposed project would involve both structures and work in or affecting navigable waters of the United States and the discharge of dredged or fill material into waters of the United States, the entire project requires authorization under Section 10 and Section 404. With the exception of activities requiring authorization under Section 103, to which special procedures apply, USACE does not evaluate different components of a single project under different authorities.

DEIS Comment	***Response***
The FEIS should describe how avoidance of corals will be achieved in positioning the pipelines. (USEPA)	In order to avoid impacting corals, the pipeline alternatives were positioned to emerge from the microtunnel in the biotope of dredged rubble, where coral cover is sparse. See Section 3.7.5. Because the anchor collars would be attached to the pipelines during assembly, it would not be possible to shift their positioning during installation; however, the pipeline route was selected to traverse areas of very low to nonexistent coral cover.
The FEIS should analyze alternative sizes and designs for minimizing impacts at the breakout point. (USEPA)	The size and configuration of the receiving pit are based on the dimensions of the microtunnel boring machine and the minimum clearance necessary to extract it from the pit once tunneling is complete. The proposed size of the receiving pit is the minimum that would allow extraction of the MTBM. Any of the other potential trenchless technologies available would require larger gross breakout areas as explained in Section 2.5.5.
Consider impacts from physical disturbance, anchoring and chemical discharges to marine resources at the staging area in Ke‘ehi Lagoon. (USEPA)	The Ke‘ehi Lagoon staging area is an extremely turbid, soft-bottomed dredged channel. In-faunal organisms predominate. The proposed project would affect this community by implanting pipe piles (the same piles to be used offshore) to temporarily moor floating pipe sections. Potential impacts to the Ke‘ehi Lagoon infaunal ecosystem would be insignificant and temporary, similar to what presently occurs from vessel anchoring and moorings. No chemical discharges would occur in Ke‘ehi Lagoon (Section 3.7.5.1). Pipes sections would be welded together on land. In-water connections of pipe strings would be made using bolts.
Include quantitative biological assessments of the benthos in the breakout and pipeline sites, including coral density, size, species richness and condition. (USEPA)	The breakout site (receiving pit) is within the biotope of dredged rubble where coral cover was estimated to be 0.01% of the surface. That means the affected bottom consists of 99.99% sand and rubble. There are no reef structures in this biotope. What coral heads are present are small, widely separated and susceptible to damage from rubble movement and scour during seasonally high surf events. The composition of the benthos is described in Section 3.7.5. For the FEIS, additional surveys of the benthos along the entire pipeline route were completed and the results may be found in Appendices E (shallow water) and I (deep water).
The FEIS should assess the deep benthos to determine if mesophotic coral reef ecosystems occur along the pipeline. (USEPA)	The potential for encountering mesophotic coral reef ecosystems is evaluated in Section 3.7.5. The deep water surveys (Appendix I) found the common mesophotic scleractinian coral, *Leptoseris* sp., at depths shallower (but not at or deeper) than the new preferred discharge depth, and avoiding mesophotic corals was a significant criterion in developing the new preferred alternative.
The FEIS should present benthic photographs or maps to document avoidance of corals at the breakout point and along the pipeline. (USEPA)	Section 3.7.5 and Appendices E and I all contain photographs and maps showing biotopes and habitat examples at the proposed breakout point (receiving pit) and along the proposed pipeline route.

DEIS Comment	***Response***
Include more biologically relevant data such as coral density and habitat area and delete calculations for surface area of live coral cover. (USEPA)	The new shallow water marine biology survey (Appendix E) includes data on coral colony size and size frequency distribution by biotope. This information is summarized in Section 3.7.5. Compared to typical waters in Hawai‘i, coral cover throughout the project area is very low. For example, in the biotope of dredged rubble where the receiving pit would be located, mean coral cover was estimated to be 0.01%.
The FEIS should describe impacts to the range of marine habitats and their functions. (USEPA)	Section 3.7.5 describes potential impacts to marine habitats. New subsections have been added to describe impacts to coral reef ecological services. Appendix O is the applicant’s proposed coral transplantation and monitoring plan.
Compensatory mitigation plans should account for direct and indirect impacts, temporal losses, and the uncertainty of mitigation project success. (USEPA)	The applicant’s proposed coral transplantation and monitoring plan is Appendix O to the FEIS. In calculating damage to the benthos and specifically coral cover, both direct and indirect impacts were considered (Section 3.7.5.1). The transplantation plan includes a monitoring program to acknowledge the temporal lag in mitigation. Contingency mitigation measures are proposed in the event the transplantation actions are not successful.
The FEIS should describe best management practices to minimize construction damage. (USEPA)	BMPs for minimizing construction damage are described in the following sections: hazardous and toxic substances, Section 3.3.10; water quality, Section 3.7.4.5; protected species, Section 3.7.5.3; air quality, Section 3.8.3.2; and groundwater quality, Section 3.8.4.2.
The FEIS should describe the potential for leakage or discharge of drilling fluids and their impacts to the marine environment. (USEPA)	The microtunnel shafts would begin at the cooling station jacking pit 40 feet below ground level. As tunneling proceeds, pipes would be installed and the space between the pipe and tunnel wall grouted, precluding leakage of drilling fluids. The microtunnels would proceed to the receiving pit, entering through the sheet pile wall. Any discharge of drilling fluids would be contained in the receiving pit itself, which would be isolated from the surrounding environment by the sheet pile walls (Section 3.7.4.5).
Discuss how the alternatives analysis complies with CWA Section 404(b)(1) requirements for identification of the least environmentally damaging alternative. (USEPA)	Documentation of compliance of 404 (b) (1) guidelines is required prior to finalizing the Record of Decision.
Describe use of antifouling compounds to clean the intake and outfall pipes. (USEPA)	No antifouling compounds or other additives would be used to clean either the intake or return pipes (Section 3.3.10).
Purpose and need section should discuss the project in the context of the larger need for energy efficiency strategies and energy savings for downtown. (USEPA)	A revised statement of purpose and need may be found in Section 1.1.

DEIS Comment	***Response***
Reconsider alternatives, including off-site locations, environmentally preferable onsite alternatives and other modes of energy savings. (USEPA)	The purpose of this project, as stated in the Purpose and Need section, is to increase use of renewable energy technologies and thereby reduce the need for imported petroleum products for electricity generation on O‘ahu. The applicant proposes to accomplish this by constructing a SWAC system to serve the downtown area of Honolulu. Other renewable energy alternatives to a SWAC system are available to reduce petroleum consumption, and they have been added to the description of the No Action Alternative, as they are being developed elsewhere on O‘ahu by other entities. Other district cooling technologies are evaluated in Section 2.5.1.
The FEIS should include assessment of an alternative with a screened intake and discharge at a depth where ambient temperatures equal discharge temperatures. (USEPA)	The practicability of screening the intake is evaluated in Section 2.5.7. The entrainment analysis contained in Appendix N and summarized in Sections 3.7.5.2 and 3.7.5.3 documents why an intake screen is not needed based on the low density of biota at the intake depth and the consequent low anticipated numbers of organisms to be entrained. To match discharge and ambient temperatures the diffuser would have to be located nearly 1,000 feet deep, well below the thermocline (see Section 3.7.4.3). Such an alternative could not be permitted based on State water quality standards, under which all marine waters below the thermocline are in violation and therefore “impaired,” meaning no new discharge could be permitted.
The cooling station should be located in a non-flood zone area. (USEPA)	The cooling station must be close to customer buildings to minimize freshwater pumping costs, but also close to the shore to minimize seawater pumping costs. Developable commercial properties with these characteristics in and near downtown Honolulu are extremely limited. All available properties were considered and evaluated using a set of quantitative criteria. The only two reasonable locations were carried forward for analysis as part of the alternatives. A recent revision of flood zones changed the classification of the preferred parcel. The reclassification of its flood zone designation will have minor impacts on facility design, which will mitigate for potential impacts from flooding to the cooling station or to surrounding properties from the presence of the cooling station in the event of flooding.
The FEIS should include assessment of a double-closed loop system. (USEPA)	This alternative is considered in Section 2.5 but is not carried forward for detailed analysis.
Correct the EIS to reflect the new flood zone designation. (USEPA)	The flood zone designation and consequent implications for the design of the cooling station have been updated in Section 3.6.2.2.
Include a description of existing benthic and aquatic habitats, including locations of coral reefs in relation to the proposed pipelines, common and protected species that rely on these habitats, and the current chemical, physical and biological conditions that these species depend on. (USEPA)	Pertinent information relative to these resources may be found in Section 3.7.

DEIS Comment	***Response***
Provide a detailed analysis of potential direct, indirect and cumulative impacts to biological resources. (USEPA)	Analysis of direct and indirect impacts to biological resources may be found in Section 3.7.5 and 3.8.5. Cumulative impacts to biota are addressed in Sections 3.9.6 and 3.9.7.
Include the results of consultation with the FWS and NMFS regarding endangered and threatened species. (USEPA)	NOAA's Biological Opinion pursuant to Section 7 of the ESA is included in Appendix M and summarized in Section 3.7.5.3.
Include a commitment to mitigating all adverse impacts to human health. (USEPA)	Measures to mitigate adverse impacts to human health are described in Sections 3.3.10 and 3.3.12.
Address the potential for disproportionate adverse impacts to minority and low-income populations. (USEPA)	The applicant has prepared an Environmental Hazard Management Plan, which provides measures for the protection of all populations in or near the project site. That plan may be found in Appendix D. Shelter management would be provided with the CSMP, EPP and the HASP when they become available, and notified in the event there is a spill or release of a toxic or hazardous substance. With these measures there should be no disproportionate adverse effects to minority or low-income populations (Section 3.3.12.3).
The FEIS should commit to a notification plan to disclose to the public the health risk of exposure to hazardous or toxic substances within the region of influence. (USEPA)	The applicant has committed to a notification plan as stated in Section 3.3.10.3.
Address the potential for disproportionate adverse impacts to children. (USEPA)	These potential impacts are discussed in Section 3.3.10.3.
The FEIS should reflect that both alternative locations for the cooling station are in an AE flood zone. (USEPA)	This information is contained in Section 3.9.5.
The FEIS should discuss any impacts that the proposed project may have on the potential for flooding, as well as the impacts of potential flooding on the project. (USEPA)	These potential impacts are discussed in Section 3.6.4.
The FEIS should identify projected hazardous waste types and volumes and how they will be handled, stored, transported and disposed of. (USEPA)	The applicant has prepared an Environmental Hazard Management Plan, which describes how hazardous waste would be dealt with. That plan may be found in Appendix D. A summary is provided in Section 3.3.10.3.
Address potential impacts of hazardous waste from construction of the proposed project. (USEPA)	Potential impacts of hazardous waste are addressed in Section 3.3.10.3.
Describe air quality impacts during and after construction. (USEPA)	Air quality impacts are described in Section 3.8.3.
Demonstrate that the proposed project would comply with applicable State and Federal air quality regulations, including any permit requirements for the back-up generators and construction equipment. (USEPA)	Compliance with air quality regulations is described in Section 3.8.3. There are no air quality permits required for emergency generators or construction equipment.
Include the current NAAQS. (USEPA)	The current NAAQS are contained in Section 3.8.3.
Describe specific commitments to minimize and mitigate emissions. (USEPA)	EPA-recommended mitigation measures are contained in Section 3.8.3. and would be implemented and maintained by the applicant.
Provide alternative, deeper locations for the discharge. (DOI)	Two deeper discharge alternatives were added in the FEIS. These are described in Sections 2.4.4 and 2.4.5.

DEIS Comment	***Response***
Identify how the diffusion dynamics, characteristics of the discharge, and proximity to benthic resources differs by alternative. (NOAA, NMFS, PIRO, HCD)	Relevant information is contained in Section 3.7.5.
Identify the probability of being granted a Zone of Mixing and the alternative plan if it is not. (NOAA, NMFS, PIRO, HCD)	The applicant believes the probability of being granted a ZOM for the discharge is high because the Hawai‘i Department of Health delisted the outer portions of Māmala Bay as impaired, but if it were not granted for some reason the project could not proceed (Section 3.7.4.2).
Provide quantitative current water quality and benthic resource data for project-affected areas. (NOAA, NMFS, PIRO, HCD)	New site-specific water quality data were collected at the proposed location of the diffuser. These data are included in Section 3.7.4. New shallow and deep water biota surveys were also completed for the FEIS. They are summarized in Section 3.7.5 and reports of the studies may be found in Appendices E and I, respectively.
Identify the presence and distribution of mesophotic coral along the pipe to 200 m depth. (NOAA, NMFS, PIRO, HCD)	The deep water surveys (Appendix I) found the common mesophotic scleractinian coral, *Leptoseris* sp., at depths shallower (but not at or deeper) than the new preferred discharge depth (Section 3.7.5.1).
Quantify direct and indirect impacts to marine resources and water quality. (NOAA, NMFS, PIRO, HCD)	Quantitative impacts to marine resources are described in Section 3.7.5 and Appendices E and I. Water quality impacts are addressed in Section 3.7.4 of the EIS and Appendix L.
Identify the expected species and numbers of individuals that may be entrained at the intake and return. (NOAA, NMFS, PIRO, HCD)	Quantitative information regarding entrainment of organisms at the intake may be found in Section 3.7.5 and Appendices I and N. Organisms that were observed in the proposed depth range of the diffuser and therefore could become entrained in the return flow are also identified in Section 3.7.5 and Appendix I.
Provide a water quality monitoring plan for the return seawater. (NOAA, NMFS, PIRO, HCD)	The applicant’s proposed monitoring plan may be found in Appendix G, referenced in Section 3.7.4.5.
Describe mitigation measures to avoid and minimize impacts to water quality and benthos and how compensatory mitigation will be implemented. (NOAA, NMFS, PIRO, HCD)	The applicant’s proposed mitigation measures are summarized in Table ES-2 and Section 4.9. The applicant’s proposed coral transplantation and monitoring plan is contained in Appendix O.
Illustrate where project features are with respect to biological resources. (NOAA, NMFS, PIRO, HCD)	See Figure 3-23 for shallow water resources and Figures 3-31 and 3-32 for deep water resources.
Provide GPS coordinates for all construction activity and structure locations. (NOAA, NMFS, PIRO, HCD)	See Table 2-1.
Fully characterize impacts to EFH. (NOAA, NMFS, PIRO, HCD)	The USACE Essential Fish Habitat Assessment and Consultation may be found in Appendix J. A summary is contained in Section 3.7.5.4.
Page iv. Correct index page numbering. (NOAA, NMFS, PIRO, HCD)	Corrected.
Page 2-5. Correct coordinates. (NOAA, NMFS, PIRO, HCD)	Corrected
Page 2-7. Provide coordinates for receiving pit, barge mooring, all construction related activities. (NOAA, NMFS, PIRO, HCD)	Receiving pit coordinates may be found in Table 2-1. Detailed work plans are not yet available so information on the type, size and positioning of support vessels is not yet available.
Page 2-9. Correct distance from jacking pit to receiving pit and beginning of diffuser. (NOAA, NMFS, PIRO, HCD)	Corrected.

DEIS Comment	***Response***
Page 2-12. Clarify if collars are sectional or continuous. (NOAA, NMFS, PIRO, HCD)	A clarification was added to Section 2.4.2.2.
Page 2.17. Clarify size of staging areas in and out of the water. (NOAA, NMFS, PIRO, HCD)	The landside staging area is 17.7 acres and the in-water staging area is 49.9 acres (Section 2.4.2.6).
Page 2-50. State how microtunneling may affect benthic resources and water quality. (NOAA, NMFS, PIRO, HCD)	Additional explanations were added to Sections 3.7.4.5 (water quality) and 3.7.5.1 (benthic biota).
Page 2-53. Clarify if the jacking shaft is the same as the receiving pit. (NOAA, NMFS, PIRO, HCD)	To avoid confusion, throughout the FEIS the term jacking shaft was replaced with the term jacking pit. A jacking pit is the excavation from which the microtunnel boring machine begins boring. Boring proceeds from the jacking pit to the receiving pit, from where the boring machine is extracted. If the overall distance from the beginning of the microtunnel to the end is too long for a single drive, an intermediate pit is required. In such a case the intermediate pit would be both a receiving pit for the first drive and a jacking pit for the second drive.
Page 2-54. Clarify if microtunneling can extend to 80 feet depth to avoid shallower impacts. (NOAA, NMFS, PIRO, HCD)	See Section 2.4.2.1 for clarification.
Page 2-55. Clarify the character of pollutants of the HECO discharges into Honolulu Harbor. Unless it is comparable to the HSWAC discharge, they should not be compared. (NOAA, NMFS, PIRO, HCD)	The intent in Section 2.5.7.1 was to explain that Honolulu Harbor was considered as a location for discharge of the return seawater and provide a rationale for why it wasn't considered appropriate. The discharge from the Honolulu Generating Station is warmed above the ambient temperature of the receiving water in the harbor. By mixing the two discharge streams it was thought that it might mitigate the thermal impacts of both. The macronutrient loads in the HSWAC discharge, however, could not be sufficiently diluted to meet water quality standards, and the resultant nutrient rich waters exiting Honolulu Harbor could stimulate growth of benthic macroalgae outside of the harbor. The inclusion of the HECO permit data is intended to provide one example of anthropogenic influences on waters in the project area.
Page 2-56. Define shallow coastal waters. Explain the significance of difference in temperature, density, dissolved oxygen, etc. (NOAA, NMFS, PIRO, HCD)	The term coastal waters is defined in Hawai‘i Revised Statutes Chapter 54 Water Quality Standards and means waters within three miles of the islands of the State. The distinction in the DEIS between shallow and deep was somewhat arbitrary and did not specifically define a depth break. The intention was to contrast nearshore discharge options at depths of 30-40 feet depths with deeper and farther offshore options such as at 120-150 feet depths. A range of possible discharge temperatures was presented in the DEIS because it would vary diurnally and seasonally with the cooling load on the system. In any event, the temperature of the discharge water would be less than that of the receiving waters. The temperature of the receiving water was estimated as a worst case, i.e., summer surface heating and a completely uniform mixed layer temperature. The higher density of the return water means that the plume would tend to sink rather than rise to the surface as is the

DEIS Comment	***Response***
	case with generating station thermal effluents or wastewater effluents. The dissolved oxygen concentration of waters below the thermocline is lower than that in waters above the thermocline because of a predominance of decomposition rather than photosynthesis and physical separation from atmospheric interactions by the density barrier of the thermocline. Conversely, dissolved inorganic nutrient concentrations are higher below the thermocline because of the predominance of decomposition, which breaks down organic matter into inorganic constituents, and the lack of nutrient uptake by primary producers, which need light for photosynthesis. See Section 3.7.4 for additional discussion of water quality parameters.
Page 2-57. Explain CORMIX analysis, assumptions, etc. (NOAA, NMFS, PIRO, HCD)	The CORMIX assumptions may be found in Section 2.4.2.4 of the DEIS. These are the parameters that must be provided for the model to determine dilution of the discharge in the waters surrounding the diffuser. For purposes of impact assessment, “worst case” assumptions were used for environmental variables. Characteristics of the diffuser were first established by using the model CORHYD. The output from that model, an optimized diffuser design, was used in the CORMIX model. Three different water current scenarios were investigated to examine how the diffuser would perform under different tidal states. Comparison of the water quality characteristics of the deep intake water with the State’s water quality standards revealed that while temperature and dissolved oxygen concentrations are concerns at the discharge location, the parameter requiring the greatest dilution to meet applicable water quality standards would be nitrate+nitrite nitrogen. Therefore, the size of the proposed Zone of Mixing was predicated on there being sufficient dilution of the nitrate+nitrite nitrogen concentration at the Zone of Mixing boundary under the worst case current conditions, i.e., low current velocities, to meet State water quality standards. For the FEIS, additional CORMIX modeling was performed using more precise bathymetry and a new version of the software, and modeling of a deeper diffuser was performed.
Page 3-75. Describe the exact difference in return water compared to ambient water for temperature, salinity, density, pH, dissolved gasses and inorganic nutrients, and characterize environmental consequences of these differences. (NOAA, NMFS, PIRO, HCD)	Please see Section 3.7.4 for this information.
Page 3-92. Characterize and quantify impacts from construction and operations. (NOAA, NMFS, PIRO, HCD)	Section 3.7.5 incorporates the results of new, quantitative, shallow water and deep water surveys of the entire proposed pipe route. The reports of these surveys (Appendices E and I, respectively) quantify the impacts to benthic habitat and corals specifically from construction and operations of the system.

DEIS Comment	***Response***
Page 3-95. Clarify if CORMIX accounts for duration of different current velocities. (NOAA, NMFS, PIRO, HCD)	Three different current velocities were modeled. The model was run until the output reaches steady state conditions. This clarification was added to Section 2.4.2.4.
Page 3-96. Provide a water quality monitoring plan. (NOAA, NMFS, PIRO, HCD)	The applicant's proposed monitoring plan may be found in Appendix G to the FEIS, and referenced in Section 3.7.4.5.
Page 3-96. Justify how it is appropriate to compare 84 MGY sewage versus 23,360 MGY. (NOAA, NMFS, PIRO, HCD)	The 84 MGY is the decreased amount of water that would be directed into the wastewater treatment system from cooling tower operations if the HSWAC system is fully utilized. Buildings that are connected to the HSWAC system would no longer have to operate cooling towers. See Section 3.3.8.3 for further clarification.
Page 3-98. Provide references supporting the statement that the pipeline corridor is the most degraded coastal habitat in the State and provide that there are in fact limited resources. (NOAA, NMFS, PIRO, HCD)	Māmala Bay is ringed with industry; pineapple canneries, gas and oil storage, and numerous other industrial enterprises have operated, or are still operating, there, and it is adjacent to the most densely populated area in the State. Pollution is well known in Honolulu Harbor; poor conditions are described as early as 1920 in references cited by Cox and Gordon (1970). (Se Section 3.3.3.1.) Several regulated and unregulated point sources of pollution discharge into Māmala Bay. Most prominent are the three wastewater treatment plant ocean outfalls (Sand Island, Fort Kamehameha, and Honouliuli). The diffuser for the Sand Island WWTP deep ocean outfall lies about two miles west of the proposed site of the HSWAC seawater return diffuser. Sewage has been pumped into the ocean offshore of Kewalo and Sand Island since the 1930s. The early inputs were all raw sewage released in shallow water (not exceeding 20 feet in depth). The actual points of release varied through time as different pipes were constructed and used. The multitude of perturbations that occurred in shallow water from these early sewage inputs continued until the construction of the present Sand Island deep-water outfall in 1978 (Brock, 1998). (See Sections 3.3.3.1, 3.7.2.1, and 3.7.4.5.) Other notable discharges to Māmala Bay include the Ala Wai Canal (into which Mānoa Stream discharges); Nuʻuanu, Kapālama, Kalihi, and Moanalua Streams; other small streams and drainage channels; and Pearl Harbor, which receives runoff from five perennial and three intermittent streams. West of Kewalo Basin, on lands now occupied by the Kakaʻako Waterfront Park, stood the former Honolulu incinerator and dump. While in operation, this dump received both burned and unmodified wastes from urban Honolulu. Because the unlined dump filled in a section of old coastline in excess of 330 feet seaward, these materials along the seaward side are exposed to seawater and there is a potential for leaching of pollutants (Brock, 1998). Māmala Bay has been used as a dumping ground for dredged materials from both Pearl Harbor and Honolulu

DEIS Comment	***Response***
	Harbor. There have been three main dump sites in Māmala Bay: the former Pearl Harbor site, the former Honolulu Harbor Site, and the active South O‘ahu Site, which was approved for use by the USEPA in 1980. That site is approximately 1.5 miles west of the proposed HSWAC seawater intake site. Prior to establishment of those sites, dumping of dredged materials from Honolulu Harbor was unregulated and often done in shallow water adjacent to the harbor entrance channel. Exacerbating the effects of these perturbations is the fact that Māmala Bay is exposed to seasonally high energy wave events that resuspend sediments and move rubble, keeping the biological community in an early successional stage. Compared with most coastal areas in Hawai‘i, species diversity is low and benthic epifauna is found mainly on elevated reef spurs where it's somewhat protected from rubble worked by wave action. The new shallow water and deep water marine biology surveys prepared for incorporation into the FEIS confirm the degraded nature of the bottom along the entire proposed pipe route when compared with other coastal areas around Hawai‘i.
Page 3-99. Provide analysis whether 44 MGD of return water might cause marine community phase shifts as the Māmala Bay study clearly states that this happened in the past due to water quality effects of untreated sewage. (NOAA, NMFS, PIRO, HCD)	The correct flow rate is 44,000 gpm. There are significant differences between the proposed HSWAC discharge and a wastewater discharge. First, wastewater is of much lower salinity and much higher nutrient content. Second, the wastewater density is much lower than that of the receiving waters, meaning the plume tends to surface and be influenced by wind-driven surface currents. The HSWAC discharge plume would be negatively buoyant because its density would be greater than that of the receiving waters. Results of the plume modeling exercise show that some plume-seabed interaction is anticipated in the immediate vicinity of the diffuser; however, substantial initial dilution implies plume properties would be close to ambient when the plume encounters the seabed. This argues against a phase shift in the vicinity of the diffuser. A clarification has been added to Section 3.7.5.1.
Page 3-100. Provide updated studies beyond Grigg (1995) which are now over 15 years old. (NOAA, NMFS, PIRO, HCD)	New water quality data from the intake and diffuser locations and new quantitative biological data collected along the entire proposed pipe route have been collected since publication of the DEIS and these are used as baseline information in Sections 3.7.4 and 3.7.5.
Page 3-101. Provide up to date and high resolution benthic maps. The NOAA benthic maps in the Atlas are not always accurate and of low resolution. (NOAA, NMFS, PIRO, HCD)	The delineation of bottom types on the NOAA map generally agrees with the results of benthic surveys done for this project. A bathymetric map of the pipe corridor was produced in sufficient detail for engineering purposes and is reproduced as Figure 2-16.
Page 3-102. Provide quantitative and detailed comprehensive benthic survey data for each of the potential impact sites. (NOAA, NMFS, PIRO, HCD)	New detailed and quantitative shallow water and deep water marine biological surveys were completed for the FEIS and may be found in Appendices E and I, respectively. Summaries may be found in Section 3.7.5.

DEIS Comment	***Response***
Page 3-105. Clarify that 75% coral coverage as reported for some areas in the project footprint is very high. (NOAA, NMFS, PIRO, HCD)	The areas where coral cover may approach 75% are not within the project footprint. A clarification was added to Section 3.7.5.1.
Page 3-108. Remove the statement that there are no stony corals below 100m as there is evidence that indicates otherwise. (NOAA, NMFS, PIRO, HCD)	The text has been changed in Section 3.7.5.1 to say "Below 130 meters, only a few, if any, stony corals occur."
Page 3-110. Remove the statement that Alternative 1 will have "long-term less than significant impact" as there is inadequate information provided to support this statement. (NOAA, NMFS, PIRO, HCD)	The statement was removed. The conclusion in Section 3.7.5 was changed to read: "….In the longer-term (operational phase), benthic biota in the immediate vicinity of the diffuser, including corals, may be significantly adversely affected, although corals are scarce at the Alternative 1 diffuser location. The indirect long-term effect of the increased hard substratum provided by the pipes and collars may be beneficial in terms of the ecological services rendered by the ecosystem."
Page 3-110. Clarify how the proposed break-out point was chosen to avoid coral reef as the data provided in reports is qualitative. Clarify if other data was used. (NOAA, NMFS, PIRO, HCD)	A clarification was added to Section 2.4.2.1.
Page 3-112. Describe in greater detail, using scientifically valid up to date research, the potential positive as well as negative impacts to the biological community within and outside the ZOM – short-, mid-, and long-term. Remove or support with scientifically valid data, statements that consequences will be positive long-term. (NOAA, NMFS, PIRO, HCD)	Section 3.7.5 has been modified to include the results of new shallow and deep water biological surveys. Long-term positive impacts would result from the presence of the structures, as has been documented at the NELH facility on Hawaiʻi island. Please see Figure 3-33.
Page 3-130. Correct the water column EFH depth designation: it is 200m not 100m. (NOAA, NMFS, PIRO, HCD)	Corrected.
Page 3-131. Modify statement and remove the word "possible" from "possible effects to EFH…" Effects will very likely occur. (NOAA, NMFS, PIRO, HCD)	The EFH section was modified and the word "possible" replaced with the word "potential" in the FEIS.
Page 3-131. Include assessment of impacts to EFH nearshore as coral reef EFH is all substrate down to 100m depth. (NOAA, NMFS, PIRO, HCD)	The FEIS contains a new appendix (Appendix J) with USACE's EFH assessment. Impacts to coral reef EFH are described in greater detail in that appendix and summarized in Section 3.7.6.4.
Page 3-131. Describe in far greater detail the impacts to all EFH, including coral reef EFH nearshore. Justify any statements that effects will only be temporary or minimal. Any injury to coral is permanent effect. (NOAA, NMFS, PIRO, HCD)	The FEIS contains a new appendix (Appendix J) that separates and augments the discussion of effects to EFH in the DEIS. Impacts to coral reef EFH are described in greater detail in that appendix and summarized in Section 3.7.6.4. The statement that any injury to coral is a permanent effect makes sense for individual coral polyps, but damaged coral colonies may re-grow. With return to existing (or creation of improved) habitat conditions, new colonies may develop within a damaged area.
Page 3-132. Describe how benthic algal communities might be influenced by nutrient flux within return water and if this might lead to phase shifts of algal dominance. (NOAA, NMFS, PIRO, HCD)	Descriptions have been added to the impact sections in Section 3.7.5.1.

DEIS Comment	***Response***
Page 3-132. Provide a detailed and comprehensive EFH assessment labeled "EFH assessment" in the final EIS if the wish is to use the NEPA document for EFH consultation with NOAA. (NOAA, NMFS, PIRO, HCD)	USACE provided its EFH Assessment to NOAA on December 5, 2011, and completed consultation on February 28, 2013, by providing NOAA with its final response to NOAA's EFH conservation recommendations. The EFH Assessment and the record of consultation are attached as Appendix J.
Page 3-142. State whether and if so how the marine environment might be impacted if the groundwater levels will be affected when dewatering occurs. (NOAA, NMFS, PIRO, HCD)	Dewatering of the jacking pit, the cooling station receiving pit, and various locations along the distribution route would be required. Effects would be localized and are not expected to affect the marine environment. This clarification has been added to Section 3.8.4.2.
Page 3-147. Revise Section 3.9.6 as the analysis is inadequate and flawed in its approach and scope. (NOAA, NMFS, PIRO, HCD)	Section 3.9.6 provides a summary of previously described natural and anthropomorphic influences on the project area and the cumulative effects that would result from implementation of the proposed project. Additional text and cross-references to appropriate sections in Chapter 3 have been added to Section 3.9.6. Table 3-17 provides a quantitative analysis of the net effects of the action alternatives to substrata and coral cover.
Page 4-2. Revise this section by providing far more detail and a comprehensive quantification based analysis of what unavoidable impacts will be. (NOAA, NMFS, PIRO, HCD)	This section is a summary of impacts described throughout the previous chapter. References to the appropriate sections in Chapter 3 have been added to Section 4.8. Table 3-17 provides a quantitative analysis of the net effects of the action alternatives to substrata and coral cover.
Page 4.2. Revise this section and provide a comprehensive vetted mitigation plan consistent with the 2008 EPA and DA Final Rule on compensatory mitigation. (NOAA, NMFS, PIRO, HCD)	The applicant's proposed coral transplantation and monitoring plan may be found in Appendix O.
Page 4-3. Clarify whether break-out point is around sand or rubble. (NOAA, NMFS, PIRO, HCD)	The breakout point is in the biotope of dredged rubble, but there is both sand and rubble present. Clarifications of this have been added to Sections 2.4.2.1, 3.7.4.5, 3.7.5.1, and 4.9.
Where are the flow dynamic models to assess whether local fish and benthic community will be affected by either intake or return flows? (DOI)	Please see Section 2.4.2.4 for an explanation of the diffuser modeling. The modeling, performed as required by the USEPA, was used to characterize changes to water quality in the vicinity of the diffuser and that in turn was used to assess impacts to marine communities in the vicinity. For the FEIS, additional modeling was performed using more precise bathymetric data and a new version of the software.
DEIS does not propose mitigation measures commensurate with the range of potential adverse impacts. (DOI)	Additional measures to avoid and minimize the adverse impacts of the proposed project have been incorporated into appropriate sections of this FEIS.
Revise the EIS to include more complete information based on a commitment to avoid and minimize impacts and compensate for significant unavoidable impacts. (DOI)	New shallow and deep water surveys were completed for the FEIS (Appendices E and I, respectively). Two new alternatives were added and the preferred location of the discharge was moved to a location about 225 feet deeper than in the DEIS. This was done to minimize possible impacts at the shallower discharge site. In addition, the applicant has proposed both water quality and biota monitoring (Appendix G) and a coral transplantation and monitoring plan (Appendix O).

DEIS Comment	***Response***
DEIS does not describe approximate depth steel pipes would be driven into benthic substrate in Ke‘ehi Lagoon nor total fill area of pipe and anchors. (DOI)	Although the contractor would determine the actual methodology, the applicant’s intention is to use in Ke‘ehi Lagoon the 20-inch diameter pipe piles that would later be used to secure the offshore pipe collars. The piles would be 30-40 feet long. Because they would have to be extracted and then reused, the applicant anticipates that they would be driven into the Ke‘ehi Lagoon bottom to a depth not to exceed 20 feet. This information has been added to Section 2.4.2.6.
Specific details of length of pipe, combination collars and fill that may result from Alternative 2 are not provided as for Alternative 1. (DOI)	This information may be found in Table 2-1.
Recommend a revised DEIS with an alternative discharge at a depth where ambient temperature is 58 degrees F. (DOI)	To reach a depth where ambient temperature is 58 degrees F the diffuser would have to be located nearly 1,000 feet deep, well below the thermocline and consequently in waters with ambient nutrient concentrations well above State water quality standards. Such an alternative could not be permitted based on State water quality standards. Where water quality standards are exceeded, there is no assimilation capacity for a new discharge, and an NPDES permit cannot be granted.
DEIS should include a discussion of how potential impacts of increased water temperatures might be avoided or minimized. (DOI)	After passing through the heat exchangers, the return seawater would be warmed from its intake temperature. However, the temperature of the return water at the diffuser would be below the ambient temperature of the receiving waters. Accordingly, the proposed project would not have any impacts due to increased water temperatures. The potential impacts due to the temperature differential between the return seawater and the receiving waters, and potential measures to avoid and minimize those impacts, are addressed in Section 3.7.5.
Ecological data in the DEIS are qualitative and do not describe ecological functions. (DOI)	New quantitative shallow and deep water surveys were completed for the FEIS (Appendices E and I, respectively). Section 3.7.5 summarizes these studies and describes potential impacts to marine habitats. New subsections were added to Section 3.7.5.1 to evaluate the ecological services of the project area and assess potential impacts to those services from the action alternatives.
Include biological surveys at appropriate depths. Include biomass, densities and size frequency of coral reef organisms. (DOI)	The new shallow water marine biology survey (Appendix E) includes data on coral colony size and size frequency distribution by biotope, invertebrate species and individual density, and fish species and individual density and biomass. This information is summarized in Section 3.7.5.1.
Recommend collection of quantitative data at Ke‘ehi Lagoon to describe the biological community and ecological functions. (DOI)	Quantitative biological data on Ke‘ehi Lagoon biota adequate for baseline community description and potential impact assessment were sourced from a study conducted by the Hawaii Biological Survey of the B.P. Bishop Museum (1999) and are summarized in Section 3.7.5.1.

DEIS Comment	***Response***
Discussion of the mesophotic community is not adequately presented. (DOI)	Observations of mesophotic organisms from a submersible survey of the route are described in the new deep water survey, Appendix I. Additional discussion of the mesophotic community has been added to Section 3.7.5.
Recommend that marine biological surveys be conducted to quantify species that may be affected by placement of collars and pipes on coral reef. (DOI)	The results of new shallow and deep water surveys may be found in Appendices E and I, respectively. Summaries of these surveys may be found in Section 3.7.5.
Recommend selection of preferred seawater pipe alignment be based on least environmentally damaging practicable alternative. (DOI)	All DA permits subject to Section 404 of the Clean Water Act must comply with the applicable provisions of the 404(b)(1) Guidelines at 40 CFR Part 230. Accordingly, USACE may only issue a DA permit for discharges, which represent the least environmentally damaging practicable alternative (LEDPA).
Recommend quantitative marine surveys be conducted. (DOI)	Quantitative surveys have been done (Appendices E and I) and results are summarized in Section 3.7.5.
Recommend examination of long-term impacts if intake is not screened. (DOI)	An entrainment analysis was prepared by the applicant and may be found in Appendix N. Results of this analysis are summarized in Section 3.7.5.2.
Recommend mooring and anchor sites be identified by divers to avoid significant coral reef resources. (DOI)	This has been proposed as a mitigation measure.
Pipes or cement structures are not adequate to offset impacts to coral reef communities. (DOI)	USACE will determine the appropriate and practicable mitigation to avoid minimize, and/or compensate for losses of aquatic resources.
Recommend references to support the statement: "The marine areas in the proposed pipeline corridor are among the most historically degraded coastal habitats in the State….and that this area has limited marine biological resources." (DOI)	Supporting references include Cox and Gordon (1970) and Brock (1998) and may be found in Section 3.3.3.1.
Recommend references to support the statement: "Marine mammals have a much greater tolerance to temperature extremes than do corals." (DOI)	See Section 3.7.5.3.
Recommend references to support the statement: "…in the unlikely event that a Hawaiian monk seal or sea turtle entered the cone of influence of the HSWAC intake, their swimming capability would be more than adequate to escape entrainment." (DOI)	See Section 3.7.5.3.
Consider the potential effects of the intake on the mesopelagic boundary community. (Christina Comfort, UH)	Observations of mesopelagic organisms from a submersible survey of the route are described in the new deep water survey, Appendix I. Additional discussion of the mesopelagic community has been added to Section 3.7.5.2.

CHAPTER 6.
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6.2 LAWS, REGULATIONS, EXECUTIVE ORDERS, ORDINANCES AND PLANS

International
1982 United Nations Convention on the Law of the Sea

Federal
Clean Air Act, 42 U.S.C. 7401 et seq.
Coastal Zone Management Act of 1972, 16 CFR 1451 et seq.
Compensatory Mitigation for Losses of Aquatic Resources; Final Rule (Mitigation Rule), 33 CFR Parts 325 and 332, and 40 CFR Part 230
Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9601 et seq.
Coral Reef Conservation Act of 2000, 16 U.S.C. 6401 et seq.
Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA, 40 CFR 1500-1508
Emergency Planning and Community Right to Know Act, 42 U.S.C. 11001 et seq.
Endangered Species Act of 1973, 16 U.S.C. §§ 1531-1544, as amended
Executive Order 11988, Floodplain Management
Executive Order 11990 Protection of Wetlands
Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low- Income Populations
Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks
Executive Order 13089, Coral Reef Protection
Executive Order 13112, Non-Native Species
Executive Order 13158, Marine Protected Areas
Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds
Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management
Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance
Federal Water Pollution Control Act or Clean Water Act, 33 U.S.C. 1251 et seq.
Fish and Wildlife Conservation Act, 16 U.S.C. 2901 et seq.
Fish and Wildlife Coordination Act, 16 U.S.C. 661-667e, as amended
Fishery Conservation and Management Act, Public Law 94-265; 16 U.S.C. 1801 et seq. (the Magnuson Act, and later, after amendments, the Magnuson-Stevens Act [MSA], the Magnuson-Stevens Fishery Conservation and Management Act [MSFMCA], the Sustainable Fisheries Act [SFA], and most recently the Magnuson-Stevens Reauthorization Act [MSRA])
Marine Mammal Protection Act, 16 U.S.C. 1361 et seq.

Marine Protection, Research and Sanctuaries Act of 1972, 16 U.S.C. 1401-1445
Migratory Bird Treaty Act, 16 U.S.C. 703-712, as amended
National Environmental Policy Act, 42 U.S.C. 4321 et seq.
National Historic Preservation Act, 16 U.S.C. 470 et seq.
National Marine Sanctuaries Act, 16 U.S.C. 1431 et seq.
Noise Control Act of 1972, PL 92-574 and Amendments of 1978, PL 95-609; and the U.S. Environmental Protection Agency (USEPA) Subchapter G-Noise Abatement Programs (40 CFR 201-211)
Occupational Safety and Health Act, 29 U.S.C. 651 et seq.
Pollution Prevention Act of 1990, 42 U.S.C. 13101 et seq.
Resource Conservation and Recovery Act, 42 U.S.C. 6901 et seq.
Rivers and Harbors Acts of 1890 (superseded) and 1899, 33 U.S.C. 401, et seq.
Rivers and Harbors Appropriation Act of 1899, 33 U.S.C. 403 et seq.
Submerged Lands Act of 1953, U.S.C. Title 43 Chapter 29
Superfund Amendments and Reauthorization Act, 42 U.S.C 9601 et seq.
Toxic Substances Control Act, 15 U.S.C. 2601 et seq.
U.S. USACE "Procedures for Implementing NEPA," 40 CFR 1500-1508

<u>State</u>
Aquatic Resources, Chapter 187A Hawaiʻi Revised Statutes
Coastal Zone Management, Chapter 205A Hawaiʻi Revised Statutes
Community Noise Control, Chapter 46 Hawaiʻi Administrative Rules
Comprehensive Approach to Achieving Energy Self-sufficiency for the State, Act 96, Session Laws of Hawaiʻi 2006
Conservation District, Hawaiʻi Revised Statutes Chapter 183C and Chapter 190D
Conservation District Policies and Regulations, Chapter 13-5, subchapter 1, Hawaiʻi Administrative Rules
Endangered Species Law, Chapter 195D Hawaiʻi Revised Statutes
Energy Objectives, Chapter 226-18 Hawaiʻi Revised Statutes
Greenhouse Gas Reduction Mandate, Act 234, Session Laws of Hawaiʻi 2007
Hawaiʻi Ocean Resources Management Plan (HCZMP, 2006)
Hawaiʻi State Plan, Chapter 226 Hawaiʻi Revised Statutes
Kakaʻako Community Development District, Makai Area Plan
Land Use Commission, Chapter 205 Hawaiʻi Revised Statutes
Ocean and Submerged Lands Leasing, Chapter 190D Hawaiʻi Revised Statutes
Renewable Energy Portfolio Standard, Act 95, Session Laws of Hawaiʻi 2004
State Land Use Law, Chapter 205 Hawaiʻi Revised Statutes
Water Quality Standards, Chapter 11-54, Hawaiʻi Administrative Rules

<u>County</u>
City and County of Honolulu Development Plan, Chapter 24 Revised Ordinances of Honolulu
City and County of Honolulu Sustainability Initiative

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CHAPTER 7. **INDEX**

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CHAPTER 8. **PREPARERS OF THE EIS**

The following individuals contributed to production of this EIS:

<u>Cardno TEC, Inc.</u>

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APPENDIX A
BUREAU OF OCEAN MANAGEMENT, REGULATION AND ENFORCEMENT DECISION LETTER

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United States Department of the Interior

BUREAU OF OCEAN ENERGY
MANAGEMENT, REGULATION AND ENFORCEMENT

Pacific OCS Region
770 Paseo Camarillo
Camarillo, California 93010-6064

Mr. Scott Higa
Honolulu Seawater Air Conditioning, LLC
7 Waterfront Plaza, Suite 407
500 Ala Moana Boulevard
Honolulu, HI 96813

November 23, 2010

Dear Mr. Higa:

We are writing to inform you of our decision concerning the need for a lease, easement or right-of-way from the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) for your proposal to construct a seawater air conditioning system serving downtown Honolulu buildings. You have described, in your October 15, 2010, email to BOEMRE, that the project involves installing deepwater pipelines that would bring cold seawater from the Outer Continental Shelf (OCS) to a shore-based centralized air conditioning system in Honolulu.

The BOEMRE has determined it does not have the authority to issue a lease, easement or right-of-way under the OCS Lands Act ("Act") (43 U.S.C. 1331, *et seq.)* for the project you described in your October 15, 2010, email to BOEMRE. In particular, section 8(p) of the Act, which provides authority for the BOEMRE to consider approvals for renewable energy projects on the OCS, does not provide the authority to issue a lease, easement or right-of-way for your project because the project does not produce or support production, transportation or transmission of energy from sources other than oil and gas.

While the BOEMRE has no authority to issue a lease, easement or right-of-way for your project, you may be required to seek approvals for your project from other federal agencies. If you have any questions, please contact Maurice Hill, Pacific OCS Region Renewable Energy Program Coordinator, at (805) 389-7815, or maurice.hill@boemre.gov.

Sincerely,

Ellen G. Aronson
Regional Director

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APPENDIX B
USACE NATIONAL HISTORIC PRESERVATION ACT SECTION 106 CONSULTATION

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Galloway, Peter C POH

From: Galloway, Peter C POH
Sent: Tuesday, March 06, 2012 12:03 PM
To: 'Pua.Aiu@hawaii.gov'
Cc: Theresa.K.Donham@hawaii.gov
Subject: RE: Seawater Air (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Dr. Aiu,

Thank you for your response.

Sincerely,

Peter C. Galloway, Ecologist
Regulatory Branch, CEPOH-EC-R
USACE, Honolulu District
Building 230
Fort Shafter, Hawaii 96858-5440
Phone 808-438-8416
peter.c.galloway@usace.army.mil
Website: www.poh.usace.army.mil/EC-R/EC-R.htm

-----Original Message-----
From: Pua.Aiu@hawaii.gov [mailto:Pua.Aiu@hawaii.gov]
Sent: Thursday, March 01, 2012 4:16 PM
To: Galloway, Peter C POH
Cc: Theresa.K.Donham@hawaii.gov
Subject: Seawater Air

Peter,

Please note that we have let your request for concurrence with your "no historic properties affected" lapse. Thus, you can presume concurrence.

Mahalo,
Pua Aiu
Administrator
Historic Preservation Division
601 Kamokila Blvd Room 555
Kapolei, HI 96707
808-692-8016

Classification: UNCLASSIFIED
Caveats: NONE

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

January 3, 2012

Regulatory Branch

File No. POH-2004-01141

Dr. Pua Aiu, Administrator
Historic Preservation Division
601 Kamokila Blvd., #555
Kapolei, HI 96706

Dear Dr. Aiu:

Thank you for your letter dated May 2, 2011 (Log No. 2011.1192, Doc No. 1105PA01), which provided National Historic Preservation Act Section 106 review comments on the federal *Draft Environmental Impact Statement (DEIS) for the proposed Honolulu Seawater Air Conditioning Project, Honolulu, Hawai'i.* The Honolulu District of the U.S. Army Corps of Engineers is considering issuance of a Department of the Army (DA) permit to authorize construction of the project.

This letter clarifies our determination of the area of potential effect (APE) and our assessment of effects for the proposed undertaking as described in the federal DEIS and our transmittal letter to you dated March 18, 2011. Those documents described the APE as including the waters and submerged lands offshore of Kaka'ako where seawater intake and return pipes would be deployed, the area where vessels involved with offshore construction activities would operate, the Keehi Lagoon/Sand Island staging area, the area of the onshore cooling station, and "all areas to be excavated for pipelines."

Per federal regulations at 33 CFR 325 Appendix C, we have determined that although the proposed activity to create the freshwater (overland) distribution pipeline system (i) would not occur but for the authorization of the work or structures within the waters of the United States and (ii) is essential to the completeness of the overall project, it (iii) is not directly associated (first order impact) with the in-water work and structures to be authorized by DA permit. Therefore, the APE for this federal permit action is as described in the above paragraph, except that it does not include areas of excavation for the overland freshwater pipeline system. The APE does include work areas for the proposed seawater pipelines, onshore jacking pit, and cooling station which are described in Section 2.4.2.1 of the DEIS. The Final EIS will reflect this clarification of the APE for the federally regulated activity.

There are no historic properties listed on the *Hawai'i and National Register of Historic Places* in the APE for the federally regulated activity. Your May 2, 2011 letter includes your agency's determination that actions on Lot D-1 (landing site) [TMK: (1) 2-1-059:027], which is also referred to in the federal DEIS as the "cooling station", would have no effect on historic properties as this is fill land in a former reef area. Further, the applicant's State Historic

Preservation Division (SHPD) approved archaeological monitoring plan,[*Archaeological Monitoring Plan in Support of the Honolulu Seawater Air Conditioning Project in Portions of Kaka'ako and Downtown Honolulu, Pauoa Ahupua'a, Honolulu (Kona) District, Island of O'ahu, State of Hawai'i, Final Report* (Sara L. Collins et al., December 2008), indicates that there is a low probability for encountering subsurface cultural deposits at the sites of the proposed onshore cooling station and jacking pit. In addition, the monitoring plan states that the project archaeologist(s) will conduct periodic monitoring of ground disturbing activities in portions of the APE that are deemed to have a low probability for encountering subsurface deposits and specifies the treatment of any archaeological materials or human remains encountered.

In compliance with Section 106 of the National Historic Preservation Act, we have determined that the proposed undertaking, with incorporation of the monitoring requirements of the applicant's approved archaeological monitoring plan as a condition of any issued DA permit, would result in "no historic properties adversely affected." I request your concurrence with our determination.

Should you have questions concerning this consultation request, please contact Mr. Peter Galloway via telephone at 808-438-8416 or via e-mail at *peter.c.galloway@usace.army.mil.*

Sincerely,

George P. Young, P.E.
Chief, Regulatory Branch

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

GUY H. KAULUKUKUI
FIRST DEPUTY

WILLIAM M. TAM
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

KAKUHIHEWA BUILDING
601 KAMOKILA BLVD STE 555
KAPOLEI HI 96706

May 2, 2011

George P. Young, PE
Department of the Army
US Army Corps of Engineers, Honolulu District
Fort Shafter, HI 96858-5440

Log No. 2011.1192
Doc No. 1105PA01
Archaeology

RECEIVED
MAY 6 2011

Dear Mr Young:

SUBJECT: **National Historic Preservation Act (NHPA) Section 106 Review- Draft Environmental Impact Statement (DEIS) for the Proposed Honolulu Seawater Air Conditioning Project Kaka'ako Ahupua'a, Kona District, Island of Oahu TMK: (1) 2-1**

Thank you for the opportunity to review the above referenced report which we received on March 22, 2011. We apologize for the delayed response. The APE for the undertaking includes the submerged lands offshore of Kakaako where seawater intake and return pipes would be deployed, the area where vessels involved with offshore construction activities would operate, the Keehi Lagoon/Sand Island staging area, the area of the cooling station and all areas to be excavated for pipelines in the downtown Honolulu area.

A review of our records indicates that there are multiple known archaeological and cultural sites, including Native Hawaiian burial sites, in the area of potential effects of the pipeline excavations that are planned for this project. For instance, 6 individuals were encountered during work in the roadway near the intersection of Halekauwila and Punchbowl Streets. This site is recorded on the State Inventory of Historic Places (SIHP) as site number 50-80-14-2964. There are many other examples of Human skeletal remains that were encountered in the roadway in the Kaka'ako area including site -5820 and the Kawaiahao and Honuakaha cemeteries that were encroached on by road development. Consultation with native Hawaiians, as part of a Cultural Impact Assessment that was submitted along with this project, identified native Hawaiian burial sites within the APE that are considered 'sacred' by Native Hawaiians (Collins et. al. 2008 pg. 133).

In Feb 2010 (Log #2010.0326, Doc #1002NM11) we determined actions on Lot D-1 (landing site) would have no effect on historic properties as this is fill land in a former reef area. In December, 2008 we responded to a State Draft Environmental Impact Statement (Log #200.5141, Doc# 0812AL26) pointing out that your report did not include a comprehensive inventory of historic sites within the APE. In November 2008 we approved your archaeological monitoring plan but did not provide an effect determination (Log#2008.4720, Doc#0811WT21).

We note that you provide a list of architectural sites that may be affected by the project. Furthermore, since all connections to historic buildings will use existing connections and will not affect the structure or appearance of the building, we concur with your "no effect" to historic properties for architectural properties along the route.

However, you did not provide a list of archaeological sites along the route that could be affected. Instead, a system of probabilities was provided, with no background as to how probabilities were determined. We are particularly concerned because of the high number of burials found in what are considered areas of "medium probability," especially where your route passes through Kaka'ako and Downtown. We also note that informants in your Cultural Inventory Survey suggested that there could be a high number of burials found during this project. Please identify known archaeological sites and an assessment of how your project will avoid them. If a burial site has been moved, please discuss whether or not it has been moved out of the impact area for this project.

Finally, given that there is a high probability of finding burials during this project, this may constitute an "adverse effect" to cultural resources of importance to Native Hawaiian Organizations. One way to mitigate the adverse effect of discovering a burial is to ensure that you have a plan to address inadvertent burials. We see no discussion of what you will do if burials are discovered during trenching. We suggest you work with Native Hawaiian organizations to address the discovery is iwi during trenching.

Finally, for areas where you will use micro-tunneling, please identify your drop, slurry and surfacing pits.

We look forward to continued consultation on this project.

If you have further question, please contact Pua Aiu or Michael Vitousek at 692-8015.

Sincerely,

Pua Aiu
Administrator

C (by e-mail): William Aila, Jr.
Keola Lindsey, OHA
Peter C. Galloway, USACE

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

March 18, 2011

Regulatory Branch

File No. POH-2004-01141

Dr. Pua Aiu, Administrator
Historic Preservation Division
601 Kamokila Blvd., #555
Kapolei, HI 967078

Dear Dr. Aiu:

The Honolulu District of the U.S. Army Corps of Engineers is considering issuance of a Department of the Army permit to authorize construction of the proposed Honolulu Seawater Air Conditioning project in navigable waters of the United States, Island of Oahu, Hawai'i (DA File No. POH-2004-01141). Enclosed is a Draft Environmental Impact Statement (DEIS) prepared for this federal regulatory action. We have enclosed one hard copy and one compact disk copy.

As described in section 3.2 of the DEIS, the Area of Potential Effect (APE) of the proposed undertaking includes the waters and submerged lands offshore of Kaka'ako where seawater intake and return pipes would be deployed, the area where vessels involved with offshore construction activities would operate, the Keehi Lagoon/Sand Island staging area, the area of the cooling station, and all areas to be excavated for pipelines.

In compliance with Section 106 of the National Historic Preservation Act, we have determined that the proposed undertaking, with incorporation of the applicant's State Historic Preservation Division (SHPD) approved *Archaeological Monitoring Plan in Support of the Honolulu Seawater Air Conditioning Project in Portions of Kaka'ako and Downtown Honolulu, Pauoa Ahupua'a, Honolulu (Kona) District, Island of O'ahu, State of Hawai'i* (approved November 10, 2008), will result in "no historic properties adversely affected." I request your concurrence with our determination.

For questions concerning this consultation request, please contact Mr. Peter Galloway via telephone at 808-438-8416 or via e-mail at *peter.c.galloway@usace.army.mil*).

Sincerely,

George P. Young, P.E.
Chief, Regulatory Branch

Enclosure

APPENDIX C
CALCULATION OF FUEL OIL SAVINGS AND AIR EMISSION REDUCTIONS FROM HSWAC

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Calculations of HSWAC Energy Savings

Connected Load	25,000	tons
Utilization Hours	4,050	eq. full load hours
Annual Cooling Requirement for Downtown Honolulu	101,250,000	ton-hr/yr
Without Transmission & Distribution Losses		
Power Requirement for Conventional Cooling (CC)	0.880	kWh/ton-hr
Average Power Requirement for SWAC	0.200	kWh/ton-hr
Power Savings for SWAC vs. CC	0.680	kWh/ton-hr
Energy Requirement for Conventional Cooling	89,100,000	kWh/yr
Energy Requirement for SWAC	20,250,000	kWh/yr
Energy Savings for SWAC vs. CC	68,850,000	kWh/yr
	77.3	%
With Transmission & Distribution Losses		
Average Transmission & Distribution Efficiency	88.8%	
Power Requirement for Conventional Cooling	0.9907	kWh/ton-hr
Power Requirement for SWAC	0.2251	kWh/ton-hr
Power Savings for SWAC vs. CC	0.7655	kWh/ton-hr
Energy Requirement for Conventional Cooling	100,303,951	kWh/yr
Energy Requirement for SWAC	22,796,353	kWh/yr
Energy Savings for SWAC vs. CC	**77,507,599**	**kWh/yr**

Calculations of HSWAC Fossil Fuel Reduction

HECO's Weighted Average Heat Rate	10,689	Btu/kWh
Electricity Generation Efficiency		
Crude Oil Production Efficiency	90.5%	
Crude Oil Shipping Efficiency	98.0%	
Crude Oil Refining Efficiency	90.0%	
Electrical Generation Efficiency	31.9%	
Transmission & Distribution Efficiency	88.8%	
Overall Efficiency	22.6%	
Where: Overall Efficiency is the electricity generation efficiency from crude oil at the source to electricity at the end use		
Calculated Overall Heat Rate of Electricity Generation		
Overall Heat Rate	15,075	Btu/kWh
Total Annual Energy Savings		
Annual Crude Oil Energy Savings	**1,037,921**	**MMBtu/yr**
Higher Heating Value of Crude Oil	5,800,000	Btu/bbl
Barrels of Crude Oil Equivalent	**178,952**	**Bbls COE**

Calculation of Water Usage and Sewer Generation for Conventional Cooling

Connected Load	25,000	tons	
Utilization Hours	4,050	eq. full load hours	
Specific Power Requirement of Conventional Chillers	0.68	kW/ton	1
Thermal Load of Cooling Tower	14,320	Btu/ton	2
Average Number of Concentrations	3.0		3
Evaporation	1.72	gal/ton-hr	4
Drift	0.03	gal/ton-hr	5
Blowdown	0.83	gal/ton-hr	6
Total Water Use	2.58	gal/ton-hr	7
	10,439	gal/ton-yr	8
	260,986,665	**gallons**	
Total Sewage Generation	3,364	gal/ton-yr	9
	84,095,703	**gallons**	

Notes:
1 = Weighted average of chiller power requirements
2 = 12,000 Btu/ton + [(3,412 Btu/kWh) x (Specific Power Requirement of Chillers)]
3 = Weighted average of sampling of large customers
4 = (Thermal Load of Cooling Tower) / [(8.33 lb/gal) x 1,000 Btu/lb)]
5 = [Evaporation (gal/ton-hr)] x [Drift (%)] / [Evaporation (%)]
6 = [Evaporation (gal/ton-hr)] x [Blowdown (%)] / [Evaporation (%)]
7 = (Evaporation) + (Drift) + (Blowdown)
8 = (Total Water Use) x (EqFLH)
9 = (Blowdown) x (EqFLH)

Calculation of HSWAC Emission Reduction

Emissions data were provided by HECO during the IRP process in a spreadsheet entitled "Source: Obj&Meas Base Scenario Graphs r2.xls, Rev 9/24/04".

Emissions were then determined on the basis of lbs/mmBtu, with the ratios of various types of pollutants to CO2 assumed to be constant.

Emission	lbs/MMBtu	tons/year *1
Carbon Dioxide (CO2)	163.3538	**84,774**
Volatile Organic Compounds (VOC)	0.0101	**5**
Carbon Monoxide (CO)	0.0535	**28**
Particulate Matter Under 10 microns (PM10)	0.0359	**19**
Nitrogen Oxides (NOx)	0.3260	**169**
Sulfur Oxides (SOx)	0.3188	**165**
*1 Based on Annual Crude Oil Energy Savings	1,037,921	MMBtu/yr

Calculation of HSWAC Electric Demand Reduction

Connected Load	25,000	tons
Without Transmission & Distribution Losses		
Power Requirement for Conventional Cooling (CC)	0.820	kW/ton
Power Requirement for SWAC	0.300	kW/ton
Demand Reduction for SWAC vs. CC	0.520	kW/ton
Total Power Requirement for Conventional Cooling	20,500	kW
Total Power Requirement for SWAC	7,500	kW
Demand Reduction for SWAC vs. CC	13,000	kW
	63.4	%
With Transmission & Distribution Losses		
Average Transmission & Distribution Efficiency	88.8%	
Power Requirement for Conventional Cooling	0.9231	kW/ton
Power Requirement for SWAC	0.3377	kW/ton
Demand Reduction for SWAC vs. CC	0.5854	kW/ton
Total Power Requirement for Conventional Cooling	23,078	kW
Total Power Requirement for SWAC	8,443	kW
Demand Reduction for SWAC vs. CC	**14,635**	**kW**

Equivalence to Other Electricity Generation Technologies

Wind - Utility Scale		
Capacity Factor	0.32	
Annual Energy Production	77,507,599	kWh/yr
Rated Capacity	27,650	kW
Equivalent Utility Scale Wind	**28**	**MW**
PV - Utility Scale		
Capacity Factor	0.21	
Annual Energy Production	77,507,599	kWh/yr
Rated Capacity	42,133	kW
Equivalent Utility-Scale PV	**42**	**MW**
Municipal Solid Waste (MSW)-to-Energy - Utility Scale		
Capacity Factor	0.65	
Annual Energy Production	77,507,599	kWh/yr
Rated Capacity	13,612	kW
Equivalent Utility-Scale MSW-to-Energy	**14**	**MW**

Equivalence to Residential Solar Water Heating Systems

Annual Energy Savings Per Residential Solar Water Heating System	2,485	kWh/yr
Average Transmission & Distribution Losses	88.8%	
Annual Energy Savings Per Residential Solar Water Heating System (with Transmission & Distribution Losses)	22,247	kWh/yr
Overall Heat Rate	15,075	Btu/kWh
Annual Energy Savings Per Residential Solar Water Heating System (with Transmission & Distribution Losses)	37,461,628	Btu/yr
	6.459	Bbl COE/yr
Equivalent Amount of Residential SWH Systems	**27,706**	**SWH Sys.**

Decrease in HSWAC Thermal Pollution

Each ton of air conditioning is equal to 12,000 Btu/hr of heat removed from an air conditioned space. Ultimately, all of the energy used to make electricity used for cooling is also exhausted to the environment (this includes the heat equivalent of the electricity, as well as the waste heat generated from the electricity generating process).

Therefore, thermal pollution can be calculated as follows:

Conventional Air Conditioning

Total Heat Released to Environment

12,000	Btu/ton-hr +	0.88	kWh/ton-hr x	15,075	Btu/kWh =	25,266	Btu/ton-hr

HSWAC

Total Heat Released to Environment

12,000	Btu/ton-hr +	0.20	kWh/ton-hr x	15,075	Btu/kWh =	15,015	Btu/ton-hr

Reduction in Total Heat Released to Environment

(	**25,266**	**-**	**15,015**	**) /**	**25,266**	**=**	**40.6%**

APPENDIX D
ENVIRONMENTAL HAZARD MANAGEMENT PLAN

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ENVIRONMENTAL HAZARD MANAGEMENT PLAN

Construction of Honolulu Seawater Air Conditioning Project
Facilities within the Special Management Area

Kaka'ako, Honolulu, Hawaii

REVISED AUGUST 10, 2012

PREPARED BY:

Owen Environmental Inc.
P. O. Box 457
Kalaheo, HI 96741

PREPARED FOR:

R. M. Towill Corporation
2024 North King Street, suite 200
Honolulu, HI 96819

ENVIRONMENTAL HAZARD MANAGEMENT PLAN

Construction of Honolulu Seawater Air Conditioning Project Facilities within the Special Management Area

Kaka'ako, Honolulu, Hawaii

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TABLE OF CONTENTS

SECTION 1.0: INTRODUCTION

Honolulu Seawater Air Conditioning, LLC is in the final stages of permitting prior to development of the Honolulu Seawater Air Conditioning (HSWAC) Project, a development that will use cold seawater from depth to chill potable water for use in chilled water driven HVAC systems at numerous buildings and other facilities throughout the downtown Honolulu Area. This Environmental Hazard Management Plan (EHMP) has been prepared as required under the Special Management Area (SMA) permit application process to address issues related to the handling and management of potentially contaminated soils and groundwater during construction within the SMA.

This EHMP has been submitted to the Hawaii State Department of Health (HDOH) Hazard Evaluation and Emergency Response (HEER) office for review and approval. Additional information to be provided by the contractor may be required by the HEER office prior to the initiation of construction activities as a condition for approval of this plan.

1.1 Purpose

The purpose of this EHMP is to identify and address issues related to the handling and management of potentially contaminated soils and groundwater during construction of the HSWAC Project within the SMA.

In a letter to Mr. Ingvar Larson of HSWAC LLC dated 11 May 2011 (included herein as **Appendix A**), the HEER office requested the following documentation relative to the proposed HSWAC project within the SMA:

1. "Summary of site investigation reports that describe historical information about the site, and previous investigations conducted.
2. Environmental Hazard Evaluation (EHE) that identifies and evaluates specific environmental concerns associated with identified contamination, and makes recommendations for additional actions (if any).
3. Environmental Hazard Management Plan (EHMP) that describes proposed construction activities (e.g. trenching, pile caps, excavation and grading) and precautionary measures and practices to be implemented to prevent exposure and ensure safety of workers. EHMP should also include procedures for groundwater handling and disposal if the development plan requires disturbance of groundwater."

This EHMP includes the requested summary of previous site investigations and EHE per items 1 and 2 (see **Sections 4** and **5**, respectively). Phase 1 and 2 Environmental Site Assessment (ESA) reports prepared for the portion of the HSWAC project within the SMA have also been submitted to the HEER office. The issues raised in item 3 are addressed elsewhere in this Plan: proposed construction activities within the SMA are described in **Section 3**; exposure management and worker protection measures are outlined in **Section 7**; soil and groundwater management procedures are described in **Sections 8** and **9**, respectively.

1.2 Project Description

The HSWAC project will bring cold, deep seawater onshore and use this cold seawater to chill potable water, which will then be used to chill HVAC systems throughout downtown Honolulu. For a more thorough and detailed description of the proposed HSWAC project, see project description as well as the following figures within the HSWAC Project SMA Permit Application and Shoreline Setback Variance Request (Chapters 1-5 included herein as **Appendix C**):

Figure 2.1: Conceptual Drawing of HSWAC System
Figure 2.2: Schematic Drawing of HSWAC System
Figure 2.7: Location of Pumping and Cooling Station for HSWAC System

1.3 Construction Activities within the Special Management Area

Construction activities with the Special Management Area will include:

- Excavation of a jacking shaft for micro-tunneling operations at the shoreline area adjacent to the southwest corner of Kaka'ako Waterfront Park;
- Excavation of a receiving shaft at the location of the proposed cooling plant on Keawe Street between Ilalo Street and Ala Moana Boulevard;
- Micro-tunneling operations from one or both shaft locations to install subsurface pipelines; and
- Construction of the Cooling plant facilities at the proposed Cooling Plant location.

For a more thorough and detailed description of the planned construction activities for the HSWAC project within the SMA, see **Section 3.0** (below) and project description as well as the following figures within the HSWAC Project SMA Permit Application and Shoreline Setback Variance Request (Chapters 1-5 included herein as **Appendix C**):

Figure 4-18: Staging Areas and Work Areas within SMA
Figure 4-19: Aerial Photograph of Proposed Jacking Shaft Location in Relation to Kaka'ako Waterfront Park
Figure 4-22: Staging Areas and Work Areas within SMA

SECTION 2.0: BACKGROUND

This section provides background information on the project location(s) and the surrounding Kaka'ako Waterfront area. A general description of the HSWAC Project Area within the SMA is provided in **Section 2.1**. Historic uses of the subject properties are described in **Section 2.2**. Current uses of the subject properties are described in **Section 2.3**. A summary of site investigations performed for the HSWAC Project is provided in **Section 2.4**. A summary of previous environmental investigations in the Kaka'ako Waterfront Area is provided in **Section 2.5.** It should be noted that much of the information in this section was taken with permission directly from the Phase 1 Environmental Site Assessment (ESA) prepared for the HSWAC Project by Kauai Environmental, Inc. (*KEI, 2009a*).

2.1 Description of Project Area

The section of the HSWAC project that will run through the SMA is located in the Kaka'ako Makai District of Honolulu, as shown in **Figure 1** (**Appendix B**). The locations of HSWAC project construction and staging areas are shown in **Figure 4.18** and **Figure 4.22** (**Appendix C**). The project area is bounded to the west by a drainage canal and the Port of Honolulu facilities at Pier 2, as well as the Ala Moana Pump Station at 240 Keawe Street. To the east, the project area is bounded by the University of Hawaii Health and Wellness Center and Medical School. To the north, the project area is bounded by Ala Moana Boulevard, which anchors a corridor of mixed-use industrial and commercial properties. Businesses in this area include auto dealerships and repair shops, retail and wholesale commercial storefronts, warehouses, restaurants, and various other businesses.

Specific properties where construction staging and/or excavation activities will be performed are listed below in **Table 1**.

Table 1: Properties where Staging and Excavation Will Occur

TMK Parcel No.	Total Area	Location / Property Description	Owner
(1) 2-1-060: 008	21.41 acres	Kaka'ako Waterfront Park	Hawaii Community Development Assoc
(1) 2-1-059: 027	0.68 acres	Parking lot at corner of Keawe Street and Ilalo Street	Kamehameha Schools
(1) 2-1-059: 029	1.20 acres	Parking lot at corner of Keawe Street and Ilalo Street	Kamehameha Schools

2.2 Current Use of Subject Properties

TMK parcel (1) 2-1-060: 008 is currently in use as the Kaka'ako Waterfront Park, a landscaped municipal park along the shoreline of urban Honolulu. A drainage canal runs along the western edge of the property. Construction and staging areas for the shoreline jacking shaft location will be located on a narrow strip between the historic landfill site and the existing drainage canal (*see Figures 4-18 and 4-22 in SMA Permit Application, **Appendix C***).

TMK parcels (1) 2-1-059: 027 and (1) 2-1-059: 029 were both part if TMK parcel (1) 2-1-059: 012, which was recently subdivided. These parcels are paved with concrete and asphalt and are currently in use as a parking lot (*see Figures 3-7 and 4-22 in SMA Permit Application, **Appendix C***).

2.3 Historic Use of Subject Properties

The route of the proposed HSWAC project through the SMA lies within the Kaka'ako Makai District, south of Ala Moana Boulevard. This area was reclaimed from the ocean and established through the construction of a series of sea walls which were backfilled primarily with noncombustible refuse materials and ash from two major incinerators that operated in the area for nearly 50 years.

Due to its location in the heart of Honolulu's maritime waterfront, the Kaka'ako area has been a heavily developed industrial and commercial zone since the early 1900s. To the west, Pier 1 and part of what is now Pier 2 were originally part of Fort Armstrong, a U.S. Army installation constructed to defend the Port of Honolulu. There has been a wastewater pump station at the site of the current Ala Moana Pump Station, at 240 Keawe Street, since at least the 1930s. To the east, the Kaka'ako peninsula was the center of the fishing and fish processing industry in Honolulu from 1930 until the late 1990s. Kaka'ako was also the trash disposal hub of urban Honolulu for nearly 50 years, from 1930 until both incinerators in the area were shut down in 1977. From 1930 to 1971, most of the ash and debris from these incinerators was used as fill material to expand the Kaka'ako waterfront and to fill low-lying areas. From 1971 to 1977, the incinerators were still in operation but the debris was hauled away to rural facilities for disposal.

The original shoreline in this area, prior to expansion and development of the Kaka'ako peninsula, was located near the present location of Ala Moana Boulevard. The natural shoreline consisted of mud flats, marshland and shallow reef. Prior to the construction of sea walls and the use of fill materials to build up the area, there were fish ponds, marshes and salt beds along the coast throughout this area.

The initial construction and development of the area occurred at the beginning of the twentieth century. The U.S. Army took over the area in 1898 and built a sea wall to establish Fort Armstrong. Subsequently, several additional sea walls were built, and the areas behind the walls were filled in over time.

TMK parcel (1) 2-1-060:008 was one of the last areas in the Kaka'ako peninsula to be filled. This area was formerly used as a landfill for disposal of ash and debris from the Kewalo Municipal Incinerator. In the 1990s, the landfill area was graded, lined with a flexible synthetic membrane that is 30 mm thick, capped with soil and vegetation, and re-branded as the Kaka'ako Waterfront Park.

TMK parcels (1) 2-1-059: 027 and (1) 2-1-059: 029 were likely filled prior to the 1930s. According to KEI's 2009 Phase 1 ESA report (*KEI, 2009a*), historical aerial photographs of the area show one or more large buildings on the site as early as 1949. The use or purpose of these buildings was not determined or reported. The structures were removed in the mid-1990s and the lot was paved for use as a parking lot.

SECTION 3.0: DESCRIPTION OF PROPOSED CONSTRUCTION ACTIVITIES

This section describes major construction activities that will occur within the SMA, including all activities that will require excavation of potentially contaminated materials and/or require construction-related dewatering, and thus management of potentially contaminated soils and groundwater.

3.1 Excavation of Shoreline Jacking Shaft

A jacking shaft will be constructed near the shoreline at the southwest corner of the Kaka'ako Waterfront Park. This shaft will be constructed and used to facilitate micro-tunneling procedures, which will be used to install pipelines for the HSWAC project through the SMA (and under the off-shore reef) without requiring open trench excavations. The jacking shaft will be a temporary feature: upon completion of construction activities, the shaft will be filled with clean material and the area restored to its current condition.

Construction of the shoreline jacking shaft will require excavation of a pit with the following approximate interior dimensions: 70 feet by 27 feet, and 62 feet deep. The proposed site for the shoreline jacking shaft is at the southwest corner of the Kaka'ako Waterfront Park, between the edge of the park and the adjacent drainage canal. **It should be noted that this location is approximately 120 feet from the edge the area covered by the synthetic membrane, and thus outside the recognized boundaries of the historic landfill materials.** The location of the proposed jacking shaft relative to the edge of the synthetic membrane covering the landfill site is shown in **Figure 2** (**Appendix B**).

Because the proposed location of the jacking shaft is outside the footprint of the historic landfill site, and construction activities at this location are not expected to disturb landfill materials, or damage the geotextile liner that covers the historic landfill site. However, based on the results of environmental studies described below in **Sections 4** and **5**, it is anticipated that historic landfill materials including ash and landfill debris may be encountered during excavation of materials near the surface, as would be the case for any property in the general vicinity of the Kaka'ako Peninsula. Once any historic fill materials near the surface (including any historic ash or other landfill debris) have been removed, the likelihood of additional contaminated materials being generated during excavation is extremely low.

Dewatering will be required during construction of the shoreline jacking shaft, however procedures such as the installation of sheet piles and grouting will be implemented to minimize groundwater infiltration during excavation.

For a detailed description of excavation activities planned for the shoreline jacking shaft location adjacent to the former landfill site at the Kaka'ako Waterfront Park, see the

HSWAC Project SMA Permit Application and Shoreline Setback Variance Request (Chapters 1-5 included herein as **Appendix C**).

3.2 Micro-tunneling

Micro-tunneling procedures will be used to install pipelines for the HSWAC project through the SMA (and under the off-shore reef) without requiring open trench excavations. Although this process will generate a slurry of ground coral and rock, this material will be derived from native, undisturbed materials. The HSWAC pipelines running from the receiving shaft location toward the shoreline and beyond will be installed at a depth of at least 48 feet, while those mauka of the receiving shaft will be installed at a depth of at least 22 feet. These procedures will therefore not disturb surface soils or historic fill materials in areas other than those affected by excavations for the jacking and receiving shafts. It is anticipated that only native materials will be disturbed during micro-tunneling operations. Based on the depth of these micro-tunneling operations and the geology of the area, it is not anticipated that any contaminated materials will be generated during these activities.

Dewatering may be required during micro-tunneling activities, as fines will be removed as slurry. Special equipment will be used to separate the slurry into liquid and solid components. Following this separation, the solids will be managed according to procedures outlined in **Section 8** (Soil Management Plan) while the liquids will be recycled or managed as groundwater according to procedures outlined in **Section 9** (Groundwater Management Plan).

For a thorough description of micro-tunneling procedures and the equipment involved, see the HSWAC Project SMA Permit Application and Shoreline Setback Variance Request (Chapters 1-5 included herein as **Appendix C**).

3.3 Excavation of Receiving Shaft at Cooling Plant Location

A receiving shaft will be constructed at the proposed location of the cooling plant, on TMK parcel (1) 2-1-059: 027. This shaft will be constructed and used to facilitate micro-tunneling procedures, which will be used to install pipelines for the HSWAC project through the SMA without requiring open trench excavations, and to allow the cold seawater pipelines to enter the cooling plant.

Construction of the receiving shaft will require excavation of a pit with the following approximate interior dimensions: 30 feet by17 feet, and 70 feet deep.

Based on the results of environmental studies described below in **Sections 4** and **5**, it is anticipated that contaminated materials including ash and landfill debris will not be encountered during excavation at the cooling plant and receiving shaft location. However, these materials were used as fill materials throughout the Kaka’ako area, so it is possible that such materials may be encountered during excavation. Previous studies also indicate the possible presence of localized areas of petroleum contamination at this site. Once surface materials have been removed (including any historic ash or other landfill debris and any petroleum-contaminated surface soils), the likelihood of additional contaminated materials being generated during excavation will be much lower.

Dewatering will be required during construction of the receiving shaft, however procedures such as the installation of sheet piles and grouting will be implemented to minimize groundwater infiltration during excavation.

For a detailed description of the planned excavation and construction activities for the receiving shaft and cooling plant located on Keawe Street, see the HSWAC Project SMA Permit Application and Shoreline Setback Variance Request (Chapters 1-5 included herein as **Appendix C**).

3.4 Injection of Grouting for Subsurface Stabilization

Although not anticipated during this project, micro-tunneling operations occasionally require injection of concrete grouting for subsurface stabilization. When soft or unstable conditions are encountered in the subsurface strata where tunneling operations are taking place, a drill rig is used to penetrate from the surface and concrete grout is injected to stabilize the area. This allows micro-tunneling operations to proceed without failure of the tunnel.

In the event that injection grouting is required during construction of HSWAC project facilities within the SMA, all tailing materials will be managed according to procedures established for handling and management of excavated materials as described elsewhere in this EHMP.

SECTION 4.0: SUMMARY OF RESULTS FROM PREVIOUS ENVIRONMENTAL SITE INVESTIGATIONS

This section summarizes results from previous environmental site investigations, including Phase 1 and Phase 2 ESAs for properties to be affected by proposed construction activities within the SMA. Results from site investigations conducted on behalf of HSWAC LLC for the HSWAC project are summarized in **Section 4.1**. Results from previous investigations conducted for nearby or adjacent sites and reviewed during the Phase 1 ESA process are summarized in **Section 4.2**.

4.1 Summary of Project Site Investigation History

In preparation for the development of the HSWAC project in the SMA, HSWAC LLC commissioned the R. M. Towill Corporation (RMTC) to prepare Phase 1 and Phase 2 ESAs for the shoreline section of the HSWAC project. RMTC hired KEI to prepare these reports in late 2009. A Phase 1 ESA report was produced in September 2009 (*KEI, 2009a*) with a Phase 2 ESA report following in December 2009 (*KEI, 2009b*). Findings from these investigations are summarized below in **Sections 2.4.1** and **2.4.2**, respectively.

4.1.1 Summary of Conclusions from KEI's 2009 Phase 1 ESA

The following recognized environmental conditions (RECs) and historical recognized environmental conditions (HRECs) were identified in association with the subject properties and properties adjacent to the subject properties:

- The Kaka'ako Waterfront Park was constructed on top of the Kewalo Municipal Incinerator landfill. Soil and groundwater samples collected at the site have been shown to contain elevated levels of pesticides, heavy metals, volatile and semi-volatile organic contaminants, petroleum hydrocarbons, and dioxins. The landfill materials were covered with a membrane liner and cap of clean soil, however surface soils along the perimeter of the landfill may have been impacted historically.

- Groundwater transport of metals, pesticides, PCBs and semi-volatile organic compounds has been documented in the Kaka'ako area.

- The entire Kaka'ako peninsula south of Ala Moana Blvd. was reclaimed from the Pacific ocean using fill materials at a time when trash, debris and incinerator ash was readily available and was considered a viable and safe material to be used as fill. Buried ash and other waste materials from the municipal incinerators in the area have been encountered on the Kaka'ako peninsula in areas where these materials had not been anticipated.

- Site investigations conducted at the Ala Moana Pump Station at 240 Keawe St, located adjacent to Keawe Street and across Keawe Street from the proposed site for the HSWAC Project receiving shaft and cooling station, found soil and groundwater contamination at the site. Contaminants of concern identified at the site include petroleum hydrocarbons, dioxins, heavy metals, and PAHs. Many of these contaminants likely originated on site and may be limited to localized areas. For other contaminants including metals, dioxins and toluene, contaminant migration and historical fill materials in the Kaka'ako area have been suggested as possible sources.

The Phase 1 ESA report identified the following potential impacts to the construction of this section of the HSWAC Project pipeline have been identified:

1. Ash and/or other buried waste materials may be encountered during excavation of the shoreline jacking shaft on TMK parcel (1) 2-1-060:008 and the receiving shaft on TMK parcel (1) 2-1-059:012.

2. Surface soils at the shoreline jacking shaft on TMK parcel (1) 2-1-060:008 may be impacted due to historical contaminant migration and/or pesticide application for vector control.

3. Historical fill materials at the shaft sites may be contaminated, or may be impacted due to possible contaminant migration.

4. Groundwater throughout the project area may be impacted due to extensive use of fill materials in the area including ash and other debris from the municipal incinerators that operated in the Kaka'ako area for many years, as well as the extensive current and historical industrial use of the area.

4.1.2 Summary of Conclusions from KEI's 2009 Phase 2 ESA

A total of four soil samples were collected from boring locations near the shoreline jacking shaft location and the receiving shaft location associated with the proposed cooling plant location in conjunction with drilling for geotechnical investigations. All samples were analyzed for a suite of contaminants of potential concern (COPC) including: total petroleum hydrocarbons; the 8 RCRA metals; volatile and semi-volatile organic compounds; and PCBs. The single soil sample collected from a location near the proposed shoreline jacking shaft location was also analyzed for chlorinated pesticides and TEQ dioxins as this sample, though collected outside the historic landfill area, showed signs of ash and other landfill debris (a second sample was not collected due to obstruction of the drill rig by a subsurface metallic object). Results from these limited sampling activities indicated the following:

- The sample collected near the proposed shoreline jacking shaft location contained visible ash and other non-combustible debris. This material was analyzed and found to contain detectable levels of lead; chlorinated pesticides including DDT, DDE, total chlordane and dieldrin; and TEQ dioxins. Lead levels (660 ppm) and dieldrin levels (58 ppb) measured in this sample exceeded HDOH Tier 1 action levels for residential areas (400 ppm and 3.3 ppb, respectively).

- No COPC were identified in any of the samples collected in the vicinity of the cooling plant and receiving shaft location, however elevated PID (photo-ionization detector) readings at one sampling location was considered potentially indicative of limited petroleum-related contamination in the area, as consistent with previous site investigations conducted for the adjacent Ala Moana Pump Station location.

- Recommendations included preparation of project specifications that assume ash and landfill debris would be encountered in surface soils near the waterfront area, while limited petroleum contamination may be encountered at the receiving shaft and cooling plant location.

4.2 Summary of Previous Investigations in the Kaka'ako Waterfront Area

This section summarizes results from previous investigations performed in the Kaka'ako Waterfront area that were reviewed by KEI during the Phase 1 and Phase 2 ESA process.

4.2.1 Site Investigations for Point Panic Area

These reports were produced for HCDA during the evaluation of potential contamination at Point Panic, which includes Unit 2 and Unit 4 of the Kaka'ako Brownfields Project. This area is located in relatively close proximity to the subject property (approximately one quarter mile away), and shares much of the history of the Kaka'ako Waterfront Park area in terms of its historic use as a landfill for the Kewalo Incinerator.

Phase 1 Environmental Site Assessment (ETC, 2006)
This report documents the historical use of the area as a incinerator landfill; the historical presence of a leaking underground storage tank on the site; the historical presence of a City and County base yard on the site; presence of petroleum and heavy metal-impacted soil and groundwater on the site; the potential presence of ash, unburned refuse, construction debris, etc. on the site, and; the potential presence of petroleum impacted soils from historic subsurface release(s) on the site.

Site Investigation and Preliminary Remedial Alternatives Analysis (ETC, 2007)
A total of 84 soil samples and 20 groundwater samples were collected and analyzed for a wide range of potential contaminants. For subsurface soils: residual range organics; metals including arsenic, barium, cadmium, lead and selenium; and the pesticides dieldrin and endrin were identified as the primary contaminants of concern. For groundwater, metals and dioxins/furans were determined to be the primary contaminants of concern. Various PAH compounds and other chlorinated pesticides were also found at levels exceeding DOH Tier 1 Environmental Action Levels (EALs).

4.2.2 Site Investigations for Ala Moana Pumping Station

The Ala Moana Pumping Station (also referred to as the Ala Moana WWPS, the Historic Ala Moana Pumping Station and the Kaka'ako Pump Station) is located at 240 Keawe Street, across Keawe Street from the proposed location of the receiving shaft and cooling station for the HSWAC Project. A waste water pump station has been located at this site since the early 1900s. Historical operations and structures include boilers, a grease rack, and a chimney vent stack.

Final Site Investigation Report (Environet, 2004)
This report reviewed several previous site investigations which had indicated the presence of lead, toluene and benzo(a)pyrene in soil and groundwater samples collected from the WWPS site. Twenty-one soil samples and nine groundwater samples were collected for this study. Results from the analysis of these samples indicated the presence of these contaminants but at low levels in localized areas. The report suggested that the toluene contamination “may potentially be due to off-site migration.”

Phase 1 Environmental Site Assessment (ETC, 2007)
This report documented the presence of an underground oil reservoir beneath the eastern portion of the property. Also noted was a Limited Phase 1 ESA performed by RMTC in 1993, which found petroleum and heavy metals impacted soils on the property, and attributed this contamination to historic landfill operations in the Kaka'ako area.

Phase 2 ESA and Preliminary Remedial Alternatives Analysis (ETC, June 2008)
This study was conducted to evaluate soil and groundwater contamination on the site. Petroleum contamination (diesel and residual range organics) was detected in several soil samples at levels exceeding DOH Tier 1 EALs. Dioxins and heavy metals were detected in several ash samples collected from the site at levels exceeding their respective Tier 1 EALs, and various PAH compounds were detected in soil and groundwater samples at levels exceeding their respective EALs.

SECTION 5.0: SUMMARY OF POTENTIAL ENVIRONMENTAL HAZARDS

This section summarizes potential environmental hazards associated with contaminants identified in the investigations summarized in the previous section.

5.1 Contaminants of Potential Concern

Contaminants of Potential Concern (COPC) identified in the Phase 1 and Phase 2 ESAs prepared for the HSWAC project within the SMA (including those identified in previous studies reviewed during the Phase 1 ESA process) are defined below in **Table 2**. Specific contaminants identified in previous site investigations and the associated risks posed by these potential contaminants are described below. These contaminants include heavy metals (**Section 5.1.1**) chlorinated pesticides (**Section 5.1.2**) and dioxins (**Section 5.1.3**).

Table 2: Contaminants of Potential Concern

Shoreline Jacking Shaft Location	
surface soils containing ash or debris	RCRA metals, chlorinated pesticides, dioxins
surface soils not containing ash or debris	RCRA metals, chlorinated pesticides
subsurface materials	none
groundwater	*to be determined**
Cooling Plant / Receiving Shaft Location	
surface soils containing ash or debris	RCRA metals, dioxins
surface soils with indications of petroleum	TPH and related compounds (SVOCs)
surface soils not containing ash or debris, and no indications of petroleum	none
subsurface materials	none
groundwater	*to be determined**
Micro-tunneling spoils	
spoils with no indications of potential contamination	none
groundwater	*to be determined**

*: See **Section 9.0**: Groundwater Management Plan

5.1.1 Heavy Metals

In the Phase 2 ESA performed for the HSWAC Project within the SMA Permit Area, laboratory results for the soil sample collected near the proposed shoreline jacking shaft location indicated the presence of lead at concentrations above the DOH Tier 1 EAL for unrestricted use. The concentration of lead measured in this sample (from location B-9) was 660 mg/Kg, which exceeds the DOH Tier 1 EAL of 200 mg/Kg. Although lead was the only metal detected in this study at levels exceeding the DOH Tier 1 EALs for unrestricted use, other metals have also been reported at levels exceeding DOH Tier 1 EALs in previous site investigations from this area (see **Section 4.2**). Therefore, the 8 RCRA metals have been identified as COPC for his project.

Heavy metals are naturally occurring elements that are naturally present at relatively low background levels in native Hawaii soils. The elevated levels of these compounds detected in soil samples from the Kakaako area are believed to be associated with residual contamination associated with the former municipal incinerators and incinerator landfills that operated in the area for many years. As naturally occurring elements, metals are persistent in the environment and do not break down or decay.

Humans are exposed to metals primarily through ingestion. Inhalation of dust is also a potential exposure pathway, but in most cases this is a minor source of exposure. Ingestion is the primary exposure pathway. Dermal exposure is generally not considered relevant, except insofar as it may lead to accidental ingestion.

Risks to Human Health and the Environment from Exposure to Heavy Metals

Adverse human health impacts have been reported as a result of exposure to high levels of various heavy metals. Lead in particular is known to have developmental impacts at relatively low exposure levels while causing systemic toxicity at higher levels of exposure. Exposure to low levels of lead has been shown to impact neurological development in fetuses and infants, causing slower development, increased aggression and lower IQ. At higher levels of exposure, lead can cause systemic toxicity including liver and kidney failure. Lead is cycled in the body as an analog to calcium, and can be stored over time in the bones. When a woman becomes pregnant or is lactating, this reservoir of lead stored in the body can be re-mobilized, with potential developmental consequences for the woman's fetus and/or child. At-risk populations for low-level lead exposure therefore include women who are pregnant or who may become pregnant, as well as young children.

Although lead may cause similar impacts in terrestrial and aquatic ecosystems, low-level environmental impacts are not well understood. Therefore, guidelines for lead exposure (including the DOH Tier 1 EALs) are intended to limit potential human health impacts due to exposure to at-risk populations, including children or women who are or may become pregnant.

5.1.2 Chlorinated Pesticides

In the Phase 2 ESA performed for the HSWAC Project within the SMA Permit Area, laboratory results for the soil sample collected near the proposed shoreline jacking shaft location indicated the presence of dieldrin at concentrations above the DOH Tier 1 EAL for unrestricted use. The concentration measured in the sample from location B-9 was 58 μg/Kg, which exceeds the DOH Tier 1 EAL of 3 μg/Kg. Although dieldrin was the only chlorinated pesticide detected in this study at levels exceeding the DOH Tier 1 EALs for unrestricted use, other chlorinated pesticides were detected in the sample (including DDT, DDE, total chlordane). These and other related compounds and have also been reported at levels exceeding DOH Tier 1 EALs in previous site investigations from this area (see **Section 4.2**). Therefore, chlorinated pesticides have been identified as COPC for his project.

Chlorinated pesticides are a class of chlorinated organic molecules that were developed historically for vector control. Although many have been banned in the U.S., these compounds are highly persistent in the environment. In general, they are relatively insoluble in water and highly persistent in soils. In organisms, these compounds bioaccumulate in adipose or fatty tissues and biomagnify in the food chain.

Elevated levels of chlorinated pesticides in the Kakaako area may be related to historic use of these chemicals for vector control in and around the municipal incinerator and incinerator landfill facilities in this area.

The primary exposure pathway for chlorinated pesticides is through ingestion. Inhalation of dust is not a major route of exposure. Dermal exposure is generally not considered relevant, except insofar as it may lead to accidental ingestion.

Risks to Human Health and the Environment from Exposure to Chlorinated Pesticides

Chlorinated pesticides have been shown to have a host of negative impacts on human health, ranging from neurological impacts to carcinogenic effects. These compounds can be stored over time in the body's adipose tissues and then be re-mobilized when the body is under stress to create increased systemic exposures.

Environmental impacts due to contamination with chlorinated pesticides are a persistent problem for high trophic level predators. Due to the tendency of these compounds to be sequestered and stored in fatty tissues and to biomagnify through trophic interaction, high-level predators are often at risk of severe toxic effects including reproductive failure due to elevated levels of pesticide exposure as these compounds become concentrated through their diets.

5.1.3 Dioxins

Although dioxins were not identified in any of the samples collected for the Phase 2 ESA performed for the HSWAC Project within the SMA Permit Area at concentrations exceeding the DOH Tier 1 EAL for unrestricted use, TEQ dioxins were detected in the soil sample collected near the proposed shoreline jacking shaft location (sample location B-9) and dioxins had been reported at levels exceeding DOH Tier 1 EALs in previous site investigations from this area (see **Section 4.2**). Therefore, dioxins have been identified as COPC for his project.

Dioxins are a group of compounds that form as by-products of incomplete combustion. They can also be produced as by-products from various industrial processes such as the bleaching of paper pulp in paper mills, but the elevated dioxin levels reported in soil samples from the Kakaako area are believed to be associated with combustion at the historic municipal incinerators in the area. For this reason, dioxins are considered a COPC whenever historic incinerator ash deposits are identified.

As is the case with metals and chlorinated pesticides, the primary exposure pathway for dioxins is through ingestion. Inhalation of dust is not a major route of exposure. Dermal exposure is also a potential exposure pathway as dioxins can be absorbed through the skin, but this pathway is generally not considered significant, except insofar as it may lead to accidental ingestion.

Risks to Human Health and the Environment from Exposure to Dioxins

Dioxins occur naturally in the environment and are found at very low levels throughout the natural world in soils, surface waters, sediments, and plant and animal tissues (*WHO, 2010*). These compounds are very stable and therefore extremely persistent in the environment. Like chlorinated pesticides, these compounds are hydrophobic and are therefore stored and may accumulate in adipose tissue.

More than 90% of human exposure to dioxins is believed to be dietary, with the primary sources of dioxins being meat, dairy products, fish and shellfish. Whether or not dioxins cause human health impacts is determined by dose, which depends on both the concentration and the duration of exposure. Long-term, continuous exposure to trace levels of dioxins (such as levels found in natural food products) has not been shown to pose a risk to human health. At higher levels of exposure, dioxins can cause human health impacts including severe acne, liver toxicity and various cancers. In animal studies, dioxins have been shown to cause nerve damage, birth defects, and various other neurological, developmental and immunological impacts.

5.2 Conceptual Site Model

A Conceptual Site Model (CSM) for potential human and ecological receptors has been prepared based on results of previous investigations summarized above in **Section 4.0**. This CSM is presented as a table in **Appendix D**.

A CSM is a model that provides a framework for evaluation of potential exposure pathways based on the types of contaminants and potentially contaminated media in question.

Based on the results of previous site investigations, the following receptors and exposure pathways have been identified and incorporated into the CSM for this project:

- The following have been identified as potential human receptors: on-site workers, trespassers on the site, and off-site workers and the general public.

- The following potential exposure pathways for potential human receptors have been identified: incidental ingestion or dermal contact with soil, sediment or groundwater; inhalation or ingestion (possibly based on dermal contact) with airborne dust; incidental ingestion and/or dermal contact with groundwater (either in situ or following dewatering activities).

- The following environmental receptors have also been identified: terrestrial ecological receptors, aquatic ecological receptors, and general gross contamination of the environment.

5.3 Potential Environmental Hazards

Direct exposure to contaminated soils and/or groundwater, and impacts due to gross contamination of terrestrial and aquatic habitats are potential environmental hazards that have been identified. These potential environmental hazards are further discussed in **Section 5.4**.

5.4 Targeted Environmental Hazards

Direct exposure to contaminated media (soils and/or groundwater) is the most likely and most potentially detrimental hazard to human health. Gross contamination from soils due to spills, leaching, run-off or wind-blown dust and gross contamination due to spills of groundwater during dewatering activities are the most likely and most potentially detrimental hazards to the environment.

For this project. the potential for human health impacts due to direct exposure to contaminated media and/or environmental impacts due to gross contamination from soils or groundwater will be limited to potential impacts due to construction-related activities. Therefore, proper management procedures, including procedures for the handling and disposal of potentially contaminated materials (i.e., excavated soil and groundwater from dewatering activities) will be critically important for avoiding any such impacts. Detailed descriptions of the procedures to be used for management of contaminated soils and groundwater will be provided in the Contractor’s Contaminated Soils Management Plan (CSMP), as described in **Sections 8.0** and **9.0**.

SECTION 6.0: INSTITUTIONAL AND ENGINEERING CONTROLS

This section describes institutional and engineering controls currently in place to limit migration of and/or potential exposure to potentially contaminated materials within the proposed Project Area for the HSWAC Project within the SMA. Institutional controls are legal or administrative measures designed to limit or prevent exposure to contaminants or contaminated media through laws, rules, permits, restrictions, warnings or advisories. Engineering controls are durable physical barriers designed to prevent physical contact with contaminants or contaminated media, such as membranes, walls, pavement, etc.

6.1 Institutional Controls

This section describes institutional controls at the properties to be affected by excavation activities during construction of HSWAC project facilities within the SMA, including existing institutional controls at these locations (**Section 6.1.1**) and additional institutional controls to be implemented during construction (**Section 6.1.2**).

6.1.1 Existing Institutional Controls

This section describes existing institutional controls currently in place at the properties to be affected by excavation activities during construction of HSWAC project facilities within the SMA.

No existing institutional controls have been identified at these locations.

6.1.2 Additional Institutional Controls To Be Implemented

This section describes additional institutional controls to be implemented during construction and excavation activities to control exposure by limiting the potential for human contact with potentially contaminated materials.

The following institutional controls will be implemented during construction and excavation activities within the SMA:

- Chain-link fencing with “No Trespassing” signs will be erected to control access to all staging and construction areas.
- A dust fence will be installed around the perimeter of the shoreline jacking shaft work area to control airborne dust.
- Re-use of contaminated soils will be forbidden without express permission from the HDOH HEER office.
- Only native or clean fill materials will be used as backfill for excavated areas.

6.2 Engineering Controls

This section describes engineering controls at the properties to be affected by excavation activities during construction of HSWAC project facilities within the SMA, including existing engineering controls at these locations (**Section 6.2.1**) and additional engineering controls to be implemented during construction (**Section 6.2.2**).

6.2.1 Existing Engineering Controls

This section describes existing engineering controls currently in place at the properties to be affected by excavation activities during construction of HSWAC project facilities within the SMA.

No existing engineering controls have been identified at these locations. Although the historic landfill site at the Kaka'ako Waterfront Park (TML parcel # (1) 2-1-060: 008) is covered by synthetic liner and several feet of clean topsoil, these engineering controls do not extend to the proposed location of the shoreline jacking shaft and will not be impacted by construction or excavation activities at the site.

6.2.2 Additional Engineering Controls To Be Implemented

This section describes additional engineering controls to be implemented during construction and excavation activities to control exposure by limiting the potential for human contact with potentially contaminated materials.

- On-site vegetation will be maintained where feasible during construction activities.

- A 6-inch laver of gravel or base course material will be used to cover the areas around the edges of the excavated shaft locations to ensure that there is no potential exposure to site workers due to exposed historic fill materials or other contaminated media.

6.3 Long-term Monitoring Requirements

No additional long-term monitoring requirements will be necessary as a result of this project. Upon completion of construction activities, the temporary shoreline jacking shaft location will be filled in and the site returned to its original condition. Only clean fill materials will be used for this purpose. Normal maintenance of the Kakaako Waterfront part area will resume. The receiving shaft and cooling plant location will be covered by a building (the cooling plant). No further potential will exist at either site for either direct exposure or gross contamination due to excavation or dewatering activities.

SECTION 7.0: EXPOSURE MANAGEMENT AND WORKER PROTECTION

This section describes procedures to be used to manage worker exposure to potentially harmful contaminants during excavation and dewatering activities within the SMA.

7.1 Environmental Protection Plan and Worker Health and Safety Plan

The contractor shall be required to prepare an Environmental Protection Plan (EPP), a Contaminated Soil Management Plan (CSMP), and a Worker Health and Safety Plan (HASP) that are specific to the requirements and hazards associated with excavation and construction activities on this project. The EPP, CSMP and HASP will be reviewed and approved and a Certified Industrial Hygienist (CIH) and a Certified Safety Professional (CSP). Signed, stamped copies of the approved EPP and HASP will be submitted to the Project Engineer and the HDOH HEER office prior to the start of any mobilization, excavation or construction activities for this project. The CSMP will also address public health and safety, with specific attention to adverse exposures to potentially high-risk populations including families with children who may be residing at the Next Steps Homelesss Shelter (located across the drainage channel from jacking shaft location) or using the Kakaako Waterfront Park.

7.2 Awareness Training

Project specific Health & Safety and Awareness Training covering relevant aspects of this EHMP and all aspects of the contractor's site specific EPP and HASP will be conducted by the prime contractor's designated Safety Officer for all personnel working on or having access to the project Work Area, including the contractor's employees as well as subcontractors and their employees, visitors to the site, etc. This Health & Safety Awareness Training will be conducted prior to the employee being allowed onto the job site and prior to the employee being allowed to perform of any work at the jobsite. A written record of all training sessions will kept by the designated Safety Officer, who will sign and date the record for each session. The employees receiving training will also sign and date the record.

7.3 Construction Worker Notification

Copies of the approved EPP and HASP, and a copy of this EHMP, will be kept at the job site and will be accessible to all employees and subcontractor's employees as part of the contractor's OSHA-compliant Hazard Communication Program (as required under 29 CFR 1910 and 29 CFR 1926).

7.4 Construction Worker Protection

Construction workers will not come into direct contact with contaminated or potentially contaminated materials. This includes ash and landfill debris as well as other potentially contaminated excavated materials, as well as potentially contaminated groundwater.

Adequate Personal Protective Equipment (PPE) will be issued to all employees working in areas where potentially contaminated materials have been exposed. Specific requirements for PPE will be detailed in the contractor's site specific HASP and shall be approved by the CIH and CSP that review and approve those plans.

7.5 Public Health and Safety

The Contractor's CSMP will address public health and safety, with specific attention to adverse exposures that might affect potentially high-risk populations, including families with children who may be residing at the Next Steps Homelesss Shelter (located across the drainage channel from jacking shaft location) as well as families or homeless individuals using or living in the Kakaako Waterfront Park area. Containment and engineering controls including BMPs and on-site monitoring will be established to ensure that any potential exposures to hazardous materials that may be encountered during excavation at the shoreline jacking shaft location are limited to the designated work area, and that access to this area is tightly controlled.

SECTION 8.0: SOIL MANAGEMENT PLAN

This section describes methods and procedures to be used for management of excavated materials during construction-related excavation activities within the SMA.

8.1 Consultation with the HDOH HEER Office

This EHMP has been submitted to the HDOH HEER office for review and approval. Additional documentation (to be provided by the contractor) may be required by the HDOH HEER office prior construction as a condition for approval of this EHMP. Required documentation may include the plans described below in **Section 8.2**. The HEER office project manager for this project is Melody Calisay; any required documentation should be submitted directly to her, unless another project manager is designated by the HEER office.

8.2 Environmental Protection Plan, Contaminated Soil Management Plan and Worker Health and Safety Plan

The contractor shall be required to prepare an Environmental Protection Plan (EPP), a Contaminated Soil Management Plan (CSMP), and a Worker Health and Safety Plan (HASP) that are specific to the requirements and hazards associated with excavation and construction activities on this project. The EPP, CSMP and HASP will be reviewed and approved and a Certified Industrial Hygienist (CIH) and a Certified Safety Professional (CSP). Signed, stamped copies of the approved EPP and HASP will be submitted to the Project Engineer and the HDOH HEER office prior to the start of any mobilization, excavation or construction activities for this project.

The contractor's site specific EPP shall contain specific procedures to be used to ensure that any contaminated or potentially contaminated materials excavated during this project are handled, stored, and (if necessary) transported and disposed of safely and in compliance with all applicable State and Federal regulations. The EPP will also contain erosion control and dust control measures to be used to ensure that contaminated materials are not spread or transported off-site via wind or water.

The contractor's site specific CSMP shall contain specific procedures to be used to ensure that any contaminated or potentially contaminated materials generated during excavation activities within the SMA are managed, handled and disposed of in accordance with all applicable State and Federal regulations, HDOH requirements and recommendations, project specifications and the requirements of this EHMP. This CSMP will include a detailed description of handling procedures for re-use and disposal including: sampling and analysis for disposal characterization; landfill acceptance requirements; and criteria for re-use of excavated materials.

The contractor's site specific HASP shall contain specific procedures to be used to ensure that any workers who could potentially be exposed to contaminated or potentially contaminated materials as a result of their work activities are adequately trained and are provided with adequate PPE to allow them to perform their work safely.

8.3 Soil Excavation and Handling Procedures

Soil excavation and handling procedures will be detailed in the contractor's site specific EPP and/or CSMP. At a minimum, the following requirements will be observed:

- Initial excavation of surface materials at both the jacking shaft location and the receiving shaft location will be monitored by an independent industrial hygiene technician using a photo-ionization detector (PID). Any soils that show visual (discoloration) or olfactory (odor) indications of petroleum, or trigger elevated PID readings, will segregated and managed as petroleum contaminated materials pending results of characterization for COPC as listed in **Table 2** per requirements and recommendations outlined in the HDOH Technical Guidance Manual (*HDOH, 2009*).

- Any materials excavated at either the jacking shaft location OR the receiving shaft location that shows signs of ash or other debris, which may indicate the historic use of landfill materials as fill materials, will be segregated and managed as contaminated materials pending results of characterization for COPC as listed in **Table 2** per requirements and recommendations outlined in the HDOH Technical Guidance Manual (*HDOH, 2009*).

- Surface soils from the jacking shaft location that DO NOT show signs of either ash or debris will be segregated and managed separately, as potentially contaminated materials, pending results of results of characterization for COPC listed in **Table 2** per requirements and recommendations outlined in the HDOH Technical Guidance Manual (*HDOH, 2009*).

- All imported fill materials will be certified as clean fill materials per HDOH guidance (*HDOH, 2009*). Native materials that show no signs of contamination may be re-used on site as fill materials. In the event that these materials are transported off-site for temporary storage pending eventual re-use as fill materials, the materials will be tested and characterized for re-use as clean fill materials per HDOH guidance (*HDOH, 2009*).

8.4 Storage of Excavated Materials

Excavated materials will be handled and stored in compliance with all applicable State and Federal regulations, and in such a manner as to prevent potential escape, leakage or transport off-site of contaminated or potentially contaminated materials. Specific details for handling and storage of excavated materials will be provided by the contractor in the site specific EPP, or in a separate Contaminated Soils Management Plan (CSMP).

8.5 Re-use and/or Disposal of Excavated Materials

Excavated materials that do not show any sign of petroleum contamination (including visual or olfactory indications or elevated PID readings), and which do not contain any visible sign of ash or debris that might indicate the presence of historic landfill materials, may be re-used on site without prior characterization provided that these materials are not transported off site and are covered with at least two feet of clean material.

Excavated materials that are characterized for COPC as described above in Section 7.3 may be re-used on site with HDOH HEER office approval.

All materials not re-used on site or transported off site for temporary storage, re-use or disposal must be characterized prior to re-use or disposal in accordance with HDOH requirements, landfill requirements, and applicable State and Federal regulations. Characterization and disposal procedures will be outlined in the contractor's approved EPP and/or CSMP.

8.6 Specific Consideration of Public Health and Safety

The Contractor's CSMP will specifically address issues related to public health and safety, with specific attention to adverse exposures that might affect potentially high-risk populations, including families with children who may be residing at the Next Steps Homelesss Shelter (located across the drainage channel from jacking shaft location) as well as families or homeless individuals using or living in the Kakaako Waterfront Park area. Containment and engineering controls including BMPs and on-site monitoring will be established to ensure that any potential exposures to hazardous materials that may be encountered during excavation at the shoreline jacking shaft location are limited to the designated work area, and that access to this area is tightly controlled.

SECTION 9.0: GROUNDWATER MANAGEMENT PLAN

This section describes methods and procedures to be used for management of groundwater during construction dewatering activities within the SMA.

9.1 Consultation with the HDOH HEER Office

This EHMP has been submitted to the HDOH HEER office for review and approval. Additional documentation (to be provided by the contractor) may be required by the HDOH HEER office prior construction as a condition for approval of this EHMP. Required documentation may include the plans described below in **Section 9.2**. The HEER office project manager for this project is Melody Calisay; any required documentation should be submitted directly to her, unless another project manager is designated by the HEER office.

9.2 Groundwater Management During Construction

Dewatering activities will generate groundwater that will require management during each phase of construction with the SMA. Construction methods and procedures will be implemented to minimize groundwater infiltration into excavated areas. Excess groundwater generated during construction activities will be managed according to the following options:

1. If possible, all excess groundwater generated during this project will be returned to the water table via recharge into one or more specially constructed recharge basins that will be constructed in the immediate vicinity of the dewatering location(s). Excess groundwater may be pumped directly from the active work site(s) (i.e., excavation or slurry separator) into the recharge basin(s), or it may be pumped into a mobile storage container designed for that purpose pending recharge at a later date.

2. If excess groundwater quantities are such that recharge, for whatever reason, is not feasible, then excess groundwater pumped into temporary storage containers may be removed from the site for off site disposal by a waste disposal contractor. The waste disposal contractor would be required to dispose of the excess groundwater in full compliance with all applicable State and Federal regulations.

3. In the event that subsurface petroleum contamination is encountered to such an extent that a sheen is observed on groundwater being dewatered, then this water will be pumped directly into an oil, water separator. Once the petroleum product has separated from the water, the water may be recharged as described above while any petroleum product will be characterized and disposed of by a waste disposal contractor.

9.3 Environmental Protection Plan and Worker Health and Safety Plan

The contractor shall be required to prepare an Environmental Protection Plan (EPP), a Contaminated Soil Management Plan (CSMP), and a Worker Health and Safety Plan (HASP) that are specific to the requirements and hazards associated with excavation and construction activities on this project. The EPP, CSMP and HASP will be reviewed and approved and a Certified Industrial Hygienist (CIH) and a Certified Safety Professional (CSP). Signed, stamped copies of the approved EPP and HASP will be submitted to the Project Engineer and the HDOH HEER office prior to the start of any mobilization, excavation or construction activities for this project.

In addition to requirements described above in **Sections 7.1** and **8.2**, the contractor's site specific EPP and/or CSMP shall contain specific procedures to be used to ensure that any groundwater disturbed during this project will be handled, stored, transported and (if necessary) disposed of safely and in compliance with all applicable State and Federal regulations, and without impacting the surrounding area or leaking into storm drains (*see Figure 4-19 in SMA Permit Application*, ***Appendix C***), the drainage canal (*see Figures 5-4 and 5-5 in SMA Permit Application*, ***Appendix C***), or the Pacific Ocean.

In addition to requirements described above in **Sections 7.1** and **8.2**, the contractor's site specific HASP shall contain specific procedures to be used to ensure that any workers who could potentially be exposed to contaminated or potentially contaminated groundwater as a result of their work activities are adequately trained and provided with adequate PPE to allow them to perform their work safely.

SECTION 10: REFERENCES

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APPENDIX A:

HDOH HEER Office Correspondence from 11 May 2011

Rec 5/18-11

NEIL ABERCROMBIE
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500 Ala Moana Boulevard
Honolulu, Hawaii 96813

Subject: Special Management Area (SMA) Use and Hawaii Coastal Zone Management (CZM) Federal Consistency Applications for Honolulu Seawater Air Conditioning Project, Kakaako Makai District, Honolulu, HI

Dear Mr. Larson:

The State of Hawaii, Department of Health, Hazard Evaluation and Emergency Response (HEER Office) is writing this letter in response to Item No. 16 of Mr. Jesse K. Souki letter Ref. No.P-13245. The Department of Health HEER Office reviews, and oversees the assessment and cleanup of contaminated properties and guides selection of remedial alternatives in the cleanup process. Just for clarification, HEER Office does not require that "hazardous substances are not present on the site" to approve a HRS 128D compliant redevelopment of the property. Instead, HEER requires that the developer agree to investigate and manage contamination that may exist on site in accordance with HEER guidance and recommendations. These activities can happen concurrently with development planning and need only to be initiated prior to issuance of the SMA permit. Your firm, Honolulu Seawater Air Conditioning, LLC has made initial contact with HEER, and has taken the initial steps needed to begin the formal investigation and oversight process.

As discussed in the meeting with Mr. Frederick Berg and Mr. Abbott of TEC on December 15, 2010, in fulfillment of the requirement in your applications for SMA permit and the Hawaii Coastal Zone Management Federal Consistency Review, the HEER Office is willing to work with you and provide oversight in handling and managing contaminated soil expected to be encountered during planned construction activities to ensure that the project will not pose risk to human health and the environment.

The HEER Office has overseen a number of investigations pertaining to soil and groundwater contamination in the Kakaako Makai District project area over the past several years. Results of these previous investigations indicated elevated levels of contaminants as a result of previous activities conducted at the site. Based on historical information about various operations and the results of several investigations to date, the HDOH recommends that, in the absence of specific local data that shows area to be clean, all soils in the Kakaako area be managed assuming they are contaminated and may pose hazards to construction workers.

The Kewalo Incinerator Landfill was operated as an ash dump from the burning of municipal refuse between 1927 and 1977. Other waste suspected of being disposed on the site include unburned refuse, construction debris, household debris, and some unknown waste from illegal dumping. In 1988, Woodward-Clyde Consultants conducted a preliminary soil and shallow groundwater investigation at Kewalo Incinerator Landfill. Results of the investigation indicated elevated levels of pesticides (dieldrin, chlordane, DDE, DDD), metals and semi-volatile organic compounds (SVOCs). Preliminary Assessment was conducted by Ecology and the Environment at the Kewalo Incinerator Landfill in 1989, and determined that at the site does not appear to be eligible for National Priorities List (NPL). EPA concluded that the landfill is not posing a threat to the drinking water aquifer and to the Pacific Ocean and a release of landfill gases is unlikely due to thick engineered soil cover over the refuse.

Based on the proposed micro-tunneling route, there is a plan to dig a jacking pit on the EWA end of Kewalo Incinerator, potentially disrupting the cap and encountering the contaminated refuse material. There is no investigation and assessment conducted at on the proposed location of the pumping station area as of to date. In order to prepare a basis to properly manage the contaminated soil, HDOH requests that Honolulu Seawater Air Conditioning, LLC submit the following information:

1. Summary of site investigation reports that describe historical information about the site, and previous investigation conducted.
2. Environmental Hazard Evaluation that identifies, evaluates specific environmental concerns associated with identified contamination, and makes recommendations for additional actions (if any).
3. Environmental Hazard Management Plan (EHMP) that describes proposed construction activities (e.g. trenching, pile caps, excavation, and grading) and precautionary measures and practices to be implemented to prevent exposure and ensure safety of workers. EHMP should also include procedure for groundwater handling and disposal if the development plan requires disturbance of groundwater.

In this regard, the HEER Office recommends that you select an environmental consultant familiar with our office procedures and guidance. EHMP should be submitted to HEER Office for review and approval before the start of any construction activities.

Please feel free to call me at 808-586-7577 or email me at melody.calisay@doh.hawaii.gov if you have further questions.

Sincerely,

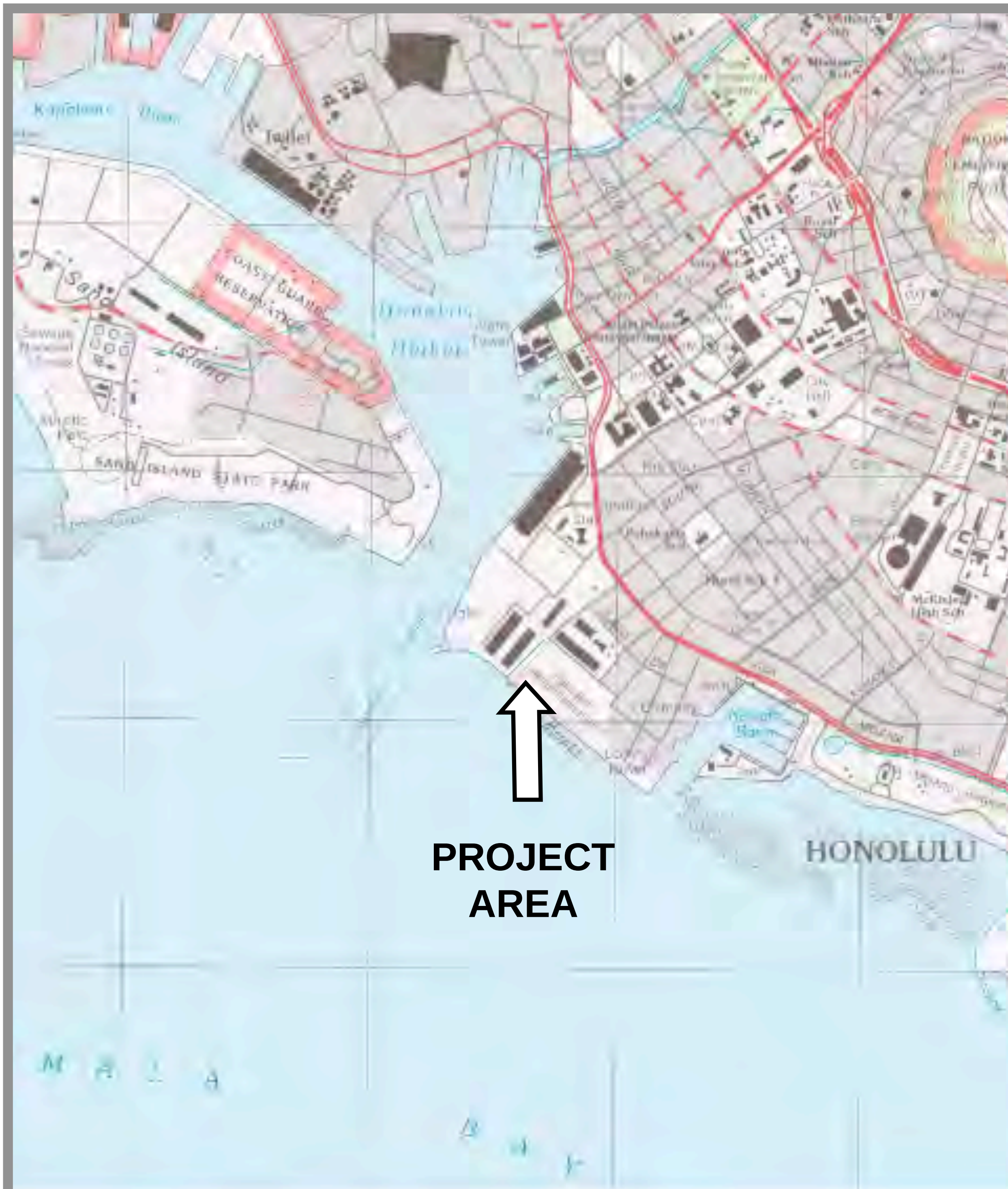
mgcalisay

Melody Calisay
Project Manager
HEER Office-HDOH

cc : Mr. Anthony Ching/Deepak Neupane, HCDA

APPENDIX B:

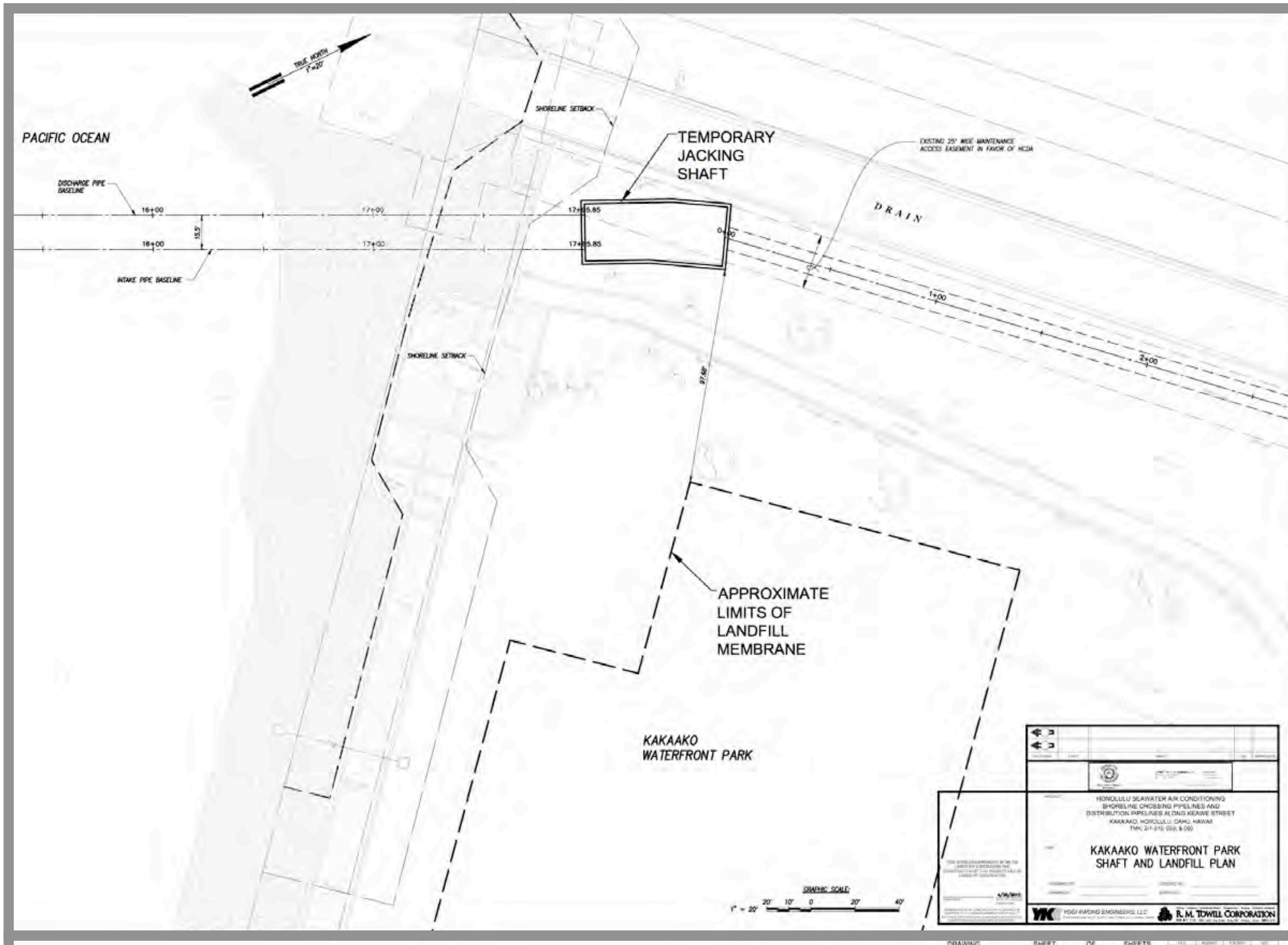
Figures



HSWAC EHMP
Owen Environmental, Inc.
December 2011

Figure 1: Site Location Map

Source: USGS Quad Topo Map



HSWAC EHMP
Owen Environmental Inc.
December 2011

Figure 2: Relative Locations of Shoreline Jacking Shaft and Landfill Boundary
Source: Client Documents

APPENDIX C:

HSWAC Project SMA Permit Application
(Chapters 1-5)

This Appendix is not included here.

APPENDIX D:

Conceptual Site Model for HSWAC Project within SMA

Conceptual Site Model for Potential Exposure pathways, HSWAC Project within SMA

Potential Exposure Pathways						Potential Receptors								
						Human Health						Current Environmental		
						During Construction			Post Construction					
Primary Source	Primary Release Mechanisms	Secondary Source	Secondary Release Mechanisms	Pathway	Exposure Route	On-site Workers	Trespassers	Off-site Workers, General Public	On-site Workers	Trespassers	Off-site Workers, General Public	Terrestrial Ecological	Aquatic Ecological	Gross Contamination
Application of pesticides for vector control, storage of pertoleum products, and waste incineration	Leaks, spills, and historic use of incinerator waste as fill material	Surface soil	None	Surface Soil	Ingestion	X	X		X		X	X	X	X
					Dermal	X	X		X		X	X	X	X
			Dust	Air / Wind	Inhalation	X	X	X	X			X	X	X
					Ingestion	X	X	X	X			X	X	X
					Dermal	X	X	X	X			X		X
			Runoff	Surface Water and Sediment	Ingestion	X	X	X	X			X	X	X
					Dermal	X	X	X	X			X		X
			Leaching	Subsurface Soil	Ingestion	X						X		
					Dermal	X						X		
				Groundwater	Ingestion	X								
					Dermal	X								
					Inhalation	X								
		Groundwater dewatering	None	Direct contact	Ingestion	X								
					Dermal	X								
			Spills	Surface Soil	Ingestion	X	X	X				X		X
					Dermal	X	X	X				X		X
				Surface Water and Sediment	Ingestion	X	X	X				X		X
					Dermal	X	X	X				X		X
				Groundwater	Ingestion	X								
					Dermal	X								

X = potentially complete exposure pathway

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APPENDIX E
HSWAC SHALLOW WATER MARINE BIOLOGY SURVEY

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HONOLULU SEAWATER AIR CONDITIONING PROJECT:

IMPACTS TO SHALLOW WATER MARINE BIOTA WITH

CONSTRUCTION AND OPERATION

Prepared for:

Honolulu Seawater Air Conditioning, LLC
1132 Bishop Street, Suite 1410
Honolulu, Hawaii 96813

Prepared by:

Richard Brock, Ph.D.
Environmental Assessment, LLC
1232 Lunalilo Home Road
Honolulu, Hawaii 96825

EALLC Report No. 2011-18

September 2011

EXECUTIVE SUMMARY

Honolulu Sea Water Air Conditioning, LLC (HSWAC) proposes to bring deep cold seawater ashore via a pipeline and indirectly use this seawater to cool office buildings in downtown Honolulu. This project will develop and use an alternative means of air conditioning for many of Honolulu's office buildings which will realize a substantial savings in electrical costs, thus oil. HSWAC proposes to have this pipeline enter the ocean along the Kaka'ako Waterfront Park placing the intake and discharge pipes in a tunnel beneath the shallow limestone reef platform fronting the waterfront park. This tunneling strategy results in largely avoiding disturbance to the shallow coral reefs and the pipes would "daylight" at a depth ~10 m near the seaward edge of the reef (~0.5 km offshore). Seaward of this, the pipes would be placed on concrete collars or saddles keeping them elevated above the substratum and the intake will extend roughly 7.2 km seaward terminating at a depth of ~540 m where water temperatures are ~6^{o}C. The cold seawater will be pumped to a shore-based heat exchanger and used (~11^{o}C) seawater will be returned to the ocean via a diffuser at a distance of ~1.06 km offshore at depths between 36 and 45 m. This study focuses on the impacts that may be created with the development and operation of this system on the biota found between the breakout point where the pair of pipes exits the tunnel and crosses the substratum in a seaward direction to the end of the seawater return pipe (at the end of the diffuser) which is a distance of ~580 m.

Underwater surveys have noted the presence of four different ecological zones or biotopes present from the breakout point to the lower end of the diffuser; seven stations each centered in the middle of the proposed pipeline alignment at different depths were established to quantitatively sample marine communities present in each of these biotopes. At each of the four shallowest stations (at 9. 5m, 10 m, 13.7 m and 18 m) two 25 m long transects were established perpendicular to the pipeline alignment both at the same depth thus sampling from the midline of the pipeline to the east and west of it. Due to bottom time constraints at the three deeper stations (at 27, 35 and 40 m), a single 25 m long transect was established again centered on the pipeline alignment with sampling to the east and west of it. On each transect fish species, numbers of individuals and estimates of standing crop were made; coral communities were assessed using both measures of coverage by species as well as estimates of individual maximum colony diameters. For diurnally-exposed macroinvertebrates, both the species and their abundance were noted. Using coral coverage as a simple measure of marine community development, marine community development is greatest in the shallow biotope of scattered corals, especially along its seaward edge where a series of channels and ridges (spur and groove formations) occur that are naturally cut into the limestone substratum; overall mean coral coverage in this area is 7.5%. The breakout point where the pair of pipes come to the surface of the seafloor (thus exiting the tunnel) is in a limestone channel at the seaward edge of the biotope of scattered corals. This channel was selected for the microtunnel exit because of near complete absence of coral in the channel floor. The shallowest sampling station was established just inshore of that point. Within 25 m seaward of this point is the biotope of shallow dredged rubble where the second sampling station was established and overall mean coral coverage is 3.2%. The biotope of shallow dredged rubble slopes away to the biotope of sand and the third station at 13.7 m depth was in a zone of transition between the biotope of shallow rubble and the biotope of sand as was the fourth station established in 18 m of water. Quantitative sampling was carried out in both of these biotopes at these two depths; at the 13.7 m depth overall mean coral coverage is 1.0 % and at the 18 m depth station, it is 0.5%. The biotope of deep dredged rubble is present at the three deep stations established at 27, 35 and 40 m where overall mean coral coverage among these stations is 1.1%.

The diversity of species, numbers of individuals and sizes of corals appear to decrease with depth. Within 25 m seaward of the proposed pipeline breakout point, marine community development is poor and remains this way in a seaward direction relative to many other Hawaiian marine communities at similar depths elsewhere. The probable agents responsible for this low diversity are a combination of substratum characteristics (here primarily dredge tailings from development and early maintenance of Honolulu Harbor but also the presence of sand) as well as the fact that the deeper portions of the studied marine communities are exposed to occasional physical damage due to tug and barge operations where just prior to entry into Honolulu Harbor, tugs drop their tow lines to shorten the distances between the tug and barge for better maneuvering within the harbor. If the distance between the tug and barge is greater than twice the depth, the heavy cable falls to the bottom and drags across it, destroying sessile species in its path. Since many Hawaiian corals have slow growth rates, these events do not have to occur more than once a decade to keep benthic communities at an early point in succession. Tug and barge operations have been ongoing for at least the last 80 years.

Since the marine communities along the majority of the shallow pipeline alignment are not well developed, the deployment and operation of the HSWAC system will have a minimal negative impact. Assuming a conservative approach where all coral resources within a 10 m radius of the receiving pit (where the HSWAC pipes daylight) are lost due to construction activities, approximately 23.6 m^2 of coral will be negatively impacted. The concrete anchor collars that cradle the pair of pipes above the substratum when deployed will result in loss of an additional 6.7 m^2 of living coral over the 580 m distance to the end of the discharge diffuser. During operations, low temperature of the discharge water will probably have the greatest negative impact to sessile species such as corals resident to the area. Mixing model results suggest that ambient temperatures will be attained within 12.2 m (most conservative) to about one meter (average) of the discharge plume centerline depending upon current flow. Assuming all corals within the conservative envelope formed by the diffuser succumb, there will be an additional estimated loss of 27 m^2 of coral. To offset these losses, the 91 combination concrete collars as well as the two HDPE pipes will provide more than 7,800 m^2 of elevated hard surfaces over the 580 m distance from breakout to the end of the discharge diffuser. Settlement on elevated hard substratum decreases chances of scouring during periods of high surf. Both HDPE pipes and concrete collars are highly suitable for recruitment by benthic species including corals. HDPE pipes at the Natural Energy Laboratory of Hawai‘i at Keahole Point on Hawai‘i Island are heavily colonized by Hawaiian corals. If recruitment and growth of corals to the HDPE pipes and collars occurs at rates similar to those at the Natural Energy Laboratory (~25% coverage after ~12 years) more than 1,950 m^2 of corals should be present on the HSWAC pipes following a ten to twelve year period over the 580 m length of the pipeline between breakout and the discharge diffuser.

1. INTRODUCTION

Purpose:

Honolulu Seawater Air Conditioning, LLC (HSWAC) proposes to bring deep cold seawater ashore via a pipeline and indirectly use this seawater to cool office buildings in downtown Honolulu. HSWAC will use an alternative means of air conditioning for many of Honolulu's office buildings which will realize a substantial savings in electrical costs (i.e., oil). HSWAC proposes to have this pipeline enter the ocean along the Kakaʻako Waterfront Park placing the intake and discharge pipes in a tunnel beneath the shallow limestone reef platform fronting Kakaʻako Waterfront Park. This tunneling strategy results in largely avoiding disturbance to the shallow coral reefs and the pipes would "daylight" at a depth of ~10 m near the seaward edge of the reef. Seaward of this the pipes would be placed on concrete trestles or saddles keeping them elevated above the substratum and the intake will extend roughly 7.5 km seaward terminating at 540 m deep where water temperatures are ~6^{o}C. The cold seawater will be pumped to a shore-based heat exchanger and used (~11^{o}C) seawater will be returned to the ocean via a diffuser at depths from 36 to 45 m.

Comments to a draft environmental impact statement (dEIS) have been received from both the Environmental Protection Agency (EPA) and the National Marine Fisheries Service (NMFS) that require addressing in the final EIS. Comments related to shallow water marine communities that are pertinent to this study are summarized as follows:

EPA Comments:

1. More comprehensive aquatic resource surveys and impact assessment data are needed;

2. The distribution of corals and coral reefs through the proposed project area is needed, including mapping of habitats as well as quantitative data on corals and other macro-invertebrate species, coverage, density and condition;

3. The impact of turbidity and physical disturbance on both hard and soft substratum communities during deployment as well as during operations must be addressed.

NMFS Comments:

1. Quantitative current data on water quality and benthic resources where potential impacts may occur should be included. Data needed should include coral size frequency, density of non-coral invertebrates and biomass of fish;

2. Expected impacts to resources should be quantified;

3. Maps of the pipeline route should be superimposed on maps of the biological resources and these benthic maps should be up-to-date and of high resolution;

4. Impacts to all Essential Fish Habitats (EFH) should be characterized and described in more detail;

5. Quantitative and detailed comprehensive benthic survey data should be provided.

Less than 8% of the proposed exposed pipeline route lies at depths where conventional diving gear can be safely used in conducting underwater quantitative biological surveys. This study was undertaken to address the EPA and NMFS questions posed above for the marine communities present at depths less than 40 m (~130 feet) in the area of the proposed HSWAC pipeline alignment.

Background:

Honolulu Harbor lies just west of the Kaka‘ako Waterfront Park and has been the primary commercial port for the State of Hawai‘i since before 1900 (Scott 1968). The harbor is the result of dredging what was originally the drainage basin of Nu‘uanu Stream. Dredging began before 1900, and periodic maintenance dredging still occurs. Until about 1960, spoils were dropped at a variety of locations outside of the harbor and in the early years apparently just east of the Waikiki Entrance Channel of the Harbor fronting Kaka‘ako Waterfront Park. Besides shipping, the Harbor is ringed with industry; pineapple canneries, gas and oil storage, and numerous other businesses have operated or are still operating there. Storm drainage into the Harbor and nearby Ke‘ehi Lagoon carries runoff from Honolulu’s streets and suburbs into the ocean. Pollution is well known in the Harbor; poor conditions are described as early as 1920 in references cited in Cox and Gordon (1970). Sewage has been pumped into the ocean offshore of the Kaka‘ako Waterfront Park and Sand Island since the early 1930's. The early inputs were all raw sewage released in water not exceeding 20 m in depth. The actual points of release varied through time as different pipes were constructed and used. The multitude of perturbations that occurred in shallow water (less than 20 m) from these early sewage inputs continued until the construction of the present deepwater outfall in 1978 (Brock 1998).

The present-day Kaka‘ako Waterfront Park is built on a former Honolulu dump that was closed in the early 1960's. The seaward (or makai) side of the landfill is contained by placement of a boulder riprap which was constructed on a limestone bench in water from 2 to 5 m in depth. As noted above, the eastern entrance to Honolulu Harbor lies just west of the Kaka‘ako Waterfront Park and just east of the Park is the entrance to Kewalo Basin which was constructed in the 1920's and 1930's to serve Honolulu’s fishing fleet and former commercial tuna cannery (built in 1917). Water circulation seaward of the old Kewalo Landfill is good with waves breaking directly on the boulder riprap during periods when surf is emanating out of the SE through SW directions. Surfers utilize the breaking waves in the eastern portion of the limestone platform offshore of the Kaka‘ako Waterfront Park. While in operation, the dump received both burned and unmodified wastes from urban Honolulu (personal observations) at a period of time when concern over pollution from anthropogenic sources was less than now; since the landfill filled in a section of old coastline to a point greater than 100 m seaward, the landfill materials along the seaward side are exposed to seawater with possible potential leaching of pollutants.

Similarly, Sand Island which is situated seaward of Honolulu Harbor initially was an isolated sandbar located on the Harbor’s seaward reef. This area was expanded during the 1900 - 1940 period using dredge spoils from inside as well as from subtidal areas to the west of Honolulu Harbor. The present boundaries of Sand Island were delineated using boulder riprap set on the shallow reef fronting the Harbor and spoils placed within this riprap. In the late 1800's through early 1900's Sand Island served as an immigration station. Later the land was occupied by businesses including auto wreaking yards and today the mauka (inner) part of Sand Island serves to receive trans-Pacific shipping, a Coast Guard station and shoreline park. Since the 1950's the City and County of Honolulu has operated sewage treatment facilities on the makai side of the island. Thus from a historical perspective, the lands around Honolulu Harbor have received considerable modification and industrial use and in the past the waters seaward of the Harbor have been a repository for unwanted materials. However, despite the long history of environmental insult, marine communities seaward of the Kaka‘ako landfill continue to persist as detailed below.

Ecologists have long recognized that physical disturbance in both terrestrial and aquatic communities is a major force in determining the structure and function in natural communities. Thus fire is very important in the structure of temperate forests as are storm winds (e.g., hurricanes, cyclones, etc.) in tropical forests and on coral reefs where waves impact benthic communities. In the case of marine communities fronting the western part of the Kaka‘ako Waterfront Park, not only have impacts from natural events (i.e., seasonal and occasional storm waves resulting in the scouring of benthic sessile species and habitats by sand and rubble) occurred, it is surmised that there have been impacts caused by human shipping activities through Honolulu Harbor over the last ~80 years. Since the 1930's interisland shipping has utilized tugs and barges. At sea, tugs usually pay out sufficient cable to keep the tug well separated from its cargo (on the barge). Often several hundred feet of cable will be used in this manner. On approach to the harbor, the tug slows its speed but due to inertia, the barge continues to move forward and the tow cable slackens, often falling to the bottom where it drags across the substratum destroying benthic communities in its path. Slackening a tow cable allows the tug to retrieve the excess cable thus decreasing the distance between the tug and barge which facilitates safe handling of the barge on entering the harbor. Tug and barge operations occur daily in Honolulu Harbor and on every entry into the harbor, a tug must slacken its tow cable. If the depth of water is less than one half of the initial open-ocean length between the tug and barge, the cable will fall to the bottom and drag across the substratum. Falling and dragging across a sand bottom probably causes less physical damage to benthic communities than dragging across hard bottom communities colonized by corals. Because many Hawaiian corals have relatively slow growth characteristics, a cable dragging through an area does not have to occur more than once every ten years or so in order to keep that community in a relatively early stage of succession and growth. The impact of tug and barge operations on benthic communities are readily apparent offshore of the western portion of Kakaʻako Waterfront Park and fronting Sand Island and this source of disturbance may be largely responsible for the relatively low coverage by corals noted in this study at depths below 20-25 m.

Past Qualitative Studies

Early marine biological studies in support of the HSWAC project were focused on qualitatively examining the shallow water communities fronting the Kakaʻako Waterfront Park with the objective of delineating the major ecological zones or biotopes present as well as to determine the degree of development of the communities in these biotopes. This work was done to find possible pipeline alignments that would have the least environmental damage within the general constraints given by construction methodologies that were being considered at that time. These methodologies included possibly placing the pipeline in a trench dug across the shallow reef areas or use of microtunneling beneath much of the shallow reef area, thereby avoiding direct disturbance to the marine communities present mauka (landward) of the breakout point. Because of the presence of coral reefs, microtunneling became the method of choice and at least three different locations were considered for the seaward breakout point. However, as with all marine construction work, there are limitations and constraints with any method of choice; in the case of microtunneling, the distance at which such tunneling can be performed is limited due to substratum type and as distance increases, the ability to keep the tunneling within the desired alignment becomes more difficult.

Thus in completing the initial qualitative marine biological work, Brock (2005) used several methods which included towing a diver behind the support vessel over much of the study area. Where water clarity would permit, this diver made observations from the surface and verbally reported these observations to personnel on the vessel who noted these comments and also marked the location of these observations using a hand-held GPS. This exercise allowed a rough delineation of benthic communities and ecological zonation in the path of the diver. Other than towing a diver behind the support vessel, all underwater work was completed using self contained diving gear. Coral community development was assessed by determining species present and estimating their coverage on the bottom. Photographs were taken of representative sections of the substratum. Despite having preliminary preselected locations for possible pipeline alignment, much of the shallow water fronting the Kakaʻako Waterfront Park at depths ranging from 2 to 20 m was examined for determining the geographic extent of the biotopes (or ecological zones) found in this study.

The proposed point of departure from land was just west of an open drainage canal that lies along the western boundary of the Kakaʻako Waterfront Park. This point of departure defined the primary study area in an approximate equilateral triangle with the apex at the boulder riprap and the base offshore at roughly the 20 m (60-foot) isobath. This rough triangle enclosed a study area of about 17 hectares (42 acres) which assisted in defining the major biotopes present in the area. To obtain data at a finer scale, a 730-meter (2,400 foot) line was laid from the 20 m isobath commencing in the possible pipeline alignment towards the shore using the shoreline entry point as the target endpoint. The line ended in water from 2.4 to 3 m (8 to 12 feet) in depth close to the shoreline. The coral and benthic communities were examined by diving along the line to provide data on the status of the communities present in the alignment.

Irrespective of the subtidal construction methods used for pipeline deployment, turbidity will be generated and may impact sessile corals if it occurs at high concentrations or if the exposure is for extended periods of time. In general, currents offshore of the Kaka‘ako Waterfront Park flow towards the southwest which is similar to the tradewind flow (personal observations). Thus coral communities occurring in waters less than 20 m of depth were examined in the early study.

The early work noted four major biotopes present in the study area offshore of the Kaka‘ako Waterfront Park; these are the biotope of scoured limestone, the biotope of scattered corals, the biotope of dredged rubble and the deep offshore biotope of sand. As noted above, HSWAC proposed microtunneling beneath the shallow reef platform to avoid impact to the marine resources present on the platform. Thus all of the biotope of scoured limestone as well as almost all of the biotope of scattered corals will be avoided using this approach. The pipeline emerges from the microtunnel approximately 547 m (1,796 feet) offshore in a limestone channel where coral coverage is very low. The general characteristics of the three most seaward biotopes examined in the early qualitative study through which the proposed HSWAC pipeline will pass are described below.

The Biotope of Scattered Corals

This biotope is situated seaward of the biotope of scoured limestone from about 50 to over 100 m from the shoreline at depths commencing in 4 to 6 m and ending in depths from about 12 to 18 m. This biotope is the most common feature of the Kaka‘ako limestone platform and occupies a band about 300m in width and about 900 m in length between the Waikiki Entrance Channel for Honolulu Harbor on the west and the abandoned sewer line near the Kewalo Basin Entrance Channel on the east. Thus the biotope encompasses about 30 ha or 75 acres. However, the proposed microtunnel for the HSWAC pipeline will pass beneath most of this biotope, emerging at the seaward edge of the biotope in a natural channel cut in the limestone about 547 m (1,796 feet) from the shoreline.

Along the inner reaches of this biotope the smooth limestone of the shallower, more inshore areas transitions to a series of limestone ridges (or spurs) separated by channels (or grooves). The spurs may rise as much as 1.5 to 2 m above the general substratum and are separated by channels often filled with sand and/or coralline rubble. These spurs and grooves have a general orientation that is perpendicular to shore and the ridges or “spurs” are from 2 to 25 m in width, up to 1.5 to 2 m in height and have lengths up to about 60 m. Channels are from one to 12 m in width and are up to 40-50 m in length.

Along the shallower inner reaches of this biotope corals are scattered but with increasing depth (8 to 12 m) and distance from shore, corals and their coverage increases such that over areas of 20 to 150 m^2, coverage may approach 75%. A gross overall mean estimate of coral coverage in this biotope is 5%. Corals are commonly seen on the ridges which lie above the sand-scour that occurs during periods of high surf. Common species include the cauliflower coral (*Pocillopora meandrina*), antler coral (*Pocillopora eydouxi*), rice corals (*Montipora capitata, M. patula*), lobate coral (*Porites lobata*), mound coral (*Porites lutea*) as well as other usually less dominant species (*Porites compressa, Montipora verrilli, Pavond varians, P. duerdeni, Letastrea purpurea*, etc.). Most of the other invertebrates and fishes seen in this area are all species common to Hawaii's reefs. Diurnally-exposed macroinvertebrates seen include the pearl oyster or pâ (*Pinctada margaritifera*), octopus or he'e (*Octopus cyanea*), sea cucumbers (*Holothuria atra, H. edulis, Actinopyge mauritana*), starfishes (*Linckia multiflora, L. diplax, Acanthaster planci*), cone shells (*Conus imperialis, C. leopardus, C. lividus, C. ebreus, C. miles* and *C. distans*), cowry (*Cypraea maculifera*), spindle shell (*Latirus nodus*), Christmas tree worm (*Spirobranchus gigantea*), polychaete (*Loimia medusa*), boring bivalve (*Arca ventricosa*), mantis shrimp (*Gonodactylus* spp.), occasional slipper lobsters or ula'pâpa (*Paribaccus antarcticus*) and small xanthid crabs. Fishes commonly seen include surgeonfishes (manini - *Acanthurus triostegus,* na'ena'e - *A. olivaceus,* pualo - *A. xanthopterus* and *A. blochi*, palani - *A. dussumieri*, maiko'iko - *A. leucoparieus,* ma'i'i'i - *A. nigrofuscus,* kole - *Ctenochaetus strigosus*, lau'ipala - *Zebrasoma flavescens,* kala - *Naso unicornis,* umaumalei - *N. lituratus,* kala holo - *N. hexacanthus*, kala lolo - *N. brevirostris*, kihikihi - *Zanclus cornutus*, lauwiliwili - *Chaetodon miliaris, C. multicinctus, C. ornatissimus,* lauhau - *C. quadrimaculatus,* lauwiliwili nukunuku'oi'oi - *Forcipiger flavissimus*, mamo - *Abudefduf abdominalis*, piliko'a - *Paracirrhites arcatus,* toby - *Canthigaster jactator*, and damselfishes (*Chromis hanui, C. vanderbilti, C. agilis*). Fish species of commercial importance that are seen include goatfishes such as the moano - *Parupeneus multifasciatus,* malu - *P. pleurostigma,* weke - *Mulloidichthys flavolineatus,* weke'ula - *Mulloides vanicolensis*, roi - *Cephalopholis argus*, po'opa'a - *Cirrhitus pinnulatus*, rarely the omilu - *Caranx melampygus*, opelu - *Decapterus pinnulatus*, palukaluka - *Scarus rubroviolaceus* and uhus - *Chlorurus spilurus* and *Scarus psittacus.*

The Biotope of Dredged Rubble

Seaward of the spur and groove formations that are common elements of the biotope of scattered corals, the ridges become less obvious often sloping seaward and coalescing with sand and rubble floors of adjacent channels thus creating a relatively open bottom largely covered with coralline rubble. Much of this rubble appears to be quite angular and ranges from several centimeters to about 0.75 m in diameter, but the majority of it is small. This coral rubble is what remains from the dredging activities in Honolulu Harbor and these tailings were deposited in the area probably from about 1920 through about 1960. With sufficient material, the old seaward face of the limestone platform fronting Kaka'ako Waterfront Park was extended seaward probably adding anywhere from 10 to 40 m to the outer edge of the platform. This biotope is recognizable at depths from about 9 to 12 m and extends seaward sometimes as a relatively steep slope or otherwise as a gentle slope from 20 to 60 m in width and at its deepest point is found at depths up to about 24 to 29 m where a sand/rubble bottom is encountered. The distance between the most obvious spur and groove formations with reasonable coral coverage to the top of the more offshore rubble slope ranges from 20 to over 50 m.

In the zone of coral rubble dredge tailings, benthic and fish communities are not well-developed. The relatively unstable nature of the substratum does not promote coral growth; most corals seen in this biotope (zone) are small. Coral species seen include the cauliflower coral (*Pocillopora meandrina*), antler coral (*Pocillopora eydouxi*), lobate coral (*Porites lobata*), and rice corals (*Montipora capitata* and *M. patula*). Corals are best developed on the larger pieces of limestone. Mean coral coverage in this biotope is less than 0.1% (overall mean estimated cover is 0.01% in this biotope) and species commonly seen include the cauliflower coral (*Pocillopora meandrina*), the lobate coral (*Porites lobata*), the rice corals (*Montipora capitata* and *M. patula*) and less frequently the antler coral (*Pocillopora eydouxi*).

Fishes met with in this area are usually small (either juveniles) or species that do not attain large sizes (gobies, some labrids, etc.) probably due to the lack of shelter. Where larger limestone/dead coral pieces or metal/concrete debris are found, the fish communities are better developed probably due to the shelter afforded by these materials. Most fishes encountered in this biotope are around available shelter; species commonly seen include the moano (*Parupeneus multifasciatus*), lauwiliwili (*Chaetodon miliaris*), butterfly fish (*Chaetodon kleini*), mamo (*Abudefduf abdominalis*), alo‘ilo‘i (*Dascyllus albisella*), dartfish (*Ptereleotris heteroptera*), piliko‘a (*Paracirrhites arcatus*), toby (*Canthigaster jactator*), puhi laumilo (*Gymnothorax undulatus*), ‘o‘opu hue (*Arothron hispidus*), ala‘ihi (*Sargocentron xantherythrum*), surgeonfishes (pualo - *Acanthurus blochi, A. xanthopterus*, palani - *A. dussumieri*) ma‘i‘i‘i (*A. nigrofuscus*), kala holo (*Naso hexacanthus*), kala lolo (*N. brevirostris*), humuhumu lei (*Sufflamen bursa*), humuhumu mimi (*S. fraenatus*) and wrasses, the a‘awa - *Bodianus bilunulatus*, hinalea ‘i‘iwi - *Gomphosus varius*, small wrasses - *Macropharyngodon geoffroy, Pseudocheilinus octotaenia, P. evanidus, Oxycheilinus bimaculatus* as well as the ‘omaka - *Stethojulis balteata* and hinalea lauwili - *Thalassoma duperrey*.

Commonly seen diurnally-exposed macroinvertebrates in this biotope include sea urchins (*Echinothrix diadema, E. calamaris, Diadema paucispinum, Tripneustes gratilla*), boring bivalve (*Arca ventricosa*), rock oyster (*Spondylus tenebrosus*), sponges including *Mycale armata, Suberites zeteki, Chondrosia chucalla, Spirastrella coccinea, Tethya diploderma, Mycale cecilia, Halichondria coerulea, Iotrochota protea, Halichondria dura* and *Tedania macrodactyla*, sea cucumbers (*Holothuria atra, H. hilla, H. verrucosa*), polychaete (*Loimia medusa*), he‘e (*Octopus cyanea*) and cushion starfish (*Culcita novaeguineae*).

The Biotope of Sand

Below and seaward of the rubble slope, the substratum flattens out and is comprised of sand and coral rubble. Offshore (within 100 m of the rubble slope and to the east of the proposed pipeline alignment) are several mounds of coral/limestone rubble that rise up to 5-8 m above the surrounding substratum that probably represent one or more barge loads of dredge tailings. The diversity of life on the sand/rubble plain seaward of the 20 m isobath is not well-developed and was not examined in the 2005 preliminary description of biotopes present in the vicinity of the proposed HSWAC pipeline alignment due to diver bottom time constraints using conventional diving gear.

Recent Studies

Comments received from the regulatory community (noted above) pointed out the necessity of carrying out quantitative studies in the proposed HSWAC pipeline alignment from the microtunneling receiving pit (where the pipes come to the surface of the seafloor) on down to the deep seawater intake at 540 m depth. Concerns addressed herein include the quantitative studies carried out from the breakout point of the pipes to the return water diffuser located at depths between 36 and 46 m (120 to 150 feet). To meet this objective, transects were established to quantify biota present. Relative to the general configuration of biotopes present, the studies carried out at depths below 20 m show that from the base of the rubble slope where the sand/rubble plain commences, the slope becomes and remains gradual to a depth of 23-24 m (75-80 feet) at which point the slope again increases and remains this way to the 40 m isobath (130 feet, the depth limit of this study). As shown below, the substratum on both the initial or shallower slope as well as the slope met with at 23-24 m is comprised primarily of rubble which continues from the 23-24 m isobath to the 40 m isobath. This rubble substratum appears to be largely comprised of dredge tailings which continues to depths below the diffuser. Thus in summary the relatively flat biotope of sand (above) is sandwiched between the biotope of dredged rubble both on the mauka (landward) and makai (seaward) sides in the vicinity of the proposed HSWAC pipeline route.

2. MATERIALS AND METHODS

Strategy

Marine environmental surveys are usually performed to evaluate feasibility of and ecosystem response to specific proposed activities. Appropriate survey methodologies reflect the nature of the proposed activities. An acute potential impact (such as channel dredging) demands a quantitative survey designed to determine the route of least harm and the projected rate and degree of ecosystem recovery. Impacts that are more chronic or progressive require different strategies for measurement. Management of chronic stress to a marine ecosystem demands identification of system perturbations which exceed boundaries of natural fluctuations. Thus a thorough understanding of normal ecosystem variability is required in order to separate the impact signal from background “noise”.

The proposed deployment of the HSWAC pipeline as well as its operation (i.e., the release of returning seawater via a diffuser) encompass a wide array of potential impacts to the resident marine communities. Impacts associated with the construction and deployment of the pipeline are direct, i.e., such as disturbance to and loss of the marine communities in the proposed pathway of the pipe system. Indirect impacts may occur with the operation of the HSWAC system where relatively cold, previously used seawater is returned back to the marine environment where it may impinge on the resident benthic communities. Initially, release of the returning cold seawater will undoubtedly cause shifts in benthic community structure and function. However, once these impacts have been imposed and shifts in community structure have occurred, the indirect impact of a continuing, non-changing volume and narrow range of temperature of discharge water should result in a relatively permanent shift in community structure and function.

Monitoring strategies for assessing both direct and indirect impacts to marine communities rely on comparative spatial and temporal evaluations of ecosystem structure and function in relation to ambient conditions. Usually in order to reliably detect system perturbations, detailed quantitative descriptions of the pre-development environment are necessary as a "benchmark" against which later studies may be comparatively analyzed. This approach has been used in this study.

Field Methods

In order to insure that sampling stations are positioned to provide sufficient quantitative information on the marine communities present, a knowledge of the geographic extent of the major ecological zones or biotopes present in the study area is necessary. Once defined, sampling stations are placed in each biotope and these reflect the marine communities representative of the biotope. Biotopes are defined by the major structural elements present such as the dominant substratum type(s), visually important species as well as the degree to which communities are exposed to or influenced by physical factors such as wave energy (which is usually related to depth) and inputs from land (freshwater, pollutants, etc.). As noted above, early qualitative work found four major biotopes present in the area proposed for the HSWAC pipeline alignment. Sampling stations were established for quantitative studies in representative areas of the identified biotopes.

Following station identification, divers equipped with conventional diving gear carried out the collection of data. The sampling protocol occurred in the following sequence: on arrival at a given station, a visual fish census was undertaken first to estimate the abundance of fishes. These censuses were conducted over a 4 x 25 m corridor and all fishes within this area to the water's surface or upper visual range of the diver were counted. Data collected included species, numbers of individuals and an estimate of the length of each fish; the length data were later converted to standing crop estimates using linear regression techniques (Ricker 1975). A diver carrying a transect line, slate and pencil would enter the water, count and note all fishes in the prescribed area (method modified from Brock 1954). The 25 m transect line was paid out as the census progressed, thereby avoiding any previous underwater activity in the area which could frighten wary fishes.

Fish abundance and diversity is often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., cross coral mounds, sand flats and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (25 m in length) has proven adequate in sampling many Hawaiian benthic communities (Brock and Norris 1989).

Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels (family Muraenidae) and nocturnal species, e.g., squirrelfishes (family Holocentridae), aweoweos or bigeyes (family Priacanthidae), etc. This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate in areas of low relief, although some fishes with cryptic habits or protective coloration (e.g., the nohus, family Scorpaenidae; the flatfishes, family Bothidae) might still be missed. Obviously, the effectiveness of the visual census technique is reduced in turbid water and species of fishes which move quickly and/or are very numerous may be difficult to count and to estimate sizes. Additionally, bias related to the experience of the diver conducting counts should be considered in making any comparisons between surveys. In spite of these drawbacks, the visual census technique probably provides the most accurate nondestructive method available for the assessment of diurnally active fishes (Brock 1982).

After the assessment of fishes, an enumeration of epibenthic invertebrates (excluding corals and sponges) was undertaken using the same transect line as established for fishes; this assessment was carried out only at the shallowest pair of stations sampled in this study. In this case, exposed invertebrates usually greater than 2 cm in some dimension (without disturbing the substratum) were censused in the 4 x 25 m area. At other deeper stations, the assessment of epibenthic diurnally-active invertebrates was completed by the examination of photographs taken of five one-meter square quadrats randomly placed on each transect as well as in photographs taken as general views showing the degree of development in benthic communities present at each station. As with the fish census technique, this sampling methodology is quantitative for only a few invertebrate groups, e.g., some of the echinoderms (some echinoids and holothurians). Most coral reef invertebrates (other than corals and some sponges) are cryptic or nocturnal in their habits making accurate assessment of them in areas of topographical complexity very difficult. This, coupled with the fact that the majority of these cryptic invertebrates are small, necessitates the use of methodologies that are beyond the scope of this study (e.g., see Brock and Brock 1977). Recognizing constraints on time and the scope of this study, the invertebrate censusing technique used here attempted only to assess those few macroinvertebrate species that are large and diurnally exposed.

Exposed sessile benthic forms such as corals, sponges and macrothalloid algae were quantitatively surveyed by use of quadrats. Quadrat sampling consisted of recording benthic organisms, algae and substratum type present as a percent cover in five, one-meter square frames randomly placed on the transect line established for fish censusing. Besides visually noting the percent contribution of species or substratum type present, a photograph was taken of each quadrat for later use in the laboratory. Photographs were examined to ascertain and confirm data visually collected in the field as well as to serve as a source for the determination of the greatest lengths of all coral colonies found within each quadrat. In this case, the greatest lengths of all colonies that were both totally in and/or only partially inside of a quadrat were also estimated. Photographs taken to provide general views of the status of benthic and fish communities in the vicinity of each transect were also examined to determine the greatest lengths of each coral colony seen in the foreground of the photographs. Because photographs were used in making the estimates of coral colony size, size estimates were made in centimeters and colonies less than one centimeter were not generally visible creating a lower cutoff size of 1 cm or greater. Besides these estimates of colony size, the area examined in each photograph for the collection of these data was also estimated providing some estimate of colony sizes per unit area.

The reason for not having carried out all measurements of coral colony size in the field was due to the limitation of bottom time which became a critical factor at those stations completed at greater depths (27-40 m or 90-130 feet). Related to this was the number of transects performed at each station representative of each biotope; at shallower stations (9.5 to 18 m or 30 to 60 feet), a pair of 25 m transects were carried out with one transect commencing at the midline of the proposed pipeline alignment and sampling to the east along the isobath (120^{o} orientation) and the second commencing at the same start point (i.e., middle of the pipeline alignment at the same depth) and sampling for a distance of 25 m to the west (270^{o} orientation). Because of bottom time constraints, only a single 25 m long transect was established and sampled at the 27 m (90-foot), 35 m (115-foot) and 40 m (130-foot) stations (See Figure 1). Every effort was made to perform the quantitative studies in the same manner at all transect sites to make the data comparable.

3. RESULTS AND DISCUSSION

In summary, along the western part of the limestone platform that fronts all of the Kaka‘ako Waterfront Park, the biotope of scattered corals terminates in a series of limestone ridges (or “spurs”) and channels (or “grooves”). Coral communities are relatively well-developed on the limestone ridges. The channels or grooves may have a veneer of sand and rubble; in a seaward direction the limestone spurs merge into the surrounding deeper sand/rubble substratum; further seaward, this sand and rubble veneer merges with the rubble substratum comprising the biotope of dredged rubble. The dredged rubble is obvious being angular and sharp-edged rather than rounded and smooth as is most naturally-derived coralline reef rubble. The proposed exposed portion of the HSWAC pipeline route was selected to avoid areas of coral and thus emerges from the microtunnel in a natural channel and continues seaward across areas having little marine community development as given below.

In total seven stations were established to sample marine communities in the different biotopes and at different depths through which the shallow water portion of the proposed

HSWAC pipeline alignment is to cross. The location of each sampling station was determined by examining all qualitative data that had been previously collected as well as observations made during the current quantitative work. Station locations were placed to sample biotopes present in the proposed pipeline alignment. These sample sites were selected as being representative of the marine communities present at given depths. The exposed portion of the pipeline alignment commencing at 9.5 m (31 feet) depth (at the microtunnel exit point) down to roughly the midpoint of the proposed discharge diffuser (at a depth of 40 m or 130 feet) was qualitatively examined prior to selecting representative areas for sampling. The distance from the receiving pit (the exit point for the intake and discharge pipes) to the seaward end of the diffuser (at a depth of 46 m or 150 feet) is approximately 580 m (1,900 feet); this study examined about 468 m or about 81 percent of the pipeline alignment from the breakout point to the seaward end of the discharge diffuser. Bottom time limitations prevented working at greater depths with conventional diving gear.

Station Locations

Once qualitative observations were made through the study area that defined the approximate boundaries of each major biotope present in the vicinity of the proposed HSWAC pipeline alignment, careful examination along the proposed alignment allowed us to select seven sites representative of the biotopes present at different depths. These sites were fixed using a hand-held GPS which allowed quantitative sampling at a later date. At all seven stations, once arriving at the designated coordinates, a weighted line and float were used to mark the site to insure that quantitative sampling was centered on the middle of the pipeline alignment. Station coordinates were determined by (1) being located on the midline of the proposed pipeline alignment as well as (2) being representative of the communities present in that biotope(s) present at that depth.

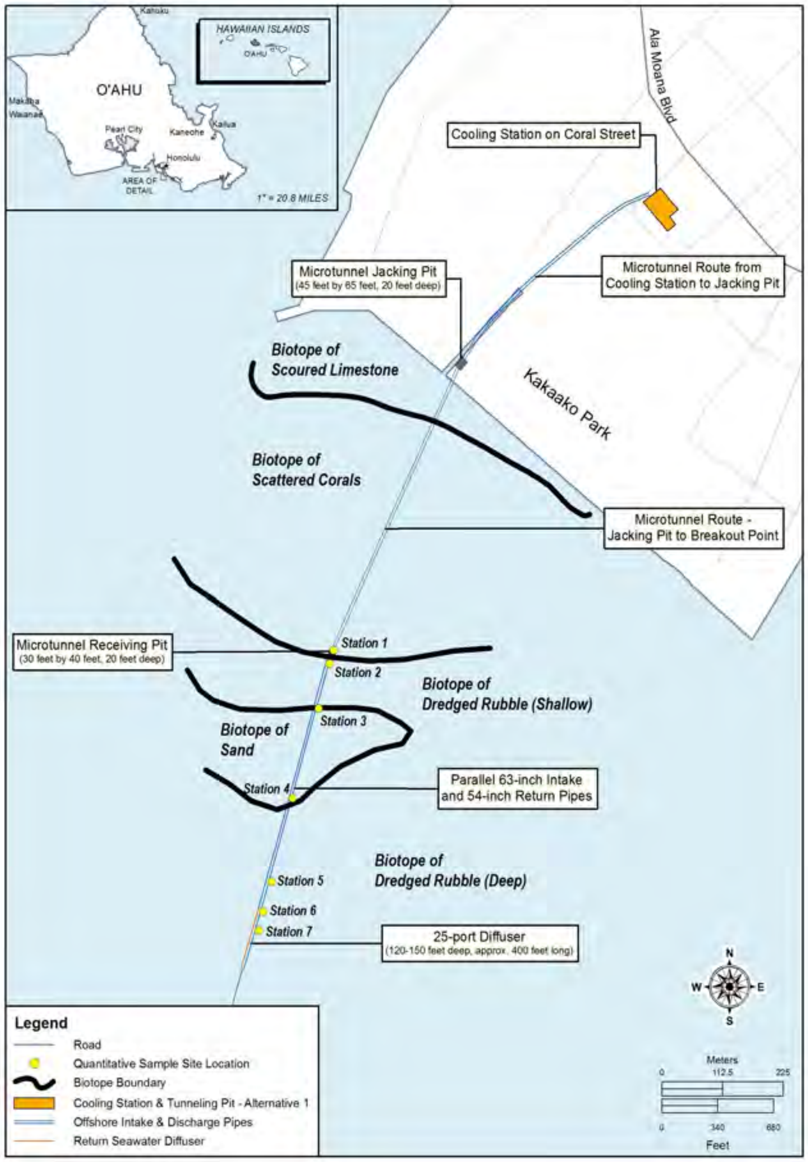
As noted above to avoid much of the shallow coral reef ecosystem, HSWAC has proposed to microtunnel beneath much of the shallow limestone platform commencing close to the shoreline and extending about ~547 m (~1,796 feet) seaward at which point the pipeline emerges above the substratum (through a receiving pit) and continues seaward with the pipes set into a series of concrete collars or saddles designed to keep the pipeline in place. It is proposed that the 12.2 x 12.2 m (40 x 40-foot) receiving pit (excavated to a depth of 6 m or 20 feet where the intake and discharge pipes emerge from the substratum) is to be located in the outer portion of the spur and groove formation that defines the seaward side of the biotope of scattered corals. The proposed receiving pit is located in a channel approximately 14 m in width at a depth of 9.5 m (~31 feet). A marine biological sampling station was established centered close to the middle of the inshore wall of the receiving pit (21º17.410' N, 157º52.125' W) with Transect A established and sampling to the east (compass bearing 120º) and Transect B to the west (compass bearing 270º). All transects are 25 m in length and thus sample both in the channel (the area proposed for disturbance) as well as outside and lateral to it. A second station located approximately 24 m (80 feet) seaward was established at 21º17.395' N, 157º52.127' W where the depth was 10.9 m (36 feet) to sample the seaward end of the same channel and limestone ridges; Transect C sampled the channel floor and limestone ridge on the east (compass heading 120º) and Transect D sampled the same channel as well as the west limestone ridge (compass heading 270º). This pair of transects sampled at the seaward edge of the biotope of scattered corals where the biotope of dredged rubble is first encountered. The locations of the seven stations sampled in this study are given in Figure 1 along with the approximate boundaries of the different ecological zones or biotopes in the vicinity of the proposed pipeline route.

The receiving pit is centered in the bottom of the channel to avoid coral colonies present on the nearby limestone spurs or ridges. Similarly, the midline of the pipeline at Station 2 is centered on the sand and rubble substratum; it is on the shoreward edge of the biotope of shallow dredged rubble. The biotope of dredged rubble derived from early development and maintenance of Honolulu Harbor (above) is recognizable at depths from 9 to 12 m and extends seaward 20 to 60 m, often forming a relatively steep slope that terminates on the relatively flat sandy bottom (the biotope of sand) at depths from 20 to 24 m along much of the western end of the Kakaʻako limestone platform. However, in the vicinity of the proposed HSWAC pipeline alignment, the slope of the rubble is less and the sand biotope starts at a depth of about 15 m. The relatively flat biotope of sand continues seaward to a depth between 23-24 m (75-80 feet) at which point in the vicinity of the proposed HSWAC pipeline alignment again becomes a steep slope comprised largely of dredge tailings that continue seaward to depths below 40 m (130 feet; the lower limit of this study). There are isolated areas of dredge tailings situated in the biotope of sand; where met with these areas of dredge material usually rise no more than 0.5-0.75 m above the surrounding sand bottom and occupy areas up to 50 m or more across.

The third marine biological sampling station was established to sample the ecotone (or zone of transition) between the biotope of shallow dredge tailings and the biotope of sand. This station was again located on the centerline of the proposed pipeline alignment at 21º17.352' N, 157º52.139' W at a depth of 13.7 m (45 feet). Transect E (compass heading 100º) sampled the area to the east and Transect F (compass heading 270º) sampled the marine communities situated to the west of the alignment centerline. The fourth station was established on the midline of the pipeline alignment at 21º17.266' N, 157º52.168' W at a depth of 18 m (60 feet) in the biotope of sand. Transect G sampled the benthic community on the east (compass heading 120º) which crosses dredge tailings that to the east form a near continuous habitat type from 12 m down into deeper waters (See Figure 1). Transect H sampled communities from the centerline of the alignment to the west (compass heading 270º) which was located primarily on a sand substratum.

The fifth, sixth and seventh marine biological stations were all established in the deeper portion of the biotope of dredge tailings. Since minimizing bottom time is more critical at greater depths, only one 25-m transect was established at each of these stations. In these cases the transect was centered at the station coordinates on the center line of the pipeline alignment keeping it on the same isobath, with 12.5 m of the transect line extending to the east (compass heading 120º) and 12.5 m heading west (compass heading 270º). The fifth station was located at 21º17.186' N, 157º52.191' W at a depth of 27 m (90 feet) where Transect I was carried out. The sixth station was located at 21º17.157' N, 157º52.200' W at a depth of 35 m (115 feet) where Transect J was completed. The seventh station was established at a depth of 40 m (130 feet) at

FIGURE 1. Map showing the reef area offshore of the Kaka‘ako Waterfront Park with the boundaries of four of the five ecological zones or biotopes given in the vicinity of the proposed pipeline route. Note that Station 1 is located at the breakout point (receiving pit) for the proposed pipeline. At greater depths the intake and discharge pipes will rest in a series of concrete collars or saddles set on the surface of the seafloor in a seaward direction to the lower end of the discharge diffuser at 46 m (150 feet) depth. Also shown on the proposed pipeline alignment are seven stations where quantitative studies of the marine communities were carried out. Station 1 is in 9.5 m of water, Station 2 at 10 m depth, Station 3 at 13.7 m depth, Station 4 at 18 m, Station 5 at 27 m, Station 6 at 35 m and Station 7 at 40 m depth.


Kahuku
HAWAIIAN ISLANDS
O'AHU
O'AHU
Makaha
Waianae
Pearl City
Kaneohe
Kailua
Honolulu
AREA OF DETAIL
1" = 20.8 MILES
Ala Moana Blvd
Cooling Station on Coral Street
Microtunnel Jacking Pit
(45 feet by 65 feet, 20 feet deep)
Microtunnel Route from Cooling Station to Jacking Pit
Biotope of Scoured Limestone
Kakaako Park
Biotope of Scattered Corals
Microtunnel Route - Jacking Pit to Breakout Point
Microtunnel Receiving Pit
(30 feet by 40 feet, 20 feet deep)
Station 1
Station 2
Biotope of Dredged Rubble (Shallow)
Station 3
Biotope of Sand
Station 4
Parallel 63-inch Intake and 54-inch Return Pipes
Biotope of Dredged Rubble (Deep)
Station 5
Station 6
Station 7
25-port Diffuser
(120-150 feet deep, approx. 400 feet long)
N
W
E
S
Legend
Road
Quantitative Sample Site Location
Biotope Boundary
Cooling Station & Tunneling Pit - Alternative 1
Offshore Intake & Discharge Pipes
Return Seawater Diffuser
Meters
0
112.5
225
0
340
680
Feet

21°17.139' N, 157°52.205' W where Transect K was conducted.

Quantitative Results

Due to the greater depths of some stations sampled in this study, we did not have sufficient bottom time to carry out all of the benthic sampling that is usually completed in coral reef quantitative studies. A decision was made to focus field quantitative studies on the collection of data that can only be obtained while on station; data on other benthic groups that could be quantified in the laboratory from photographs was collected in this manner at each station. Thus sampling over the 4 x 25 census area focused on enumerating all fishes seen in the area (by species as well as the number of individuals of each and an estimate of individual fish lengths for later standing crop determination) and conducting a field assessment of benthic species and substratum characteristics present (as well as photographs of each) of the five randomly-placed one-square-meter quadrats along each transect line. In addition, photographs were taken of the surrounding benthic community to provide a general overview of the status of these communities. Bottom time constraints dictated that field measurement of the length frequencies of corals was not possible; thus greatest lengths of all coral colonies as well as the enumeration of diurnally-exposed macroinvertebrates was completed using field-generated photographs. In an effort to make data comparable, the same methods were used at all stations sampled in this study.

Appendix 1 (Parts 1 through 11) present the quantitative data collected on each of the eleven transects established commencing at the proposed receiving pit in 9.5 m of water to the middle of the diffuser at 40 m depth. In Appendix 1, information on the benthic communities is presented as percent cover for sessile forms (i.e., algae, corals and sponges) as well as substratum type based on five randomly-selected square meter quadrats of sampled substratum along each transect line. In addition, the greatest lengths of each coral colony found partially or fully within each quadrat was estimated in cm from these photographs and these data are also included in Appendix 1. Each quadrat was photographed so field-generated estimates of benthic cover could be checked in the laboratory which greatly reduced unnecessary accumulation of bottom time in the field. All of these photographs are given in Appendix 2.

Since the quadrats each sample only a square meter of substratum, additional effort was made to utilize photographs that were taken in the general area around each of the transects. The primary purpose of these photographs is to provide the reader with a visual picture of the degree of marine community development in the area around each transect site and these photographs are usually shot in a horizontal view plain. Many of these photographs show a larger area of substratum than just a square meter, thus allowing one to carry out rough estimates of size frequency of coral colonies at "sampling" scales greater than a square meter. In this case, the approximate area examined in each photograph (usually in the foreground) was also estimated; both the size frequency of each coral species identified in these photographs as well as any diurnally-exposed macroinvertebrates present were noted. In addition, an estimate of the area examined in the photograph was also made. The size frequency data for corals and estimated areas examined are given in Appendix 3 and the data on the species and numbers of diurnally-exposed macroinvertebrates are presented in Appendix 4. During the fieldwork an effort was made to note any unusual diurnally-exposed macroinvertebrate that may have been present in the 4 x 25 m transect area; these "unusual" species encountered are also given in Appendix 4. The photographs used in this work are identified in Appendices 3 and 4 and are presented in the text.

Appendix 5 presents the results of the census of fishes at each of the eleven transects. The number of species, number of individuals and estimate of standing crops (g/m^2) for each of the eleven transects are given at the foot of the appendix. Other than the fish community present at Station 1, Transect B in the biotope of scattered corals, the numbers of species, individuals and standing crop estimates are all quite low relative to estimates made in many Hawaiian fish community studies (Brock and Norris 1989) which is probably related to the lack of adequate local shelter space.

Table 1 presents a summary of the biological parameters measured in this study. Referring to Table 1, in general all parameters show a decrease with depth; thus the number of coral species, the percent cover by corals, coral colony size, the number of invertebrate species and individuals as well as the number of fish species, individuals and standing crop all show a decline with increasing depth. In general the diversity and abundance in many coral reef communities is greater in areas where greater shelter space is present. Shelter space may be provided by geological structure as well as by the growth of sessile benthic marine species such as corals. Coral development as given by the parameters measured here is greatest at the shallow stations located in the channels and ridges of limestone (the "spur and groove" formation) that is present along the seaward edge of the Kakaʻako reef platform.

Physical disturbance from occasional storm surf is one of the most important parameters in determining the structure of Hawaiian coral communities (Dollar 1982). Numerous studies have shown that occasional storm generated surf may keep coral reefs in a non-equilibrium or sub-climax state (Grigg and Maragos 1974, Connell 1978, Woodley *et al*. 1981, Grigg 1983).

Coral communities that receive some level of natural disturbance as from occasional wave impact often over time develop a greater species diversity (the intermediate disturbance hypothsis; Connell 1978). Furthermore, corals found in areas that receive disturbance from occasional wave impact often are better developed (i.e., larger colony size and greater coverage) in locations elevated above surrounding relatively flat substratum where sessile species present are subject to greater abrasion and scour that occurs during periods of high surf. The south shore of Oʻahu is annually exposed to surf emanating from the south usually during the summer months and the seaward edge of the shallow reef fronting the Kakaʻako Waterfront Park is exposed to this impact. The result is that in the present study area, topographical complexity is greater in the shallow stations relative to those situated further offshore in deeper water.

Table 2 presents the means for the parameters measured in this study by biotope. In this case, the most shoreward station (represented by Transects A and B) sampled near the seaward edge of the biotope of scattered corals at 9.5 m (31 feet) depth. The second station located just 24 m seaward was established in the shoreward side of the shallow biotope of dredged rubble (Transects C and D) at a depth of 10 m (33 feet). The station established at 13.7 m (45 feet) sampled the zone of transition between the biotope of shallow dredged rubble and the deeper biotope of sand (Transects E and F). The biotope of sand as well as some isolated dredge tailings were sampled at 18 m (60 feet) depth (Transects G and H) and the biotope of dredged rubble in deeper waters was sampled at three stations situated at 27 m (90 feet, Transect I), 35 m (115 feet, Transect J) and 40 m (130 feet, Transect K). The results from Table 2 clearly show the decrease in all measured parameters with increasing depth. These general findings are discussed further below.

Biotope of Scattered Corals

HSWAC proposes to develop a microtunnel commencing on the shoreline and boring in a seaward direction beneath most of the limestone platform fronting Kaka‘ako Waterfront Park. The proposed 12.2 x 12.2 m (40 x 40 feet) receiving pit where the intake and discharge pipes of the HSWAC pipeline would emerge from the bore is situated ~547 m (1,796 feet) offshore at a depth of 9.5 m (31 feet) in a natural limestone channel. At the point of emergence, the channel width is about 14 m. The first station for quantitative sampling was established at a point that would be in the middle of the shoreward boundary of the receiving pit. As given above one 4 x 25 m transect commenced at this point (21^{o}17.410' N, 157^{o}52.125'W) and sampled from a compass heading of 120^{o} (Transect A, to the east) and the second 25 m line commenced at the same point but sampled at a compass heading of 270^{o} (Transect B, to the west). The middle of the channel where the proposed receiving pit is to be located is shown in Figures 2 (looking seaward down the channel) and 3 (looking shoreward up the channel).

The proposed location of the receiving pit is close to the seaward edge of the biotope of scattered corals in the spur and groove formation that is well-developed in this area. The results of the census work at Transect A are given in Appendix 1 Part 1 and for Transect B (to the west) data are given in Appendix 1, Part B. Other data from this pair of transects are given in Appendices 2, 3, 4 and 5. Mean coral coverage on Transect A is estimated at 4.3% and on Transect B it is 10.7%. If these two transects had been oriented in a mauka-makai (landward-seaward) direction on each of the two limestone ridges separating the channel proposed for the receiving pit, the coral coverage is estimated to be approximately 15% on the eastern spur and 21% on the western spur. However, since the transects also incorporated the channel floor where coral coverage is close to zero, the mean coverage was less as given in Appendix 1 Parts 1 and 2. Measured coral colony sizes are given in Appendix 1 Parts 1 and 2 and are summarized in Table 1. Estimated colony sizes (from the 5 m^2 sample area) show that colonies are not particularly large. However, a better estimate of coral colony size may be obtained from the photographs taken on each of these two adjacent limestone ridges. Figure 4 is an example of one of the larger *Porites lobata* colonies on the eastern spur; a more common spacing and size of colonies on the eastern spur is seen in Figures 5 and 6.

Figure 2. Photo taken from the center of the proposed receiving pit at Station 1, depth 9.5m on 24 August 2011 looking in a seaward direction down the channel.

Figure 3. Photo taken from the center of the proposed receiving pit at Station 1, depth 9.5m on 24 August 2011 looking towards shore.

Figure 4. Photo of a Porites lobata colony in the vicinity of Transect A (Station1).

Figure 5. Photo taken on the limestone ridge east of the proposed receiving pit on 24 August 2011 showing the typical coral coverage in the vicinity of Transect A (Station 1). Depth ~ 8.5m.

Figure 6. Photo taken on the limestone ridge east of the proposed receiving pit on 24 August 2011 showing local coral coverage in the vicinity of Transect A (Station 1). Depth ~ 8.5m.

Figure 7. Photo of a Porites lobata colony located west of the proposed receiving pit (Station 1) along the western channel wall on 24 August 2011. Depth ~ 9.8m.

Photographs taken of the substratum on the limestone ridge in the vicinity of Transect B are shown in Figure 7 at a depth of 9.6 m along the edge of the channel west of the proposed receiving pit. As noted above on the west limestone ridge, coral coverage is estimated to be about 21% and Figure 8 provides some idea of the density of living corals in this area. Finally, Figure 9 depicts the single largest coral colony found in the area sampled by Transect B on the western limestone spur. This colony is west and slightly shoreward of the proposed receiving pit and is approximately 120 cm in diameter.

Biotope of Shallow Dredged Rubble

Because of the local-high diversity/coverage coral community in proximity to the proposed receiving pit, a second station was established 24 m (80 feet) seaward of the receiving pit (as measured from the center of the pit) situated at the midline of the proposed pipeline alignment (at 21°17.395' N, 157°52.127'W) at a depth of 10 m (33 feet). This station is again in the middle of the same channel at a point where the two limestone ridges (to the east and west of the channel) merge with the rubble that comprises the biotope of shallow dredged rubble. Transect C sampled marine communities present to the east (compass heading 120°) and Transect D sampled those to the west (compass heading 270°). This station sampled emergent limestone, sand and coralline rubble; where the limestone substratum continues to be present, some corals are found (Figures 10 and 11) but mean coverage is only 3.2% and the fish community was not well developed (mean number of species/transect = 10, mean number of individuals/transect = 27 individuals, mean standing crop = 31 g/m^2 , Appendix 5). The relatively poor development in the coral community may be related to scour and abrasion that probably impacts this area during high surf events. The quantitative data for this transect pair are given in Appendix 1 Parts 3 and 4 as well as in Appendices 2, 3, 4 and 5.

Ecotone Between the Biotope of Shallow Dredged Rubble and the Biotope of Sand

The third station was established at a depth of 13.7 m (45 feet) at 21°17.352' N, 157°52.139' W in an area of transition (or ecotone) from the biotope of shallow dredged rubble to the biotope of sand; the 4 x 25 m transects sampled to the east (compass heading 100°) and west (compass heading 270°) of this point. Quantitative data are presented in Appendix 1, Part 5 for Transect E and Appendix 1, Part 6 for Transect F and other data are in Appendices 2, 3, 4 and 5. Again, coral coverage and mean colony sizes were less than found in shallower water probably related to the lack of appropriately-scaled hard substratum available for settlement and growth. As with the previous station, where emergent limestone substratum is encountered, corals are present. The eastern transect (Transect E) crossed one area of hard substratum (Figure 12) which was sampled but such substratum is rare in the area. Figure 13 shows the common substratum (a mix of dredge tailings and sand) present in the area sampled at this station.

Biotope of Sand

The fourth station was established on the midline of the proposed pipeline alignment at a

Figure 8. Photo of the typical local coral coverage on the limestone ridge just west of the receiving pit near Transect B (Station 1) on 24 August 2011. Depth ~ 8.5m.

Figure 9. Photo of a Porites lobata colony sampled on Transect B (Station 1). Date 24 August 2011, depth ~ 9m.

Figure 10. Photo showing hard substratum and debris in the vicinity of Transect C (Station2) showing small Porites lobata colonies. Depth 10.5m, 11 August 2011.

Figure 11. Photo showing limestone substratum and corals in the vicinity of Transect D (Station 2), depth 10.5m, 11 August 2011.

Figure 12. Photo showing diver censusing fishes on Transect E (Station 3) depth 13.7m on 10 August 2011. Note the open nature of the limestone substratum.

Figure 13. Photo of a “dart” marker placed west of the center of the proposed pipeline alignment on Transect F (Station 3), 13.7m deep 10 August 2011.

depth of 18 m (60 feet) at 21°17.266' N, 157°52.168' W. Transect G (compass heading 120°) sampled to the east and the results are given in Appendix 1, Part 7 and Transect H (compass heading 270°) sampled to the west and these data are presented in Appendix 1, Part 8). Other quantitative data are given in Appendices 2, 3, 4 and 5. The two transects sampled different substrata types; to the east, the 4 x 25 m transect was situated on dredge tailings which were colonized by some coral (Figures 14 and 15) and where larger pieces of limestone were encountered, more coral was seen (Figures 16 and 17). Overall mean coral coverage on Transect G (to the east) was 0.9% and to the west on Transect H which sampled an area of sand, no corals were sampled in the five, one square meter quadrats. Figure 18 shows the sand substratum at Transect H where little hard substratum is present. The fish communities sampled on Transects G and H were not well-developed having a mean number of species = 4, 7 individuals and standing crop = 5.5 g/m^2 (see Appendix 5) which is probably related to the lack of appropriately scaled shelter space. Where shelter space is available such as that provided by an isolated antler coral colony (*Pocillopora eydouxi*; Figure 19) small reef fishes may be present.

Biotope of Deeper Dredged Rubble

Figure 1 shows the approximate boundaries in the vicinity of the proposed HSWAC pipeline route of the major biological zones (or biotopes) identified in this study. Between the receiving pit where the proposed HSWAC pipeline emerges from the substratum and the terminus of the outfall diffuser at 46 m (150 feet) most of the exposed pipeline passes through the biotope of dredged rubble. To the east of the proposed pipeline alignment, the biotope of dredged rubble appears to be a near-continuous feature from about 12 m to 46 m in depth. This rubble has probably covered considerable areas that were comprised of limestone, sand and coral. Viewing videotapes from a remotely operated video camera shows that the dredged rubble is a near continuous feature along the proposed pipeline route from about 24 m (80 feet) to at least 61 m (200 feet). Because the quantitative data collected at Transects I (27 m or 90 feet), J (35 m or 115 feet) and K (40 m or 130 feet) were similar these stations are considered together.

Quantitative data from Transect I (27 m) located at 21°17.186' N, 157°52.191' W is presented in Appendix 1, Part 9 as well as in Appendices 2, 3, 4 and 5. The transect was carried out on a rubble substratum (Figure 20) where mean coral coverage was 2.5%. Besides dredge tailings much old debris is also present (Figures 20, Figure 21) as well as modern refuse (Figure 22). As found elsewhere in this study, where larger pieces of dredged limestone are encountered, corals and other biota are found (Figure 23). Earlier survey work for the HSWAC project placed a series of PVC pipe “darts” to the west of the approximate proposed midline of the pipeline route. Figure 24 shows the dart placed at the 27 m depth and also shows the common characteristics of the substratum at this transect site. Development of most coral reef species is minimal and this is reflected in the quantitative data collected at this and the other two deep transect sites.

Transect J was situated at 21°17.157' N, 157°52.200'W located on substratum at a depth of 35 m (115 feet) again on the midline of the proposed pipeline alignment. Data from the quantitative survey carried out at Transect J are given in Appendix 1, Part 10 as well as in Appendices 2, 3, 4

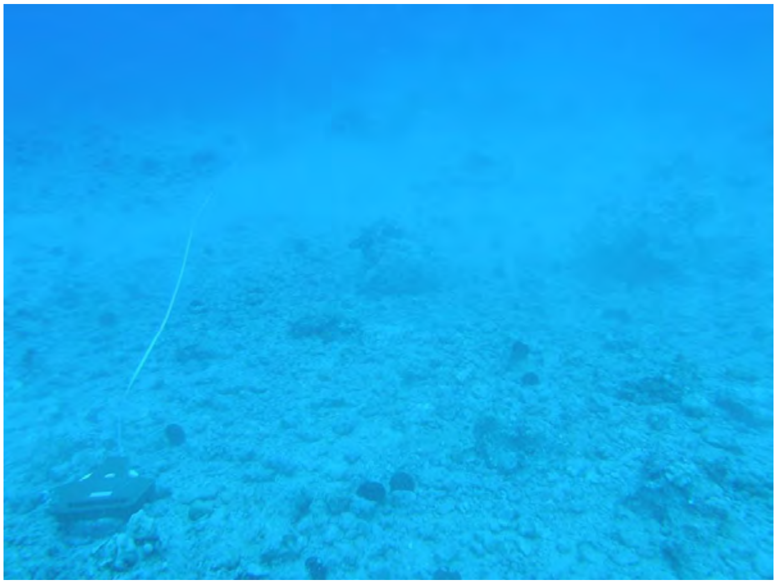


Figure 14. Photo taken on Transect G (Station 4) showing the rubble substratum present in the area. Photo date 10 August 2011, depth 18m.

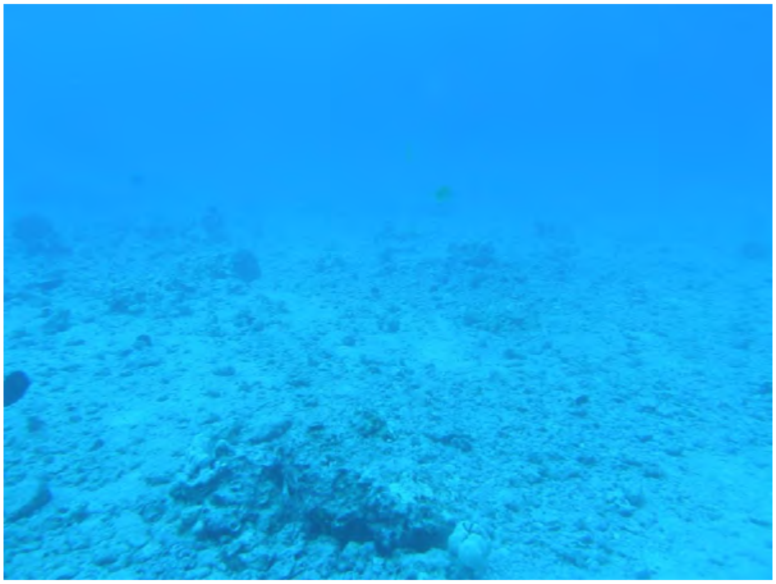


Figure 15. A second photo taken in the vicinity of Transect G (Station 4) on 10 August 2011, depth 18m showing the typical coralline rubble present in the area.

Figure 16. Photo of a larger piece of coralline rubble showing the growth of corals on it in the vicinity of Transect G (Station 4), 10 August 2011, depth 18m.

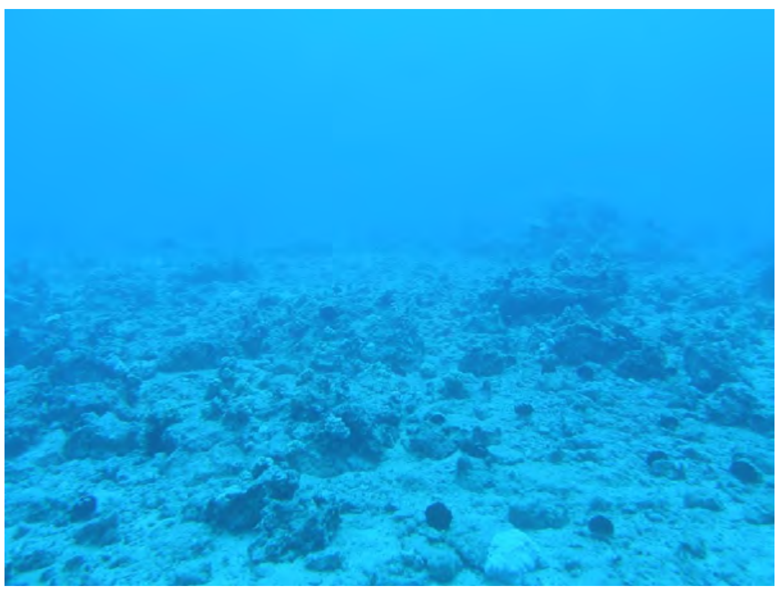


Figure 17. Photo shot in the vicinity of Transect G (Station 40 again showing the coralline rubble substratum and sea urchins (Tripneustes gratilla), depth 18m, 10 August 2011.

Figure 18. Photo showing sand substratum present at Transect H (Station 4) on 10 August 2011. Depth 18m.

Figure 19. Where hard substratum is present in the otherwise sand substratum at Transect H (Station 4), corals such as this antler coral (<u>Pocillopora</u> <u>eydouxi</u>) are seen. 10 August 2011, depth 18m.

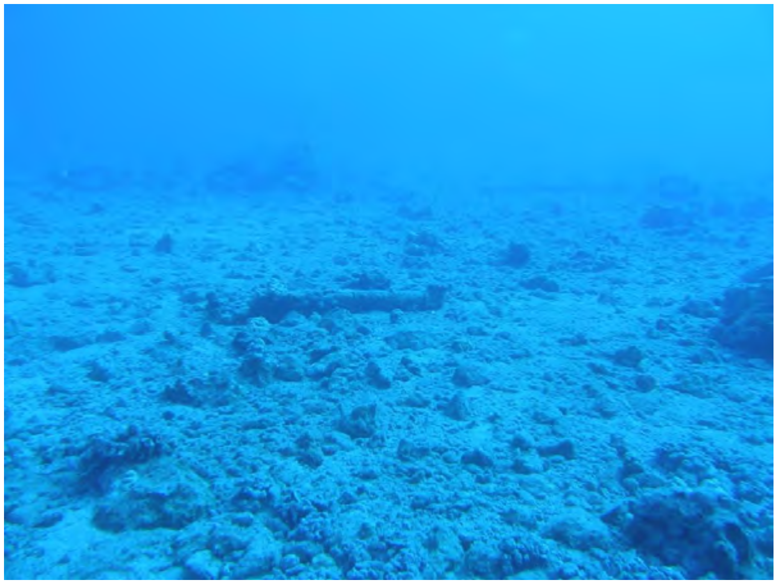


Figure 20. Photo of typical coralline rubble substratum present at Transect I (Station 5). Note the metal debris (pipe) in the background, 10 August 2011, depth 27m.

Figure 21. Photo showing debris at Transect I (Station 5) with some coral recruitment occurring on the debris. Date 10 August 2011, depth 27m.

Figure 22. Photo showing modern debris at Transect I (Station 5) with coral recruits on adjacent limestone rubble. Depth 27m, 10 August 2011.

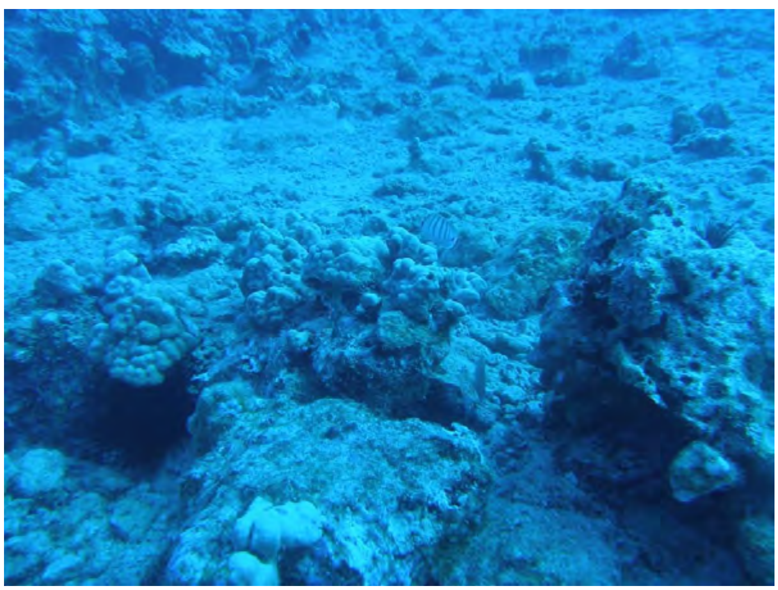


Figure 23. Where rubble is of sufficient size corals successfully recruit to it. Transect I (Station5), 10 August 2011, 27m depth.

Figure 24. Another “dart” just west of the proposed pipeline alignment on Transect I (Station 5), 27m depth, 10 August 2011.

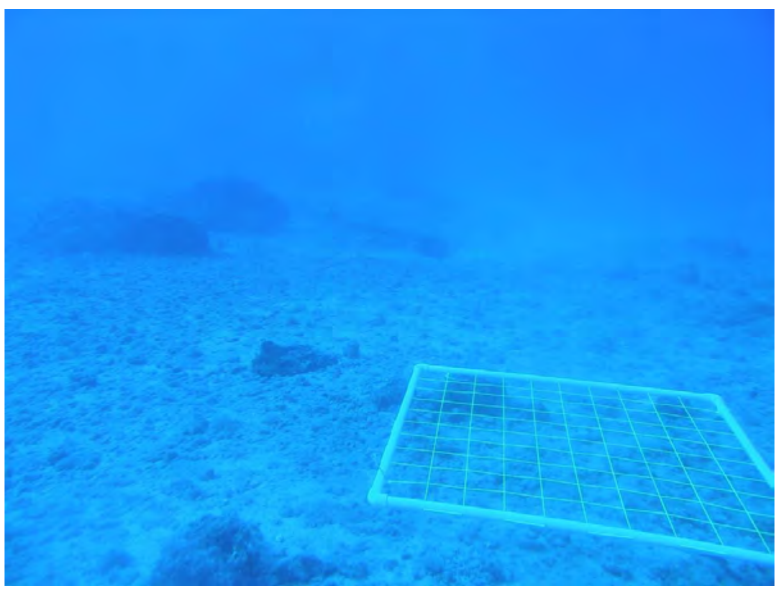


Figure 25. Photo showing square meter quadrat and typical coralline rubble present at Transect J (Station 6) in the Biotope of Deep Dredged Rubble on 9 August 2011, depth 35m.

and 5. Mean coral coverage at this location was 0.6% and again the photographs show that the benthic community at this location appears to be depauperate (Figures 25, 26 and 27).

Transect K was located at 21º17.139' N, 157º52.205'W again situated on the midline of the proposed pipeline route at a depth of 40 m (130 feet). The quantitative data from this transect are given in Appendix 1, Part 11 as well as in Appendices 2, 3, 4 and 5. Again like the two preceding transects, the benthic and fish communities are poorly developed. Photographs (Figures 28 and 29) show the mix of dredge tailings and sand present at this location.

4. ANALYSIS OF IMPACTS

If the proposed HSWAC project proceeds there are both direct and indirect impacts that may occur to the marine communities in the affected area. Direct impacts are those associated with the construction of the pipeline that includes those due to obliteration which will occur in the footprint of the proposed receiving pit due to removal of substratum as well as possibly due to placement of anchors, cables, etc. used in the construction of the receiving pit. Other direct impacts include those that will occur with the deployment of the pipeline across the surface of the substratum when benthic species in the footprint of each concrete collar or saddle are obliterated when collars are placed on the substratum as well as those that will occur from the generation of turbidity during the construction and pipe deployment process which may impact resident benthic and fish resources in the area. Additional direct impacts include those that may occur with the operation of the HSWAC system; of primary concern would be potential impacts that may occur with the discharge of seawater with lower temperatures and oxygen concentrations as well as higher nutrient concentrations that will comprise the seawater return. This discharge water will impinge on benthic communities in the vicinity of the diffuser. These potential impacts are assessed using data from the quantitative studies as given below and possible mitigation is proposed.

Impacts Due to Receiving Pit Construction

The proposed location of the receiving pit is in the middle of a limestone channel (at 21º17.410' N, 157º52.125'W); this pit is 12.2 x 12.2 m (40 x 40 feet) in dimensions and will be constructed by removing material from within this area to a depth of 6 m (20 feet) and driving sheet piling into the substratum to eliminate slumping of loose material back into the pit. The current plan is to utilize these sheet piles that will be driven into the substratum to define the walls of the receiving pit to a point above the sea surface thus containing most of the sediment generated by the excavation. Materials from within the structure would be removed using a clam shell dredge and transferred to a barge for transport to land. Such a strategy would greatly reduce the possibility of high local turbidity loading in the surrounding waters. Once completed the steel sheet piling would be cut off below grade and removed from the area. Similarly, to reduce the potential for anchor/line impact it has been proposed that anchor locations will be selected which are free of or have little benthic community development present. At the selected

Figure 26. Another view of the rubble substratum present at Transect J (Station 6) on 9 August 2011, depth 35m. looking shoreward.

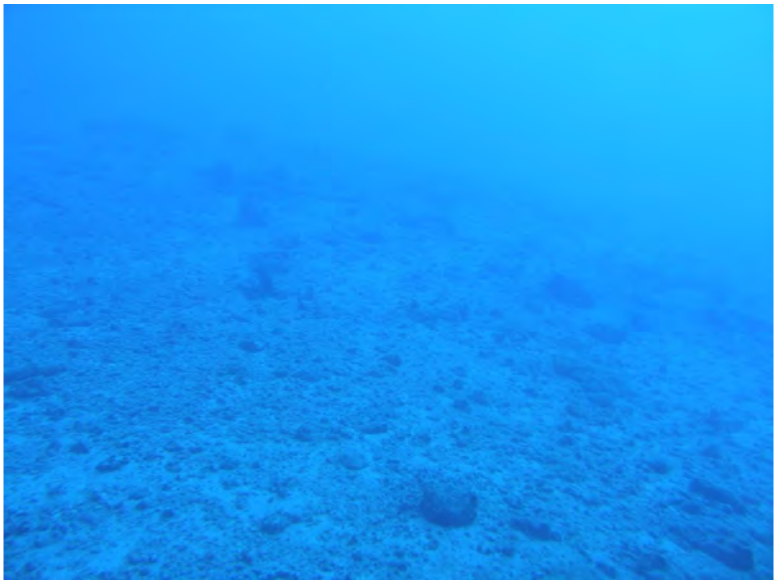


Figure 27. View of rubble substratum at Transect J (Station 6) looking seaward, 9 August 2011, depth 35m.

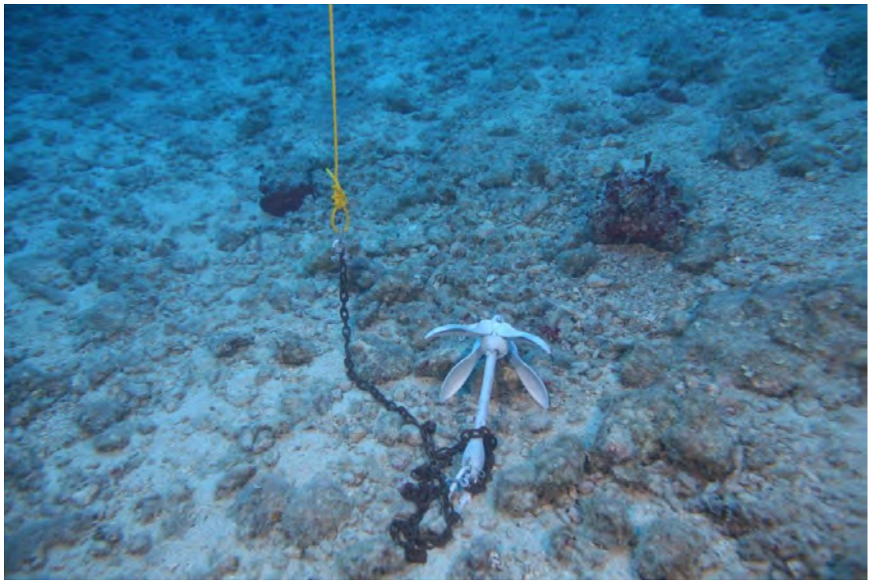


Figure 28. Substratum on the proposed pipeline alignment on Transect K (Station 7) showing typical mix of sand and rubble present. 9 August 2011, depth 40m.

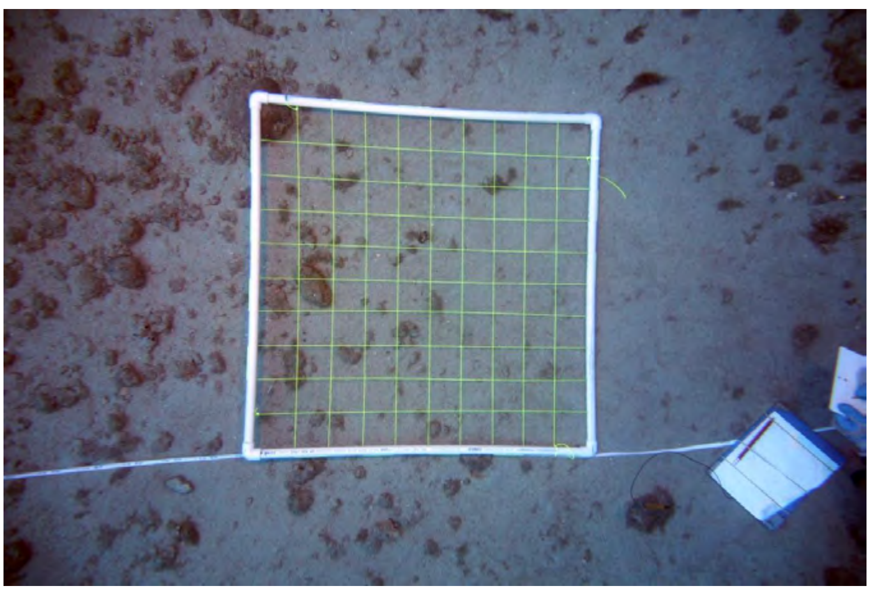


Figure 29. Photo showing sand and rubble substratum around Transect K (Station 7), 9 August 2011, depth 40m.

sites, piles will be driven into the substratum with a portion remaining upright and above the surrounding benthic communities. Vessels can be held in position using tautline moorings to these vertical anchor points which keep moorings off the substratum. Once work has been completed, these vertical moorings will be removed. These strategies will reduce the generation of turbidity thus its potential negative impact to surrounding benthos.

The proposed receiving pit will occupy most of the 14 m width of the limestone channel which suggests that benthic species located on the adjacent limestone ridges (to the east and west) could also be subject to impact. The question, “What will this impact be and over what distance will it occur?” needs to be addressed. The greatest coral development in the proposed project area occurs as a band along the seaward edge of the biotope of scattered corals in the spur and groove system that is present in the area. The width of the band of high coral coverage varies along the reef edge but it approximately follows the width of the spur and groove formations. In the general area of the proposed receiving pit the width ranges from 40 to 80 m thus the mean width is 40+80/2 = 60 m. Mean coral coverage is 0.9% on the channel floor occupied by the receiving pit and more coral is found surrounding it on the limestone ridges at a mean coverage of 7.5%. Assume a conservative approach where all corals within a 10 m radius centered on the middle of the receiving pit will succumb with the construction of the receiving pit from both physical impact (breakage, etc) as well as from turbidity thus the total area impacted is:

$$\text{Area} = 3.14 \times (10\ \text{m}^2) = 314.0\ \text{m}^2$$

With mean coverage over the entire area being 7.5%, coral loss would be:

$314.0\ \text{m}^2 \times 0.075 = 23.6\ \text{m}^2$ of living coral lost with construction of the receiving pit.

This value does not necessarily represent what will occur but is used for purposes of illustrating the level of impact that could occur. The proposed construction measures as given above should reduce the extent of negative impacts occurring outside of the receiving pit footprint.

Turbidity is an issue that should be examined relative to the construction of the receiving pit. In general currents fronting the Kaka‘ako Waterfront Park roughly follow the tradewind flow and hence move water from the east towards the southwest (See also Laevastu *et al.* 1964, Bathen 1978). Thus, any sediment generated by the construction/deployment of the HSWAC pipeline would probably have a greater impact on benthic communities present in a southwest direction rather than on communities in locations upcurrent (to the east). The receiving pit and the above-grade portion of the proposed pipeline route are located at the seaward edge of the biotope of scattered corals where the highest coral diversity and coverage occurs. If turbidity is generated in this shallow area, most of it would flow to the southwest where the biotopes of dredged rubble and sand are found having a low diversity and coverage by corals, thus reducing potential impact.

Sedimentation has been implicated as a major environmental problem for coral reefs. Increases in turbidity may decrease light levels resulting in a lowering of primary productivity. Perhaps a greater threat would be the simple burial of benthic communities that may occur with high sediment loading. Many benthic species including corals are capable of removing sediment settling on them but there are threshold levels of deposition where cleaning mechanisms may be overwhelmed and the individual colony becomes buried. Dollar and Grigg (1981) studied the fate of benthic communities at French Frigate Shoals in the Northwest Hawaiian Islands following the accidental spill of 2000 tons of kaolin clay. These authors found that there was no damage to the reef corals and associated communities except where organisms were actually buried by the clay deposits for a period of more than two weeks. Similarly, coral communities along the southern shoreline of Lanaʻi Island were exposed to prolonged high turbidity due to a series of high rainfall events (29 January 2002 - 7.75 inches, 12-13 May 2002 - 4.10 inches, 14-17 October 2002 - 13.10 inches). The high turbidity conditions persisted for an 18-month period (up to August 2003) due to unusually poor coastal circulation. Despite the prolonged period of extreme turbidity in permanently marked transects, mortality in the monitored coral communities was low (grand mean across all stations: April 2002 - 1.1%, May - 0.7%, November - 0.6% with no subsequent mortality). Mortality was restricted primarily to one species, the cauliflower coral (*Pocillopora menadrina*). These data are a testimony to the resiliency of these communities in the face of this natural perturbation (Brock 2011). These results suggest that despite some level of turbidity that could be generated by the proposed HSWAC construction, the impact may be much less than otherwise expected especially if mitigation measures are in place.

Construction of the receiving pit will generate noise; besides the digging and removal of materials from within the pit, the driving of sheet piles to reduce slumping will generate noise as will the percussion hammering of piles that will serve to anchor the combination collars (cradling the pair of HSWAC pipes) to the substratum between the receiving pit and the end of the discharge diffuser. This noise may temporarily cause motile species to leave or in the case of large predators may serve to attract them. However, these impacts are transitory and once the construction activities are completed the impact of noise ceases. Green sea turtles (*Chelonia mydas*) are known to frequent the waters fronting the Kakaʻako Waterfront Park particularly in proximity to Kewalo Basin; if past observations are the norm, concerns over noise generated by underwater construction having a negative impact on green turtle behavior suggests that such noise may not be a problem but there are no unequivocal answers to the question of noise generated by underwater construction creating a negative impact to resident green turtles. However, drawing on past observations regarding green turtles and their response to construction activities may provide some reasonable insight as to what negative impacts may occur.

The first relevant observation comes from the work of Brock (1990) and citing the executive summary,

"From April 1987 through July 1990 we examined the stability of the green turtle population

in nearshore waters fronting a 2.1 km section of coastline at West Beach, Oahu...This study has been undertaken to address the question 'Have the shoreline construction activities at West Beach had any discernable impact on the resident green turtle population?'".

By way of background, the construction activities developed four large swimming lagoons that are connected to the adjacent ocean. These lagoons were initially dug "in the dry" shoreward of the beachrock bench that fronts the entire West Beach coastline. The construction included the use of dynamite, bulldozers and large cranes. Dredging was necessary to connect the lagoons with the ocean and resulted in considerable transitory turbidity. The noise levels in the ocean were readily discernable to divers up to one kilometer seaward observing green turtles in their resident habitat. Because of heightened concern over the welfare and status of the resident turtles, a representative from the National Marine Fisheries Service Honolulu Laboratory (Mr. John Naughton) accompanied the author on all of the field surveys carried out over the 13-month period of the study.

"Underwater surveys were conducted to census the green turtles in their resting habitat offshore of West Beach. Our data show that in the time between preconstruction surveys (June 1987) and the commencement of shoreline construction (June 1988), green turtle numbers decreased. Once construction started remaining individuals appeared to abandon an offshore diurnally used resting site which is more than one kilometer from shore in favor of a resting area about 250 m offshore of the construction area. A 90-day construction moratorium appeared to have little impact on resident turtles; during this time many turtles dispersed along the coast, having a diurnal distribution along the entire project site about 400 m of the shore. This distribution changed little during the subsequent 13-month period of construction of three additional lagoons. As an unbiased measure of abundance, the time necessary for an observer to sight a turtle increased but did not statistically change through the period of this study.

There has been a decrease in the mean size of turtles sighted in the project area since the commencement of construction. Using visual estimates of size, prior to construction, 49 percent of the turtles were adults; seven months following the termination of construction, it is estimated that eleven percent of the turtles sighted were adults. These changes in the size of turtles encountered at West Beach may be related to migration of the adults to the Northwest Hawaiian Islands for reproductive purposes.

The construction activities do not adequately explain the changes in the apparent abundance of green turtles. Despite the changes to the shoreline, subtidal algal species appropriate as turtle forage increased in abundance adjacent to the construction sites. The movement of turtles to a new resting site within 250 m of the actual 'in water' construction activities and the appearance of juveniles in these same waters where they had not been seen previously suggest that the observed changes may not be construction related.

In short, we know little of the small-scale and short term movement patterns or resting habitat requirements of Hawaiian green turtles. Furthermore, we are unaware if long term cycles of *local abundance do occur; lacking this knowledge hampers the interpretations of data. Until we have a better understanding of the population structure and local movement patterns of green turtles over a much broader area than the West Beach site, any conclusion as to the impact of lagoon construction on green turtles is difficult to unequivocally ascertain."*

The primary point to be gleaned from the above information is that green turtles were apparently unaffected by the considerable construction noise and in fact moved from a resting site located more than a kilometer offshore to a new resting area within 250 m of the ongoing construction activities. This suggests that the ambient construction noise and resulting high turbidity were unimportant to these turtles. If this is correct, noise and turbidity generated by the HSWAC underwater construction and pipeline deployment (including percussion hammering of steel pipe piles used to provide additional stability to the combination collars used from breakout to the end of the discharge diffuser) will probably have little negative impact on the green turtles utilizing resting sites and forage areas in the vicinity of the HSWAC project site.

Impacts Due to Deployment of the Shallow Portion of the HSWAC Pipeline

The HSWAC pipeline will be constructed in sections elsewhere and floated to the site for final deployment on the seafloor. The shallow portion of the exposed pipeline considered here is that part of the system from the breakout point at the receiving pit (at 9.5 m depth) down through the discharge diffuser which ends at a depth of 46 m (150 feet). This section of the pipeline is ~580 m (1,916 feet) in length and carries both the 63-inch HDPE intake pipe as well as the 54-inch HDPE seawater return discharge pipe. This pair of 580 m long pipes will be held in place on the substratum using a series of concrete combination collars or saddles which cradle both pipes. These collars are simply gravity anchors, many of which in the shallow section considered here will be further secured to the bottom using steel pipe approximately two feet in diameter that would be driven through sleeves in the collars using a percussion hammer and once in place the upper portions of the steel pipes would be filled with tremie concrete. In total from the breakout at the receiving pit to the end of the diffuser, 91 combination collars will be deployed to hold the system in place.

The shallow water collars occupy a footprint of 76 square feet (or 7.06 m^2) so the total area of contact with the seafloor in the shallow water section of the pipeline (i.e., from breakout to the end of the discharge diffuser) is:

(1) 7.06 m^2 per combination collar x 91 collars = 642.5 m^2 of substratum covered

The impact of pipeline deployment in the shallow section between the receiving pit and the end of the discharge diffuser with respect to collars covering benthic communities should be addressed. Assuming that the 91 combination collars are given an equidistant spacing that translates to:

(1) Each combination collar has a width of 23.3 inches (=59 cm) thus collars occupy:

59 cm x 91 collars = 53.7 m of the pipeline length

Thus,

(2) 580 m pipeline length - ~54 m occupied by collars = 526 m for spacing between collars.

Hence,

(3) 526 m of pipeline / 91 combination collars = 5.78 m spacing between each collar.

For the purpose of computations, a collar is 59 cm wide plus the 5.78 m distance occupied by pipes (to the next collar) thus the total is 6.37 m so to simplify computations below this is rounded to 6.4 m.

Since the pipeline alignment leaves the receiving pit in an area with low coral coverage (see Appendix 1, Part 1 quadrat at 5 m no coral coverage, Part 2 quadrat at 2 m with coverage at 1.7% thus channel bottom mean = 1.7% / 2 = 0.9%) and within 24-25 m is in the biotope of shallow dredged rubble where Station 2 has a mean coral coverage = 3.2% and Station 3 has a mean coral coverage = 1.0% which results in an overall coral coverage of:

(1) 0.9% + 3.2% + 1.0% = 5.1% / 3 = 1.7% coral coverage through this area.

This 1.7% mean coverage applies to the first 99 m of the pipeline which lies between the receiving pit and Station 3 (at 13.7 m depth). Assuming a spacing of 6.4 m between combination collars, results in 99 m / 6.4 m = ~15 collars deployed in this area. As given above, each combination collar is deployed on the substratum and occupies 7.06 m^2 thus the 15 collars used in this area occupy:

(1) 15 collars x 7.06 m^2 /collar = 105.9 rounded to 106 m^2 of substratum covered

With mean coverage being 1.7 % the loss of coral by collar pad placement is:

(2) 1.7% x 106 m^2 = 1.80 m^2 of coral loss in the first 99 m long segment of the pipeline

Approximately 100 m down the pipeline from the receiving pit the biotope of sand commences; mean coral coverage in the biotope of sand is 0.5% (Table 2) and approximately a 148 m length of pipeline crosses the biotope of sand. In this section there will be:

(1) 148 m length / 6.4 m spacing = 23.1 or 23 collars used

If 23 collars are deployed with each having a footprint of 7.06 m^2 then:

(2) 23 collars x 7.06 m^2 = 162 m^2 total area covered and

(3) 162 m^2 x 0.5% mean coral coverage = 0.81 m^2

Thus 0.81 m^2 of live coral will be lost due to the placement of collar pads in the biotope of sand.

The remaining 333 m of pipeline between the seaward edge of the biotope of sand and the end of the diffuser crosses the biotope of deep dredged rubble. Mean coral coverage in this area is 1.1% (Table 2). With the required 6.4 m spacing between collars, there will be

(1) 333 m length / 6.4 m spacing = ~53 collars used and with 7.06 m^2 footprint,

(2) 53 collars x 7.06 m^2 = 374.2 m^2 and,

(3) 374.2 m^2 x 1.1% mean coral coverage = 4.12 m^2

Thus 4.12 m^2 of live coral will be lost due to the collars deployed in the biotope of deep dredged rubble. Summing these losses up results in a total loss of 1.80 + 0.81 + 4.12 = 6.73 m^2 of coral. This loss does not include loss that may occur from anchors or by divers assisting in the deployment process where anchors and/or divers trample or break coral as well as other resident benthic species. Since the deployment strategy utilizes a gradual sinking of the entire length of the pipeline with collars attached (see the dEIS) commencing from the shallow end and ending with the deep end, losses due to anchors and/or divers assisting with the deployment in the shallow section from the breakout point to the end of the discharge diffuser are expected to be minimal.

Positive Impacts Due to Pipeline Deployment

Not all marine construction activities result in a permanent loss of environmental quality; for example, the construction and deployment of designed artificial reefs may have a positive influence on the species composition, abundance and biomass of resulting fish communities that develop due to the presence of appropriate foraging and shelter space (Brock *et al*. 1985). The presence of the HSWAC pipes from the point where they “daylight” and continue seaward across the substratum on concrete collars, would create an elevated hard substratum as well as some shelter space in an otherwise relatively featureless sand and rubble bottom habitat. Previous biological studies of marine community development around similar pipes and deployment methods (Smith *et al.* 2006) have noted the development and persistence of a considerably diverse, high biomass fish community along pipes. In this case, a sewage outfall was constructed by tunneling beneath much of the limestone reef platform with trenching seaward of this finally “daylighting” at an approximate 26 m depth, close to the eastern edge of the Pearl Harbor Entrance Channel (approximately 8.7 km west of the Kaka‘ako Waterfront Park). The Pearl

Harbor sewage disposal pipe continues seaward across a sand and rubble substratum similar to that found fronting parts of Kaka‘ako Waterfront Park. Past studies of fish communities on these deeper sand areas has found fish community standing crops in the 0.2 to ~2 g/m^2 range; following pipe deployment at Pearl Harbor, the resident fish community standing crop was 126 g/m^2 (Smith *et al.* 2006) which is an increase of 63 times over predeployment standing crops. Thus it is expected that the deployment of the HSWAC pipelines will enhance local fish communities.

Each of the 91 combination concrete collars proposed for deployment over the 580-m long area between the receiving pit and the seaward end of the discharge diffuser has an estimated surface area of 313 ft^2 or 29.1 m^2 that would potentially be available for recruitment by benthic species once the combination collars have been deployed. Concern has been voiced regarding the recruitment of benthic species (especially corals) to both concrete and the HDPE pipe that will be used for both intake and discharge in this proposed system. Comments were received on the dEIS stating that neither concrete nor the HDPE pipe are suitable surfaces for the recruitment of corals due to the antifouling properties of each. Published studies have shown that concrete structures provide a surface that is preferred by many coral reef species colonizing hard substrata (including corals). Preference in substratum types found that both natural dead coral and concrete received the greatest recruitment (both in terms of the diversity of species as well as their abundance) and survival of recruits was better relative to other tested substrata (e.g., metal and tires; Fitzhardinge and Bailey-Brock 1989). Other studies have found that corals will settle on natural and artificial substrata within four months of immersion (Birkeland *et al.* 1982, Harriott and Fisk 1987, Sammarco and Carleton 1982, Wallace 1985, Wallace and Bull 1982).

The HDPE pipe will also provide a substratum that will be situated well above the substratum and away from much of the sand scour that occurs across the flat limestone in the shallows during periods of high surf. The comment that corals will not recruit to the HDPE pipes because of antifouling properties of this pipe is incorrect. Figure 30 is a photograph of one of the HDPE pipes at the Natural Energy Laboratory of Hawai‘i at Keahole Point, Hawai‘i and corals have obviously been successful at recruiting to and growing on this HDPE pipe. This photograph was taken in 2008 and the pipe pictured was deployed about twelve years earlier. Thus HDPE pipe does provide a suitable habitat for the settlement and growth of Hawaiian corals and it is expected that the HDPE pipe used in the proposed HSWAC system will likewise be a suitable surface for the recruitment and growth of benthic species.

How much habitat could the 91 combination collars provide for coral and other sessile benthic species recruitment? As noted above each combination collar has an approximate outer surface area of 29.1 m^2 thus the total area of concrete available for settlement is 29.1 m^2 x 91 = 2,648 m^2 through the 580 m long distance between the breakout point of the pipeline and the end of the discharge diffuser. There are two HDPE pipes; the intake is 63 inches (or 1.60 m) in diameter and is 580 m in length between the receiving pit where it first “daylights” above grade to the end of the discharge diffuser thus this pipe provides the following surface area:

Figure 30. Photo of one HDPE coldwater pipeline at the Natural Energy Laboratory of Hawaii at Keahole Point, Hawaii. The three most abundant corals on this pipe at this depth (8m) are Pocillopora meandrina, Porites lobata and Montipora capitata. Photo taken in 2008 and this pipeline had been place about twelve years.

(1) Area = 3.14 x 1.60 m x 580 m = 2,914 m^2

and for the 54-inch (or 1.37 m) diameter seawater return pipe, the area is:

(2) Area = 3.14 x 1.37 m x 580 m = 2,495 m^2

thus the total HDPE pipe surface available is:

(3) Area = 2,914 m^2 + 2,495 m^2 = 5,409 m^2

but subtracting the area of pipe resting on the 91 collars (total area = 250 m^2) results in

(4) 5,409 m^2 - 250 m^2 = 5,159 m^2 of pipe surfaces available for recruitment.

Finally the total combined surface area available for benthic recruitment with the deployment of the HSWAC system between the breakout point at the receiving pit and the seaward end of the discharge diffuser is:

(5) Area = 2,648 m^2 + 5,159 m^2 = 7,807 m^2

In summary deployment of the proposed HSWAC system will provide a considerable increase in available hard surfaces for the successful recruitment of benthic species such as corals requiring such substratum for growth and reproduction.

Impacts Due to the Operation of the HSWAC System

The 1.37 m diameter seawater return pipe will be deployed with and lie adjacent to the 1.60 m diameter intake pipe. The seawater return pipe will run from the shaft breakout and 580 m seaward to a depth of 46 m (150 feet). The seawater return pipe will be constructed of the same material (HDPE) using the same techniques as the intake pipe, but has a smaller diameter (1.37 m) relative to the intake pipe. This is possible because the return flow will be under pressure. The temperature of the return seawater would vary between 53ºF and 58ºF (11.6 - 14.4ºC) depending on system demand. The seawater return pipe terminates in a 25-port diffuser that commences at a depth of 36.5 m (120 feet) and ends at 46 m (150 feet). HSWAC has proposed the delineation of a zone of mixing (ZOM) around the diffuser. Computer simulations using CORMIX software were used in determining the boundaries of the ZOM where a dilution factor of 100 is necessary to meet water quality standards at the ZOM boundary.

The rationale for establishing a ZOM around a discharge into an aquatic environment is made in recognition by regulatory agencies that an input of a material may exceed state and/or federal water quality standards over some area and/or volume of the receiving water. A ZOM allows for a variance in the concentration of constituents that are at levels outside of ambient or normally allowed ranges within the ZOM but at the ZOM boundary due to dilution, the constituent concentrations should be at ambient and/or in compliance with applicable state and federal standards. Thus granting the establishment of a ZOM infers that the regulatory community recognizes that some area and/or volume will be impacted by the applicant's activity. However, in granting such permits, the applicant must monitor the status of parameters as well as impacts to determine that physical and biological conditions at and outside of the ZOM boundary are within applicable standards or at ambient and are not impacting biota outside of the area.

The return seawater is not only colder, but has a lower concentration of dissolved oxygen and has a higher concentration of dissolved nutrients than the ambient seawater into which it is discharged. The physical properties of the discharge water could have a negative impact on the resident marine communities. The question "What will the impact be on the resident biota in the vicinity of the return seawater discharge?" should be addressed. Higher nutrient concentrations could serve to stimulate phytoplankton and/or benthic algal production. If dissolved oxygen concentrations were significantly below ambient, this could serve to inhibit species that require higher dissolved oxygen content in the water and lower temperatures could cause the elimination of species that cannot tolerate the lower temperatures in the area immediately around the discharge diffuser. Species susceptible to the lower temperatures would be those that are sessile such as corals. Hawaiian corals have not shown any negative impact due to increased nutrient loading as from the discharge of treated sewage wastes in marine habitats with reasonable currents and mixing (Grigg 1994). In contrast, studies of coral growth (or carbonate accreation) finds decreases in growth of the same species subject to lower mean water temperatures (Grigg 1981, 1982). Thus, water temperature is a parameter of primary concern with respect to potential impacts to corals resident to the area of the HSWAC diffuser.

Thus low temperatures rather than nutrients would probably impose the greatest impact to sessile species such as corals. The minimum temperature of the discharge water is 11.7°C (or 53°F) and the surrounding ambient water temperature at the diffuser is 25°C (or 77°F). The CORMIX model found that ambient temperatures are attained within 0.5 m of the diffuser centerline under high natural current flow. Under worst case low current flow, ambient temperatures are attained within 12.2 m (or 40 feet) of the diffuser centerline. Under average current flow conditions ambient temperature is attained in about one meter as measured horizontally from the plume centerline. As the plume is denser than the receiving water, it will tend to sink and would not approach the surface.

If the mixing model studies are correct, there should not be a discernible biological impact due to temperature at a distance greater than 12.2 m from the plume centerline. Assume that the maximum calculated distance from the center of the discharge plume to the distance at which discharged water is at ambient temperature is 12.2 m (40 feet) which occurs only under low current flow and assume the lowest discharge temperature (here 11.7°C). Further assume that the ZOM will form an envelope around the entire diffuser and the diffuser length is 76 m (250 feet) long, the rectangle forming the ZOM boundaries would be:

(1) total length = 76 m + 2(12.2 m) = 100.4 m long and:

(2) total width = 12.2 m + 12.2 m = 24.4 m in width

Thus the total maximum area impacted by decreased temperatures in the proposed ZOM is:

(3) 24.4 m x 100.4 m = 2,450 m^2

The diffuser is in the biotope of deep dredged rubble which has a mean coral coverage of 1.1%. Assuming that the lower temperatures within the ZOM would be the primary source of mortality to corals and that this mortality would occur to all corals within the maximum areal extent of temperatures less than ambient, the loss of coral cover would be:

(1) Maximum Affected Area = 2,450 m^2 x 1.1% Mean Coral Cover = ~27 m^2 of coral loss

However the temperatures of the discharge water are in the range of 11.6 to 14.4°C (53-58°F) when they exit the diffuser but warm with ongoing mixing that occurs within the ZOM. Sea surface temperatures at Midway Atoll in the Papahanaumokuakea Marine National Monument where many Hawaiian coral species flourish has winter ocean temperatures down to 17.8°C (64°F) thus some of corals in the ZOM may adapt to the lower temperatures that they are exposed to in the ZOM. It should also be realized that under normal or average current flow, ambient temperatures within state standards are attained only about one meter away from the centerline of the plume; assuming average current conditions and using the lowest discharge temperature (here 11.7°C), the maximum affected area is 156 m^2 and the loss of coral is calculated to be 1.7 m^2.

If a ZOM is accepted by the regulatory community, the benthic and fish resources that will remain and/or recruit to the area within the ZOM will be those with that can tolerate the physical conditions found within the ZOM. Theoretically, species from deeper benthic communities could colonize within the ZOM thus increasing local biodiversity.

In summary and assuming the most conservative approach for impact to corals with the construction and operation of the proposed HSWAC system, the impact to coral coverage will be: during construction (loss around receiving pit = 23.6 m^2 ; loss due to collar deployment = 6.7 m^2) and loss due to the operation of the ZOM = 27 m^2 resulting in a total estimated loss of ~57 m^2 of coral in the area between the receiving pit to the end of the discharge diffuser 580 m seaward. In contrast, the HDPE pipes and concrete collars over this same distance provide 7,807 m^2 of surfaces for the recruitment of benthic species including corals. If coral recruitment occupies ~25% of this substratum as it does on the HDPE pipes at Keahole Point, Hawai‘i, then coverage should be:

(1) 7,807 m^2 x 25% = 1,952 m^2 of coral

thus the 57 m^2 of loss is just 3% of what replaces it. Assuming a “worst case” scenario of 2.5% coverage on the pipeline, the coverage would be:

(2) $7{,}807\ m^2 \times 2.5\% = 195\ m^2$ of coral

which is still greater than the loss caused by deployment and operation of the HSWAC system. These calculations ignore the gains made in energy savings by the operation of this proposed system.

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TABLE 1. Summary of the biological parameters measured at each of eleven transects sampled in this study. Note that the number of coral species, percent coral cover, number of coral colonies measured, mean coral colony size, number of motile macroinvertebrate species and the number of motile invertebrate individuals are based on data from the five square meters sampled with a quadrat and photography on each transect. Fish data from 100 m^2 transect area. Pl = *Porites lobata*, Mc = *Montipora capitata*, Mp = *Montipora patula*, Pm = *Pocillopora meandrina*, Pd = *Pavona duerdeni*, Pe = *Pocillopora eydouxi*, Lp = *Leptastrea* sp. and Ls = *Leptoseris* sp.

Transect No. & Depth	No. Coral Spp	% Coral Cover	No. of Colonies in 5 m^2 Sampled	Mean Coral Colony Size (cm) By Species: Pl	Mc	Mp	Pm	Pd	Pe	No. Invert Spp	No. Invert Ind	No. Fish Spp	No. Fish Ind	Fish Biomass (g/m^2)
A 9.5 m	4	4.3	21	8.8	1.5	5.0	16.6			3	7	24	77	23
B 9.5 m	5	10.7	42	17.4	10.2	23.4	6.7			1	10	32	178	224
C 10 m	5	2.1	23	6.4	5.3	3.0	9.8	10.0		2	10	11	28	53
D 10 m	5	4.2	14	13.9	13.3	14.5	12.0		25.0	0	0	9	25	8
E 13.7 m	4	1.9	30	4.5	2.3		5.5		21.0	1	1	18	77	23
F 13.7 m	1	0.02	1		3.0					0	0	3	4	0.3
G 18 m	2	0.9	32	3.1	3.8					2	10	7	12	11
H 18 m	0	0	0							0	0	1	1	0.03
I 25 m	3	2.5	32	6.6	4.5	Lp = 3.0				2	2	4	6	1
J 35 m	1	0.6	17	3.9						1	4	3	5	0.6
K 40 m	2	0.3	21	1.4		Ls = 4.0				1	1	7	29	4

TABLE 2. Summary of the mean number of coral species, mean coral cover and colony size by biotope based on the five square meters sampled at each transect site. Note that mean colony size is computed for coral species where more than one individual was measured in that biotope. Thus mean colony sizes are given for Pl = *Porites lobata*, Mc = *Montipora capitata,* Mp = *Montipora patula*, Pm = *Pocillopora meandrina*.

Transect No. & depth	Biotope	Mean No. Coral Spp	Total No. of Corals Measured	Mean Coral Cover (%)	Mean Colony Size (cm) Pl	Mc	Mp	Pm
A 9.5 m B 9.5 m	Biotope of Scattered Corals	4.5	63	7.5	13.1	5.9	14.2	11.7
C 10 m D 10 m	Biotope of Dredged Rubble (Shallow)	5.0	37	3.2	10.2	9.3	8.8	10.9
E 13.7 m F 13.7m	Ecotone between Biotope of Dredged Rubble & Sand Biotope	2.5	31	1.0		2.7		
G 18 m H 18 m	Biotope of Sand	1.0	32	0.5				
I 27 m J 35 m K 40 m	Biotope of Dredged Rubble (Deep)	2.0	70	1.1	4.0			

APPENDIX 1. PART 1. Summary of the benthic survey conducted at Transect A at 21°17.410' N, 157°52.125' W on the 9.5 m isobath following a compass heading of 120° on 24 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect Part D presents counts of motile invertebrates seen in the 100 m^2 of substratum sampled on this transect. A short summary of the fish census is given in Part E. Mean coral cover = 4.3% (quadrat method).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**5m**	**11m**	**17m**	**21m**	**24m**
Algae					
Lyngbya majuscula	0.8			0.1	0.3
Sponges					
Spirastrella coccinea			0.5		
Corals					
Porites lobata		1.9	10.0		
Montipora capitata		0.1			
Montipora patula			1.8		
Pocillopora meandrina		3.4	4.4		
Colonial Anemones					
Palythoa caesia			0.7		
Sand	6.0	1.5		90.9	68.7
Rubble	7.0	10.0		9.0	12.0
Hard Substratum	86.2	83.1	82.6		19.0

B. Length Frequencies of Coral Colonies In Five 1 x 1 m^2 Quadrats

Porites lobata	*Montipora capitata*	*M. patula*	*Pocillopora meandrina*
2 cm - 1	1 cm - 1	4 cm - 1	12 cm - 1
3 cm - 2	2 cm - 1	6 cm - 1	13 cm - 1
4 cm - 1			18 cm - 2
5 cm - 1			22 cm - 1
6 cm - 2			
8 cm - 1			
11 cm - 1			
15 cm - 1			
18 cm - 1			
24 cm - 1			

APPENDIX 1. PART 1. Continued.

C. Invertebrate Census (from 5 m^2 quadrats)

Species	Number
Phylum Echinodermata	
Echinothrix diadema	5
Echinometra mathaei	1
Holothuria atra	1

D. Invertebrate Census (Present in 100 m^2 area)

Species	Number
Phylum Mollusca	
Streptopinna saccata	1
Conus leopardus	1
Phylum Annelida	
Spirobranchus gigantea	23
Phylum Echinodermata	
Echinostrephus aciculatum	3
Echinothrix diadema	79
Echinothrix calamaris	3
Echinometra mathaei	7

E. Fish Census (4 x 25 m)

24 Species
77 Individuals
Estimated Standing Crop = 23 g/m^2

APPENDIX 1. PART 2. Summary of the benthic survey conducted at Transect B at 21°17.410' N, 157°52.125' W on the 9.5 m isobath following a compass heading of 270° on 24 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect. Part D presents counts of motile invertebrates seen in the 100 m^2 of substratum sampled on this transect. A short summary of the fish census is given in Part E. Mean coral cover = 10.7% (quadrat method).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**2m**	**7m**	**9m**	**13m**	**19m**
Algae					
Lyngbya majuscula	0.5				
Amansia glomerata		0.6			
Pneophyllum conicum		1.5			1.4
Sponges					
Microciona maunaloa	0.2				
Spirastrella coccinea		0.3	0.2		1.3
Corals					
Porites lobata	1.7	9.0	4.5	2.7	
Montipora capitata		3.0	1.0	2.3	
Montipora patula			20.0	4.5	
Pocillopora meandrina		1.2	0.7	0.7	
Pocillopora eydouxi					2.3
Sand	62.6				9.0
Rubble	21.0			3.0	36.3
Hard Substratum	14.0	85.0	73.6	86.8	52.0

B. Length Frequencies of Coral Colonies In Five 1 x 1 m^2 Quadrats

Porites lobata		*Montipora capitata*	*M. patula*	*Pocillopora meandrina*
2 cm - 1	21 cm - 1	1 cm - 1	14 cm - 2	3 cm - 1
5 cm - 1	22 cm - 1	3 cm - 1	21 cm - 1	4 cm - 2
6 cm - 1	25 cm -1	4 cm - 1	24 cm - 1	5 cm - 1
7 cm - 1	120 cm -1	6 cm - 1	30 cm - 2	8 cm - 1
8 cm - 2		23 cm - 1	31 cm - 1	11 cm - 1
10 cm - 2		24 cm - 1		12 cm - 1
11 cm - 2				
12 cm - 2				
13 cm - 1				
14 cm - 1				
15 cm - 3				
20 cm - 1				

APPENDIX 1. PART 2. Continued.

C. Invertebrate Census (from 5 m^2 quadrats)

Species	Number
Phylum Echinodermata	
Echinothrix diadema	10

D. Invertebrate Census (Present in 100 m^2 area)

Species	Number
Phylum Mollusca	
Spondylus tenebrosus	2
Phylum Annelida	
Spirobranchus gigantea	31
Phylum Echinodermata	
Echinothrix diadema	76
Echinostrephus aciculatum	16
Heterocentrotus mammillatus	1
Echinometra mathaei	19

E. Fish Census (4 x 25 m)

32 Species
178 Individuals
Estimated Standing Crop = 224 g/m^2

APPENDIX 1. PART 3. Summary of the benthic survey conducted at Transect C at 21°17.395' N, 157°52.127' W on the 10 m isobath following a compass heading of 120° on 11 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect. A short summary of the fish census is given in Part D. Mean coral cover = 2.1% (quadrat method).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**2m**	**8m**	**13m**	**21m**	**24m**
Algae					
Ralfsia expansa	0.4				
Lyngbya majuscula			0.9		
Pneophyllum conicum					0.1
Sponges					
Spirostrella vagabunda	0.1	0.1			0.3
Spirostrella coccinea					1.0
Corals					
Porites lobata	1.5	0.8			1.3
Pavona duerdeni					0.7
Montipora capitata	0.7	0.4			1.2
Montipora patula					0.1
Pocillopora meandrina	3.8				
Sand		4.0	33.1	30.0	0.5
Rubble	13.0	12.7		40.0	1.5
Hard Substratum	80.5	82.0	66.0	30.0	93.1

B. Length Frequencies of Coral Colonies In Five 1 x 1 m^2 Quadrats

Porites lobata	*Montipora capitata*	*M. patula*	*Pocillopora meandrina*	*Pavona duerdeni*
2 cm - 1	1 cm - 1	3 cm - 1	3 cm - 1	10 cm - 1
3 cm - 2	2 cm - 2		5 cm - 1	
5 cm - 1	4 cm - 1		6 cm - 1	
6 cm - 2	7 cm - 1		11 cm - 1	
7 cm - 1	8 cm - 1		24 cm - 1	
12 cm - 1	13 cm - 1			
14 cm - 1				

C. Invertebrate Census (from 5 m^2 quadrats)

Species	**Number**
Phylum Echinodermata	
Echinothrix diadema	3
Echinostrephus aciculatum	7

APPENDIX 1. PART 3. Continued.

D. Fish Census (4 x 25 m)

11 Species
28 Individuals
Estimated Standing Crop = 53 g/m^2

APPENDIX 1. PART 4. Summary of the benthic survey conducted at Transect D at 21°17.395' N, 157°52.127' W on the 10 m isobath following a compass heading of 270° on 11 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect. A short summary of the fish census is given in Part D. Mean coral cover = 4.2% (quadrat method).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**5m**	**8m**	**13m**	**17m**	**23m**
Algae					
Lyngbya majuscula		0.7	0.3	1.2	
Sponges					
Chondrosia chucalla	0.1				
Corals					
Porites lobata	1.4				14.0
Montipora capitata	0.5				0.4
Montipora patula	0.3				1.3
Pocillopora meandrina					0.7
Pocillopora eydouxi					2.3
Sand	0.7	96.3	95.7	91.8	2.0
Rubble	12.0		2.0	2.0	9.0
Hard Substratum	85.0	3.0	2.0	5.0	70.3

B. Length Frequencies of Coral Colonies In Five 1 x 1 m^2 Quadrats

Porites lobata	*Montipora capitata*	*M. patula*	*Pocillopora meandrina*	*P. eydouxi*
2 cm - 2	6 cm - 1	8 cm - 1	12 cm - 1	25 cm - 1
3 cm - 1	17 cm - 2	21 cm - 1		
4 cm - 1				
6 cm - 1				
20 cm - 1				
60 cm - 1				
14 cm - 1				

C. Invertebrate Census (from 5 m^2 quadrats)

Species	**Number**
None seen	

D. Fish Census (4 x 25 m)

9 Species
25 Individuals
Estimated Standing Crop = 8 g/m^2

APPENDIX 1. PART 5. Summary of the benthic survey conducted at Transect E at 21°17.352' N, 157°52.139' W on the 13.7 m isobath following a compass heading of 100° on 10 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect. A short summary of the fish census is given in Part D. Mean coral coverage = 1.9% (quadrat method).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**6m**	**13m**	**19m**	**22m**	**25m**
Algae					
Plocamium sandvicense (?)	1.2				
Lyngbya majuscula	1.1		2.0		
Padina australis		0.1	0.1	0.1	0.1
Sponges					
Chondrosia chucalla	0.1			0.1	0.4
Corals					
Porites lobata	0.5	1.0	0.3	1.3	1.5
Montipora capitata	0.3		0.1	0.3	0.1
Pocillopora meandrina	0.2			0.9	0.2
Pocillopora eydouxi					3.0
Sand	43.5	7.0	27.5	20.3	18.0
Rubble	30.0	63.9	30.0	5.0	41.7
Hard Substratum	23.0	28.0	40.0	72.0	35.0

B. Length Frequencies of Coral Colonies In Five 1 x 1 m^2 Quadrats

Porites lobata	*Montipora capitata*	*Pocillopora meandrina*	*P. eydouxi*
1 cm - 3	1 cm - 1	3 cm - 1	21 cm - 1
2 cm - 4	2 cm - 7	4 cm - 1	
4 cm - 2	3 cm - 3	5 cm - 1	
5 cm - 1	4 cm - 1	10 cm - 1	
6 cm - 1			
14 cm - 1			
15 cm - 1			

C. Invertebrate Census (from 5 m^2 quadrats)

Species	**Number**
Phylum Echinodermata	
Pseudoboletia indiana	1

APPENDIX 1. PART 5. Continued.

D. Fish Census (4 x 25 m)

18 Species
77 Individuals
Estimated Standing Crop = 23 g/m^2

APPENDIX 1. PART 6. Summary of the benthic survey conducted at Transect F at 21°17.352' N, 157°52.139' W on the 13.7 m isobath following a compass heading of 270° on 10 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect. A short summary of the fish census is given in Part D. Mean coral coverage = 0.02% (quadrat survey).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**2m**	**5m**	**12m**	**16m**	**19m**
Algae					
Padina australis	0.3	0.4	0.1	0.8	0.5
Lyngbya majuscula			1.3	0.2	0.1
Pneophyllum conicum		0.3	0.2		
Sponges					
Chondrosia chucalla	0.4	0.1	0.1		
Corals					
Montipora capitata		0.1			
Sand	63.3	43.1	45.3	44.0	24.4
Rubble	30.0	41.0	49.0	55.0	65.0
Hard Substratum	6.0	15.0	4.0		10.0

B. Length Frequencies of Coral Colonies In Five 1 x 1 m^2 Quadrats

Montipora capitata
3 cm - 1

C. Invertebrate Census (from 5 m^2 quadrats)

Species	**Number**
None Seen	

D. Fish Census (4 x 25 m)

3 Species
4 Individuals
Estimated Standing Crop = 0.3 g/m^2

APPENDIX 1. PART 7. Summary of the benthic survey conducted at Transect G at 21°17.266' N, 157°52.168' W on the 18 m isobath following a compass heading of 120° on 10 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect. A short summary of the fish census is given in Part D. Mean coral coverage = 0.9% (quadrat method).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**8m**	**10m**	**12m**	**17m**	**21m**
Algae					
Pneophyllum conicum					0.7
Sponges					
Chondrosia chucalla	0.2		0.5	0.3	
Corals					
Porites lobata	0.5	0.3	2.3	0.2	0.5
Montipora capitata		0.2	0.3	0.3	
Sand	13.3	76.5	54.9	78.2	43.5
Rubble	80.0	23.0	38.0	21.0	32.0
Hard Substratum	6.0		4.0		24.0

B. Length Frequencies of Coral Colonies In 5 m^2 Quadrats

Porites lobata	*Montipora capitata*
1 cm - 3	2 cm - 1
2 cm - 15	4 cm - 2
3 cm - 4	5 cm - 1
4 cm - 2	
5 cm - 2	
10 cm - 1	
15 cm - 1	

C. Invertebrate Census (from 5 m^2 quadrats)

Species	**Number**
Phylum Echinodermata	
Pseudobolecia indiana	6
Tripneustes gratilla	4

D. Fish Census (4 x 25 m)

7 Species
12 Individuals
Estimated Standing Crop = 11 g/m^2

APPENDIX 1. PART 8. Summary of the benthic survey conducted at Transect H at 21°17.266' N, 157°52.168' W on the 18 m isobath following a compass heading of 270° on 10 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect. A short summary of the fish census is given in Part D. Mean coral coverage = 0% (quadrat method).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**6m**	**9m**	**16m**	**19m**	**25m**
Algae					
Padina australis	0.2	0.3	0.1		
Lyngbya majuscula			28.0	4.5	3.0
Haliophila decipiens	20.0	28.0			
Sand	67.8	61.7	66.9	94.5	96.5
Rubble	12.0	10.0	5.0	1.0	0.5

B. Length Frequencies of Coral Colonies In Five 1 x 1 m^2 Quadrats

No corals present in quadrats

C. Invertebrate Census (from 5 m^2 quadrats)

Species	Number
None seen	

D. Fish Census (4 x 25 m)

1 Species
1 Individual
Estimated Standing Crop = 0.03 g/m^2

APPENDIX 1. PART 9. Summary of the benthic survey conducted at Transect I at 21°17.186' N, 157°52.191' W on the 27 m isobath on 10 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect. A short summary of the fish census is given in Part D. Mean coral coverage = 2.5% (quadrat method).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**3m**	**11m**	**16m**	**21m**	**24m**
Algae					
Lyngbya majuscula				0.8	
Sponges					
Spirastrella coccinea			0.1		1.0
Corals					
Porites lobata	9.5	0.2	0.7	0.3	0.3
Leptastrea sp.	0.2				
Montipora capitata	0.4	0.6		0.1	0.1
Sand	46.9	54.2	24.2	78.8	8.6
Rubble	15.0	45.0	60.0	20.0	70.0
Hard Substratum	28.0		15.0		20.0

B. Length Frequencies of Coral Colonies In Five 1 x 1 m^2 Quadrats

Porites lobata		*Montipora capitata*	*Leptastrea* sp.
2 cm - 5	10 cm - 1	2 cm - 1	3 cm - 1
3 cm - 2	12 cm - 4	3 cm - 1	
4 cm - 2	15 cm - 1	5 cm - 1	
5 cm - 4		8 cm - 1	
6 cm - 1			
8 cm - 7			

C. Invertebrate Census (from 5 m^2 quadrats)

Species	**Number**
Phylum Echinodermata	
Pseudoboletia indiana	1
Holothuria atra	1

D. Fish Census (4 x 25 m)

4 Species
6 Individuals
Estimated Standing Crop = 1 g/m^2

APPENDIX 1. PART 10. Summary of the benthic survey conducted at Transect J at 21°17.157' N, 157°52.200' W on the 35 m isobath on 9 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect. A short summary of the fish census is given in Part D. Mean coral coverage = 0.6% (quadrat method).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**4m**	**9m**	**13m**	**19m**	**21m**
Sponges					
Spirastella coccinea	1.5	1.5		1.0	0.4
Microciona maunaloa		0.4	0.1		
Corals					
Porites lobata	2.1		0.8		0.3
Colonial Anemones					
Zoanthus sp?			0.3		
Sand	43.4	54.6	18.8	19.0	15.0
Rubble	53.0	41.0	80.0	80.0	80.8
Hard Substratum		2.5			3.5

B. Length Frequencies of Coral Colonies In Five 1 x 1 m^2 Quadrats

Porites lobata
1 cm - 2
2 cm - 5
3 cm - 2
5 cm - 3
6 cm - 3
7 cm - 1
8 cm - 1

C. Invertebrate Census (from 5 m^2 quadrats)

Species	**Number**
Phylum Echinodermata	
Pseudobolecia indiana	4

D. Fish Census (4 x 25 m)

3 Species
5 Individuals
Estimated Standing Crop = 0.6 g/m^2

APPENDIX 1. PART 11. Summary of the benthic survey conducted at Transect K at 21°17.139' N, 157°52.205' W on the 40 m isobath on 9 August 2011. Results of the 5 m^2 quadrat sampling of the benthic community are expressed as a percent cover in Part A and length frequencies for corals in Part B. Part C presents counts of motile invertebrates seen in the 5 m^2 of substratum photographed on this transect. A short summary of the fish census is given in Part D. Mean coral coverage = 0.3% (quadrat method).

A. Quadrat Survey

	Quadrat Random Placement				
Species	**3m**	**6m**	**11m**	**17m**	**23m**
Algae					
Peyssonellia rubra?				0.2	
Sponges					
Spirastella coccinea	0.1		0.1		0.1
Chondrosia chucalla	0.3	0.3	0.5		0.1
Corals					
Porites lobata	0.8	0.3			
Leptoseris sp?		0.2			
Sand	36.8	55.2	64.4	59.8	84.8
Rubble	39.0	44.0	35.0	40.0	15.0
Hard Substratum	23.0				

B. Length Frequencies of Coral Colonies In Five 1 x 1 m^2 Quadrats

Porites lobata	*Leptoseris* sp?
1 cm - 16	4 cm - 1
2 cm - 1	
3 cm - 3	

C. Invertebrate Census (from 5 m^2 quadrats)

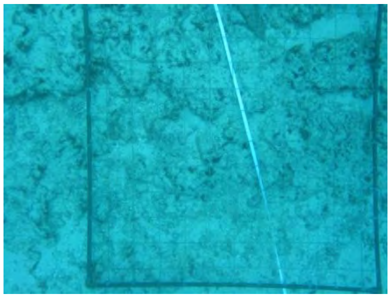
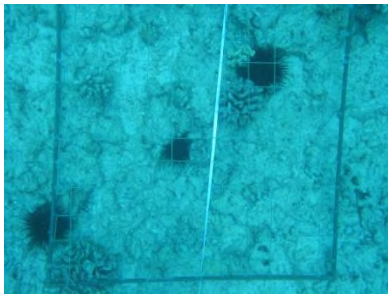
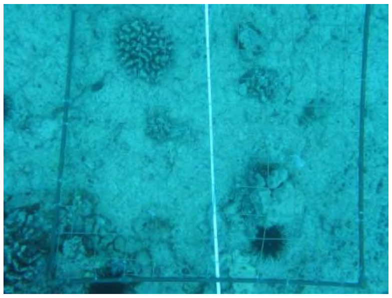
Species	**Number**
Phylum Mollusca	
Streptopinna saccata	1

D. Fish Census (4 x 25 m)

7 Species
29 Individuals
Estimated Standing Crop = 4 g/m^2

APPENDIX 2. Photographs from each of five randomly-placed square meter quadrats on each of the eleven transects established to sample marine communities in this study. Note that where two transects were completed at each of the four shallower stations (Stations 1 thorough 4) the photographs for that station are given on a single page. On the three deeper Stations (5, 6 and 7) only a single transect was carried out (Transects I - 27 m, J - 35 m and K - 40 m) and the photographs for these stations are given on separate pages.

STATION 1 – 9.5m

A-5m A-11m A-17m

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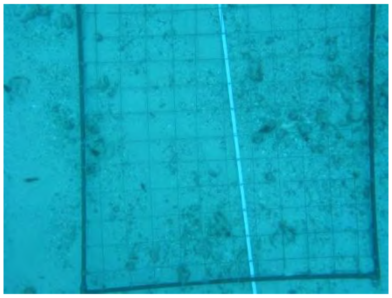
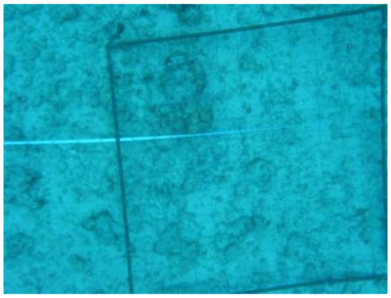
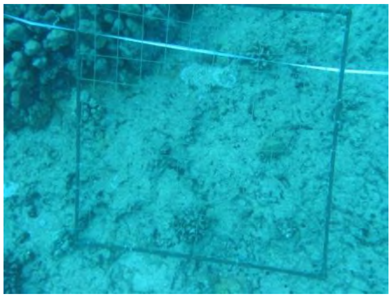
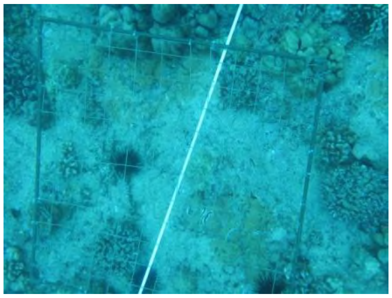
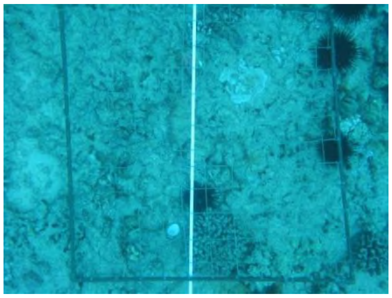
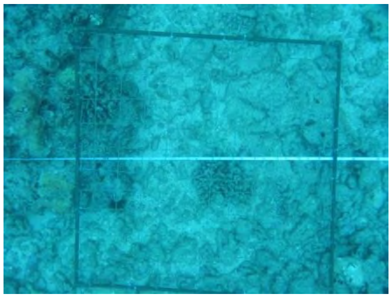


A-21m A-24m

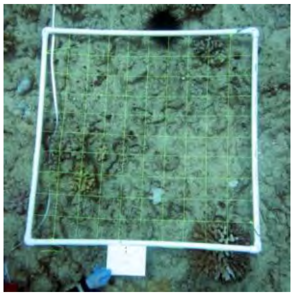




B-2m B-7m B-9m

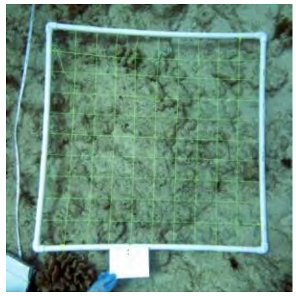



B-13m B-19m

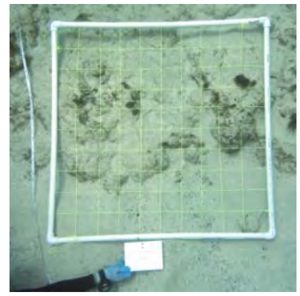
STATION 2 -10m



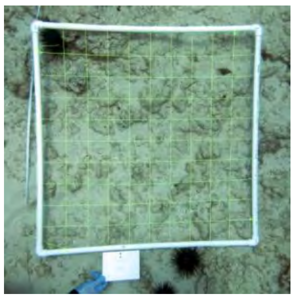
C-2m



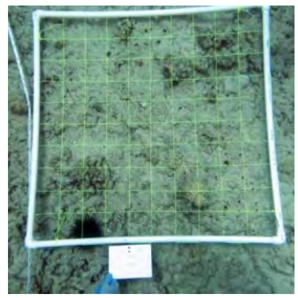
C-8m



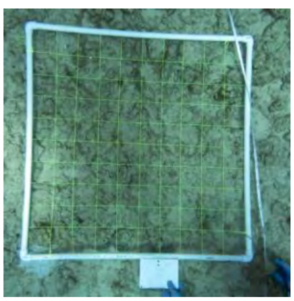
C-13m



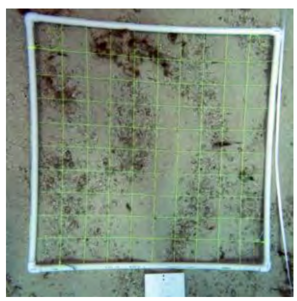
C-21m



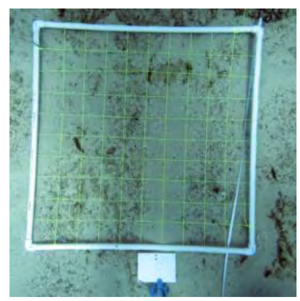
C-24m



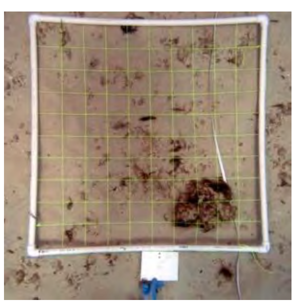
D-5m



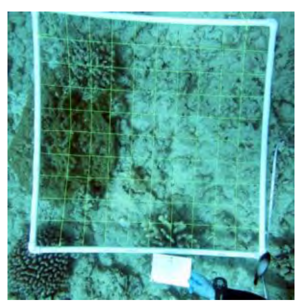
D-8m



D-13m

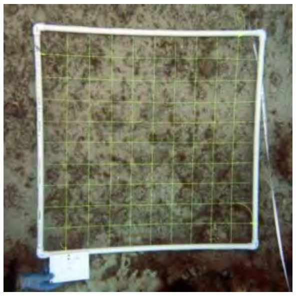


D-17m

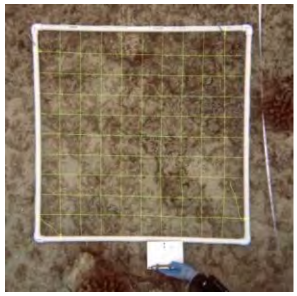


D-23m

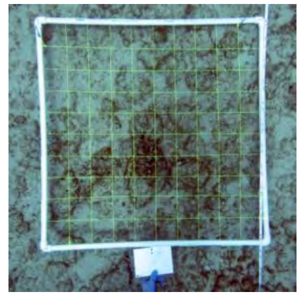
STATION 3 – 13.7m



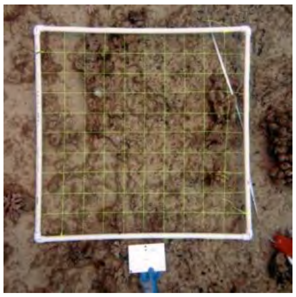
E-6m



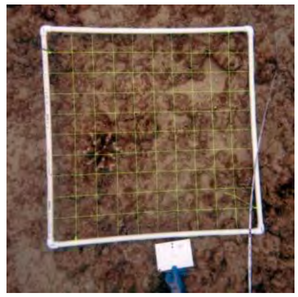
E-13m



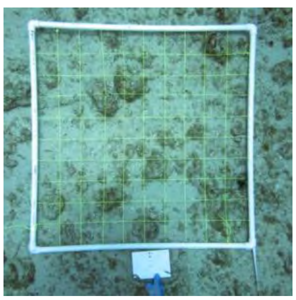
E-19m



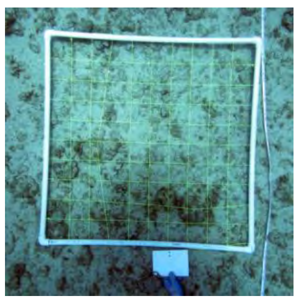
E-22m



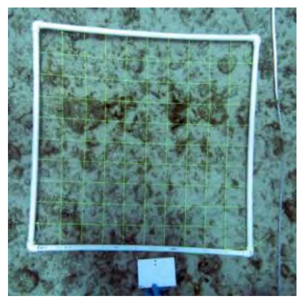
E-25m



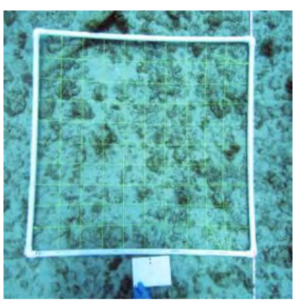
F-2m



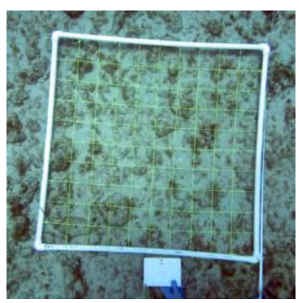
F-5m



F-12m

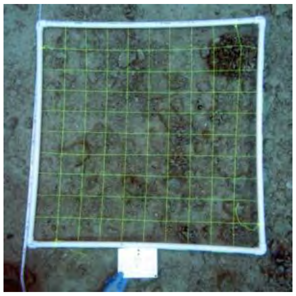


F-16m

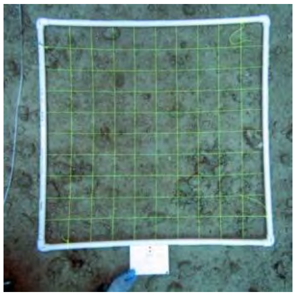


F-19m

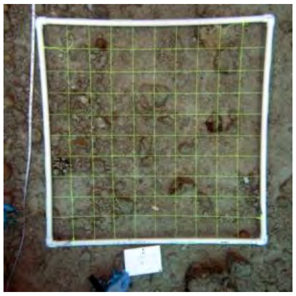
STATION 4 – 18m



G-8m

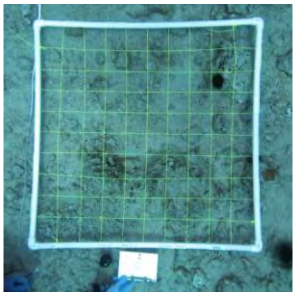


G-10m

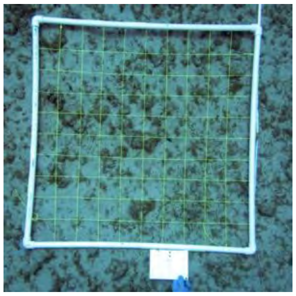


G-12m

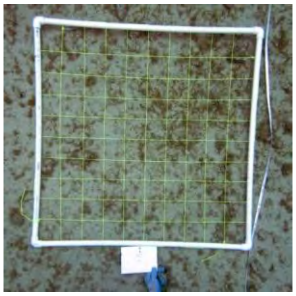
G-17m



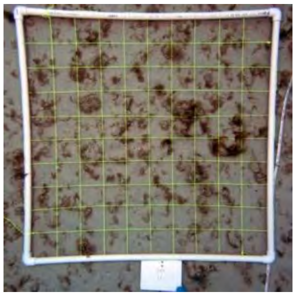
G-21m



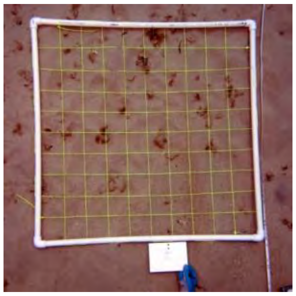
H-6m



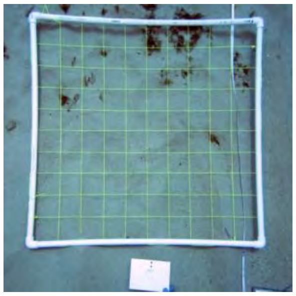
H-9m



H-16m

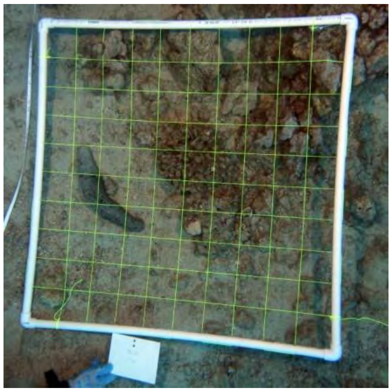


H-19m

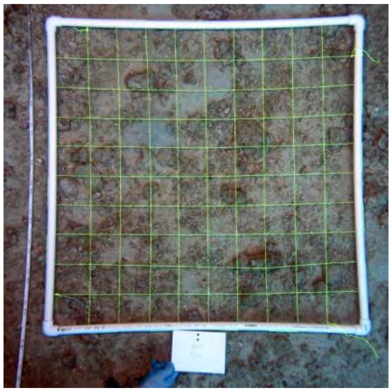


H-25m

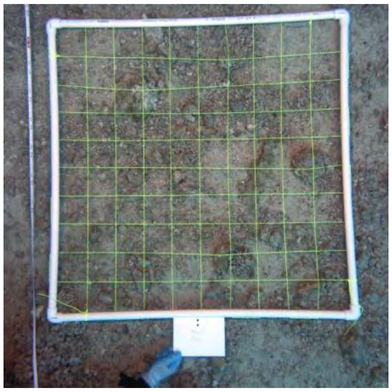
STATION 5-27m



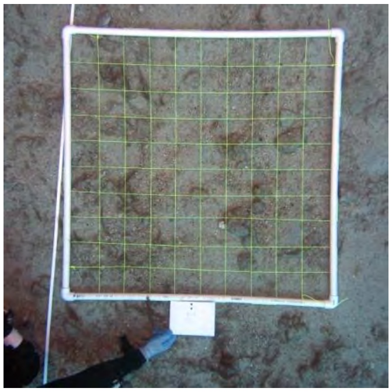
I-3m



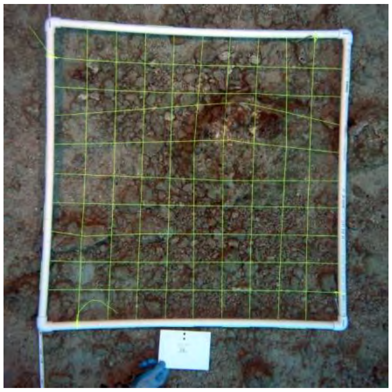
I-11m



I-16m

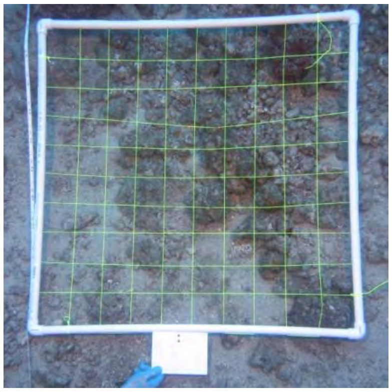


I-21m

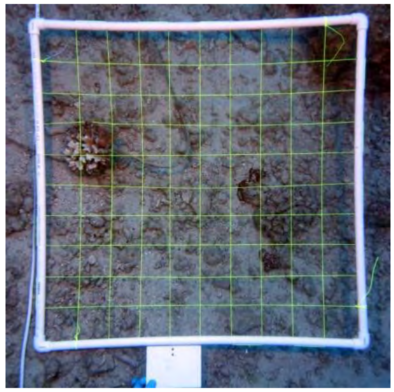


I-24m

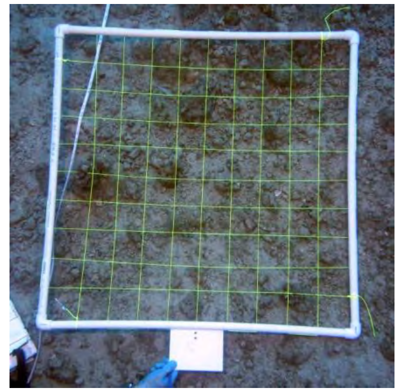
STATION 6 – 35m



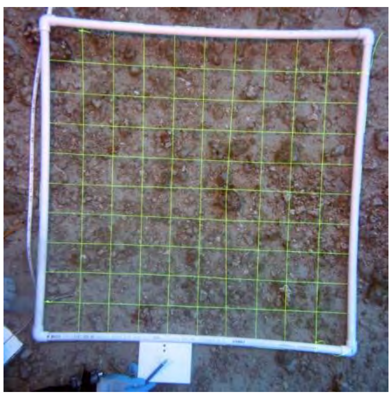
J-4m



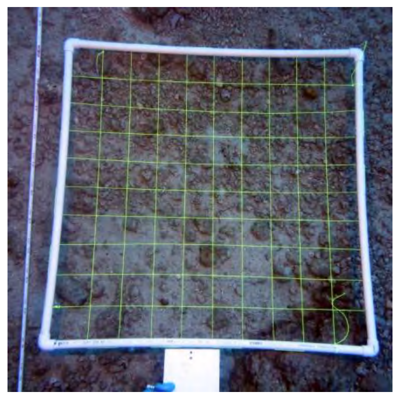
J-9m



J-13m

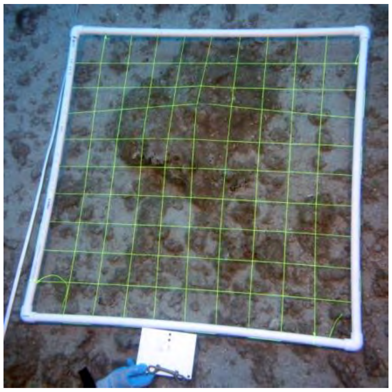


J-19m



J-21m

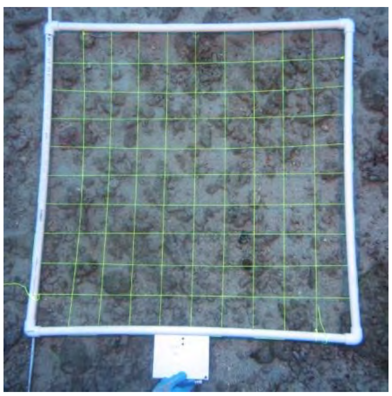
STATION 7 - 40m



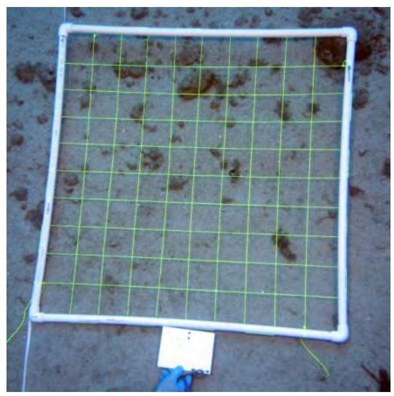
K-3m

K-6m

K-11m



K-17m



K-23m

APPENDIX 3. Summary of estimated greatest lengths of coral colonies from photographs taken in the vicinity of each of the seven transect sites. The approximate area examined in each photograph is also given (as an estimated area); photographs are presented in the text.

Date	Transect No.	Depth m	Photo# & Estimated Area	Coral Species	Coral Sizes (cm)	Numbers of Individuals
24Aug11	A (east)	8-9.5	Figure 4	*P. lobata*	18	1
			1.85 m^2		120	1
				P. compressa	15	1
					18	1
				P. meandrina	13	1
					15	1
			Figure 5	*P. lobata*	5	1
			2.20 m^2		23	2
					35	1
					38	1
				M. capitata	5	1
				M. patula	33	1
					35	1
				P. meandrina	5	1
			Figure 6	*P. lobata*	10	4
			1.85 m^2		13	1
					20	1
					25	1
					75	1
				P. meandrina	5	2
					13	3
					15	2
					18	1
					25	1
					30	1
24Aug11	B (west)	7.5-9.5	Figure 7	*P. lobata*	10	2
			2.31 m^2		13	2
					20	1
					130	1
				M. patula	46	1
				P. meandrina	10	1
					13	1
					20	2
					23	1
					33	3

APPENDIX 3. Continued.

Date	Transect No.	Depth m	Photo# & Estimated Area	Coral Species	Coral Sizes (cm)	Numbers of Individuals
			Figure 8	*P. lobata*	10	1
			0.56 m^2		15	1
					18	2
					62	1
				M. patula	25	1
				P. meandrina	8	1
					18	1
					23	2
			Figure 9	*P. lobata*	8	1
			2.31 m^2		10	1
					13	1
					18	1
					20	2
					23	2
					25	1
					46	1
					130	1
				M. patula	36	1
				P. meandrina	8	1
					12	1
					18	1
					23	1
					38	1
11Aug11	C (east)	10	Figure 10	*P. lobata*	13	2
			0.27 m^2		15	1
					18	2
					23	1
				M. capitata	25	1
				M. patula	15	1
11Aug11	D (west)	10	Figure 11	*P. eydouxi*	41	1
			1.08 m^2	*P. meandrina*	10	1
					13	1
					15	1
					18	1

APPENDIX 3. Continued.

Date	Transect No.	Depth m	Photo# & Estimated Area	Coral Species	Coral Sizes (cm)	Numbers of Individuals
				P. lobata	10	2
					13	1
					18	2
					33	1
					41	1
				M. patula	13	1
10Aug11	E (east)	14	Figure 12	*P. lobata*	200	1
			3.83 m^2	*P. eydouxi*	21	1
10Aug11	F (west)	14	Figure 13	No Coral		
			0.54 m^2			
10Aug11	G (east)	18	Figure 14	*P. lobata*	8	1
			3.83 m^2	*P. meandrina*	6	1
			Figure 15	*P. lobata*	2	4
			2.70 m^2		4	4
					6	5
					10	1
				P. meandrina	25	1
			Figure 16	*P. lobata*	2	8
			2.78 m^2		5	6
					7	3
					10	3
					13	6
					15	4
					20	2
					25	3
					30	1
					36	1
				P. lutea	20	1
				M. capitata	8	1
				P. meandrina	5	1

APPENDIX 3. Continued.

Date	Transect No.	Depth m	Photo# & Estimated Area	Coral Species	Coral Sizes (cm)	Numbers of Individuals
		18	Figure 17			
			5.49 m^2	*P. lobata*	5	3
					8	1
					10	13
					13	14
					15	13
					18	8
					20	13
					25	8
					30	1
10Aug11	H(west)		Figure 19	*P. lobata*	30	1
			0.56 m^2	*P. eydouxi*	51	1
			Figure 18	No Coral		
			4.64 m^2			
10Aug11	I	27	Figure 20	*P. lobata*	2	3
			13.94 m^2		8	4
					10	4
					15	1
			Figure 23	*P. lobata*	2	5
			2.23 m^2		10	4
					15	4
					20	4
					25	1
			Figure 22	*P. lobata*	2	1
			0.09 m^2		3	3
					5	2
					8	1
				P. compressa	8	1
			Figure 21	*P. lobata*	1	2
			0.56 m^2		2	4
					3	2

APPENDIX 3. Continued.

Date	Transect No.	Depth m	Photo# & Estimated Area	Coral Species	Coral Sizes (cm)	Numbers of Individuals
			Figure 24	*P. lobata*	10	1
			0.56 m^2		15	2
				M. capitata	3	1
				Leptastrea sp.	15	1
				P. meandrina	6	1
09Aug11	J	35	Figure 25 2.78 m^2	No corals		
			Figure 26 3.72 m^2	*P. lobata*	10	1
			Figure 27 5.58 m^2	No corals		
09Aug11	K	40	Figure 29 2.91 m^2	*P. lobata*	14	1
			Figure 28	*P. lobata*	4	1
			1.85 m^2	*P. meandrina*	4	1

APPENDIX 4. List of macroinvertebrates other than corals seen in photographs taken in the vicinity of each of the eleven transects. Photographs are presented in Appendix 4.

Transect	Figure No.	Photo Area (m^2)	Invertebrate Species # Individuals & Common Name
A	4	1.85	*Pinctado margaritifera* (1; Pa or pearl oyster)
			Echinothrix diadema (1; wana)
	5	2.20	*Echinothrix diadema* (4; wana)
	6	1.85	*Echinothrix diadema* (2; wana)
			Echinostrephus aciculatum (1; boring urchin)
B	7	2.31	*Echinothrix diadema* (5; wana)
	8	0.56	*Echinothrix diadema* (1; wana)
	9	2.31	*Echinothrix diadema* (1; wana)
C	10	0.27	No macroinverts
D	11	1.08	No macroinverts
	Note: 1 juvenile *Panulirus marginatus* seen		
E	12	3.83	No macroinverts
F	13	0.54	No macroinverts
G	14	3.83	*Tripneustes gratilla* (14, collector urchin)
			Echinothrix diadema (1; wana)
	15	2.70	*Tripneustes gratilla* (8; collector urchin)
	17	5.49	*Tripneustes gratilla* (19; collector urchin)
			Echinothrix diadema (1; wana)
	16	2.78	*Echinothrix diadema* (2; wana)
			Tripneustes gratilla (10; collector urchin)
			Echinostrephus aciculatum (1; boring urchin)
H	19	0.56	No macroinverts
	18	4.64	No macroinverts

(See Next Page)

APPENDIX 4. Continued.

Transect	Figure No.	Photo Area (m^2)	Invertebrate Species # Individuals & Common Name
I	20	13.94	*Pseudoboletia indiana* (1; pebble collector urchin)
	23	2.23	*Echinothrix diadema* (2; wana)
	22	0.09	*Tripneustes gratilla* (1; collector urchin)
	21	0.56	No macroinverts
	24	0.56	*Echinothrix diadema* (1; wana)
	Note: one *Scyllarides squamosus* ~30 cm long seen		
J	25	2.78	No macroinverts
	26	3.72	No macroinverts
	27	5.58	No macroinverts
	Note: 8 *Pseudoboletia indiana* and 1 *Echinothrix diadema* recorded		
K	29	2.91	No macroinverts
	28	1.85	No macroinverts

APPENDIX 5. List of the fish species and their abundance on each of eleven transects carried out over seven stations. Transects A and B were done at Station 1 (9.5m deep) , C and D at Station 2 (10m deep), E and F at Station 3 (13.7 m deep), G and H at Station 4 (18m deep), Transect I at Station 5 (27m deep), J at Station 6 (35m deep) and K at Station 7 (40 m deep). At the foot of the table are given the totals for each transect and the estimated standing crop.

SPECIES	A	B	C	D	E	F	G	H	I	J	K
SYNODONTIDAE											
Synodus ulae									1		
HOLOCENTRIDAE											
Myripristis amaenus					6						
APOGONIDAE											
Pristiapogon kallopterus					9						
MALACANTHIDAE											
Malacanthus hoedti	2										
LUTJANIDAE											
Aprion virescens		1									
SPARIDAE											
Monotaxis grandoculis		8									
MULLIDAE											
Mulloides vanicolensis					3						
Parupeneus pleurostigma				4							8
Parupeneus multifasciatus	4	5		8	7						
CHAETODONTIDAE											
Chaetodon multicinctus		2					2				
Chaetodon miliaris					1						
POMACENTRIDAE											
Dascyllus albisella	13			1	21			1			9
Plectroglyphidodon johnstonianus	2	3		2							
Chromis vanderbilti	14	17			1						
Chromis ovalis		14									
Chromis hanui	2				1		1				
Stegastes fasciolatus	4										
Stegastes marginatus			1	1							
CIRRHITIDAE											
Paracirrhites arcatus	1		2	1							
Cirrhitops fasciatus					1						
LABRIDAE											
Labroides phthirophagus		1			2						
Bodianus albotaeniatus			1								1
Bodianus bilunulatus		1									
Oxycheilinus bimaculatus	1		3		6		2			1	5
Pseudocheilinus evanidus		2								3	
Pseudocheilinus octotaenia	1	1	2								
Cirrhilabrus jordani	1	1					1				2

TABLE 6. Continued.

SPECIES	A	B	C	D	E	F	G	H	I	J	K
LABRIDAE											
Novaculichthys taeniourus		1									
Cymolutes sp.						1					
Thalassoma duperrey	10	24		3	8						
Coris venusta	4	3	2		1						
Coris gaimard	1	1			1						
Pseudojuloides cerasinus	1	1	1	4	4	1	3				
Stethojulis balteata	4										
Macropharyngodon geoffroy	1	1									
Anampses chrysocephalus					1						
Anampses cuvier		1									
SCARIDAE											
Calotomus carolinus		7									
Scarus rubroviolaceus		1	1		2						
PARAPERCIDAE											
Parapercis schaunslandi	1								2	1	2
ACANTHURIDAE											
Acanthurus triostegus		19									
Acanthurus nigrofuscus	2	9	1		2						
Acanthurus nigroris	1										
Acanthurus blochi		1									
Acanthurus olivaceus	2	6	9				2				
Acanthurus dussumieri	1										
Naso hexacanthus		19									
Naso lituratus		4									
Naso unicornis		2									
ZANCLIDAE											
Zanclus cornutus		1									
BALISTIDAE											
Rhinecanthus rectangulus	1	1									
Melichthys niger		19									
Sufflamen bursa				1							
MONACANTHIDAE											
Pervagor melanocephalus		1									
TETRAODONTIDAE											
Canthigaster coronata									1		
Canthigaster jactator	3		5			2	1		2		2
Number of Species	24	32	11	9	18	3	7	1	4	3	7
Number of Individuals	77	178	28	106	77	4	12	1	6	5	29
Biomass (g/m2)	23	224	53	8	23	0.3	11	0.03	1	1	4

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APPENDIX F
SAND ISLAND WWTP OCEAN OUTFALL
WATER QUALITY MONITORING DATA

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Appendix F Sand Island WWTP Ocean Outfall Water Quality Monitoring Data

Units are µg/L except turbidity, which is in Nephelometric Turbidity Units (NTU)

Station	*Date*	*NO2+NO3*	*NH4*	*TN*	*TP*	*Turb*	*Chl*
C4 (surface)	3/30/2006	19.00	6.00	106.00	11.00	1.14	0.47
	5/17/2006	1.00	1.00	103.00	7.00	0.25	0.22
	8/1/2006	1.00	1.00	73.00	7.00	0.21	0.17
	10/24/2006	1.00	2.00	98.00	6.00	0.14	0.15
	1/24/2007	4.00	2.00	97.00	7.00	0.50	0.27
	4/10/2007	2.00	1.00	85.00	7.00	0.19	0.17
	7/11/2007	1.00	1.00	136.00	6.00	0.20	0.17
	10/3/2007	2.00	3.00	82.00	5.00	0.23	0.13
	2/4/2008	2.00	1.00	118.00	8.00	0.33	0.17
	4/16/2008	1.00	3.00	90.00	8.00	0.38	0.09
	7/9/2008	2.00	2.00	87.00	7.00	0.20	0.21
	10/1/2008	1.00	1.00	86.00	6.00	0.16	0.16
	2/18/2009	2.00	1.00	88.00	5.00	0.26	0.22
	4/7/2009	2.00	1.00	74.00	8.00	0.28	0.17
	7/28/2009	1.00	1.00	101.00	7.00	0.23	0.18
	11/17/2009	1.00	1.00	74.00	6.00	0.17	0.17
	2/17/2010	1.00	1.00	78.00	7.00	0.14	0.16
	7/7/2010	2.00	1.00	109.00	9.00	0.26	0.10
	11/4/2010	3.00	1.00	128.00	7.00	0.21	0.22
	2/8/2011	1.00	3.00	77.00	7.00	0.26	0.34
	GM	1.67	1.43	92.97	6.94	0.25	0.18
C4 (mid)	3/30/2006	1.00	1.00	77.00	7.00	0.38	0.18
	5/17/2006	1.00	1.00	89.00	6.00	0.23	0.22
	8/1/2006	1.00	1.00	74.00	7.00	0.18	0.18
	10/24/2006	2.00	2.00	96.00	5.00	0.18	0.17
	1/24/2007	1.00	2.00	88.00	6.00	0.30	0.30
	4/10/2007	2.00	1.00	98.00	7.00	0.22	0.19
	7/11/2007	1.00	1.00	120.00	7.00	0.22	0.17
	10/3/2007	2.00	3.00	85.00	5.00	0.24	0.13
	2/4/2008	2.00	1.00	133.00	7.00	0.38	0.16
	4/16/2008	1.00	3.00	89.00	8.00	0.44	0.11
	7/9/2008	2.00	3.00	77.00	7.00	0.14	0.23
	10/1/2008	1.00	1.00	89.00	8.00	0.28	0.18
	2/18/2009	1.00	1.00	90.00	6.00	0.41	0.22
	4/7/2009	2.00	1.00	77.00	8.00	0.27	0.19
	7/28/2009	1.00	1.00	101.00	7.00	0.23	0.18

Station	Date	NO2+NO3	NH4	TN	TP	Turb	Chl
	11/17/2009	1.00	1.00	75.00	6.00	0.20	0.16
	2/17/2010	1.00	1.00	79.00	7.00	0.13	0.21
	7/7/2010	1.00	1.00	106.00	9.00	0.22	0.23
	11/4/2010	1.00	1.00	98.00	7.00	0.11	0.18
	2/8/2011	0.50	4.00	75.00	7.00	0.20	0.36
	GM	1.19	1.35	89.64	6.78	0.23	0.19
C4 (bottom)	3/30/2006	2.00	1.00	78.00	7.00	0.24	0.19
	5/17/2006	1.00	1.00	85.00	6.00	0.17	0.23
	8/1/2006	1.00	2.00	77.00	8.00	0.43	0.29
	10/24/2006	2.00	1.00	126.00	5.00	0.16	0.18
	1/24/2007	1.00	2.00	83.00	6.00	0.15	0.29
	4/10/2007	2.00	1.00	94.00	8.00	0.25	0.18
	7/11/2007	1.00	1.00	121.00	6.00	0.25	0.17
	10/3/2007	1.00	4.00	81.00	5.00	0.41	0.16
	2/4/2008	4.00	1.00	135.00	7.00	0.37	0.16
	4/16/2008	1.00	4.00	89.00	8.00	0.18	0.15
	7/9/2008	1.00	1.00	86.00	8.00	0.22	0.26
	10/1/2008	2.00	1.00	90.00	8.00	0.30	0.18
	2/18/2009	2.00	1.00	96.00	6.00	0.55	0.26
	4/7/2009	2.00	1.00	78.00	9.00	0.36	0.18
	7/28/2009	1.00	1.00	92.00	7.00	0.24	0.25
	11/17/2009	2.00	1.00	89.00	7.00	0.43	0.19
	2/17/2010	1.00	1.00	78.00	7.00	0.16	0.20
	7/7/2010	1.00	1.00	114.00	9.00	0.27	0.15
	11/4/2010	2.00	1.00	93.00	7.00	0.16	0.16
	2/8/2011	1.00	2.00	80.00	8.00	0.33	0.80
	GM	1.41	1.27	91.92	7.00	0.26	0.21
D4 (surface)	3/30/2006	1.00	1.00	79.00	5.00	0.18	0.16
	5/17/2006	1.00	1.00	95.00	6.00	0.14	0.18
	8/1/2006	1.00	4.00	79.00	7.00	0.24	0.23
	10/24/2006	1.00	1.00	83.00	6.00	0.09	0.13
	1/24/2007	1.00	1.00	84.00	6.00	0.21	0.21
	4/10/2007	1.00	1.00	111.00	8.00	0.22	0.18
	7/11/2007	1.00	1.00	117.00	6.00	0.10	0.12
	10/3/2007	1.00	1.00	112.00	5.00	0.14	0.07
	2/4/2008	1.00	1.00	96.00	7.00	0.22	0.19
	4/16/2008	1.00	3.00	102.00	8.00	0.26	0.08

Station	***Date***	***NO2+NO3***	***NH4***	***TN***	***TP***	***Turb***	***Chl***
	7/9/2008	1.00	3.00	84.00	5.00	0.12	0.11
	10/1/2008	1.00	1.00	62.00	7.00	0.20	0.30
	2/18/2009	1.00	5.00	85.00	5.00	0.24	0.19
	4/7/2009	1.00	1.00	55.00	5.00	0.24	0.09
	7/28/2009	1.00	1.00	81.00	6.00	0.24	0.07
	11/17/2009	1.00	1.00	68.00	6.00	0.12	0.11
	2/17/2010	1.00	4.00	118.00	7.00	0.11	0.21
	4/6/2010	1.00	2.00	92.00	8.00	0.12	0.14
	7/7/2010	1.00	1.00	98.00	8.00	0.19	0.12
	11/4/2010	1.00	1.00	80.00	7.00	0.11	0.16
	2/8/2011	1.00	4.00	88.00	7.00	0.21	0.27
	GM	1.00	1.51	87.40	6.34	0.17	0.15
D4 (mid)	3/30/2006	1.00	1.00	72.00	5.00	0.21	0.17
	5/17/2006	1.00	1.00	103.00	6.00	0.12	0.13
	8/1/2006	1.00	6.00	77.00	7.00	0.14	0.27
	10/24/2006	1.00	1.00	109.00	6.00	0.11	0.14
	1/24/2007	1.00	1.00	101.00	6.00	0.22	0.23
	4/10/2007	1.00	1.00	84.00	7.00	0.18	0.18
	7/11/2007	1.00	1.00	124.00	6.00	0.17	0.13
	10/3/2007	1.00	1.00	99.00	5.00	0.13	0.08
	2/4/2008	1.00	1.00	85.00	7.00	0.22	0.20
	4/16/2008	1.00	3.00	136.00	8.00	0.32	0.11
	7/9/2008	1.00	4.00	89.00	8.00	0.14	0.11
	10/1/2008	1.00	1.00	79.00	8.00	0.26	0.27
	2/18/2009	1.00	1.00	75.00	6.00	0.22	0.22
	4/7/2009	1.00	1.00	58.00	5.00	0.26	0.08
	7/28/2009	1.00	1.00	80.00	6.00	0.18	0.08
	11/17/2009	1.00	1.00	72.00	6.00	0.14	0.23
	2/17/2010	1.00	3.00	128.00	8.00	0.10	0.24
	4/6/2010	1.00	2.00	93.00	8.00	0.11	0.15
	7/7/2010	1.00	1.00	90.00	7.00	0.20	0.13
	11/4/2010	1.00	1.00	84.00	6.00	0.11	0.19
	2/8/2011	1.00	3.00	96.00	7.00	0.18	0.09
	GM	1.00	1.41	90.18	6.49	0.17	0.15
D4 (bottom)	3/30/2006	2.00	1.00	102.00	6.00	0.20	0.19
	5/17/2006	2.00	4.00	88.00	6.00	0.14	0.21
	8/1/2006	1.00	5.00	73.00	6.00	0.21	0.28
	10/24/2006	1.00	1.00	94.00	6.00	0.10	0.15

Station	***Date***	***NO2+NO3***	***NH4***	***TN***	***TP***	***Turb***	***Chl***
	1/24/2007	1.00	10.00	120.00	7.00	0.28	0.21
	4/10/2007	1.00	1.00	113.00	7.00	0.26	0.26
	7/11/2007	1.00	1.00	135.00	6.00	0.17	0.15
	10/3/2007	1.00	1.00	77.00	5.00	0.12	0.11
	2/4/2008	1.00	1.00	85.00	7.00	0.22	0.18
	4/16/2008	1.00	3.00	108.00	7.00	0.56	0.13
	7/9/2008	3.00	12.00	107.00	11.00	1.20	0.43
	10/1/2008	1.00	1.00	103.00	6.00	0.36	0.21
	2/18/2009	1.00	2.00	100.00	5.00	0.60	0.25
	4/7/2009	1.00	1.00	68.00	6.00	0.23	0.13
	7/28/2009	1.00	1.00	84.00	11.00	1.63	0.62
	11/17/2009	3.00	2.00	76.00	6.00	0.17	0.22
	2/17/2010	2.00	1.00	129.00	6.00	0.12	0.30
	4/6/2010	1.00	2.00	96.00	8.00	0.16	0.16
	7/7/2010	1.00	1.00	99.00	8.00	0.26	0.13
	11/4/2010	1.00	1.00	83.00	6.00	0.11	0.25
	2/8/2011	1.00	1.00	77.00	7.00	0.10	0.21
	GM	1.23	1.69	94.41	6.66	0.24	0.21
E4 (surface)	3/30/2006	1.00	1.00	73.00	5.00	0.14	0.16
	5/17/2006	1.00	1.00	82.00	6.00	0.18	0.05
	8/1/2006	1.00	3.00	74.00	7.00	0.11	0.16
	10/24/2006	1.00	1.00	116.00	6.00	0.15	0.12
	1/24/2007	1.00	1.00	84.00	6.00	0.14	0.18
	4/10/2007	1.00	1.00	93.00	7.00	0.18	0.21
	7/11/2007	1.00	1.00	123.00	7.00	0.15	0.15
	10/3/2007	1.00	1.00	89.00	6.00	0.19	0.08
	2/4/2008	1.00	3.00	89.00	7.00	0.22	0.21
	4/16/2008	1.00	3.00	158.00	14.00	0.30	0.10
	7/9/2008	1.00	2.00	87.00	7.00	0.11	0.07
	10/1/2008	1.00	4.00	58.00	6.00	0.15	0.29
	2/18/2009	1.00	4.00	84.00	6.00	0.26	0.32
	4/7/2009	1.00	1.00	59.00	4.00	0.42	0.07
	7/28/2009	1.00	3.00	100.00	7.00	0.17	0.05
	11/17/2009	1.00	1.00	68.00	6.00	0.28	0.09
	2/17/2010	1.00	1.00	108.00	7.00	0.14	0.13
	4/6/2010	1.00	1.00	101.00	8.00	0.16	0.12
	7/7/2010	1.00	5.00	117.00	9.00	0.22	0.14
	11/4/2010	1.00	1.00	95.00	7.00	0.11	0.17
	2/8/2011	1.00	6.00	96.00	8.00	0.23	0.34

Station	***Date***	***NO2+NO3***	***NH4***	***TN***	***TP***	***Turb***	***Chl***
	GM	1.00	1.71	90.48	6.75	0.18	0.13
E4 (mid)	3/30/2006	1.00	1.00	81.00	5.00	0.12	0.20
	5/17/2006	1.00	1.00	88.00	6.00	0.18	0.06
	8/1/2006	1.00	5.00	83.00	8.00	0.15	0.32
	10/24/2006	1.00	1.00	77.00	6.00	0.93	0.13
	1/24/2007	1.00	6.00	89.00	7.00	0.24	0.18
	4/10/2007	1.00	10.00	96.00	9.00	0.21	0.23
	7/11/2007	1.00	2.00	139.00	7.00	0.24	0.14
	10/3/2007	1.00	1.00	79.00	7.00	0.16	0.13
	2/4/2008	2.00	2.00	113.00	8.00	0.24	0.20
	4/16/2008	1.00	3.00	91.00	7.00	0.36	0.13
	7/9/2008	1.00	16.00	97.00	9.00	0.24	0.59
	10/1/2008	1.00	4.00	75.00	6.00	0.16	0.17
	2/18/2009	1.00	1.00	63.00	6.00	0.24	0.19
	4/7/2009	1.00	1.00	58.00	5.00	0.13	0.07
	7/28/2009	1.00	2.00	71.00	7.00	0.23	0.19
	11/17/2009	2.00	9.00	78.00	8.00	0.25	0.25
	2/17/2010	2.00	1.00	137.00	7.00	0.12	0.29
	4/6/2010	1.00	3.00	85.00	8.00	0.09	0.13
	7/7/2010	1.00	4.00	95.00	7.00	0.15	0.17
	11/4/2010	1.00	2.00	77.00	6.00	0.09	0.22
	2/8/2011	1.00	2.00	89.00	6.00	0.12	0.08
	GM	1.10	2.48	86.63	6.82	0.19	0.17
E4 (bottom)	3/30/2006	4.00	1.00	78.00	6.00	0.23	0.20
	5/17/2006	7.00	1.00	85.00	5.00	0.11	0.12
	8/1/2006	3.00	4.00	85.00	5.00	0.15	0.22
	10/24/2006	1.00	1.00	99.00	6.00	0.10	0.17
	1/24/2007	3.00	2.00	87.00	6.00	0.16	0.16
	4/10/2007	6.00	11.00	115.00	8.00	0.23	0.19
	7/11/2007	1.00	2.00	134.00	6.00	0.16	0.22
	10/3/2007	9.00	1.00	85.00	7.00	0.16	0.14
	2/4/2008	7.00	1.00	134.00	7.00	0.15	0.17
	4/16/2008	1.00	2.00	143.00	6.00	0.25	0.26
	7/9/2008	9.00	4.00	110.00	9.00	0.20	0.24
	10/1/2008	2.00	7.00	107.00	6.00	0.19	0.19
	2/18/2009	4.00	3.00	91.00	6.00	0.26	0.23
	4/7/2009	4.00	4.00	69.00	6.00	0.14	0.21
	7/28/2009	5.00	3.00	77.00	6.00	0.21	0.26

Station	***Date***	***NO2+NO3***	***NH4***	***TN***	***TP***	***Turb***	***Chl***
	11/17/2009	8.00	1.00	76.00	6.00	0.16	0.11
	2/17/2010	4.00	1.00	144.00	7.00	0.15	0.29
	4/6/2010	8.00	1.00	100.00	8.00	0.16	0.25
	7/7/2010	4.00	4.00	103.00	8.00	0.32	0.25
	11/4/2010	11.00	3.00	90.00	7.00	0.08	0.11
	2/8/2011	10.00	2.00	99.00	7.00	0.08	0.08
	GM	4.25	2.14	98.29	6.50	0.16	0.18

GM = Geometric Mean

APPENDIX G
HSWAC PROPOSED WATER QUALITY AND BIOTA MONITORING PROGRAM

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PROPOSED WATER QUALITY AND BIOTA MONITORING PLAN HONOLULU SEAWATER AIR CONDITIONING

April 2013

Copy Control Number _______

RECORD OF CHANGES

To ensure that the Field Sampling Plan is current at all times and distributed to all appropriate personnel, changes issued to this plan are to be entered and recorded on this page.

Change Number	Date of Change	Subject or Description of Change	Entered By (Initials)/Date
1			
2			
3			
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LIST OF ACRONYMS AND ABBREVIATIONS

AMAP	Applicable Monitoring and Assessment Plan
CWB	Clean Water Branch
EIS	Environmental Impact Statement
ESE	East Southeast
FSP	Field Sampling Plan
ft	feet
GPS	global positioning system
HDOH	Hawaii Department of Health
HECO	Hawaii Electric Company, Inc.
HSWAC	Honolulu Sea Water Air Conditioning, LLC
M	meter
ml	milliliters
NNE	North Northeast
NPDES	National Pollutant Discharge Elimination System
PCBs	polychlorinated biphenyls
pH	potential hydrogen
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
SCUBA	Self Contained Underwater Breathing Apparatus
SSW	South Southwest
TEC	Cardno TEC, Inc.
USEPA	Unites States Environmental Protection Agency
USGS	United States Geological Survey
WNW	West Northwest
WWTP	wastewater treatment plant
ZOM	Zone of Mixing

1.0 INTRODUCTION

The Field Sampling Plan (FSP) presented herein was prepared for Honolulu Sea Water Air Conditioning, LLC, (HSWAC) for submittal to the Hawaii Department of Health (HDOH), Clean Water Branch (CWB) as part of the Applicable Monitoring and Assessment Plan (AMAP) required as a component of the application for a Section 401 Water Quality Certification. The FSP describes the program of water quality monitoring and marine biological surveying in offshore areas potentially affected by construction and operation of the HSWAC offshore pipes in Mamala Bay. The objectives of the program are to ensure: (1) the data quality objectives specified for this project are met; (2) the field sampling protocols are documented and reviewed in a consistent manner; and (3) the data collected are scientifically valid and defensible.

Field personnel conducting the water quality sampling and marine biological surveying are required to read the FSP. A copy of the FSP shall be in the possession of the field team during sampling. All contractors and subcontractors shall be required to comply with the procedures documented in this FSP in order to maintain comparability and representability of the data collected and generated during these investigations.

The Cardno TEC, Inc. (TEC) Project Manager shall control distribution of the FSP to ensure the current and approved version is being used. A sequential numbering system shall be used to identify controlled copies of the FSP and the respective recipients. Controlled copies shall be provided to applicable project personnel, HSWAC managers, regulatory agencies, and quality assurance (QA) coordinators. Whenever revisions are made or addenda added, the document control system shall be used to assure (1) all parties holding a controlled copy of the FSP receive the revisions/addenda, and (2) outdated material is removed from circulation. The document control system does not preclude making and using copies of the FSP; however, the holders of controlled copies are responsible for distributing additional material to update any copies within their organizations. TEC's Project Manager shall maintain the distribution list for controlled copies.

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2.0 PROJECT BACKGROUND

The HSWAC project is proposed for the downtown area of Honolulu, on the leeward shores of Oahu. Large diameter seawater intake and return pipes will be deployed offshore of Honolulu in the area between Honolulu Harbor and Kewalo Basin. Cold, deep seawater will be pumped through heat exchangers on shore and then returned to the sea at a shallower depth. Additional project details are included in the body of the AMAP.

2.1 PURPOSE AND SCOPE OF THE FIELD INVESTIGATIONS

Installation and operation of the seawater pipes may affect water quality and/or marine biota and consequently numerous permits are required, including a Section 401 Water Quality Certification for construction activities and an Individual National Pollutant Discharge Elimination System (NPDES) permit for the return seawater discharge. Each of these permits will require environmental monitoring; however, at this writing, discussions are ongoing with the CWB about the size and shape of a Zone of Mixing (ZOM) for the return seawater, and therefore the precise locations of the monitoring stations around the ZOM cannot be specified at this time. Once the ZOM is defined, this plan will be updated to include the precise monitoring locations and depths. This FSP describes the parameters to be monitored, how the monitoring locations and depths will be specified, and monitoring frequencies for the construction and operations phases of the HSWAC project.

2.2 PROJECT SITE DESCRIPTION

Mamala Bay includes the ocean area from Diamond Head to Kalaeloa (Barbers Point) on the southern coast of Oahu. The bay fronts the most urbanized portion of the State, including Honolulu and has historically been the recipient of both natural and anthropogenic discharges. Discharges from Nuuanu, Kapalama, Kalihi, Moanalua, Manoa, and other streams and storm drains enter Mamala Bay through Pearl Harbor, Honolulu Harbor, the Ala Wai Canal and nearby Keehi Lagoon, carrying nonpoint source runoff from Honolulu's streets and suburbs into the Bay. Sewage has been pumped into the ocean offshore of Kewalo and Sand Island since the 1930's. Early inputs were raw sewage released in shallow-water (not exceeding 20 feet in depth). The actual points of release varied through time as different pipes were constructed and used. The multitude of perturbations that occurred in shallow-water from these early sewage inputs continued until the construction of the present Sand Island deep ocean outfall in 1978 (Brock, 1998). Currently, three wastewater treatment plant (WWTP) outfalls (Sand Island, Fort Kamehameha, and Honouliuli) discharge into Mamala Bay.

The HSWAC pipeline corridor is close to the entrance to Honolulu Harbor. Honolulu Harbor has been the primary commercial port for the State of Hawaii since before the turn of the century (Scott, 1968). The harbor is the result of dredging what was originally the drainage basin of Nuuanu Stream. Dredging began before 1900, and periodic maintenance dredging still occurs. Until about 1960, spoils were dropped just outside of the harbor, generally to the east of the Sand Island WWTP Deep Ocean Outfall (Brock, 1998). This is the area proposed for the HSWAC pipelines. An Environmental Protection Agency (EPA) approved dredged material dump site now lays in deeper water to the west. Other physical perturbations to the pipeline corridor area include dragging of barge tow cables on the seafloor by tugs as they enter and exit the Harbor, seasonally large surf events in the summer, and occasional storm surge.

Honolulu Harbor discharges just west of the proposed pipeline corridor. Two streams, Kapalama and Nuuanu, and numerous ditches and storm drains discharge into Honolulu Harbor, along with associated pollutants. Honolulu Harbor is also ringed with industry. Pollution is well known in the harbor; poor conditions are described as early as 1920 in references cited by Cox and Gordon (1970). Water quality in the Kapalama Basin portion of the harbor is particularly poor because of discharges from Kapalama Stream. The parameters of greatest concern in the Harbor are nutrients, metals, suspended solids, pathogens, and turbidity (HDOH, 1998). Coliform bacteria, nitrogen, phosphorus, and turbidity levels in the water regularly exceed State water quality standards. In 1978 and subsequent HDOH sampling, heavy metals, chlorinated pesticides, polychlorinated biphenyls (PCBs), chlordane, and dieldrin (a toxic chlorinated organic compound used in insecticides) have been identified in harbor waters. The Harbor also receives the thermal effluents from HECO's Honolulu Generating Station.

At the shoreline adjacent to the proposed path of the drilled shaft or tunnel is an abandoned, capped but unlined landfill. While in operation, this landfill (now part of Kakaako Waterfront Park) received both incinerated and unmodified wastes from urban Honolulu. Between 1927 and 1977 a debris mound 400-feet wide by 1,700-feet long and 15 to 55-feet in elevation was created (Wilson Okamoto & Associates, 1998). The mound was reshaped in conjunction with development of the park. At its highest point the mound is currently 53-feet in elevation (Wilson Okamoto & Associates, 1998). Because the landfill filled in a section of old coastline in excess of 330-feet seaward, materials along the seaward side are exposed to seawater and there is a potential for leaching of pollutants (Brock, 1998).

Bottom photography conducted during the 1977/1978 dredged materials dump site study also shows that anthropogenic debris litters the seafloor of Mamala Bay (Chave and Miller, 1977a, 1977b, 1978; Tetra Tech 1977). Video and still photography collected during a United States Geological Survey (USGS) survey conducted in May 1994 (Torresan, et al, 1994) documents the debris to include military ordnance, barrels, and a variety of canisters, tires, and lengths of wire rope.

3.0 FIELD ACTIVITIES

Installation of the seawater pipes and operation of the seawater pipes present different types of potential environmental impacts and will take place at different locations and at different times. Therefore, in the following descriptions, the two project phases are addressed separately.

3.1 VESSEL OPERATIONS

Each project phase will require both water quality and marine biological monitoring. A small boat will be leased for field operations. The vessel operator will be responsible for providing all necessary safety equipment, applicable insurance and a licensed captain. Safety briefings shall be conducted prior to each sampling event.

3.2 SAMPLING LOCATIONS

The route of the intake and discharge pipelines and their terminal locations are shown on Figure 3-1. Also shown are the portions of the route that will be tunneled beneath the seabed, the nearshore jacking pit, the tunnel breakout point at approximately 31 feet deep, the portions of the route where the pipes will be fixed to the bottom, and the location of the return seawater diffuser in 326-423 feet of water.

3.2.1 Construction Phase

The primary concern during construction is generation of turbidity at the receiving pit; however, because of the potential for effects on pH and dissolved oxygen concentrations, it will be necessary to monitor these parameters and depth as well. The construction monitoring will encompass development of a pre-construction baseline, during construction monitoring and a post-construction survey.

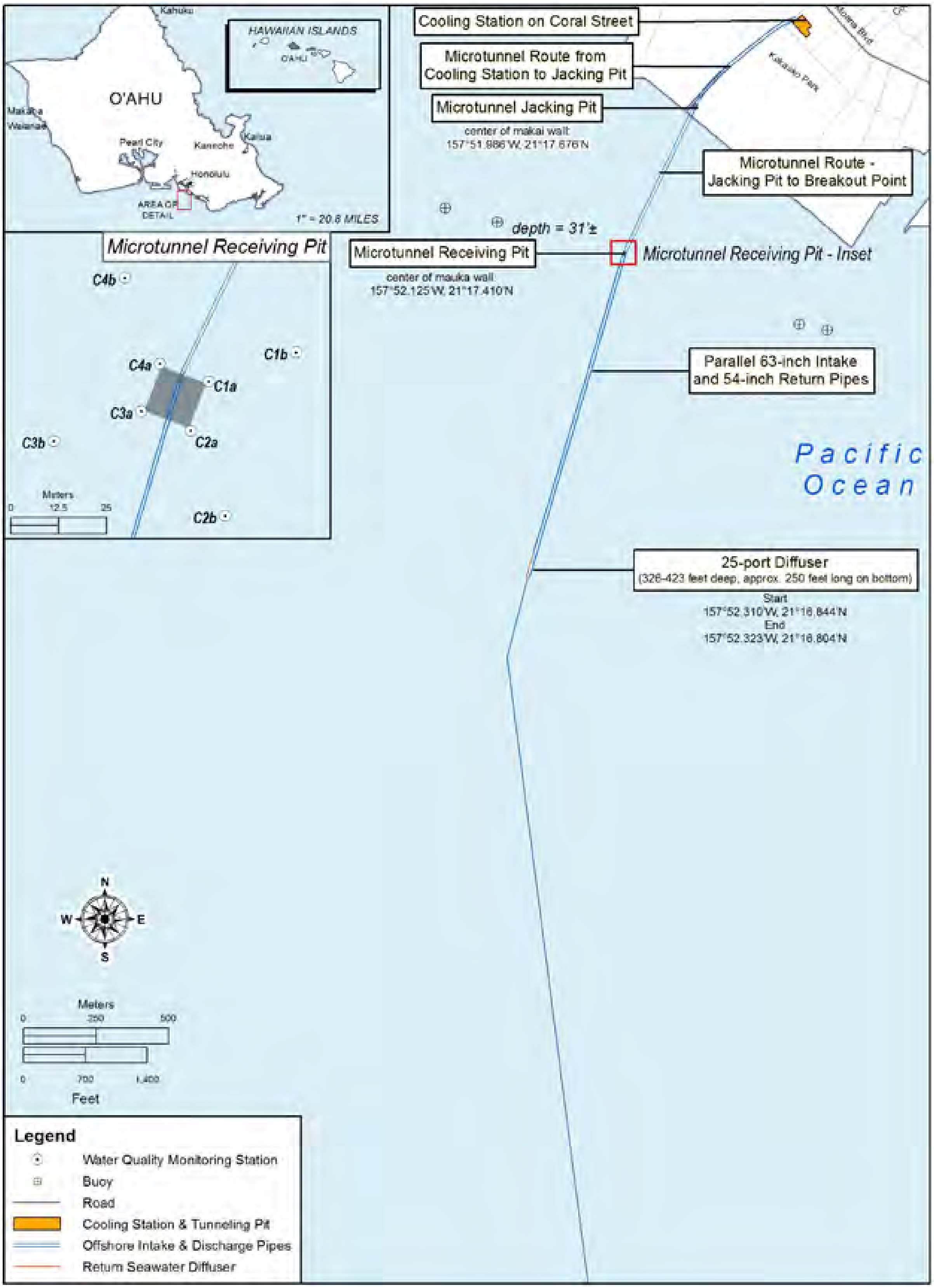

Figure 3-1: Locations of HSWAC Seawater System Infrastructure and Construction Phase Water Quality Monitoring Stations

As noted above in the description of the project area, there are numerous continuous and intermittent discharges and disturbances to Mamala Bay. It will be important to differentiate any HSWAC project-related effects from those caused by other factors, natural and anthropomorphic. Consequently, it will be necessary to include some sampling stations that will be out of the range of potential effects from the HSWAC Project. While these stations may be considered “control stations” with regard to HSWAC effects, they will be subject to effects originating from other influences.

With both biota and water quality, evidence of an HSWAC-related impact will be a statistically significant change when comparing baseline conditions to subsequent conditions. Comparisons will be made with the data from control sites relative to the “experimental” sites to demonstrate that a significant change occurring at an experimental site is due to construction activities or operations and not due to some natural or unrelated anthropomorphic event.

Water Quality

The intention of the monitoring program is to determine if construction or operations of the HSWAC system result in water quality conditions that may adversely affect nearby biota. Mamala Bay is the recipient of pollutants from a variety of sources including land-based point and non-point sources, ocean wastewater outfalls, and in situ bottom sediments mobilized by winds, waves or currents. Therefore, it is necessary to be able to distinguish between the effects of HSWAC construction or operations and effects from other sources. The proposed monitoring plan does this by positioning primary stations (“a” stations) immediately adjacent to the receiving pit and ZOM, and secondary stations (“b” stations) farther away where potential HSWAC influences will be less. Construction monitoring stations will be located as follows and as shown on Figure 3-1:

- Station C1a – One meter from the NE corner of the receiving pit,
- Station C1b – Twenty-five meters from the NE corner of the receiving pit,
- Station C2a – One meter from the SE corner of the receiving pit,
- Station C2b – Twenty-five meters from the SE corner of the receiving pit,
- Station C3a – One meter from the SW corner of the receiving pit,
- Station C3b – Twenty-five meters from the SW corner of the receiving pit,
- Station C4a – One meter from the NW corner of the receiving pit,
- Station C4b – Twenty-five meters from the NW corner of the receiving pit,

At each of these stations replicate samples will be collected from each of two depths, near surface and near bottom. A similar pattern of station locations will be established for operational monitoring. These are not included on Figure 3-1 because the position of the ZOM has not yet been finalized, but in concept they will be as follows:

- Station O1a – Five meters from the NE corner of the ZOM,
- Station O1b – One hundred meters from the NE corner of the ZOM,
- Station O2a – Five meters from the SE corner of the ZOM,
- Station O2b – One hundred meters from the SE corner of the ZOM,
- Station O3a – Five meters from the SW corner of the ZOM,
- Station O3b – One hundred meters from the SW corner of the ZOM,
- Station O4a – Five meters from the NW corner of the ZOM,

- Station O4b – One hundred meters from the NW corner of the ZOM,

Because the ZOM will be in deeper water, samples will be collected from several depths. At the stations at the shallow end of the ZOM, samples will be collected near the surface, in mid-water and near the bottom. At the stations at the deep end of the diffuser, samples will be collected near the surface, at 150 feet deep, and at 50-foot intervals from 200 to 450 feet deep. Data from the latter series of samples will be averaged to account for the possible presence of the thermocline in this depth range. Sample stations will be located using a hand-held global positioning system (GPS) to insure that the same sites are sampled on repeated surveys.

Marine Biota

Marine biological monitoring will follow a similar rationale (control and "experimental" sites), but with biota no two places are exactly alike so we propose to monitor control sites and sites fronting the development (the "experimental" sites) and note the specific changes that occur through time, trying to link any observed biological change to changes noted in the water chemistry.

As with the water chemistry monitoring, the marine biological monitoring will be quantitative so that any change encountered can be documented. A quantitative description of the marine communities in the proposed HSWAC pipeline alignment will be made to address the question, "what marine resources will be directly impacted by their removal if this project proceeds?" This question will be addressed by establishing three permanently marked stations for quantitative studies in the pipeline alignment. A second question, "What will be the impact of the construction activities on adjacent marine communities?" will be addressed by establishing permanently marked stations both to the east (three stations) and three stations to the west.

Stations will be permanently marked using a combination of GPS and bottom finding sonar to put the vessel and SCUBA diver in the general area of the transect site. Transect sites will be marked underwater using a combination of small subsurface net floats and large nylon cable ties that mark the two ends of the transect site. Transect orientation will be parallel to the coastline (thus on a single depth contour) and established in the recognized major ecological zones present in the study area. Because of bottom time constraints most transects will be established at depths of 20 m or less.

3.2.2 Operations Phase

Water Quality

During operations, the water quality decision unit will correspond to the ZOM and the surrounding area of monitoring.

Marine Biota

During the operational phase of the project, the biological monitoring will focus on the impact that the operation of the diffuser may have on marine communities in the vicinity of the discharge. As the diffuser will be situated below safe diving depths on a sand/rubble substratum, biological monitoring will quantitatively sample the soft bottom benthos in and at varying distances from the ZOM. Because the HSWAC intake and discharge pipes comprise a significant hard bottom substratum for biological resources, the biota associated with these structures both in and outside of the ZOM will be monitored using a ROV outfitted with a video camera. This sampling strategy is similar to that approved by USEPA for the monitoring of the City and County of Honolulu's deep ocean outfalls for the Sand Island and Honouliuli WWTPs. Sampling of the ZOM will occur on an annual basis.

Because currents in the area of the diffuser generally move in a southwest direction and the discharged water is colder (hence has greater density) than ambient conditions, once discharged the cooler seawater will have a tendency to move downslope into deeper waters in a southwest direction. Benthic sampling will be carried out in the ZOM, at the ZOM boundary and at two sites southwest of the ZOM (presumably receiving less disturbance with greater distance and one site at the same depth to the east to serve as a control.

3.3 WATER QUALITY PARAMETERS

Tables 3-1 and 3-2 summarize the parameters that will be monitored in the water quality portion of the program. The water quality instrument for measurement of in situ parameters will be a Hydrolab DS5.

Table 3-1: Dissolved Inorganic Nutrient Parameters for the HSWAC Monitoring Program

Parameter	Sample Type	Analytical Method	Detection Limits
Nitrate+Nitrite	Water sample	As per HAR 54 or approved equivalent (will depend on the laboratory contracted)	

Table 3-2: Parameters Measured In Situ in the HSWAC Monitoring Program

Parameter	Range	Accuracy	Resolution
Turbidity*	0-3000 NTU	± 1% up to 100 NTU ± 3% from 100-400 NTU ± 5% from 400-3000 NTU	0.1 NTU from 0-400 NTU; 1 NTU for >400 NTU
pH*	0-14 pH units	± 0.2 units	0.01 units
Dissolved Oxygen*	0-60 mg/l	± 0.1 mg/l @ ≤ 8 mg/l ± 0.2 mg/l @ > 8 mg/l ± 10% reading > 20 mg/l	0.01 mg/l
Temperature	-5 to 50°C	± 0.10°C	0.01°C
Salinity	0-70 ppt	± 0.2 ppt	0.01 ppt
Depth*	0 to 10m (vented level) 0 to 25m 0 to 100m 0 to 200m	± 0.003meters ± 0.05 meters ± 0.05 meters ± 0.1 meters	0.001 meters 0.01 meters 0.01 meters 0.1 meters

* Construction Phase monitoring parameters. All listed parameters will be monitored in the Operations Phase.

3.4 WATER QUALITY SAMPLING FREQUENCY

Establishment of the baseline will require ten sampling events. These will begin as soon as possible after the AMAP is approved. To the extent possible, sampling will be conducted during (1) normal tradewind conditions, (2) during calm wind/wave conditions (3) at a extreme high tide, (4) at a extreme low tide, (5) following a high wave event and (6) following a high rainfall event.

Baseline sampling will be completed prior to initiation of construction. During construction, water quality monitoring will take place daily, continue through completion of work at the receiving pit, and extend at least an additional three days following construction or as long as any exceedances of the turbidity standard are detected.

Upon startup, monitoring of the operational stations will take place once daily for 10 days. If after 10 days, no exceedances are recorded, the sampling frequency will be reduced to weekly. If after 4 weeks of monitoring no exceedances are recorded the frequency will be reduced to monthly. If after three months of monitoring no exceedances are recorded, the frequency will be reduced to quarterly. If an exceedance is recorded, the sampling frequency will revert to the initial frequency (daily for 10 days) and the progression sequence to less frequent sampling will begin anew.

3.5 MARINE BIOLOGICAL MONITORING FREQUENCY

For shallow water biological monitoring (stations at depths less than 60 feet depth) sampling will occur once before, once during, and quarterly for the first year following completion of construction or until no further significant changes are noted in the biota.

Monitoring following the commencement of operations will only occur annually at deeper water stations since it is the operation of the discharge that may impact biota. The monitoring schedule will be annual which is in keeping with USEPA requirements for monitoring the Honolulu WWTP outfalls' ZOM's.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

4.1. TEC PERSONNEL

TEC will utilize staff from its Honolulu, Hawaii office to perform contract administration, project management, field work and reporting. Data validation will be done by TEC's senior chemist from the Charlottesville, VA office. Responsibilities of the key personnel are described below.

- Project Manager – George Krasnick – Responsible for ensuring adequacy of resources, compliance with the FSP, data analysis and reporting, and quality control.

- Field Manager – Bill Whitman – Responsible for mobilization and demobilization of equipment, field operations, and water sample shipment to the analytical laboratory. He will be supported by a field assistant.

- Laboratory QA – Peter Chapman – Responsible for review and oversight of laboratory quality control procedures and validation of laboratory data.

4.2 Subcontractors

The marine biota monitoring will be subcontracted to Dr. Richard Brock of Environmental Assessment Company. Dr. Brock will be responsible for all aspects of the marine biota portion of the monitoring program. He will be supported by a field assistant.

An approved analytical laboratory will be subcontracted to perform the nutrient analyses on the water samples. For purposes of this plan, we assume the University of Washington laboratory will perform the nutrient chemistry, but if we can identify a competent local laboratory we will use them to eliminate potential problems associated with shipping samples to the mainland.

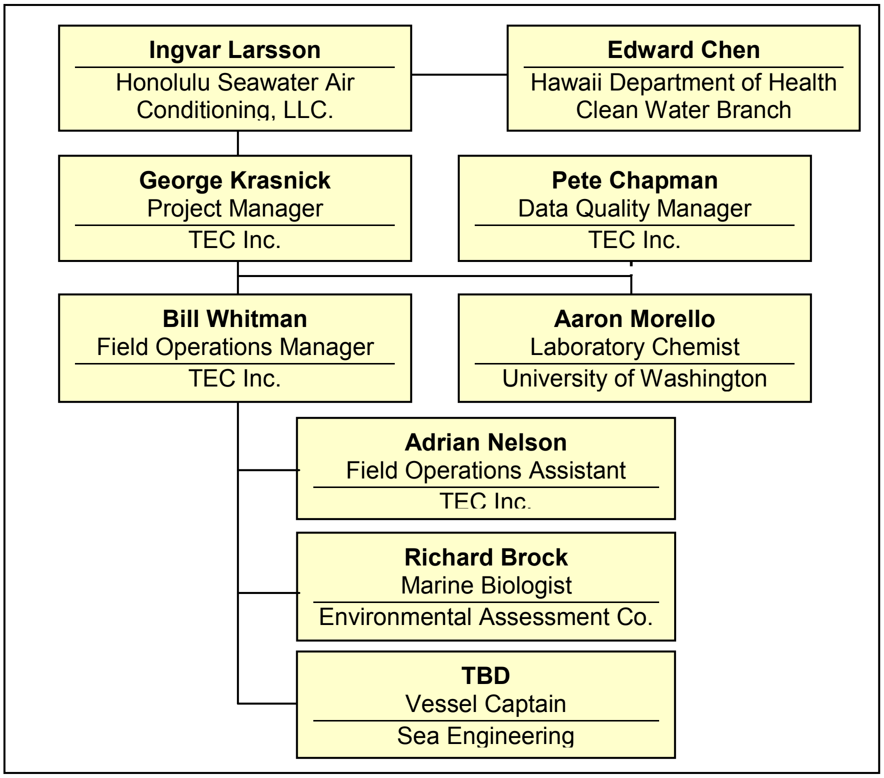

Figure 4-1: HSWAC AMAP Organization Chart

5.0 FIELD OPERATIONS

5.1 WATER QUALITY SAMPLING

Stations will be located using GPS in combination with the vessel's bottom finder. In situ measurements will be made according to the instrument's operating instructions. In addition to probes for the in situ water quality parameters, the instrument will be equipped with a pressure/depth sensor so that measurements can be obtained at the same depths as the water samples. All field measurements will be recorded in field log books and/or on sampling forms.

Water samples will be collected in a standard oceanographic Van Dorn water sampler lowered to the appropriate depth and closed. Water samples for nutrient analysis will be collected in acid-washed, triple-rinsed, 500 ml polyethylene bottles and immediately placed on ice until they are processed for shipping. Sample bottles will be pre-labeled and the chain-of custody form completed as samples are collected. Following completion of sampling, the water samples will be repacked into coolers with gel ice and shipped via FedEx to the analytical laboratory for processing and analysis.

5.2 MARINE BIOLOGICAL MONITORING

At the shallow water stations, the sampling protocol will be as follows: on arrival at a given station, a visual fish census will be undertaken first to estimate the abundance of fishes. These censuses will be conducted over a 25 x 4 m corridor and all fishes within this area to the water's surface will be counted. Data collected will include species, numbers of individuals and estimates of the lengths of all fishes seen; the length data will be later converted to standing crop estimates using linear regression techniques. A single diver equipped with SCUBA, transect line, slate and pencil will enter the water, count and note all fishes in the prescribed area (method modified from Brock, 1954). The 25 m line will be paid out as the census proceeds, thereby avoiding any previous underwater activity in the area which could frighten wary fishes.

Fish abundance and diversity is often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., cross coral mounds, sand flats, and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (25 m in length) has proven adequate in sampling many Hawaiian benthic communities (Brock and Norris, 1989).

Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels (family Muraenidae) and nocturnal species, e.g., squirrelfishes (family Holocentridae), aweoweos or bigeyes (family Priacanthidae), etc. This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief, although some fishes with cryptic habits or protective coloration (e.g., the nohus, family Scorpaenidae; the flatfishes, family Bothidae) might still be missed. Obviously, the effectiveness of the visual census technique is reduced in turbid water and species of fishes which move quickly and/or are very numerous may be difficult to count and to estimate sizes. Additionally, bias related to the experience of the diver conducting the counts should be considered in making any comparison between surveys. In spite of these drawbacks, the visual census technique probably provides the most accurate nondestructive method available for the assessment of diurnally active fishes (Brock, 1982).

After the assessment of fishes is completed, an enumeration of epibenthic invertebrates (excluding corals) will be undertaken using the same transect line as established for fishes. Exposed invertebrates usually greater than 2 cm in some dimension (without disturbing the substratum) will be censused in the 4 x 25 m area. As with the fish census technique, this sampling method is quantitative for only a few invertebrate groups, e.g., some of the echinoderms (some echinoids and holothurians). Most coral reef invertebrates (other than corals) are cryptic or nocturnal in their habits making accurate assessment of them in areas of topographical complexity very difficult. This, coupled with the fact that the majority of these cryptic invertebrates are small, necessitates the use of methodologies that are beyond the scope of this survey (see Brock and Brock, 1977). Recognizing constraints on time and the scope of this survey, the invertebrate censusing technique to be used attempts only to assess those few macroinvertebrate species that are diurnally exposed.

Exposed sessile benthic forms such as corals and macrothalloid algae will be quantitatively surveyed by use of quadrats and the point-intersect method. The point-intersect technique only notes the species of organism or substratum type directly under a point. Along the previously set fish transect line, 50 such points will be assessed (once every 50 cm). These data will be converted to percentages. Quadrat sampling will consist of recording benthic organisms, algae, and substratum type present as a percent cover in six, one-meter square frames placed at five-meter intervals along the transect line established for fish censusing (at 0, 5, 10, 15, 20, and 25 m).

If macrothalloid algae are encountered in the 1 x 1 m quadrats or under one of the 50 points, they will be quantitatively recorded as percent cover. Emphasis will be placed on those species that are visually dominant and no attempt will be made to quantitatively assess the multitude of microalgal species that constitute the “algal turf” so characteristic of many coral reef habitats.

During the course of all fieldwork, notes will be taken on the number, size and location of green sea turtles or any other threatened or endangered species seen within or near the study area. All data will be comparatively analyzed using common statistical procedures. The field procedures proposed for use here have been proven as reliable methodologies to obtain useful quantitative data on the status of and impacts to marine communities. The methods follow those as outlined in numerous peer-reviewed studies (see Brock, 1982; Brock and Norris, 1989; West Hawaii Coastal Monitoring Task Force, 1992) and were used by Brock in the USEPA-sponsored Hawaii EMAP Program.

At the deep water stations, field sampling will occur once annually at stations in and outside of the discharge ZOM using a Van Veem Grab to sample soft bottom benthos. Bottom samples will be collected in triplicate at each station to provide some replication. All biota in each sample will be identified to the lowest taxon possible and counts of all individuals of all species will be made. If sufficient material is present, biomass will be determined for all identified trophic (feeding guilds) groups. Data collected are quantitative so comparative statistical procedures will be used to determine if significant changes have occurred. Station locations will be identified using a hand-held GPS. The macrofauna (both sessile and mobile) will be semi-quantitatively sampled using a video camera mounted on a ROV. The ROV/camera will be used to examine any hard bottom present in the ZOM (such as the pipes and collars) and outside of it to determine if there are obvious differences in the biota between areas.

6.0 FIELD QUALITY CONTROL

6.1 FIELD INSTRUMENT CALIBRATION

The field instrument will be calibrated according to the manufacturer's recommended procedures prior to each use, checked once during the sampling period and checked again at the end of the day.

Before calibrating the instrument, the following will be verified:

- The instrument case contains operations manuals for troubleshooting procedures.
- The instrument is charged and running correctly.
- Spare parts and fresh batteries are available.

6.2 WATER SAMPLES

Procedures to ensure the custody and integrity of the water samples will begin at the time of sampling and continue through transport, sample receipt at the analytical laboratory, preparation, analysis and storage, data generation and reporting, and sample disposal. All samples will be uniquely identified, labeled, and documented in the field at the time of collection. All sample containers will be sealed in a manner that shall prevent and/or detect tampering, if it occurs.

Five percent of all nutrient samples collected during a single survey will be randomly selected and collected in duplicate and used for purposes of QA/QC in keeping with USEPA guidelines for the Hawaii EMAP Program.

Water samples will be shipped to an approved laboratory that has a demonstrated history of analyzing samples for low concentrations of dissolved inorganic nutrients in a seawater matrix.

6.3 BIOLOGICAL SAMPLING

Biological monitoring at shallow water stations will entail field identification of algae, invertebrates and fishes using standard coral reef monitoring techniques. If necessary, voucher specimens will be collected to confirm identifications made in the field. The collection of soft bottom benthos will be made using a Van Veem grab collecting three replicates at each sample site. Sand samples will be immediate removed from the grab, placed in marked glass containers and fixed in 10 percent formalin with a rose bengal stain added (assists in the identification of tissue). In the laboratory, samples will be elutriated and sieved to separate organisms from sand and rubble and then fixed in ethanol. Identifications will be made using a microscope and all individuals and species will be counted. All sample processing, species identifications, sample handling and data collection will be accomplished following the methods used by the University of Hawaii Water Resources Research Center's Sewage Biomonitoring Program carried out for the City and County of Honolulu which has been approved by the USEPA.

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7.0 RECORD-KEEPING AND REPORTING

Records concerning the custody and condition of the samples will be maintained in field and laboratory records. The project manager will maintain chain-of-custody records for all field and field QC samples. The field data collection form is shown in Appendix E to the AMAP. The chain of custody form will be provided by the analytical laboratory.

The following minimum information concerning the sample will be documented on the chain-of-custody form:

- Unique sample identification
- Date and time of sample collection
- Source of sample (including name, location, and sample type)
- Analyses required
- Name of collector(s)
- Pertinent field data (pH, temperature, etc.)
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Bill of lading or transporter tracking number (if applicable)

In situ and laboratory data will be collated in an electronic spreadsheet for statistical analysis and reporting. Reporting will be done as specified in the NPDES, 401 WQC and ZOM authorizations.

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8.0 FORM AND CONTENT

TEC will maintain field records sufficient to recreate all sampling and measurement activities. Field information will be recorded with indelible ink in a permanently bound notebook with waterproof paper and sequentially numbered pages. The field data form is contained in Appendix E to the AMAP.

The following information will be recorded for all field activities: (1) location, (2) date and time, (3) identity of personnel performing activities, and (4) weather conditions. For field measurements, the following are needed: (1) numerical value and units of each measurement, and (2) the identity of the field instrument and its calibration results.

The following additional information will be recorded for all sampling activities: (1) sample type and sampling method, (2) the identity of each sample and depth from which it was collected, (3) the amount of each sample, (4) identification of conditions that might affect the representative quality of a sample, and (5) time of sample collection.

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APPENDIX H
HSWAC ANTIDEGRADATION ANALYSIS

Honolulu Seawater Air Conditioning
Antidegradation Analysis
Cardno TEC, Inc., April 2013

The U.S. EPA has promulgated a water quality antidegradation policy at 40 CFR 131.12. This policy requires each state to develop and adopt a statewide antidegradation policy and identify the methods for implementing such policy. The State of Hawaii water quality standards include an antidegradation policy. Hawaii Administrative Rules §11-54-1.1 provides the State's "General policy of water quality antidegradation," which reads as follows.

(a) Existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

(b) Where the quality of the waters exceed (sic) levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the director finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the director shall assure water quality adequate to protect existing uses fully. Further, the director shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control.

(c) Where existing high quality waters constitute an outstanding resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

Federal water quality standards regulations require States to establish a three-tiered antidegradation program. Tier 1 maintains and protects existing uses and water quality conditions necessary to support such uses. Tier 2 maintains and protects "high quality" waters – water bodies where existing conditions are better than necessary to support CWA §101(a)(2) "fishable/swimmable" uses. Water quality can be lowered in such waters; however, in no case may water quality be lowered to a level that would interfere with existing or designated uses. Tier 3 maintains and protects water quality in outstanding national resource waters. Except for certain temporary changes, water quality cannot be lowered in Tier 3 waters. The proposed HSWAC discharge area is a Tier 2 water for all regulated water quality parameters. The proposed action would lower water quality within a proposed Zone of Mixing, but would not interfere with existing or designated uses, as the following analysis shows.

This antidegradation analysis is prepared in four steps, as described in U.S. EPA Region 9 "Guidance on Implementing the Antidegradation Provisions of 40 CFR 131.12." The steps are:

- Task A – Identify Actions that Require Detailed Water Quality and Economic Impact Analyses
- Task B – Determine that Lower Water Quality Will Fully Protect Designated Uses
- Task C – Determine that Lower Water Quality is Necessary to Accommodate Important Economic or Social Development in the Area in which the Waters are Located
- Task D – Complete Intergovernmental Coordination and Public Participation

The analysis below follows the proscribed steps and additional procedures presented in the above guidance document.

Task A – Identify Actions that Require Detailed Water Quality and Economic Impact Analyses.

1. Document the Degree to which Water Quality Exceeds that Necessary to Protect Uses.

Hawaii's water quality criteria are found in HAR Chapter 54. The parameters selected for inclusion there and the minimum values specified for categories of waters with a range of uses provide the criteria with which to determine the adequacy of water quality to protect designated uses. The below section summarizes the water quality standards applicable to the proposed discharge area and then compares recent water quality monitoring data from the vicinity of the proposed discharge site and new site specific data from the proposed diffuser location with the standards. By demonstrating that the existing water quality in the area exceeds the criteria for its use classification, we confirm that water quality exceeds that necessary to protect designated uses.

The waters at the proposed discharge location are classified by the state as "wet (based on the volume of fresh water discharged to the coast) open coastal – Class A." Hawaii's water quality standards Section 11-54-3 define the objective of Class A waters as follows: "…that their use for recreational purposes and aesthetic enjoyment be protected. Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters."

Water quality standards applicable to these waters include basic water quality criteria applicable to all waters and specific criteria for the respective water classifications. Basic water quality criteria applicable to all waters are as follows.

(a) All waters shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants, including:

(1) Materials that will settle to form objectionable sludge or bottom deposits;
(2) Floating debris, oil, grease, scum, or other floating materials;
(3) Substances in amounts sufficient to produce taste in the water or detectable off-flavor in the flesh of fish, or in amounts sufficient to produce objectionable color, turbidity or other conditions in the receiving waters;
(4) High or low temperatures; biocides; pathogenic organisms; toxic, radioactive, corrosive, or other deleterious substances at levels or in combinations sufficient to be toxic or harmful to human, animal, plant, or aquatic life, or in amounts sufficient to interfere with any beneficial use of the water;
(5) Substances or conditions or combinations thereof in concentrations which produce undesirable aquatic life; and
(6) Soil particles resulting from erosion on land involved in earthwork, such as the construction of public works; highways; recreational, commercial or industrial developments; of the cultivation and management of agricultural lands.

(b) [This section contains definitions and numeric standards for nearly 100 toxic pollutants, none of which are found naturally in deep seawater.]

The proposed discharge area is not degraded by any of the above types of materials and neither existing nor designated uses are currently inhibited by their presence; however, the temperature of the return seawater would be cooler than the ambient temperature of the receiving water. The HSWAC seawater discharge would contain no toxic substances. No chemicals or additives of any type would be added to the flow at any point from intake to discharge.

Specific water quality criteria for wet open coastal waters are summarized in Table 1.

Table 1: State Water Quality Standards Applicable to Wet Open Coastal Areas

Parameter	*Geometric Mean Not to Exceed*	*Not to Exceed More Than Ten Per Cent of the Time*	*Not to Exceed More Than Two Per Cent of the Time*
Total Nitrogen (µg N/l)	150.00	250.00	350.00
Ammonia Nitrogen (µg NH_4-N/l)	3.50	8.50	15.00
Nitrate + Nitrite Nitrogen (µg [NO_3 + NO_2] – N/l)	5.00	14.00	25.00
Total Phosphorus (µg P/l)	20.00	40.00	60.00
Light Extinction Coefficient (k units)	0.20	0.50	0.85
Chlorophyll *a* (µg/l)	0.30	0.90	1.75
Turbidity (N.T.U.)	0.50	1.25	2.00
pH	Shall not deviate more than 0.5 units from a value of 8.1, except at coastal locations where and when freshwater from stream, storm drain or groundwater discharge may depress the pH to a minimum level of 7.0.		
Dissolved Oxygen	Not less than 75% saturation, determined as a function of ambient water temperature and salinity.		
Temperature	Shall not vary more than one degree Celsius from ambient conditions.		
Salinity	Shall not vary more than 10% from natural or seasonal changes considering hydrologic input and oceanographic factors.		
Source: §11-54-6, HAR			

Pursuant to CWA Section 303(d) and CWA Section 305(b), the HDOH compiles a report assessing the quality of State waters. The report published in 2008 for year 2006 characterized the waters offshore of Sand Island and the oceanic waters of Māmala Bay as impaired, i.e., exceeding water quality standards, for total nitrogen and chlorophyll a. Discharge of a pollutant to a water body listed as impaired for that pollutant is prohibited and granting of a ZOM would not be possible. The HSWAC discharge would add nitrogen to the water body so, if Māmala Bay is impaired, the HSWAC project could not proceed. In discussions between the applicant and HDOH CWB personnel, it became clear that the listing of Māmala Bay was based on data more than 20 years old, no data had been collected by HDOH in the area in many years, there may have been problems with some of the earlier data and interpretations, and the listing had not been reviewed in recent years. In 2012 HDOH published an updated assessment report for 2008 and 2010 which delisted the offshore portions of Māmala Bay as impaired (HDOH, 2012).

In the following assessment, we use the City's Sand Island WWTP Outfall monitoring data to demonstrate that there is adequate assimilation capacity throughout the water column in the proposed discharge area and then we use site-specific data collected at the proposed locations of the top and bottom of the diffuser to estimate the specific assimilation capacity in the depth range of the diffuser.

To compare the water quality in the vicinity of the proposed discharge with state standards we obtained copies of the data collected from 2006 to 2011 at stations close to the proposed HSWAC diffuser location as part of the monitoring program for the Sand Island WWTP outfall. Three stations in their monitoring network (C4, D4 and E4) lie very close to the alignment of the return seawater pipe and proposed diffuser. The locations of these stations with respect to the location of the proposed diffuser are shown on Figure 1. C4 is located inshore of the diffuser and within several hundred yards of the proposed microtunnel receiving pit at a depth of 40-41 feet. D4 is located a few hundred yards northwest of the diffuser at a depth of 160-162 feet. E4 is located a few hundred yards southwest of the proposed diffuser location at a depth of 330-332 feet. At each of these stations, water samples were collected at near surface, mid-depth and near-bottom depths. The original data and the geometric means are contained in Appendix A. Original values shown as <1, essentially nondetectable, were arbitrarily converted to a value of 0.50.

No parameter at any station exceeded the respective geometric mean criterion for wet open coastal waters and with only a single exception, there were no exceedances of the 10% or 2% criteria. The sole exception was ammonia-nitrogen at mid-depth at station E4 where there was one value of 16.00 µg N/L which exceeded the 15.00 µg N/L criterion for 2% of samples. There were 21 data points at this location so the one exceedance represented 4.8% of the samples.

Table 2 summarizes the geometric means of results from all stations and depths and compares their collective arithmetic mean with the respective geometric mean water quality criterion to determine the assimilative capacity of the water in the vicinity of the proposed diffuser location for each parameter. The depths shown are the assumed nominal sampling depths based on the water depth at the respective station.

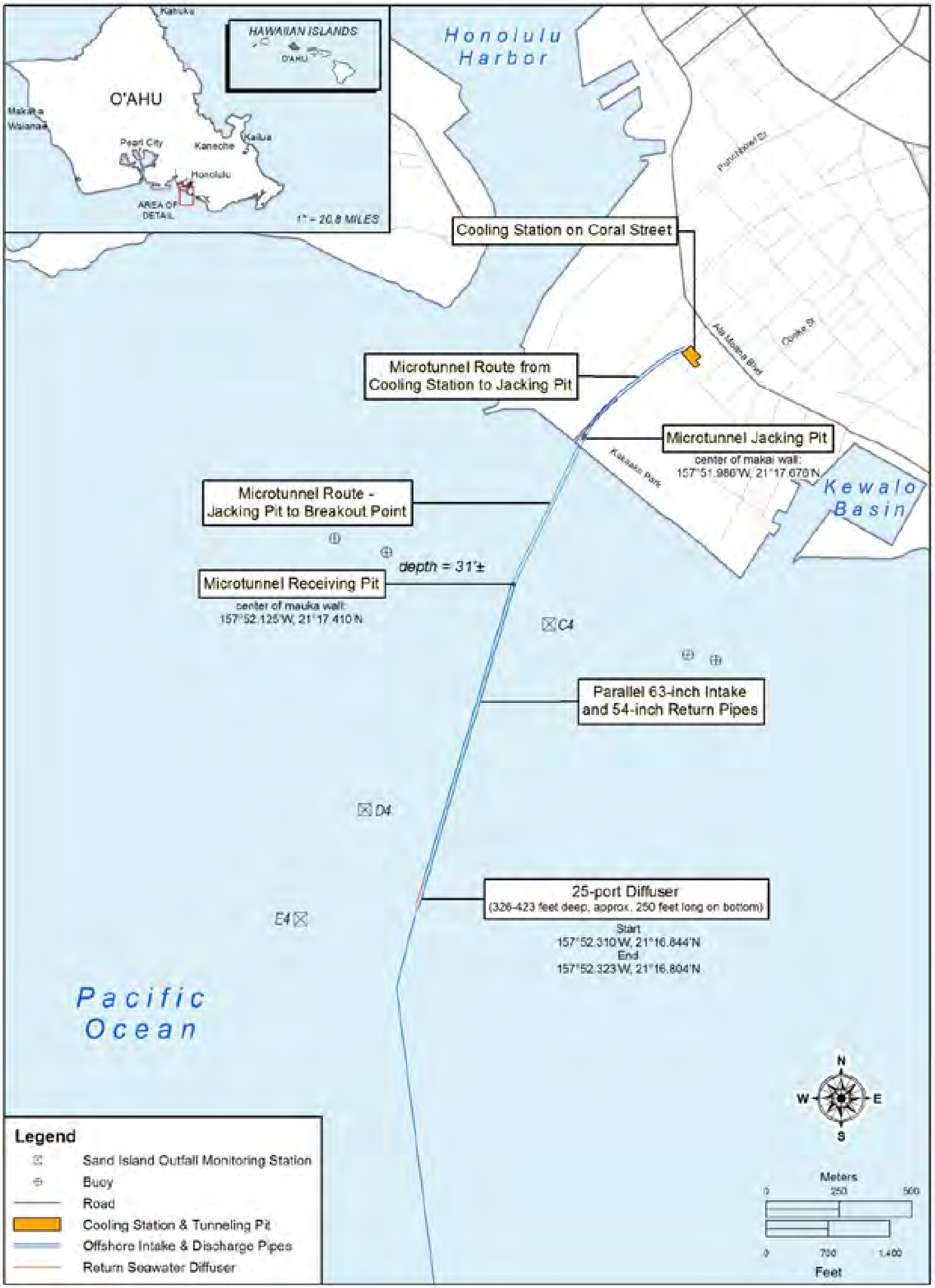

Figure 1: Locations of Sand Island WWTP Outfall Monitoring Stations near the Proposed HSWAC Diffuser Location

Table 2: Assimilation Capacity of HSWAC Receiving Waters

Station	*Depth (ft)*	*NO2+NO3*	*NH4*	*TN*	*TP*	*Turb*	*Chl*
C4 (surface)	1	1.67	1.01	92.97	6.94	0.25	0.18
C4 (mid)	20	1.19	0.89	89.64	6.78	0.23	0.19
C4 (bottom)	40	1.37	0.84	91.92	7.00	0.26	0.21
D4 (surface)	1	0.57	1.05	87.40	6.34	0.17	0.15
D4 (mid)	80	0.57	1.06	90.18	6.49	0.17	0.15
D4 (bottom)	160	0.91	1.34	94.41	6.66	0.24	0.21
E4 (surface)	1	0.52	1.31	90.48	6.75	0.18	0.13
E4 (mid)	165	0.72	2.04	86.63	6.82	0.19	0.17
E4 (bottom)	330	4.25	1.75	98.29	6.50	0.16	0.18
Mean (all stations and depths)		1.31	1.26	91.32	6.70	0.21	0.18
GM Criterion		5.00	3.50	150.00	20.00	0.50	0.30
% Capacity Remaining (all stations and depths)		73.86	64.14	39.12	66.51	58.92	41.57
Mean (surface and mid depths)		0.94	1.19	90.45	6.72	0.21	0.17
% Capacity Remaining (surface and mid depths)		81.21	65.92	39.7	66.39	57.87	41.94
% Capacity Remaining (E4 bottom)		15.00	50.00	34.47	67.50	68.00	40.00

Considering the mean values for all stations and depths, the available assimilative capacity ranges from a low of 39.12% for total nitrogen to a high of 73.86% for nitrate+nitrite nitrogen. There is adequate assimilation capacity at all stations and depths to permit a reasonably sized zone of mixing to be delineated.

Water quality, as determined by these parameters, substantially exceeds that necessary to protect all existing or designated uses despite the input of pollutants from a number of nearby sources. Several regulated and unregulated point sources of pollution discharge into Mamala Bay. Most prominent are the three wastewater treatment plant (WWTP) outfalls (Sand Island, Fort Kamehameha, and Honouliuli). Sewage has been pumped into the ocean offshore of Kewalo and Sand Island since the 1930s. The early inputs were all raw sewage released in shallow water (not exceeding 20 feet in depth). The actual points of release varied through time as different pipes were constructed and used. The multitude of perturbations that occurred in shallow water from these early sewage inputs continued until the construction of the present Sand Island deep-water outfall in 1978 (Brock, 1998). The closest major point source of pollutants to the proposed site of the HSWAC seawater return diffuser is the diffuser for the Sand Island WWTP Deep Ocean Outfall, which lies about two miles west. The monitoring data described above show no significant effect on waters near the proposed HSWAC diffuser. Because of the spatial separation and the relative densities of the two discharge plumes no interaction is expected. The Sand Island wastewater discharge is a positively buoyant plume that tends to rise toward the surface and be affected by wind driven surface currents, whereas the HSWAC discharge plume would be negatively buoyant and tend to sink seaward down the slope.

Other notable discharges to Mamala Bay include the Ala Wai Canal (into which Manoa Stream discharges); Nuuanu, Kapalama, Kalihi, and Moanalua Streams; other small streams and drainage channels; and Pearl Harbor, which receives runoff from five perennial and three intermittent streams.

West of Kewalo Basin, on lands now occupied by the Kakaako Waterfront Park, stood the former Honolulu incinerator and dump. While in operation, this dump received both burned and unmodified wastes from urban Honolulu at a period of time when concern over pollution from anthropogenic sources was less than now. Because the unlined dump filled in a section of old coastline in excess of 330 feet seaward, these materials along the seaward side are exposed to seawater and there is a potential for leaching of pollutants (Brock, 1998). In addition, according the DOH staff, feral cats and homeless people are adding fecal waste to the nearshore waters.

After consultation with regulatory agencies, HSWAC, LLC agreed to propose a final diffuser location between the depths of 326 and 423 feet on a section of relatively steep slope which begins above the diffuser and extends several hundred feet below the diffuser. The rationale for requiring this location was to move the diffuser to a depth below that where corals were observed in the route surveys and minimize the potential for biostimulation of phytoplankton or benthic algae. To characterize the baseline water quality at the final diffuser depth, three sets of measurements were considered. The first was data collected by University of Hawaii scientists at Station Aloha, north of Oahu. The second was a NOAA compilation of all historic water quality data from Mamala Bay and other locations along the southern coast of Oahu. The third was from samples collected on a recent University of Hawaii oceanographic cruise. In the latter case, HSWAC, LLC arranged for the collection and analysis of water samples from the locations of the upper and lower ends of the newly proposed diffuser location. Those data are compiled in Table 3. As is apparent in the data from a single day and frequently in the extended time-series of the other two data sets, in the proposed depth range, the diffuser will sometimes straddle the interface between the bottom of the mixed layer and the top of the thermocline. Concentrations of nitrate+nitrite nitrogen are sometimes quite different at the depths of the two ends of the diffuser. This complicates estimation of the “ambient” concentration and the assimilation capacity of the receiving waters, formulation of a water quality monitoring program, and design of a Zone of Mixing.

Table 3: Nitrate+Nitrate Nitrogen Concentrations at the Locations of the Top and Bottom of the Proposed Diffuser

Location	***Depth (Feet)***	***NO2+NO3 (µg/L)***
Diffuser - Top	0	2.52
	50	1.26
	100	1.40
	150	1.58
	200	1.40
	200	1.40
	225	1.40
	250	1.40
	300	1.68
	325	1.26
	325	1.26
Diffuser - Bottom	0	1.26
	50	1.12
	100	1.40
	150	1.40
	200	1.40
	250	1.40
	300	2.45
	350	2.66
	400	2.76
	425	7.78
	425	8.39

CORMIX modeling of the diffuser at an average depth of 375 feet determined that state water quality standards for nitrate+nitrite nitrogen would be met within 215 meters (705 feet) of the diffuser. Applying a safety factor to account for the uncertainties inherent in the CORMIX model, a Zone of Mixing with dimensions of 3,600 feet wide and 4,000 feet in length (parallel to the pipe and diffuser) is proposed. The area of the Zone of Mixing would be 330.6 acres.

2. Quantify the extent to which water quality will be lowered

Under the proposed action, marine water quality would be affected during both construction and operation of the seawater pipelines. During construction and pipeline installation, sources of impacts would include construction vessel mooring, excavation and backfill of the microtunnel receiving pit at the offshore breakout point, emplacement of the deployment holdbacks, and deployment of the pipeline anchor collars on the seabed.

At the breakout location, a work platform, likely a barge, would have to be periodically present through the estimated construction period of seven to nine months. Due to the open ocean conditions offshore of Kakaako, barges or work boats would be moored to pre-installed underwater mooring anchor piles. A similar underwater mooring was provided for work associated with retrieval of the sunken *Ehime Maru.* The breakout point is in a sand channel lacking coral reef development and installation of anchor piles would be done carefully to minimize turbidity generation. The temporary holdbacks would be installed in similar fashion. To minimize turbidity from operations in surrounding waters Best Management Practices (BMPs) would be implemented during construction, including:

- Selecting the location of moorings using divers to avoid corals or live rock
- The employment of standard BMPs for construction in coastal waters, such as daily inspection of equipment for conditions that could cause spills or leaks,
- Cleaning of equipment prior to deployment in the water,
- Proper location of storage, refueling, and servicing sites, and
- Implementation of adequate spill response and storm weather preparation plans.

To isolate the work area and contain any turbidity arising from excavation of the receiving pit, the receiving pit would be lined with sheet piling (or a combination of sheet piling and silt curtains, if feasible) from the seafloor to the water surface. However, some turbidity would be generated during initial placement of the sheet piling. Once connection of the pipes is complete, turbidity from backfilling the receiving pit would be minimized by using only pre-washed, 3/8-inch to 2-inch crushed basalt gravel. The fill at the breakout pit would not affect water circulation, salinity or other physicochemical or water quality parameters. It would be inert. It would not introduce, relocate, or increase contaminants.

All materials removed from the microtunnel and also materials removed from the piles before capping would be tested for contamination and disposed of or stored for reuse on land, as appropriate. As all potential sources of contaminant leaching arising from HSWAC construction would be capped with concrete there would be no direct, long-term degradation of water quality.

As the pipeline is lowered to the seabed in the deployment process, it could be expected that impact of each anchor collar with the sea floor would result in suspension of a small amount of sediments. This would be a brief transient series of events.

It can be seen from the above, that during construction, turbidity generation would be the primary water quality concern. Turbidity is a characteristic of many coastal waters in Hawaii. Turbidity can be caused by natural events such as storms, heavy rains and floods, which create fast running water that can carry particles and larger-sized sediments. In the coastal portion of the project area, turbidity is caused by runoff from the land during and after rainfall and resuspension of bottom sediments by waves and currents. Further, the work area in general is on an open coast exposed to high summer surf and storm surge. Much of the seafloor is covered with sediments deposited from previous dredging of Honolulu Harbor. These sediments are remobilized and resuspended during high wave energy events so the biological community is periodically exposed to high suspended sediment concentrations and turbidity.

At the breakout point, there is a possibility of contaminants from the capped landfill under Kakaako Waterfront Park being mobilized and entering the water column. To minimize this possibility, as pipe is installed inside the microtunnel, the space between the pipe and the microtunnel wall would be grouted. The mitigation measures for potential impacts from mobilizing contaminants in the microtunneling operation are:

- As pipe is installed inside the microtunnel from the cooling station to the breakout pit, the space between the pipe and the microtunnel wall would be grouted.
- All materials removed from the microtunnel and also materials removed from the piles before capping would be tested for contamination and disposed of or stored for reuse, as appropriate.

Water quality monitoring would be conducted during the construction period. Pursuant to Section 401 of the Clean Water Act, the applicant would obtain and comply with the conditions of a Water Quality Certification from the HDOH. The proposed action would also be accomplished in compliance with the conditions of the individual NPDES permit required by the Hawaii DOH.

Recreational activities on the reef fronting Kakaako Waterfront Park include swimming, surfing, snorkeling, diving, body boarding and various kinds of fishing. One of Oahu's best bodysurfing sites, Point Panic, is located at the east end of the park in front of the University of Hawaii's Kewalo Marine Laboratory. Since 1994 this site has been off-limits to board surfers. Waters to the west of Point Panic are open to board surfers (Clark 2005). Activities taking place farther offshore include sailing, paddling and other types of fishing.

During initial deployment of the surface-mounted pipes, it would be necessary to position holdbacks on the landward end of the pipes to avoid kinking. The holdbacks would be in the form of anchors or piles driven between the shoreline and the microtunnel breakout point. During the deployment operation, there would be cables under tension attached to the holdbacks, creating a public safety hazard. This would necessitate restricting recreational use of the hazardous area during the deployment event. The restricted area would be small and restriction of recreational access would only be required during the approximately one day of pipe deployment. There would be no limitation on uses of the park. Areas of sand without coral or other significant benthic macrofauna would be selected for positioning the holdbacks.

Recreational access to the waters offshore of Kakaako Waterfront Park would also be prohibited around the breakout location, which would be occupied for seven to nine months and around a larger area along the length of the pipelines, which would be off limits only during the one-day deployment of the pipelines coincident with occupation of the holdback areas. Indirect effects would include displacement of recreational activities to other shoreline or offshore areas, but these also would be short-term, less than significant effects due to the limited number of people affected and the large amount of other park area or offshore water available for any displaced activities.

Once operational, the HSWAC system would return slightly warmed (but still cooler than ambient receiving waters) deep seawater to relatively shallow depths. The character of the water would not be changed from that at the deep intake location except for being warmed approximately 9-13°F. There would be no materials that would either settle on the bottom or float to the surface. There would be no materials added to the natural seawater.

In March of 2011, water samples were collected in triplicate at the location and approximate depth of the proposed intake. The results are displayed in Table 4. Parameters for which there are State water quality standards in wet, open coastal waters are designated with an asterisk.

Table 4: Water Quality at the Proposed HSWAC Intake Location

Parameter	***Sample 1 Depth = 538 m***	***Sample 2 Depth = 535 m***	***Sample 3 Depth = 536 m***	***Mean***
PO_4 (µg P/L)	69.75	69.75	69.44	69.65
NO_3+NO_2 (µg N/L)*	466.90	474.46	475.72	472.36
NH_4 (µg N/L)*	-	0.28	0.14	0.21

Parameter	*Sample 1 Depth = 538 m*	*Sample 2 Depth = 535 m*	*Sample 3 Depth = 536 m*	*Mean*
TP (µg P/L)*	70.06	71.30	70.37	70.58
TN (µg N/L)*	513.52	522.48	516.32	517.44
Turbidity (NTU)*	0.28	0.07	0.18	0.18
Salinity (0/00)*	34.186	34.178	34.183	34.182
pH*	7.70	7.71	7.74	7.72
Chl-a (µg /L)*	0.021	0.010	0.010	0.014
TSS (µg /L)	4.74	3.03	2.05	3.27
D.O. (mg/L)	1.50	1.58	1.52	1.53
D.O. (% saturation)*	15.2	16.0	15.4	15.5
Temp. (°C)*	6.9	6.4	6.2	6.5
BOD-5 (mg/L)	3.0	1.8	4.3	3.0
COD (mg/L)	154	112	105	124
Oil & Grease (mg/L)	<5.0	<5.0	<5.0	<5.0
TOC (mg/L)	2.16	1.26	1.36	1.59

Comparing these values with the standards shown in Table 1, it's clear that the deep ocean waters violate the standards for total nitrogen, nitrate+nitrite nitrogen, total phosphorus, and dissolved oxygen. Consequently, a zone of mixing (ZOM) would have to be approved to permit these exceedances in a specified area. In order to ensure water quality standards would be met outside the ZOM, a diffuser system was designed for the end of the return seawater pipe. At the proposed depth range of the diffuser, nutrient concentrations in the discharge are not as great an issue as they would be at a shallower discharge depth because ambient concentrations are higher and the amount of photosynthetically active radiation is very low, limiting potential biostimulation of phytoplankton and benthic algae. The temperature of the discharge, however, remains an issue primarily due to potential impacts on benthic fauna.

The diffuser design was optimized using the program CORHYD and then the characteristics of the discharge plume were modeled using the program CORMIX. Three diffuser depths (150 feet, 300 feet, and 375 feet) and three different water current regimes were modeled: low current (0.16 fps [0.05 m/s]), mean current (0.46 fps [0.14 m/s]), and high current (2.0 fps [0.6 m/s]). The general conclusions were as follows:

- The design of the diffuser facilitates substantial near-field initial mixing of the return water for all current regimes considered.
- The discharge near-field behavior is dominated by the negative buoyancy of the plume. Surfacing of the plume (at a low dilution) is not anticipated; after initial mixing, the plume will have a tendency to sink.
- Some plume-seabed interaction is anticipated in the immediate vicinity of the diffuser, however, substantial initial dilution implies plume properties would be close to ambient when the seabed is encountered by the plume. Within a few meters from the centerline of the diffuser the dilution would be sufficient to meet water quality standards for temperature.
- Under low current conditions, port velocity of the diffuser would provide good initial mixing, but the weak ambient flow would allow considerable upstream intrusion of the plume. This is presumed to be acceptable, as the zone of mixing would not be directionally restricted.

- Under high current conditions, the initially mixed plume would be rapidly advected away from the diffuser, and the plume dispersed rapidly by the turbulent energy associated with the high flow.

Under the applicant's preferred alternative and the worst case low current condition, the required dilution of nitrate+nitrite nitrogen would be reached within 215 meters (705 feet) of the diffuser centerline.

The discharge will meet water quality standards for temperature within a few meters of the diffuser centerline. The temperature will be lowest immediately at the exit point of the diffuser ports where discharge velocity is greatest and will rapidly increase as it mixes and is advected away. The question is whether the temperature at worst would be toxic or harmful or interfere with any beneficial use of the water. The temperature of the discharge is expected to be in the range of 53-58°F. Organisms in the water column immediately above the diffuser would be exposed to water at this temperature but the duration of exposure would be brief. Nekton would likely avoid or exit the discharge if the decreased water temperature caused discomfort. Plankton might be entrained in the plume, but the rapid mixing would limit their exposure to depressed temperatures to a very brief period unlikely to cause permanent physiological effects. Benthic organisms in the immediate vicinity of the diffuser would also be exposed to lowered temperatures and this would be a permanent change in ambient conditions; however, benthic organisms residing in the depth range of the diffuser are exposed to temperature variations associated with fluctuations in the depth of the top of the thermocline. Considering that the temperature of the discharge plume will be close to ambient when the plume encounters the seabed, a phase shift in the community immediately adjacent to the diffuser would not be expected.

The proposed discharge would contain no sewage or other pollutants of public health significance. Nothing would be added to the deep seawater in passage through the system. In addition, the discharge plume, after initial mixing, will be negatively buoyant and sink to greater depths farther offshore. No public swimming, bathing or wading areas would be affected. Human use of the waters near the diffuser may include boating and fishing. Boating would not be affected in any way. Fishing in the vicinity of the diffuser might be more productive than in adjacent areas due to the structure provided by the pipes and collars. In any event, recreational uses in the vicinity of the diffuser would not be curtailed and may be enhanced by the uniqueness of the structures.

Once the HSWAC system becomes operational, there would be a number of beneficial effects. With regard to water quality, reductions of up to 84 million gallons/year of wastewater discharge would be eliminated. This would reduce the load to the Sand Island Wastewater Treatment Plant, and could reduce the potential for exceeding the capacity of the plant with subsequent discharges that do not meet water quality requirements.

3. Decision Criteria

As noted above, the decision criteria for maintenance of water quality sufficient to protect existing and designated uses are found in the State water quality criteria in HAR Chapter 54. Both water quality and biological monitoring would be conducted during construction and operation of the system. The above described modeling results show that deterioration of water quality will be confined to a relatively small ZOM. To insure proper functioning of the diffuser, a water quality monitoring program would be implemented to ensure that all terms and conditions of required permits are complied with. Violation of water quality standards would necessitate modifying activities to eliminate any exceedance of standards.

The proposed biological monitoring program around the receiving pit during construction and around the ZOM during operations would be comprised of two types of data collection. The first would be grab samples of bottom sediments to look at the epifaunal and infaunal communities. The second would be photographic surveys using an ROV. This program would provide the data with which to assess compliance with the criteria for bottom communities.

4. Conclusions

The conclusions of the exercise are that:

1. Ambient water quality at the proposed discharge location exceeds that necessary to protect existing and designated uses.
2. BMPs and mitigation measures will minimize construction-related water quality degradation.
3. A ZOM is necessary around the diffuser because the deep water to be discharged is in violation of water quality standards for open coastal waters.
4. Water quality will be maintained outside the ZOM.
5. Economic and social development will occur. HSWAC will provide a new service to buildings in the downtown Honolulu area.
6. The lowering of water quality within the ZOM is necessary to realize the economic and environmental benefits of the proposed action.
7. The proposed project does not involve wastewater treatment, nor does it involve non-point sources of pollution. Therefore, the lower water quality in the ZOM does not result from inadequate wastewater treatment facilities, less-than-optimal operation of adequate treatment facilities, or failure to implement or comply with methodologies to reduce or eliminate non-point source pollution.

Task B – Determine that Lower Water Quality Will Fully Protect Designated Uses

During construction there will be transient releases of turbidity from driving sheet piles, establishing bottom moorings, impact of the pipe collars with the bottom and installing piles in the collars. These effects will be temporary and localized, and turbidity will dissipate with the prevailing currents in the area. The area, as described above, is subject to periodic sediment resuspension and scouring by loose rubble during periods of high winds, high surf or storm surge. Consequently, the bottom community is held in an early stage of succession and fish density is limited by the lack of structure. Turbidity in the area, as determined from the Sand Island Wastewater Outfall monitoring data, is less than half of the geometric mean criterion for that parameter in open coastal waters. Construction phase water quality monitoring will be employed to alert contractors to potential water quality standards exceedances and revise operating procedures to avoid such events.

During construction of the receiving pit and installation of the pipes public access to the work areas would be restricted for safety reasons. This would be a temporary restriction. Upon completion of construction there would be no further restriction of recreational uses of the area.

Once the system is operational, the lower water quality anticipated within the ZOM would result from the release of seawater from greater depths. Nothing would be added to the water; the temperature would be raised somewhat in passage through the HSWAC pipes, pumps and heat exchangers. Once released, the water would very rapidly mix with receiving waters. Uses of the receiving waters include propagation of fish and shellfish and recreation. Fish propagation, depending on species, may involve laying eggs, bearing live young or discharging propagules into the water. In all cases the numbers of gametes, eggs or young greatly exceed the number required to maintain the population, and the vast majority of the spawn does not reach maturity due to predation or other causes. Within the ZOM, the sandy bottom would not provide appropriate substratum for laying eggs so this type of propagation likely would not occur there. In this type of propagation, fish have flexibility in choosing a location for depositing their eggs and if conditions are deemed unfavorable, they will elect to deposit their eggs elsewhere. Eggs or sperm discharged into the water column and passing through the zone of mixing would experience cool temperatures and lowered oxygen concentrations which could affect viability. However, given the prevailing current velocities in Mamala Bay, exposure to these conditions would be very short. Even if the eggs or sperm passing through the ZOM are rendered incompetent, it is very likely that due to the excessive numbers of gametes typically expelled, most would not enter the ZOM and recruitment to the larval stage would not be significantly reduced. The same analysis would apply to shellfish propagation.

Recreational activities in the area of the diffuser occur predominantly at the surface and include boating, fishing and swimming. Boating or swimming at the surface would not be affected by the seawater return as the plume will be negatively buoyant and will not rise to the sea surface. Fishing directly in the ZOM would not be restricted in any way, but catch-per-unit-effort (CPUE) may be lowered because some fish may avoid the deep seawater plume due to temperature or oxygen concentration preferences. The physical presence of the pipes, however, will provide structure in a flat, sandy habitat that is periodically disturbed by rough sea conditions. The pipes will provide shelter and foraging habitat for a variety of fish species and it is anticipated that fish densities will increase in the vicinity of the pipes leading to an increased CPUE for those fishing there.

In conclusion, despite the lower water quality in the ZOM, fish and shellfish propagation will be fully protected and recreational activities in the vicinity will be enhanced.

Task C – Determine that Lower Water Quality is Necessary to Accommodate Important Economic or Social Development in the Area in which the Waters are Located

As summarized below, the HSWAC Project will have significant economic benefits to the general public, government agencies, the electric utility, and system customers. The EPA guidance document for preparation of the antidegradation analysis identifies the following topics for consideration in this portion of the analysis.

1. Current state of Economic and Social Development in the Area that Would Be Affected.
    a. Population – The estimated population of Honolulu County as of July 1, 2009 is 907,574. A large percentage of that population either lives or works in the Primary Urban Center. The proposed project would have no effect on population growth or distribution or on the social character of Honolulu, but it would have other positive economic and social effects as described below. The project would have positive economic impacts on system customers because SWAC systems provide customers with reduced and stable cooling costs as a result of their relative independence from fuel price escalation. In addition, large-scale district cooling systems have lower operating and maintenance costs than individual building air conditioning systems. Other Oahu businesses and residents would indirectly benefit because the HSWAC system would eliminate about one year of HECO's projected load growth. This

reduced need for expensive new electricity generation capacity would help to keep Oahu's electric rates lower for longer.

b. Area employment (numbers employed, earnings, major employers) – Employment in the City and County of Honolulu in 2008, including government, was 449,311. Total wages were $18,916,260,000. The average annual wage was $42,101. The greatest sources of employment were government; trade, transportation and utilities; leisure and hospitality; education and health; and professional and business, respectively. The HSWAC project would generate millions of dollars in construction spending. In addition to construction jobs, long-term jobs would also be created. Other local economic development benefits would accrue from money that stays in Hawaii, and would not be used to purchase oil. The net effect is expected to be a positive impact on the social and economic character of Honolulu.

a. Area income (earnings from employment and transfer payments, if known) – Total direct federal expenditures in Honolulu in 2008 were $10,290,427,000. An Input/Output analysis was completed to determine the fiscal and economic impact of local expenditures[1] in Hawaii during the design, construction and operation of the HSWAC system and for a composite of alternative, stand-alone, conventional cooling systems in individual HSWAC customer buildings. Appropriate Type II Final Demand Multipliers were applied to local expenditures in applicable industry categories to determine fiscal impacts (State taxes) and economic impacts (output, earnings, and jobs). Type II Final Demand Multipliers used in this analysis were taken from "The 2002 State Input-Output Study for Hawai'i."[2] During the assumed 25-year lifetime of the HSWAC system, local spending would amount to more than $293 million. The calculated output based on this local spending is $484 million. This amount of local spending would also generate $166 million more in earnings and 3,850 additional full-time equivalent person-years (FTEPY) of jobs[3]. This is equivalent to 145 full-time jobs for 26.5 years. The actual useful lifetime of a SWAC system can be more than 50 years. Thus, the above benefits are likely a significant underestimate.

b. Manufacturing profile: types, value, employment, trends – In 2008 there were 13,300 workers in manufacturing industries in Hawaii. Total payroll was $502.2 million. Total value of shipments was $8,529 billion. The manufacturing sector was essentially flat in the 2003 to 2008 period. The HSWAC Project would not directly affect manufacturing in Hawaii, but it would provide a significant number of direct, indirect and induced jobs. While Hawaii traditionally and currently enjoys one of the

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[1] Most of the equipment, materials, and supplies that would be used in the construction of the HSWAC system would be manufactured out of state, and some of the required labor and services would also be sourced from out of state. In general, bond financing is assumed to come from out of state. The subject analysis considers only those expenditures that would be made in Hawaii. This includes most of the required labor and services. A significant amount of equity financing would come from within Hawaii and most of the returns on this equity investment are assumed to be expended in Hawaii. Various State taxes are assumed to be paid in Hawaii and expended here. The local share of personal consumption expenditures was corrected for exports, social security, medicare, retirement benefits, etc.

[2] "The 2002 State Input-Output Study for Hawaii," Research and Economic Development Division. Department of Business, Economic Development, and Tourism. State of Hawaii. June 2006. http://hawaii.gov/dbedt/info/economic/data_reports/2002_state_io/2002-input-output-study.pdf/download.

[3] This represents the number of direct, indirect, and induced jobs provided by local spending. Jobs = Local Spending x Appropriate Type II Multipliers.

lowest unemployment rates in the country, the current unemployment rate is uncharacteristically high, and construction is one of the weakest sectors.

c. Government fiscal base: revenues by source (employment and sales taxes, etc.) – State tax collections in 2009 were $4,712,651,000. Sources were sales and gross receipts tax $3,125,035,000; licenses $146,270,000; income taxes $1,417,299,000; and other taxes $24,047,000. – From the above analysis, State tax revenues would be $24 million over the life of the HSWAC project.

2. Incremental Increase in the Rate of Economic or Social Development

   a. Why lower water quality is necessary – To implement the HSWAC system would require sourcing and disposing of deep seawater. Deep seawater, wherever it might be disposed of, would require a ZOM because its constituents are present in concentrations that exceed water quality criteria.

   b. Other alternatives that wouldn't degrade water quality/relative costs – In a regulatory sense, disposing of the HSWAC seawater anywhere in State waters would "degrade" water quality because the concentrations of deep seawater constituents exceed the water quality criteria, which are based on concentrations in the surface mixed layer. Returning the intake water to its original depth would avoid lowering water quality in an absolute sense, but this would constitute a significant increase in the capital cost of the project. Project engineers estimate the cost of seawater piping and installation at about $1,000 per foot. The distance from the proposed diffuser to the intake is about 19,300 feet, and so the cost would be about $19.3 million. Discharging at the intake depth, however, would require separation of the pipelines to avoid recirculating the discharge water into the intake. This would entail a suite of additional costs associated with surveying another route and conducting a separate deployment because the pipes couldn't be deployed together in combination collars. Another perhaps more reasonable option would be to discharge at a depth where the temperature of the discharge approximately matches the temperature of the ambient water. From measurements in the project area, that would occur at a depth of about 1,000 feet. The additional length of pipe to reach this depth would be about 5,500 feet, representing a cost of about $5.5 million. If the intent were to limit the potential for stimulation of primary producers by the elevated nutrient content, another strategy would be to discharge below the euphotic zone, which reaches about 600 feet in these oligotrophic waters. At 600 feet, the ambient temperature is about 65°F, so the discharge would be colder than the receiving water and would likely sink further. This alternative would require about 2,650 feet of additional discharge pipe and thus cost about an additional $2.65 million. Yet another alternative would be to discharge the water below the thermocline, but because the HSWAC discharge would be negatively buoyant, there doesn't seem to be a compelling reason to discharge below the thermocline.

   c. Environmental benefits – The proposed project would have substantial environmental benefits to the community. Environmental benefits of the HSWAC system include the following:
      - Reduction of 178,000 barrels of imported fossil fuels used on Oahu per year;
      - Reduction of associated emissions of air pollutants by the following amounts:
         - CO_2 – 84,000 tons/year
         - VOC – 5 tons/year
         - CO – 28 tons/year
         - PM_{10} – 19 tons/year

    - NO_x – 169 tons/year
    - SO_x – 165 tons/year
- Savings of 77.5 million kWh/year;
- Savings of 75 percent of energy use compared to conventional chiller equipment;
- Reduction of thermal pollution of the environment by about 40% compared to conventional, electricity-powered air conditioning systems;
- Savings of about 260 million gallons/year of potable water;
- Reduction of up to 84 million gallons/year of wastewater;
- Elimination of cooling tower treatment chemicals for connected buildings; and
- Elimination of up to 14 megawatts of new generating capacity (equivalent to one year of Hawaiian Electric Company's projected load growth).

Task D – Complete Intergovernmental Coordination and Public Participation

Review of the applications for the required permits will be conducted at both state and federal levels. There will be both public notification of the proposed permits and the opportunity for public hearings. The Hawaii Department of Health will provide the required coordination.

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Appendix A: Data Collected in the City and County of Honolulu's Sand Island WWTP Outfall Monitoring Program at Stations near the Proposed HSWAC Diffuser

(Units as per Water Quality Standards in Table 1)

Station	***Date***	***NO2+NO3***	***NH4***	***TN***	***TP***	***Turb***	***Chl***
C4 (surface)	3/30/2006	19.00	6.00	106.00	11.00	1.14	0.47
	5/17/2006	1.00	0.50	103.00	7.00	0.25	0.22
	8/1/2006	1.00	0.50	73.00	7.00	0.21	0.17
	10/24/2006	1.00	2.00	98.00	6.00	0.14	0.15
	1/24/2007	4.00	2.00	97.00	7.00	0.50	0.27
	4/10/2007	2.00	0.50	85.00	7.00	0.19	0.17
	7/11/2007	1.00	1.00	136.00	6.00	0.20	0.17
	10/3/2007	2.00	3.00	82.00	5.00	0.23	0.13
	2/4/2008	2.00	0.50	118.00	8.00	0.33	0.17
	4/16/2008	1.00	3.00	90.00	8.00	0.38	0.09
	7/9/2008	2.00	2.00	87.00	7.00	0.20	0.21
	10/1/2008	1.00	0.50	86.00	6.00	0.16	0.16
	2/18/2009	2.00	1.00	88.00	5.00	0.26	0.22
	4/7/2009	2.00	1.00	74.00	8.00	0.28	0.17
	7/28/2009	1.00	0.50	101.00	7.00	0.23	0.18
	11/17/2009	1.00	0.50	74.00	6.00	0.17	0.17
	2/17/2010	1.00	0.50	78.00	7.00	0.14	0.16
	7/7/2010	2.00	0.50	109.00	9.00	0.26	0.10
	11/4/2010	3.00	0.50	128.00	7.00	0.21	0.22
	2/8/2011	1.00	3.00	77.00	7.00	0.26	0.34
	GM	1.67	1.01	92.97	6.94	0.25	0.18
C4 (mid)	3/30/2006	1.00	0.50	77.00	7.00	0.38	0.18
	5/17/2006	1.00	0.50	89.00	6.00	0.23	0.22
	8/1/2006	1.00	0.50	74.00	7.00	0.18	0.18
	10/24/2006	2.00	2.00	96.00	5.00	0.18	0.17
	1/24/2007	1.00	2.00	88.00	6.00	0.30	0.30
	4/10/2007	2.00	0.50	98.00	7.00	0.22	0.19
	7/11/2007	1.00	0.50	120.00	7.00	0.22	0.17
	10/3/2007	2.00	3.00	85.00	5.00	0.24	0.13
	2/4/2008	2.00	1.00	133.00	7.00	0.38	0.16
	4/16/2008	1.00	3.00	89.00	8.00	0.44	0.11
	7/9/2008	2.00	3.00	77.00	7.00	0.14	0.23
	10/1/2008	1.00	0.50	89.00	8.00	0.28	0.18
	2/18/2009	1.00	0.50	90.00	6.00	0.41	0.22
	4/7/2009	2.00	1.00	77.00	8.00	0.27	0.19
	7/28/2009	1.00	0.50	101.00	7.00	0.23	0.18

Station	*Date*	*NO2+NO3*	*NH4*	*TN*	*TP*	*Turb*	*Chl*
	11/17/2009	1.00	0.50	75.00	6.00	0.20	0.16
	2/17/2010	1.00	0.50	79.00	7.00	0.13	0.21
	7/7/2010	1.00	0.50	106.00	9.00	0.22	0.23
	11/4/2010	1.00	0.50	98.00	7.00	0.11	0.18
	2/8/2011	0.50	4.00	75.00	7.00	0.20	0.36
	GM	1.19	0.89	89.64	6.78	0.23	0.19
C4 (bottom)	3/30/2006	2.00	0.50	78.00	7.00	0.24	0.19
	5/17/2006	1.00	0.50	85.00	6.00	0.17	0.23
	8/1/2006	1.00	2.00	77.00	8.00	0.43	0.29
	10/24/2006	2.00	1.00	126.00	5.00	0.16	0.18
	1/24/2007	1.00	2.00	83.00	6.00	0.15	0.29
	4/10/2007	2.00	0.50	94.00	8.00	0.25	0.18
	7/11/2007	1.00	0.50	121.00	6.00	0.25	0.17
	10/3/2007	1.00	4.00	81.00	5.00	0.41	0.16
	2/4/2008	4.00	0.50	135.00	7.00	0.37	0.16
	4/16/2008	1.00	4.00	89.00	8.00	0.18	0.15
	7/9/2008	1.00	1.00	86.00	8.00	0.22	0.26
	10/1/2008	2.00	0.50	90.00	8.00	0.30	0.18
	2/18/2009	2.00	0.50	96.00	6.00	0.55	0.26
	4/7/2009	2.00	1.00	78.00	9.00	0.36	0.18
	7/28/2009	1.00	0.50	92.00	7.00	0.24	0.25
	11/17/2009	2.00	0.50	89.00	7.00	0.43	0.19
	2/17/2010	1.00	0.50	78.00	7.00	0.16	0.20
	7/7/2010	1.00	0.50	114.00	9.00	0.27	0.15
	11/4/2010	2.00	0.50	93.00	7.00	0.16	0.16
	2/8/2011	0.50	2.00	80.00	8.00	0.33	0.80
	GM	1.37	0.84	91.92	7.00	0.26	0.21
D4 (surface)	3/30/2006	0.50	0.50	79.00	5.00	0.18	0.16
	5/17/2006	0.50	0.50	95.00	6.00	0.14	0.18
	8/1/2006	1.00	4.00	79.00	7.00	0.24	0.23
	10/24/2006	0.50	1.00	83.00	6.00	0.09	0.13
	1/24/2007	1.00	0.50	84.00	6.00	0.21	0.21
	4/10/2007	0.50	0.50	111.00	8.00	0.22	0.18
	7/11/2007	0.50	0.50	117.00	6.00	0.10	0.12
	10/3/2007	0.50	0.50	112.00	5.00	0.14	0.07
	2/4/2008	1.00	1.00	96.00	7.00	0.22	0.19
	4/16/2008	0.50	3.00	102.00	8.00	0.26	0.08

Station	Date	NO2+NO3	NH4	TN	TP	Turb	Chl
	7/9/2008	0.50	3.00	84.00	5.00	0.12	0.11
	10/1/2008	0.50	0.50	62.00	7.00	0.20	0.30
	2/18/2009	1.00	5.00	85.00	5.00	0.24	0.19
	4/7/2009	0.50	0.50	55.00	5.00	0.24	0.09
	7/28/2009	0.50	0.50	81.00	6.00	0.24	0.07
	11/17/2009	0.50	1.00	68.00	6.00	0.12	0.11
	2/17/2010	0.50	4.00	118.00	7.00	0.11	0.21
	4/6/2010	0.50	2.00	92.00	8.00	0.12	0.14
	7/7/2010	0.50	0.50	98.00	8.00	0.19	0.12
	11/4/2010	0.50	0.50	80.00	7.00	0.11	0.16
	2/8/2011	0.50	4.00	88.00	7.00	0.21	0.27
	GM	0.57	1.05	87.40	6.34	0.17	0.15
D4 (mid)	3/30/2006	1.00	0.50	72.00	5.00	0.21	0.17
	5/17/2006	0.50	0.50	103.00	6.00	0.12	0.13
	8/1/2006	0.50	6.00	77.00	7.00	0.14	0.27
	10/24/2006	0.50	0.50	109.00	6.00	0.11	0.14
	1/24/2007	0.50	1.00	101.00	6.00	0.22	0.23
	4/10/2007	0.50	0.50	84.00	7.00	0.18	0.18
	7/11/2007	0.50	0.50	124.00	6.00	0.17	0.13
	10/3/2007	0.50	0.50	99.00	5.00	0.13	0.08
	2/4/2008	1.00	1.00	85.00	7.00	0.22	0.20
	4/16/2008	1.00	3.00	136.00	8.00	0.32	0.11
	7/9/2008	0.50	4.00	89.00	8.00	0.14	0.11
	10/1/2008	1.00	1.00	79.00	8.00	0.26	0.27
	2/18/2009	0.50	5.00	75.00	6.00	0.22	0.22
	4/7/2009	0.50	0.50	58.00	5.00	0.26	0.08
	7/28/2009	0.50	0.50	80.00	6.00	0.18	0.08
	11/17/2009	0.50	0.50	72.00	6.00	0.14	0.23
	2/17/2010	0.50	3.00	128.00	8.00	0.10	0.24
	4/6/2010	0.50	2.00	93.00	8.00	0.11	0.15
	7/7/2010	0.50	0.50	90.00	7.00	0.20	0.13
	11/4/2010	0.50	0.50	84.00	6.00	0.11	0.19
	2/8/2011	0.50	3.00	96.00	7.00	0.18	0.09
	GM	0.57	1.06	90.18	6.49	0.17	0.15
D4 (bottom)	3/30/2006	2.00	1.00	102.00	6.00	0.20	0.19
	5/17/2006	2.00	4.00	88.00	6.00	0.14	0.21
	8/1/2006	1.00	5.00	73.00	6.00	0.21	0.28
	10/24/2006	0.50	1.00	94.00	6.00	0.10	0.15

Station	Date	NO2+NO3	NH4	TN	TP	Turb	Chl
	1/24/2007	1.00	10.00	120.00	7.00	0.28	0.21
	4/10/2007	1.00	1.00	113.00	7.00	0.26	0.26
	7/11/2007	0.50	0.50	135.00	6.00	0.17	0.15
	10/3/2007	0.50	0.50	77.00	5.00	0.12	0.11
	2/4/2008	1.00	0.50	85.00	7.00	0.22	0.18
	4/16/2008	0.50	3.00	108.00	7.00	0.56	0.13
	7/9/2008	3.00	12.00	107.00	11.00	1.20	0.43
	10/1/2008	1.00	1.00	103.00	6.00	0.36	0.21
	2/18/2009	1.00	2.00	100.00	5.00	0.60	0.25
	4/7/2009	0.50	0.50	68.00	6.00	0.23	0.13
	7/28/2009	1.00	1.00	84.00	11.00	1.63	0.62
	11/17/2009	3.00	2.00	76.00	6.00	0.17	0.22
	2/17/2010	2.00	0.50	129.00	6.00	0.12	0.30
	4/6/2010	0.50	2.00	96.00	8.00	0.16	0.16
	7/7/2010	0.50	0.50	99.00	8.00	0.26	0.13
	11/4/2010	0.50	0.50	83.00	6.00	0.11	0.25
	2/8/2011	0.50	1.00	77.00	7.00	0.10	0.21
	GM	0.91	1.34	94.41	6.66	0.24	0.21
E4 (surface)	3/30/2006	0.50	0.50	73.00	5.00	0.14	0.16
	5/17/2006	0.50	0.50	82.00	6.00	0.18	0.05
	8/1/2006	0.50	3.00	74.00	7.00	0.11	0.16
	10/24/2006	0.50	0.50	116.00	6.00	0.15	0.12
	1/24/2007	0.50	0.50	84.00	6.00	0.14	0.18
	4/10/2007	0.50	0.50	93.00	7.00	0.18	0.21
	7/11/2007	0.50	1.00	123.00	7.00	0.15	0.15
	10/3/2007	0.50	1.00	89.00	6.00	0.19	0.08
	2/4/2008	1.00	3.00	89.00	7.00	0.22	0.21
	4/16/2008	0.50	3.00	158.00	14.00	0.30	0.10
	7/9/2008	0.50	2.00	87.00	7.00	0.11	0.07
	10/1/2008	0.50	4.00	58.00	6.00	0.15	0.29
	2/18/2009	0.50	4.00	84.00	6.00	0.26	0.32
	4/7/2009	0.50	0.50	59.00	4.00	0.42	0.07
	7/28/2009	0.50	3.00	100.00	7.00	0.17	0.05
	11/17/2009	0.50	1.00	68.00	6.00	0.28	0.09
	2/17/2010	0.50	0.50	108.00	7.00	0.14	0.13
	4/6/2010	0.50	1.00	101.00	8.00	0.16	0.12
	7/7/2010	0.50	5.00	117.00	9.00	0.22	0.14
	11/4/2010	0.50	0.50	95.00	7.00	0.11	0.17
	2/8/2011	0.50	6.00	96.00	8.00	0.23	0.34

Station	***Date***	***NO2+NO3***	***NH4***	***TN***	***TP***	***Turb***	***Chl***
	GM	0.52	1.31	90.48	6.75	0.18	0.13
E4 (mid)	3/30/2006	1.00	0.50	81.00	5.00	0.12	0.20
	5/17/2006	0.50	0.50	88.00	6.00	0.18	0.06
	8/1/2006	0.50	5.00	83.00	8.00	0.15	0.32
	10/24/2006	0.50	0.50	77.00	6.00	0.93	0.13
	1/24/2007	0.50	6.00	89.00	7.00	0.24	0.18
	4/10/2007	1.00	10.00	96.00	9.00	0.21	0.23
	7/11/2007	0.50	2.00	139.00	7.00	0.24	0.14
	10/3/2007	0.50	1.00	79.00	7.00	0.16	0.13
	2/4/2008	2.00	2.00	113.00	8.00	0.24	0.20
	4/16/2008	0.50	3.00	91.00	7.00	0.36	0.13
	7/9/2008	1.00	16.00	97.00	9.00	0.24	0.59
	10/1/2008	0.50	4.00	75.00	6.00	0.16	0.17
	2/18/2009	0.50	0.50	63.00	6.00	0.24	0.19
	4/7/2009	1.00	0.50	58.00	5.00	0.13	0.07
	7/28/2009	0.50	2.00	71.00	7.00	0.23	0.19
	11/17/2009	2.00	9.00	78.00	8.00	0.25	0.25
	2/17/2010	2.00	0.50	137.00	7.00	0.12	0.29
	4/6/2010	0.50	3.00	85.00	8.00	0.09	0.13
	7/7/2010	1.00	4.00	95.00	7.00	0.15	0.17
	11/4/2010	0.50	2.00	77.00	6.00	0.09	0.22
	2/8/2011	0.50	2.00	89.00	6.00	0.12	0.08
	GM	0.72	2.04	86.63	6.82	0.19	0.17
E4 (bottom)	3/30/2006	4.00	0.50	78.00	6.00	0.23	0.20
	5/17/2006	7.00	0.50	85.00	5.00	0.11	0.12
	8/1/2006	3.00	4.00	85.00	5.00	0.15	0.22
	10/24/2006	1.00	0.50	99.00	6.00	0.10	0.17
	1/24/2007	3.00	2.00	87.00	6.00	0.16	0.16
	4/10/2007	6.00	11.00	115.00	8.00	0.23	0.19
	7/11/2007	1.00	2.00	134.00	6.00	0.16	0.22
	10/3/2007	9.00	0.50	85.00	7.00	0.16	0.14
	2/4/2008	7.00	0.50	134.00	7.00	0.15	0.17
	4/16/2008	1.00	2.00	143.00	6.00	0.25	0.26
	7/9/2008	9.00	4.00	110.00	9.00	0.20	0.24
	10/1/2008	2.00	7.00	107.00	6.00	0.19	0.19
	2/18/2009	4.00	3.00	91.00	6.00	0.26	0.23
	4/7/2009	4.00	4.00	69.00	6.00	0.14	0.21
	7/28/2009	5.00	3.00	77.00	6.00	0.21	0.26

Station	***Date***	***NO2+NO3***	***NH4***	***TN***	***TP***	***Turb***	***Chl***
	11/17/2009	8.00	1.00	76.00	6.00	0.16	0.11
	2/17/2010	4.00	0.50	144.00	7.00	0.15	0.29
	4/6/2010	8.00	1.00	100.00	8.00	0.16	0.25
	7/7/2010	4.00	4.00	103.00	8.00	0.32	0.25
	11/4/2010	11.00	3.00	90.00	7.00	0.08	0.11
	2/8/2011	10.00	2.00	99.00	7.00	0.08	0.08
	GM	4.25	1.75	98.29	6.50	0.16	0.18

APPENDIX I
HSWAC DEEP WATER MARINE BIOLOGY SURVEY

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Analysis of Organisms Recorded on Submersible Video Along the HSWAC Pipe Route

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Summary

This report provides an analysis of organisms recorded on video from four Pisces submersible dives conducted by the Hawaii Undersea Research Laboratory (HURL) along the Honolulu Seawater Air Conditioning, LLC (HSWAC) pipe route. Two test dives were conducted in 2009 starting at 40m and 70m near the shallow end of the route extending down to approximately 400m and 200m, respectively. Two additional dives were contracted by HSWAC in 2011 that began at approximately 540m and extended up to a depth of 250m. All organisms observed on the video from these dives were counted and identified to the lowest taxonomic level using VARS (Video Annotation and Reference System) developed by the Monterrey Bay Aquarium Research Institute (MBARI). The data, which included substrate information, depths, locations, and environmental factors, were extracted and imported into ArcGIS. Based on the depth ranges of individual species as well as substrate types along the pipe route, 3 habitat zones were identified: 50-200m, 200-400m, and 400-550m. The calculated densities of all organisms for each zone were determined from the length of the submersible dive tracks multiplied by the average width (3m) of the video camera field. In addition to densities, the locations of the organisms in the water column (i.e., benthic or benthopelagic) were noted along with the substrate type benthic organisms were in contact with. These data are discussed with respect to the comments HSWAC received on their draft Environment Impact Statement (dEIS) and the potential impacts of the HSWAC pipe on the biological communities present along the proposed route.

Introduction

Honolulu Seawater Air Conditioning, LLC (HSWAC) is in the process of designing and permitting a deep seawater pipe for the purpose of providing large-scale air conditioning services to downtown Honolulu. A pipe approximately 7 kilometers long will be installed along the seafloor from the shoreline down to a depth of 540m. Seawater with a temperature of approximately 7°C will be pumped up the pipe to a large land-based heat exchanger and subsequently discharged offshore at an approximate depth of 35 to 45m. A Federal Environmental Impact Statement (EIS) is being prepared for this project subsequent to a draft document (dEIS) submitted earlier this year. Both the Environmental Protection Agency (EPA) and NOAA Fisheries replied with comments that will be addressed in the final document (FEIS). The comments pertinent to this present report can be summarized as follows:

<u>*EPA Comments*</u>

1) More comprehensive aquatic resource surveys and impact assessment data are needed for the Army Corps of Engineers

2) The potential occurrence of mesophotic coral reef ecosystems needs to be included. FEIS should describe more recent HURL survey data and include mapping of habitat sites, and quantitative data on coral cover, density, size, condition, and species.

3) Increased turbidity and physical disturbance to soft and hard sea bottoms during installation should be described.

4) Biological assessments along pipeline sites should include coral density, size, species richness, and condition.

5) Deep benthos should be assessed, particularly mesophotic coral reef ecosystems along pipe route and near discharge site.

NOAA Fisheries Comments

1) Quantitative current water quality and benthic resource data where potential impact may occur should be provided. These include coral size frequency, density of non-coral invertebrates, and biomass of fish. The presence and distribution of mesophotic coral along pipe up to 200m depths should be described.

2) Expected impacts to resources should be quantified including species, densities, and size classes of corals and densities of non-coral invertebrates.

3) The expected species and numbers of individuals that may be entrained at the deep seawater intake should be identified. The significance of this entrainment should be described.

4) A map(s) of the pipe route superimposed on a map of biological resources should be provided. These benthic maps should be up-to-date and high resolution.

5) Impact to all Essential Fish Habitats (EFH) should be characterized and described in more detail.

6) Quantitative and detailed comprehensive benthic survey data should be provided.

Approximately 84% of the pipe route is located below SCUBA depths where data on the biological resources can only be obtained by deepwater vehicles. The Hawaii Undersea Research Laboratory (HURL) operates two such vehicles, the Pisces 4 and Pisces 5 submersibles, both having a maximum operating depth of 2000m. HURL along with the Monterrey Bay Aquarium Research Institute (MBARI) are presently the only two deepwater research facilities that routinely annotate video recorded during dive operations. Both facilities also maintain extensive databases on the deepwater animals observed within their operating areas, which for HURL is primarily the Hawaiian Archipelago. Identification of deepwater animals from video is a core responsibility of HURL's Biology program. Their expertise in this area prompted HSWAC to request assistance from HURL's program biologist in addressing the comments from the dEIS. Specifically, HSWAC requested a detailed annotation be carried out on HURL submersible dives conducted in the vicinity of its pipe route. This report provides the results of that study and discusses its findings in the context of the FEIS requirements.

Methods

HURL has conducted a total of seven submersible dives in the vicinity of HSWAC's pipe route:

P5-711 test dive conducted February 10, 2009 to survey the pipe route
P4-207 test dive conducted February 10, 2009 to survey the pipe route
P5-748 contract dive conducted October 5, 2010 to recover a glider
P4-242 test dive conducted February 24, 2011
P5-753 test dive conducted February 24, 2011
P4-243 contract dive conducted March 28, 2011 to survey the pipe route
P5-767 contract dive conducted March 28, 2011 to survey the pipe route

Dives P4-242 and P5-753 began at the HSWAC pipe intake location, but subsequently moved south away from the pipe route and therefore were excluded from this study. Furthermore, after discussion with HSWAC, it was decided that the area covered during dive P5-748 was surveyed more carefully during dives P4-243 and P5-767 and video analysis from this dive would also not be necessary. This study therefore involved the detailed annotation of video from the four remaining dives. Table 1 provides information regarding dive times, depth ranges, and the number of hours of video examined for each dive.

Table 1: Dive times and hours of video annotated for each dive.

Dive #	Dive Times	Hrs of Video	Depth Range (m)
P5-711	11:38-13:43	2	75-209
P4-207	10:43-16:37	6	40-408
P5-767	09:18-16:18	7	250-559
P4-243	09:36-15:20	6	250-559
Total	**09:18-16:37**	**21**	**40-559**

P5-711 was aborted approximately 2 hours after reaching the seafloor because of a mechanical malfunction. A total of 21 hours of submersible video in the vicinity of the HSWAC pipe route were annotated, which covered depths of 40-559m. The annotations were carried out using VARS (Video Annotation and Reference System), which was developed by MBARI and provided to HURL at no cost. HURL acquired HD camera systems in 2009 for its submersibles and is in the process of converting over to VARS, which was designed specifically for annotating MBARI's HD videotapes and files. VARS includes custom scripts that automate the process of merging tracking, CTD, and depth data with animal observation records. Upon receiving VARS, HURL updated the VARS taxonomic knowledgebase for all deepwater Hawaiian fishes and invertebrates, using the World Register of Marine Species (WoRMS) as its taxonomic reference. The identifications in this study are therefore completely up to date. The VARS annotation interface provides "association buttons" which allowed detailed substrate descriptions to be included with each animal record. Finally, the VARS query interface allowed the extraction of all records in txt format, which was subsequently converted to Microsoft Excel format and imported into ArcGIS for mapping purposes.

The HD cameras were generally set to their widest field of view while the submersibles were moving along the pipe route. Lasers mounted on the cameras provided measurement scales for determining the size of objects recorded on video but also for estimating the width of the cameras' field of view. Frame grabs taken and analyzed at various points during the dives determined that the average HD camera covered a swath 3m wide. GIS analysis of the tracking data from all of the dives determined that the total distance covered during the dives was 18.8 kilometers and the total area of seafloor recorded on video (based on a 3m video swath) was 5.6 hectares (Table 2). These estimates were used to determine the densities of animals found along the pipe route.

Table 2: Dive length and area covered by video for each of the 4 dives.

Dive	Length (m)	Area (m2)	Area (ha)
P5-711	937	2811	0.2811
P4-207	5116	15348	1.5348
P4-243	5989	17967	1.7967
P5-767	6742	20226	2.0226
Total	**18784**	**56352**	**5.6352**

Results and Discussion

Figure 1 provides the submersible dive tracks superimposed over the pipe route. The total length of the pipe route starting from the shoreline and extending south to the intake is 8 km. The dives covered the lower 6.7 km or approximately 84%. The portion of the pipe route from 50m down to the proposed intake at 540m was adequately surveyed during the dives. However, dive P4-207 began 170m east of the pipe route at a depth of 40m. The habitat from this location to the pipe route appeared to be quite uniform based on the similarity between the submersible video data and the 39m diver transect data on the pipe route. Consequently, the submersible observations from 40-50m, while slightly to the east of the pipe route, were considered to be representative of the habitat on the actual route. These data however, will be treated separately at the end of this report and the data from 50-540m will be primarily used to address potential impacts during pipe installation on communities within those depths, potential consequences of the pipe and anchors changing substrate composition, and potential entrainment of deepwater species.

A total of 1,741 biological observations were recorded from the 4 dives, which represent every organism that could be extracted from the dive video. Most observations represent single individuals, however in some cases, multiple individuals were observed in the same frame or in very close proximity. In these cases, a single record was created in VARS, to which was added a count of the individuals observed. Therefore within the 1,741 records, a total of 2,530 animals were counted.

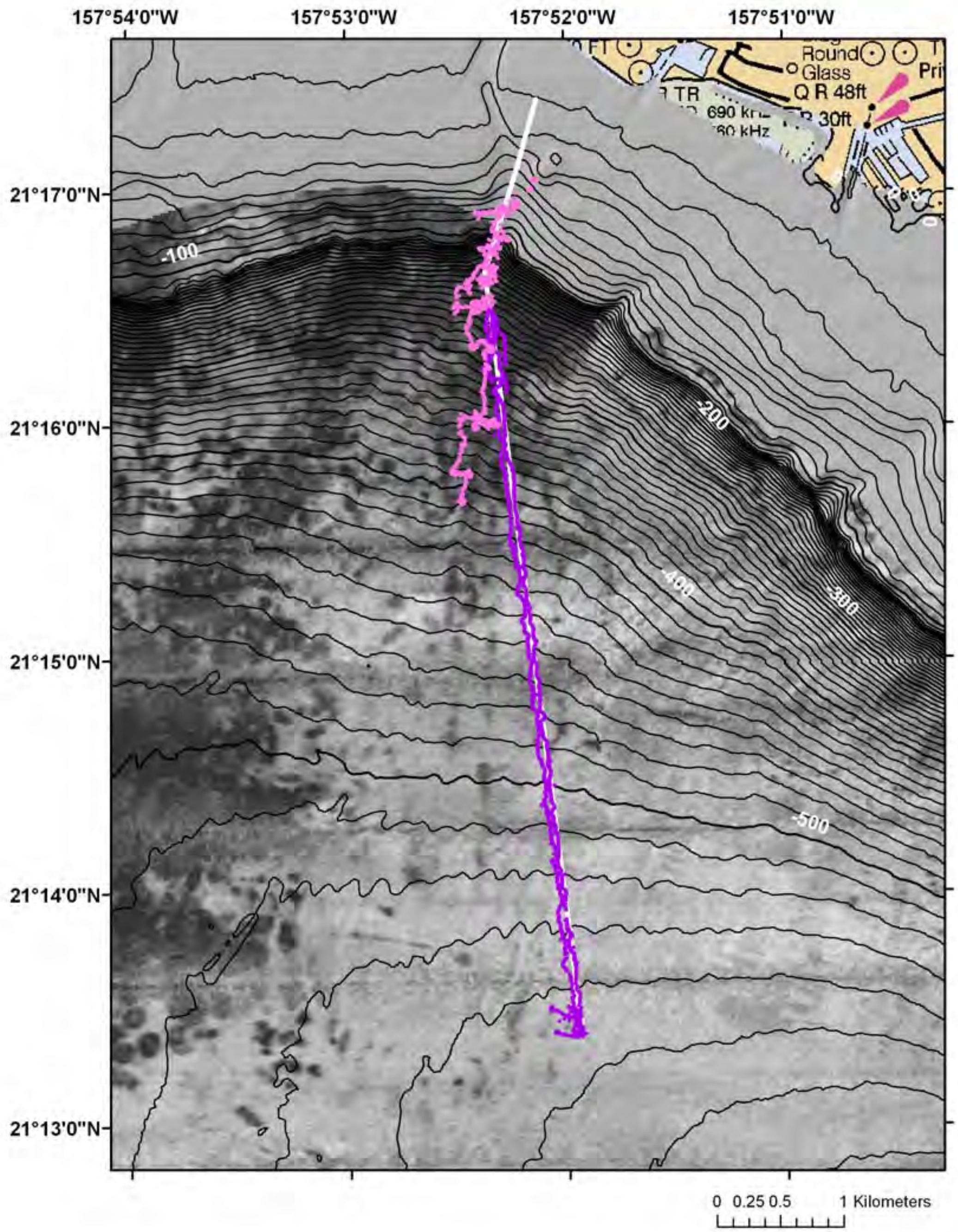

Figure 1: Map showing the tracks of the 4 Pisces submersible dives (pink and purple dots) along the HSWAC pipe route (white). The pipe route and tracks are overlaying 20m resolution multibeam sonar data (hillshaded bathymetry and backscatter) obtained from the Hawaii Mapping Research Group at the University of Hawaii at Manoa. Note that the backscatter only extends up to a depth of approximately 70m and dark areas indicated high reflectivity associated with rocks and dredge spoil.

Depth Zonation Along the Pipe Route.

Organisms were observed along the entire length of the surveyed pipe route. A total of 159 different "organism types" along with 2 algae types were identified, some only generally while others, to species. A depth range analysis indicated that animal types/species could be segregated into 3 depth zones: 50-200m, 200-400m, and 400-550m (Fig 2). These zones, labeled 1,2, and 3 starting with the shallowest, coincided with noticeable differences in substrate composition and slope (Fig. 3). In zone 1, the slope was fairly gradual from 50m down to a depth of 110m and the substrate was predominantly exposed carbonate bedrock interspersed with sediment pockets, pebbles, cobbles, boulders, and manmade debris such as discarded tires, trash, and metal objects (Fig. 4a). Many of the cobbles and boulders appeared to be dredge spoil deposits. A break-in-slope was found at 110m (Fig. 4b) where the terrain changed abruptly into a steep carbonate slope extending down to zone 1's 200m boundary. The break-in-slope is the well-known edge of an old reef feature that is believed to have drowned during the last glacial melt phase approximately 20,000-30,000 years ago (Clague, pers comm.).

Zone 2 (200-400m) was characterized by a transition from steep carbonate bedrock to sediment covered by pebbles, cobbles, boulders, and manmade debris (Fig. 5a). The more gradual slope between 200-400m presumably allowed for increased deposition of sediment, while the majority of the larger grain sizes (i.e., cobbles and boulders) were clearly dredge spoil deposits (Fig. 5b) that were likely masking a smaller amount of natural landslide debris. The large amount of dredge spoil is primarily responsible for the high backscatter return throughout most of this zone. Manmade objects were numerous and included trash, shipwrecks, discarded vehicles, miscellaneous metal debris, and a small amount of disposed ordnance. This zone had been subjected to considerable disturbance.

The substrate in zone 3 was primarily rippled sediment with pebbles, occasional cobbles, boulders, and blocks, and a considerable number of manmade objects (Fig. 6). The slope was far more gradual than either of the other two zones with virtually no exposed bedrock present. Large blocks and boulders that were occasionally encountered were believed to be natural landslide debris. Dredge spoil was far less prevalent than that observed in either zone 1 or 2. However, a significantly larger amount of disposed ordnance was encountered, which included small World War I-II era chemical weapons (M1 30 lb and MK47 100 lb bombs), both large artillery and small mortar projectiles, an aerially-deployed rocket, and a small number of 500 lb bombs with their shipping collars still attached. With the exception of the rocket and 500 lb bombs, all of the ordnance was clearly old and highly corroded. Other manmade debris included vehicles, airplane debris, large pieces of unidentified metal framing, 55 gal drums, and piles of what appeared to be discarded fuses. Similar to zone 2, the habitat in zone 3 has clearly been highly disturbed.

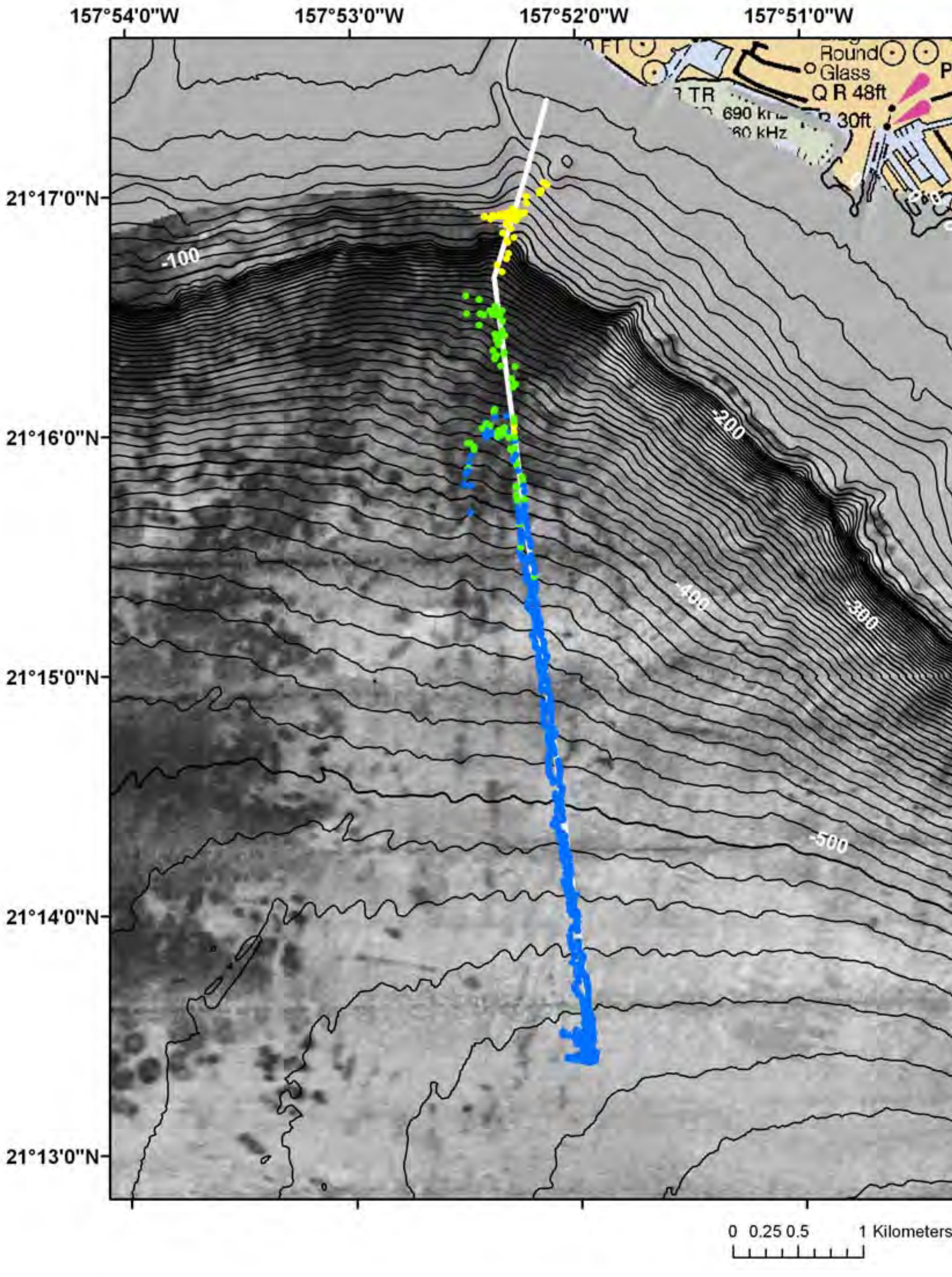

Figure 2: The location of animal records obtained from the dive video. Following a depth range analysis, animal types/species were segregated into 3 zones: zone 1 (50-200m, yellow dots), zone 2 (200-400m, green dots), and zone 3 (400-550m, blue dots).

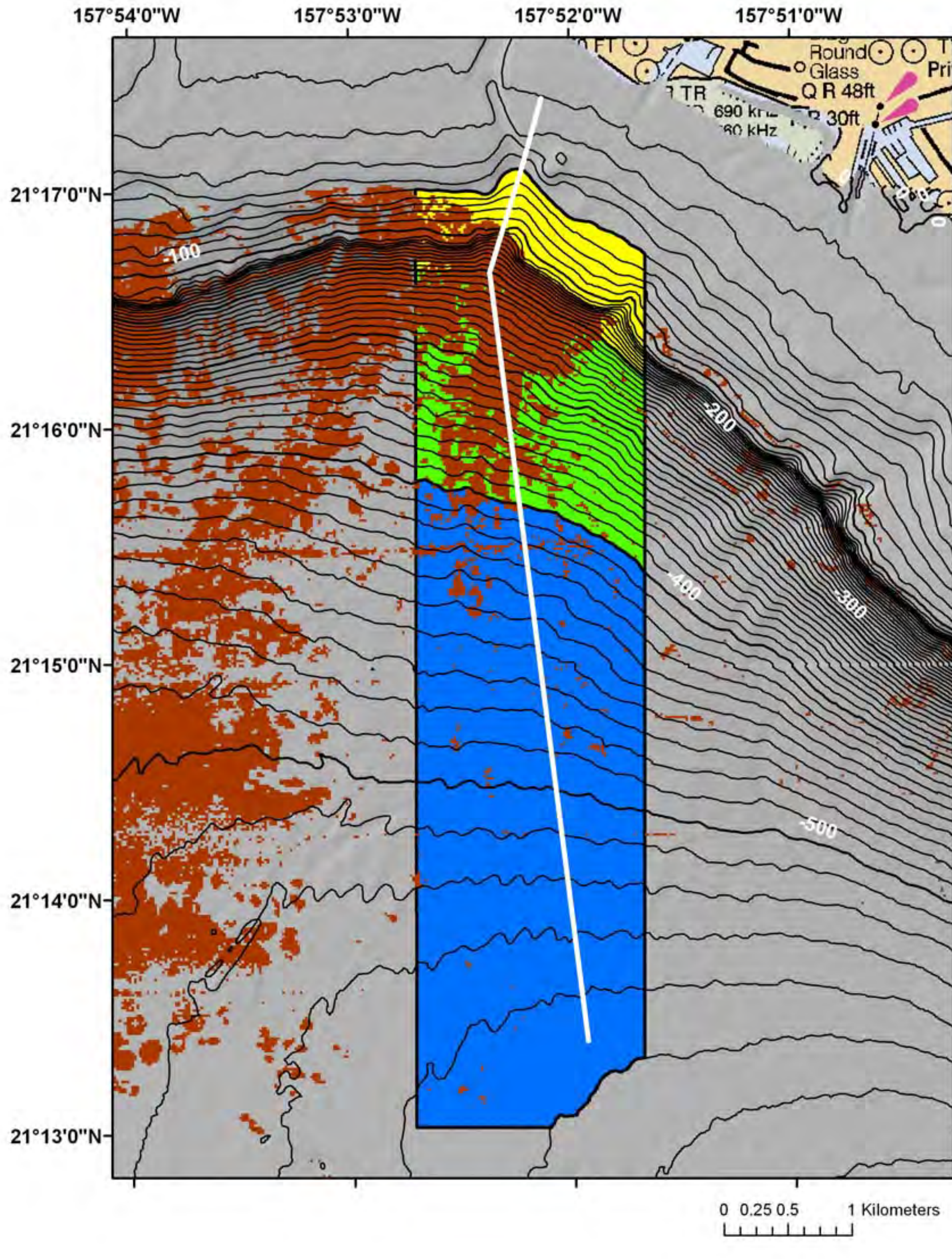

Figure 3: The three habitat zones (zone 1 yellow, zone 2 green, and zone 3 blue) shown in relationship to multibeam backscatter values greater than 187 (red areas). Note the upper part of zone 1 was outside of the backscatter data coverage, but from submersible observations, consists primary of hard substrate similar to it's lower half and zone 2.

Fig 4: Zone 1 (50-200m): a) upper terrace of bedrock covered by sediment pockets interspersed pebbles, cobbles, boulders, b) the break-in-slope at 110m.

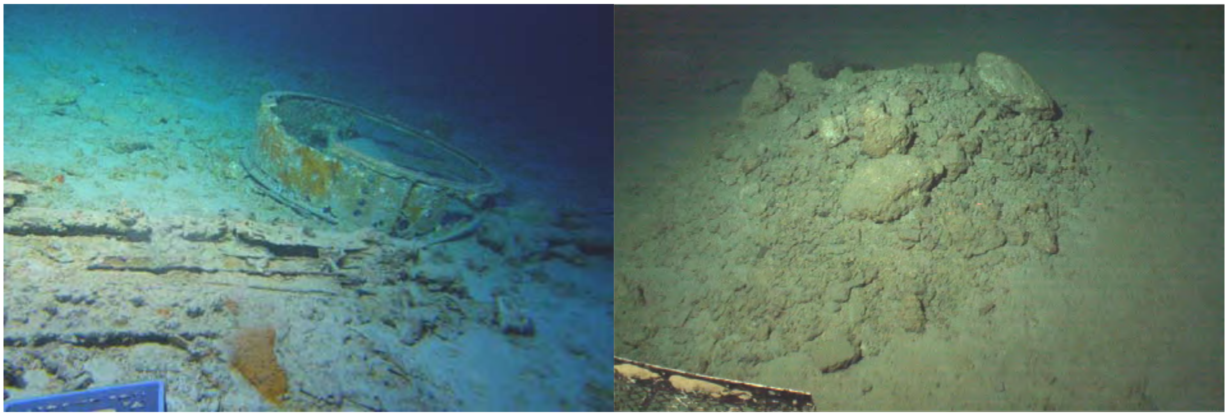

Fig. 5: Zone 2 (200-400m): a) bedrock, sediment pebbles, cobbles, boulders, and manmade debris found on upper section, b) dredge spoil on sediment found further down the slope.

Fig. 6: Zone 3 (400-550m): rippled sediment and pebbles with manmade debris including a) disposed ordnance and b) discarded metal framework.

In addition to substrate, the 3 zones differed significantly with regard to light intensity and water quality. Off the coast of Oahu, down-welling natural light reaches a depth of approximately 300m. Zone 1 was therefore mesophotic, zone 2 was transitional between mesophotic and aphotic, and zone 3 was aphotic. Pressure, while changing from 90 to 817 psi, is generally not considered a major factor in structuring marine communities above 500m. Salinity was relatively constant for all zones, ranging between 34.0-35.1 ppt while temperature and dissolved oxygen ranged from 11-16 C° and 1.7-2.9 ml/l, respectively (Table 3).

Table 3: Depth range and environmental factors for each habitat zone.

Zone	Depth Range (m)	Temp Range (C)	Salinity Range (ppt)	Oxygen Range (ml/l)
1	50-200	18.1-24.5	34.8-35.1	3.9-4.8
2	200-400	8.4-18.1	34.0-34.9	2.8-4.4
3	400-550	6.3-8.6	34.1-34.1	1.0-3.1

In general, the water in zone 1 was still relatively warm, lit, and oxygenated in contrast to the water in zone 3, which was cold, dark, and poorly oxygenated, typical of depths below 400m throughout Hawaii and the rest of the Pacific. These differences in substrate, light intensity, and water quality are most likely responsible for the observed changes in species composition along the pipe route.

<u>Animal Identifications and Densities Within Depth Zones.</u>

The identifications, counts, and estimated densities of animals observed in zone 1 are provided in Table 4. Densities are based on an estimated total survey area of 0.791 hectares for this zone. Five hundred fifty-one organisms were counted, yielding a density of 766 organisms per hectare.

Table 4: Animals identified from submersible video in zone 1: 50-200m.

Animal Category	**Name**	**Counts**	**Density (ha)**	**Density (m2)**
algae	Rhodophyta	5	6.95	0.001
	Halimeda opuntia	1	1.39	0.000
cnidarians	Leptoseris sp	41	57.02	0.006
	Hydrozoa	3	4.17	0.000
sponges	Pseudoceratina sp	383	532.61	0.053
	Porifera	11	15.30	0.002
urchins	Asterostomatidae cf	55	76.48	0.008
	unidentified	2	2.78	0.000
	Prionocidaris thomasi	1	1.39	0.000
seastars	unidentified	1	1.39	0.000
fishes	unidentified	21	29.20	0.003
	Seriola dumerili	5	6.95	0.001
	Bodianus albotaeniatus	4	5.56	0.001
	Chaetodon miliaris	3	4.17	0.000
	Dasyatis sp	3	4.17	0.000
	Parapercis schauinslandii	3	4.17	0.000
	Dascyllus albisella	2	2.78	0.000
	Scaridae	2	2.78	0.000
	Apolemichthys arcuatus	1	1.39	0.000
	Balistidae	1	1.39	0.000
	Canthigaster jactator	1	1.39	0.000
	Heniochus diphreutes	1	1.39	0.000
	Labridae	1	1.39	0.000
Zone 1 Total		**551**	**766.24**	**0.077**

Of these, twenty-three organism types were identified in this zone, 13 of which were fishes. With three exceptions, *Seriola dumerili*, *Parapercis schauinslandii*, and *Dasyatis sp*, these species are all typically observed in shallower depths associated with coral reefs. The three exceptions are less common on shallow reefs and more commonly seen in mesophotic depths on deep reefs as well as sediment flats. The relatively few invertebrates should not be construed as comprehensive because small individuals are difficult to identify from video, particularly in mesophotic depths. The presence of down-welling sunlight creates a dark blue filter on the image even in the presence of artificial lighting from the submersible. As a result, algae, cnidarians, sponges, and echinoderms are undercounted with the species here being those that were large enough and exposed enough to be seen.

Noteworthy invertebrate species were *Leptoseris sp*, a well-known mesophotic scleractinian coral, *Pseudoceratina sp*, which is a tentative identification for a large yellow demosponge, and the skunk urchin whose taxonomic standing is presently being reviewed (Mooi, pers comm.) and is therefore identified only as *Asteroschematidae cf* (Fig. 7). These urchins were only seen in a single aggregation at the break-in-slope while the other two species were only seen above the break (Fig 8). *Pseudoceratina sp* had the highest density (533/ha) of all organisms observed in this zone followed by *Leptoseris sp* (57/ha). *Leptoseris sp* was only observed as individual colonies and not as large dense biohermes that have been found off Maui and Kauai.

Plate like *Leptoseris sp* colonies were estimated to be around 30-45 cm across making them the largest invertebrates seen in this zone, followed by the more spherical *Pseudoceratina* sp sponges that reached no more than 30 cm in diameter. The largest fishes were *Seriola dumerili* (60-90 cm FL) and Dasyatis sp (60 cm in width).

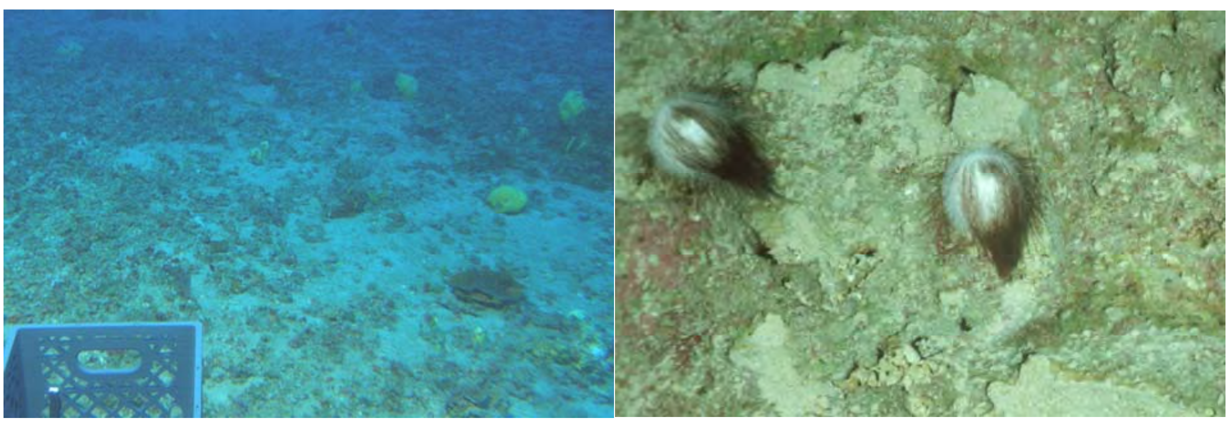

Fig 7: a) Leptoseris sp colony (lower right) and colonies of Pseudoceratina sp (yellow) along the pipe route, and b) an image of Asteroschematidae cf from the HURL gallery.

In order to put these observations into context, HURL database records were extracted to determine the total number of different organism types ever identified from submersible video in the main Hawaiian Islands for each of the three depth zones. The results of the extraction for zone 1 are provided in Table 5. HURL has documented 447 different organism types within 50-200m, with fishes being the most abundant (242), followed by cnidarians (66), sponges (20), urchins (19), and other invertebrates. Only 5.1% of all organism types from the database were observed along the HSWAC pipe route within zone 1. Due to the EPA's and NOAA Fisheries' particular concern about corals, it's also worth noting here that only 2 of the 66 cnidarians in the HURL database were observed. In comparison to other 50-200m areas HURL submersibles have been in the main islands, zone 1 of the pipe route has a very low number of species.

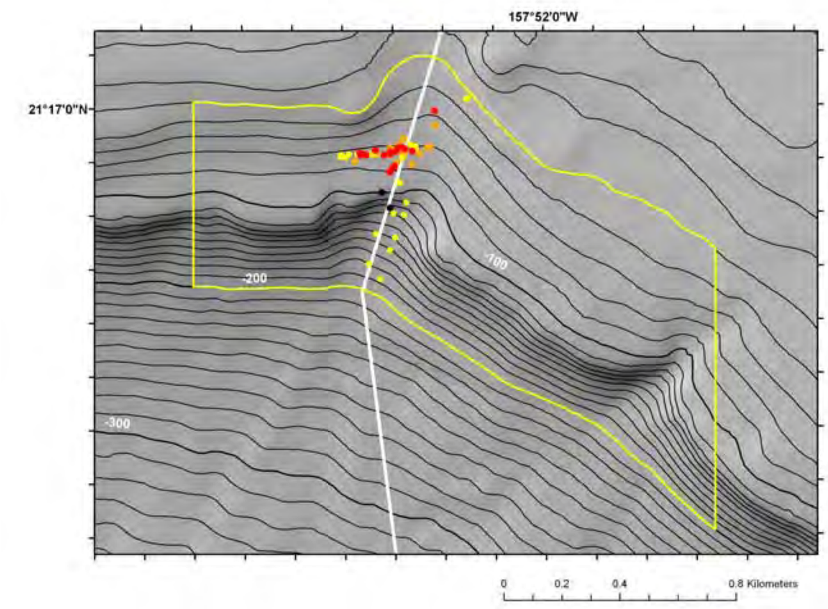

Fig 8: Locations of organisms observed in zone 1. Leptoseris sp is shown as red dots, Pseudoceratina sp as orange dots, Asteroschematidae cf as black dots, and all other animals as yellow dots.

Table 5: Number of different organism types found between 50-200m in HURL database records and the proportion of those observed during the pipe route surveys.

Category	HURL	HSWAC	% species on pipe route
algae	18	2	11.1
cnidarians	66	2	3.0
ctenophores	0	0	
sponges	20	2	10.0
urchins	19	3	15.8
seastars	14	1	7.1
brittlestars	1	0	0.0
crinoids	1	0	0.0
sea cucumbers	11	0	0.0
barnacles	2	0	0.0
crabs	8	0	0.0
shrimps	6	0	0.0
other crustaceans	4	0	0.0
octopods	3	0	0.0
squids	0	0	
gastropods	9	0	0.0
other mollusks	4	0	0.0
worms	5	0	0.0
other invertebrates	13	0	0.0
fishes	242	13	5.4
unidentified animals	1	0	0.0
Total	447	23	5.1

The identifications, counts, and estimated densities of animals observed in zone 2 are provided in Table 6. Densities are based on an estimated total survey area of 2.0058 hectares for this zone. Two hundred ninety-seven animals were counted at a density of 148 organisms per hectare.

Table 6: Animals identified from submersible video in zone 2: 200-400m.

Animal Category	Name	Counts	Density (ha)	Density (m2)
cnidarians	Scleractinia single polyp	26	12.96	0.001
	Aphanipathes sp1	20	9.97	0.001
	Hydrozoa	12	5.98	0.001
	Pennatulacea	3	1.50	0.000
	Stichopathes sp	3	1.50	0.000
	Gardineria hawaiiensis	2	1.00	0.000
	Antipatharia	1	0.50	0.000
	Swiftia sp cf	1	0.50	0.000
	unidentified	1	0.50	0.000
ctenophores	Lyrocteis sp	4	1.99	0.000
sponges	Sericolophus hawaiicus	2	1.00	0.000
	Regadrella sp	1	0.50	0.000
urchins	Stylocidaris calacantha	4	1.99	0.000
	Cidaridae	1	0.50	0.000
	unidentified	1	0.50	0.000
	Stylocidaris rufa	1	0.50	0.000
seastars	Goniasteridae	1	0.50	0.000
crinoids	Antedon sp yellow	1	0.50	0.000
barnacles	Cirripedia	3	1.50	0.000
crabs	Brachyura	1	0.50	0.000
	Galatheidae	1	0.50	0.000
	Homola dickinsoni	1	0.50	0.000
	Paguridae	1	0.50	0.000
	Paramunida hawaiiensis	1	0.50	0.000
shrimps	Decapoda shrimp	1	0.50	0.000
	Plesionika sp	1	0.50	0.000
unid crustaceans	unidentified	1	0.50	0.000
fishes	Symphysanodon maunaloae	38	18.95	0.002
	unidentified	32	15.95	0.002
	Myctophidae	30	14.96	0.001
	Etelis carbunculus	28	13.96	0.001
	Pontinus macrocephalus	14	6.98	0.001
	Scorpaenidae	9	4.49	0.000
	Chlorophthalmus proridens	6	2.99	0.000
	Roa excelsa	6	2.99	0.000
	Chrionema chryseres	5	2.49	0.000
	Etelis coruscans	4	1.99	0.000
	Holocentridae	3	1.50	0.000
	Ophichthidae	3	1.50	0.000
	Seriola dumerili	3	1.50	0.000
	Symphysanodon typus	3	1.50	0.000
	Congridae	2	1.00	0.000
	Odontanthias elizabethae	2	1.00	0.000
	Plectranthias kelloggi	2	1.00	0.000
	Anguilliformes	1	0.50	0.000
	Bothidae	1	0.50	0.000
	Canthigaster inframacula	1	0.50	0.000
	Epigonus sp	1	0.50	0.000
	Gymnothorax nuttingi	1	0.50	0.000
	Parapercis roseoviridis	1	0.50	0.000
	Physiculus sp	1	0.50	0.000
	Satyrichthys engyceros	1	0.50	0.000
	Squalus mitsukurii	1	0.50	0.000
worms	Annelida	1	0.50	0.000
Zone 2 Total		**297**	**148.07**	**0.015**

Even though the overall density was significantly lower than zone 1, the number of different organisms (55) recorded in zone 2, was significantly higher. Similar to zone 1, fishes predominated with 26 types, followed by cnidarians (9), crabs (5), urchins (4) and other invertebrates. Only 2 types of sponges were observed, *Regadrella sp* and *Sericolophus hawaiicus*, both of which are more commonly seen at deeper depths. Unlike zone 1, no shallow reef fishes or invertebrates were observed in this zone. The 200-400m depth range has been thoroughly surveyed by submersible during studies on the deepwater bottomfish fishery (see Kelley & Ikehara, 2006 as an example report). With the exception of one cnidarian tentatively identified as *Swiftia sp cf* (Fig 9a), the invertebrates and fishes observed in this zone are all common members of the bottomfish habitat community. The genus *Swiftia* is in a family of sea fans, but the animal may in fact be the black coral *Aphanipathes sp1* (Fig. 9b) since the two can be very difficult to differentiate visually. *Aphanipathes sp1* can be found in relatively dense beds off the east coast of Oahu, but was observed at a density of only 10/ha along the pipe route. Most of the two commercially harvested species of bottomfish, *Etelis coruscans* and *E. carbunculus*, were not actually on the pipe route but rather on large pieces of metal wreckage further to the west. The only other animal of particular note was a single polyp scleractinian coral that could not be identified further from the video. Given the depth range, appearance, and small size, it was likely *Desmophyllum dianthus* (Fig. 10a), which occurs in relatively dense aggregations north of Kahoolawe. Along the pipe route, only one small group was encountered at a density of 13/ha.

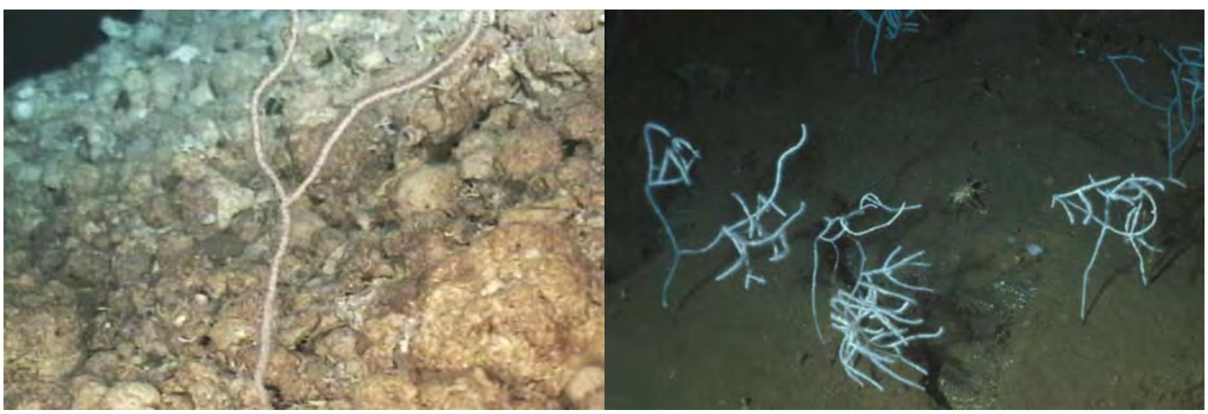

Fig 9: a) Swiftia sp cf and b) Aphanipathes sp1, both images from the HURL gallery.

Benthic animals in zone 2 included species commonly observed on both hard and soft substrates. Sediment specialists included sea pens (Pennatulacea), the sponge *Sericolophus hawaiicus*, two of the crabs, one shrimp, and various fish species that included *Chlorophthalmus proridens, Chrionema chryseres* (Fig 10b), an unidentified left-eyed flatfish (Bothidae), the puffer, *Canthigaster inframacula, Parapercis roseoviridis,* and *Satyrichthys engyceros*. The other benthic fishes and invertebrates were observed in association with hard substrate that included dredge spoil cobbles and boulders as well as manmade debris. Fig 11 shows the locations of zone 2 animals along the pipe route. The largest invertebrates found in zone 2 were the Aphanipathes sp1 (Fig. 9b above), which can reach up to 60 cm in height. *Seriola dumerili* (60-

90 cm FL) was the largest fish species. The scleractinian corals in this zone were all small, reaching no more than 10 cm in height.

Fig 10: a) the single polyp scleractinian Desmophyllum dianthus and b) benthic fish Chrionema chryseres, both images from the HURL gallery.

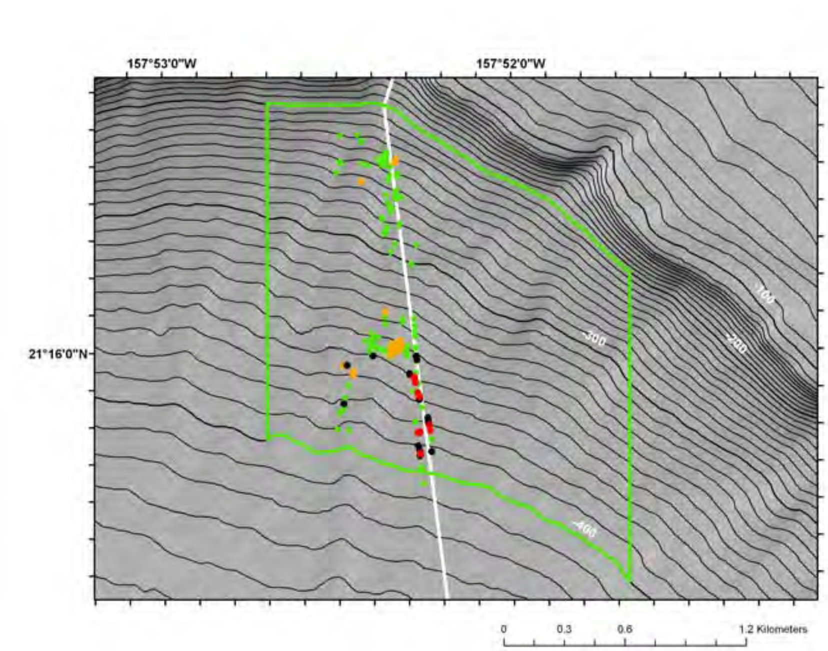

Fig 11: Locations of organisms observed in zone 2. The single polyp scleractinian shown as red dots, Swiftia sp cf and the several antipatharians as black dots, Etelis carbunculus and E. coruscans as orange dots, and all other animals as green dots.

The results of the HURL database extraction for zone 2 are provided in Table 7. HURL has documented 592 different organism types within 200-400m, with fishes being the most abundant (198), followed by cnidarians (181), crabs (35) seastars (33) and sponges (26). Only 9.3% of all organism types from the database were observed along the HSWAC pipe route within zone 2.

Only 9 of 181 cnidarians (5%) in the HURL database were observed. In comparison to other 200-400m areas HURL submersibles have been in the main islands, zone 2 of the pipe route again has a very low number of species.

Table 7: *Number of different organism types found between 200-400m in HURL database records and the proportion of those observed during the pipe route surveys.*

Category	HURL	HSWAC	% species on pipe route
algae	6	0	0.0
cnidarians	181	9	5.0
ctenophores	1	1	100.0
sponges	26	2	7.7
urchins	21	4	19.0
seastars	33	1	3.0
brittlestars	6	0	0.0
crinoids	5	1	20.0
sea cucumbers	3	0	0.0
barnacles	2	1	50.0
crabs	35	5	14.3
shrimps	19	2	10.5
other crustaceans	9	1	11.1
octopods	7	0	0.0
squids	3	0	0.0
gastropods	17	0	0.0
other mollusks	4	0	0.0
worms	7	1	14.3
other invertebrates	8	0	0.0
fishes	198	26	13.1
unidentified animals	1	1	100.0
Total	592	55	9.3

The identifications, counts, and estimated densities of animals observed in zone 3 are provided in Table 8. Densities are based on an estimated total survey area of 2.9103 hectares for this zone. A total of 1,483 organisms were counted, yielding 510 organisms per hectare. One hundred different types of organisms were recorded in zone 3, which is almost double the number of zone 2. As with the other zones, fishes had the most number of species (40), followed by cnidarians (22), urchins (7), shrimps (6), seastars (6), sponges (5) crabs (5), and other invertebrates. In terms of density, fishes were the most numerous group, followed by cnidarians, shrimps, and seastars. The seastar, *Brisinga panopla*, had the highest density (70/ha) of any animal in this zone and was observed mostly in association with large pieces of metal debris, carbonate boulders, and blocks (Fig 12a). Unlike most seastars, this species is a filter feeder, inverting its arms into the water column where it presumably catches small plankton and POM (particulate organic matter). This animal prefers to perch on hard objects in order to gain greater height above the bottom, a behavior also seen in the filter-feeding sponge, *Regadrella sp* (Fig 12b).

Unidentified species of shrimp in the genus *Plesionika* (Fig. 13a) were the next most numerous animals in this zone. These shrimp are considered benthopelagic, being observed both swimming in the water column as well as walking on the bottom. While on the bottom, they are generally seen on the sediment close to small hard objects such as ordnance and cobbles, which may offer shelter against predation. The same behavior was also seen in another larger species of shrimp, the pandalid *Heterocarpus ensifer* (Fig 13b), which is commercially harvested from time to time, mostly off the island of Niihau. The densities of this shrimp south of Honolulu are not high enough to support a regular fishery.

Table 8: Animals identified from submersible video in zone 3: 400-550m.

Animal Category	Name	Counts	Density (ha)	Density (m2)
cnidarians	Kophobelemnon stelliferum	55	18.90	0.002
	Pennatulacea white	46	15.81	0.002
	Protoptilum sp	46	15.81	0.002
	Hormathiidae sp2	44	15.12	0.002
	Pennatulacea	30	10.31	0.001
	Pennatula flava cf	25	8.59	0.001
	Actiniaria orange	17	5.84	0.001
	Actiniaria gray	9	3.09	0.000
	Primnoidae	5	1.72	0.000
	Actiniaria brown	4	1.37	0.000
	Antipatharia	3	1.03	0.000
	unidentified cnidaria	3	1.03	0.000
	Acanthogorgia sp	2	0.69	0.000
	Actiniaria	2	0.69	0.000
	Actiniaria white	2	0.69	0.000
	Hydrozoa	2	0.69	0.000
	Keroeides mosaica	2	0.69	0.000
	Narella muzikae	2	0.69	0.000
	Gardineria hawaiiensis	1	0.34	0.000
	Plexauridae	1	0.34	0.000
	Scleractinia single polyp	1	0.34	0.000
	Swiftia sp cf	1	0.34	0.000
ctenophores	Lyrocteis sp	44	15.12	0.002
sponges	Regadrella sp	52	17.87	0.002
	Sericolophus hawaiicus	31	10.65	0.001
	Hexactinellida ribbon	13	4.47	0.000
	Hexactinellida white	2	0.69	0.000
	Porifera	2	0.69	0.000
urchins	Aspidodiadema hawaiiense	20	6.87	0.001
	Histocidaris variabilis	10	3.44	0.000
	Diadematidae	9	3.09	0.000
	Echinoidea	8	2.75	0.000
	Stereocidaris hawaiiensis	8	2.75	0.000
	Echinothuriidae	1	0.34	0.000
	Laganum fudsiyama	1	0.34	0.000
seastars	Brisinga panopla	203	69.75	0.007
	Goniasteridae	4	1.37	0.000
	Henricia robusta	1	0.34	0.000
	Mediaster ornatus	1	0.34	0.000
	Plinthaster ceramoidea	1	0.34	0.000
	Sphaeriodiscus ammophilus	1	0.34	0.000
brittlestars	unidentified	7	2.41	0.000
crinoids	Comatulida	1	0.34	0.000
	Thalassometridae	1	0.34	0.000

Table 8 cont.

Animal Category	Name	Counts	Density (ha)	Density (m2)
barnacles	Heteralepas sp	7	2.41	0.000
crabs	Sympagurus dofleini	9	3.09	0.000
	Cyrtomaia smithi	4	1.37	0.000
	Brachyura	2	0.69	0.000
	Chirostylidae	1	0.34	0.000
	Galatheidae	1	0.34	0.000
shrimps	Plesionika sp	107	36.77	0.004
	Benthesicymus laciniatus	52	17.87	0.002
	Decapoda shrimp	25	8.59	0.001
	Heterocarpus ensifer	18	6.18	0.001
	Heterocarpus laevigatus	17	5.84	0.001
	Heterocarpus sp	8	2.75	0.000
fishes	Hymenocephalus antraeus	89	30.58	0.003
	Malacocephalus boretzi	51	17.52	0.002
	Chlorophthalmus proridens	47	16.15	0.002
	Macrouridae	43	14.78	0.001
	Synagrops sp	42	14.43	0.001
	Polymixia berndti	26	8.93	0.001
	Ventrifossa atherodon	26	8.93	0.001
	Actinopterygii	20	6.87	0.001
	Coelorinchus aratrum	16	5.50	0.001
	Setarches guentheri	16	5.50	0.001
	Satyrichthys hians	12	4.12	0.000
	Myctophidae	11	3.78	0.000
	Coelorinchus spilonotus	9	3.09	0.000
	Satyrichthys engyceros	9	3.09	0.000
	Ophichthidae	8	2.75	0.000
	Chascanopsetta crumenalis	7	2.41	0.000
	Ventrifossa ctenomelas	7	2.41	0.000
	Plesiobatis daviesi	6	2.06	0.000
	Ventrifossa sp	6	2.06	0.000
	Chrionema chryseres	5	1.72	0.000
	Anguilliformes	4	1.37	0.000
	Epigonus atherinoides	4	1.37	0.000
	Scorpaenidae	4	1.37	0.000
	Beryx sp	3	1.03	0.000
	Chascanopsetta sp	3	1.03	0.000
	Satyrichthys sp	3	1.03	0.000
	Stethopristes eos	3	1.03	0.000
	Chascanopsetta prorigera	2	0.69	0.000
	Chaunax umbrinus	2	0.69	0.000
	Cyttomimus stelgis	2	0.69	0.000
	Ijimaia plicatellus	2	0.69	0.000
	Squalus mitsukurii	2	0.69	0.000
	Synagrops argyreus	2	0.69	0.000
	Bembrops filifera	1	0.34	0.000
	Bembrops sp1	1	0.34	0.000
	Congridae	1	0.34	0.000
	Coryphaenoides marginatus cf	1	0.34	0.000
	Lophiodes miacanthus	1	0.34	0.000
	Nezumia burragei	1	0.34	0.000
	Nezumia or Kumba	1	0.34	0.000
octopus	Octopus sp	3	1.03	0.000
squid	Nototodarus hawaiiensis	3	1.03	0.000
gastropod	Pleurobranchidae	2	0.69	0.000
animal	unidentified	1	0.34	0.000
Zone 3 Total		**1483**	**509.57**	**0.051**

Rattail fishes (family Macrouridae) followed in abundance, particularly the benthopelagic *Hymenocephalus antraeus* (Fig. 14a) and the more benthic *Malacocephalus boretzi* (Fig. 14b). Both are associated with sediment substrates, with *H. antraeus* often seen swimming well up in the water column and may therefore be a component of the deep backscatter layer.

Not surprisingly, the most abundant cnidarians were sediment associated sea pens, particularly *Kophobelemnon stelliferum* (Fig 15a), an unidentified white species, and a species in the genus *Protoptilum* (Fig 15b). The anemone identified as Hormathiidae sp2 was the most common cnidarian observed on hard substrates such as ordnance, other metal debris, and boulders. Hormathiid anemones are identified only as sp1, sp2, etc in the HURL gallery because the various genera can only be differentiated by examination of their internal mesenteries (Foutin, pers comm.). However this particular as yet “un-named” species (sp2) is both distinctive and well known, commonly seen on submersible dives at zone 3 depths throughout the islands.

The largest invertebrates seen in zone 3 were deepwater corals, most being attached to a single large boulder. These included *Keroeides mosaica* (90 cm), *Narella muzikae* (30 cm), an unidentified primnoid (30 cm), and an unidentified plexaurid (30 cm). The two types of scleractinians were both single polyp species that did not exceed 10 cm in height. All of the sea pens observed were small (< 30 cm high) as were the sponges. The largest fishes in this zone were the ray, *Plesiobatis daviesi* (90 cm wide at most), and the dogfish shark, *Squalus mitsukurii* (90-120 cm FL).

Fig 16 shows the locations of animals found along the pipe route in zone 3. *Brisinga panopla*, most of the macrourids, and shrimps were found within the lower half of this zone. The latter two groups that include *Hymenocephalus antraeus*, *Plesionika sp*, and *Heterocarpus ensifer*, were all relatively small (5-30 cm in length) and will therefore be quite difficult to keep from entering the intake. These, along with other small fishes tentatively identified as myctophids, will likely be among those animals that become entrained after the pipe is installed and is operating.

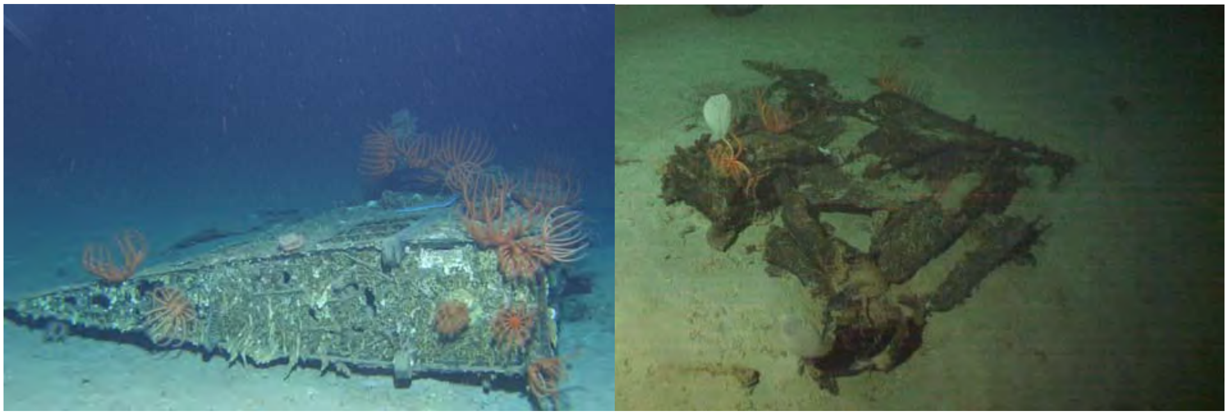

Fig 12: a) Brisinga panopla seastars (orange) on airplane wing with a Hormathiidae sp2 anemone (center) and b) Regadrella sp sponges (white upper left and foreground).

Fig 13: Zone 3 shrimps. a) Plesionika sp, and b) Heterocarpus ensifer. Images from the HURL gallery.

Fig 14: Zone 3 fishes. a) Hymenocephalus antraeus and b) Malacocephalus boretzi. Images from the HURL gallery.

Fig 15: Zone 3 sea pens. a) Kophobelemnon stelliferum and b) Protoptilum sp. Images from the HURL gallery.

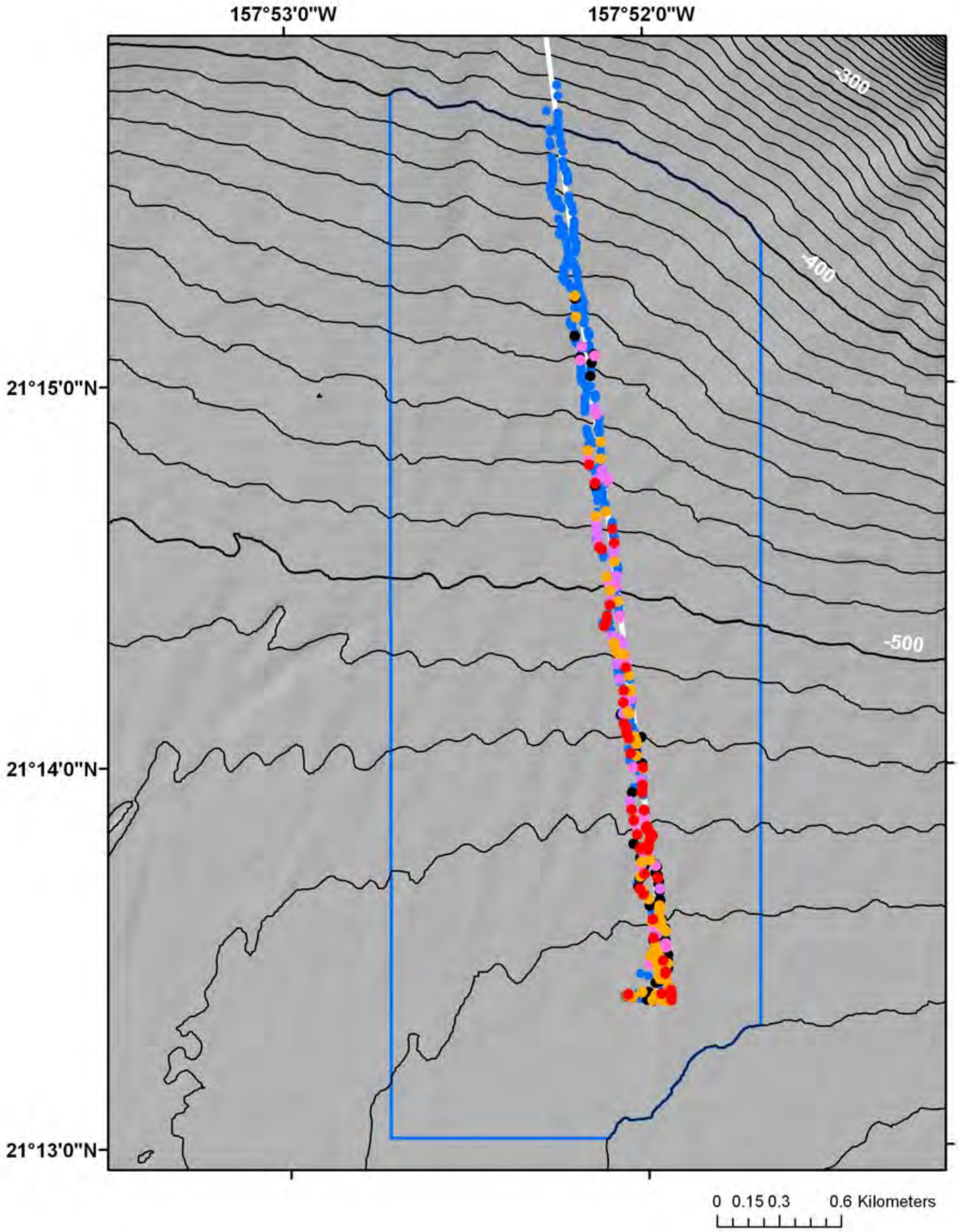

Fig 16: Locations of organisms in zone 3. Brisinga panopla is shown as red dots, the shrimps Plesionika sp and Heterocarpus ensifer as orange dots, the fishes Hymenocephalus antraeus and Malacocephalus boretzi as black dots, the sea pens Kophobelemnon stelliferum and Prototilum sp as purple dots, and all others as blue dots.

The results of the HURL database extraction for zone 3 are provided in Table 9. HURL has documented 415 different organism types within 400-550m, with cnidarians being the most abundant (145), followed by fishes (106), sponges (27) seastars (27), urchins (22), as well as other invertebrates. Approximately 24% of all organism types from the database were observed along the HSWAC pipe route within zone 3, which included 15% of the cnidarians.

Table 9: *Number of different organism types found between 400-550m in HURL database records and the proportion of those observed during the pipe route surveys.*

Category	HURL	HSWAC	% species on pipe route
algae	3	0	0.0
cnidarians	145	22	15.2
ctenophores	2	1	50.0
sponges	27	5	18.5
urchins	22	7	31.8
seastars	27	6	22.2
brittlestars	5	1	20.0
crinoids	11	2	18.2
sea cucumbers	6	0	0.0
barnacles	3	1	33.3
crabs	17	5	29.4
shrimps	15	6	40.0
other crustaceans	1	0	0.0
octopods	4	1	25.0
squids	2	1	50.0
gastropods	6	1	16.7
other mollusks	2	0	0.0
worms	4	0	0.0
other invertebrates	6	0	0.0
fishes	106	40	37.7
unidentified animals	1	1	100.0
Total	415	100	24.1

Submersible Data From the 40-50m Depth Range East of the Pipe Route

As mentioned earlier, dive P4-207 began east of the pipe route at a depth of 40m. The data extracted from this depth to 50m was not included in the analysis above but instead is briefly discussed here. The submersible moved 115m in this depth range, which yielded a survey area of 345 m^2. A total of 15 organisms were recorded on video for an overall density of 435 per hectare. These included 1 colony of algae (*Halimeda opuntia*), 2 colonies of the scleractinian coral *Porites lobata*, and 12 fishes, 9 of which were unidentified due to their small size. The three that were identified included the cleaner wrasse *Labroides pthirophagus*, the spiny puffer, *Chilomycterus reticulatus*, and a goatfish (Mullidae). With the exception of the algae, all of these organisms are typical members of the shallow reef community in Hawaii.

For context, these data were compared to those from 1) the 39m diver transect data collected for the shallow report section and 2) the submersible data from zone 1 that started at 50m. *Halimeda opuntia* was not observed on the 39m diver transect but was recorded in zone 1 so it likely is present in low densities on the pipe route between 40-50m. The coral *Porites lobata* was not recorded in zone 1 but was present on the diver transect and therefore is also likely to be present. The coral *Leptoseris sp* was present on the diver transect and in zone 1 so therefore should be present as well in the 40-50m range. No other corals were recorded in any of these data sets. Sponges, particularly the yellow *Pseudoceratina sp*, and skunk urchins were only observed in zone 1, the latter at the bottom of the break in slope. It should be assumed that at least some colonies of the sponge may be present in the 40-50m segment of the pipe route.

With respect to fish, four of the species recorded on the diver transect were also recorded in zone 1. Therefore, it seems prudent to assume all of the species recorded on the diver transect and zone 1 are likely present in the 40-50m depth range as well. With the exception of the small benthic sea perch, *Parapercis schaunslandi*, all 19 species are benthopelagic" and should have little difficulty in avoiding the pipe and weights during installation.

Potential Impacts of the Pipe in the 3 Depth Zones

The HSWAC pipe is expected to have three different types of impacts on the animals living between 50-550m along the pipe route:

1) Disturbance to benthic species in each zone during installation
2) Entrainment of benthopelagic species in zone 3 at the 540m intake location
3) Addition of a large hard substrate feature to each zone

An evaluation of the first type of impact can be made by considering the dimensions of the pipe footprint to the observed densities of animals. There will be two types of weights in contact with the substrate between 50-550m, Type B (142 units) and Type C (762 units). Type B weights are 4.826m long by 0.61m wide, yielding a benthic footprint of 2.942m^2. Type C weights are 3.251m long by 0.254m wide creating a footprint of 0.826m^2. Table 10a provides the number of weights that will be deployed in each zone and Table 10b provides the total weight footprints for each zone.

Table 10: a) Number of weights of each type that will be deployed in each zone, and b) the benthic footprint of the weights for each zone.

a)

Wt Type	50-200m	201-400m	401-550m	Total
B	136	6		142
C		275	487	762
Total	**136**	**281**	**487**	**904**

b)

Wt Type	50-200m	201-400m	401-550m	Total
B	400.1	17.7		417.8
C		227.2	402.3	629.4
Total	**400.1**	**244.8**	**402.3**	**1047.2**

The footprints in hectares can be obtained by simply moving the decimal places of the values in Table 10b four places to the left. The weights will only cover natural hard substrate in zones 1 and 2, the total footprints being 0.04 and 0.024 ha, respectively. Only the upper half of zone 2 has natural hard substrate so a more accurate estimate is 0.012 ha. The total hard substrate area displaced by the "artificial" hard substrate provided by the weights and pipe will therefore be 0.064 ha.

The numbers of each organism that the weights would potential land on can then be calculated by multiplying this value with their density per hectare. Table 11 provides the results of this analysis.

Table 11: Types and numbers of organisms potentially impacted by the pipe during installation.

Zone	Group	Identification	# Impacted
1	Cnidarians	Leptoseris sp	2
	Sponges	Pseudoceratina sp	21
		unidentified	1
	Urchins	Asterostomatidae cf	3
	Fishes	unidentified	1
2	Fishes	Symphysanodon maunaloae	1
3	Cnidarians	Kophobelemnon stelliferum	1
		Pennatulacea white	1
		Protoptilum sp	1
	Ctenophores	Lyrocteis sp	1
	Sponges	Regadrella sp	1
	Seastars	Brisinga panopla	3
	Shrimps	Plesionika sp	2
		Benthesicymus laciniatus	1
	Fishes	Hymenocephalus antraeus	1
		Malacocephalus boretzi	1
		Chlorophthalmus proridens	1
		Macrouridae	1
		Synagrops sp	1

All values were rounded to the closest whole number so the summed total for each of zones 1, 2, and 3 were 31, 4, and 21, respectively. For the entire length of pipe from 50-550m, the total number of all organisms estimated to be impacted by the pipe weights is therefore 56. This table however is conservative and does not exclude the highly mobile fishes and shrimps that should easily be able to avoid the pipe and weights as they settle on the bottom. If those animals are excluded, then the total number of animals affected by the installation decreases to 46.

The transient increase in turbidity that will occur when the weights settle on the seafloor will be low in zone 1 and the upper part of zone 2 due to the predominance of hard substrate. This turbidity will be higher in the lower part of zone 2 and in zone 3, where sediment is the predominant substrate type. This temporary condition will not affect benthopelagic species that can easily avoid the disturbance as well as benthic animals with relatively high mobility such as crabs, shrimps, and fishes. Animals that will be affected include attached cnidarians, sponges, and benthic ctenophores (*Lyrocteis sp*) as well as unattached animals with low mobility such as seastars, crinoids, and urchins. However, all of these animals should be able to endure a very short-lived sedimentation event and most, if not all have mechanisms such as mucus secretion by which to remove the excess sediment from their exterior surfaces.

The second projected impact, entrainment of animals at the intake site, cannot be adequately addressed from only the results of this survey. Nevertheless, the animals recorded in zone 3 do provide data relevant to this issue. At the intake, the pipe curves upward placing the opening approximately 3 meters above the substrate. Marine animals are typically classified into three basic zones that describe their proximity to the seafloor (Gage & Tyler, 1996). Benthic animals are those that live on or in the seafloor. Benthopelagic animals live in the water column but generally within a few to 100 meters of the seafloor. Finally, pelagic animals are those that live in the water column either near the surface or well above the seafloor. Most pelagic animals will not come close to the seafloor on a regular basis and therefore will rarely be sucked into the pipe. Benthopelagic animals are the most at risk. Often, this community exhibits a diurnal migration pattern, moving upslope (or shallower over flat substrates) at night and returning downslope or deeper during the day. One such community is known to spend daylight hours at the depth where the intake is located and is referred to as a deep scattering or backscatter layer. The composition of this community near the intake is unknown, but is assumed to consist of the same general animal groups as backscatter layers investigated elsewhere. The community typically consists of small, actively swimming adult as well as larval phases of fishes, squids, and crustaceans that provide prey for nocturnal predators who feed further up the slope.

Entrainment of backscatter layer animals by the pipe will likely reflect their vertical migration patterns, occurring more often during the day and less often at night. Benthopelagic animals observed during the daytime submersible dives included small, unidentified fishes, myctophids (i.e., lantern fishes), macrourids, particularly *Hymenocephalus antraeus*, and several species of shrimp, particularly *Plesionika sp*, and *Heterocarpus ensifer*. The small sizes of these animals may preclude effective filtering at the intake. Entrainment of small fishes and shrimps occurs almost daily at the NELH-a facility on the Big Island and may simply have to be considered an unavoidable consequence of bringing up cold water from these depths. Assuming some loss of animals is unavoidable, the impact to the overall community should be insignificant since the extent of zone 3 habitat off Honolulu and Pearl Harbor alone is over 9,779 ha.

NELH-a has recently begun a program whereby students from a nearby school regularly check and recover entrained animals that have been trapped in the sump. Many of these animals are alive and in excellent condition because the ambient temperatures from their natural environment have been maintained. At least two species of larger animals, a small shark and a squid were found to be new species. However, the HSWAC and NELHa pipes are two completely different systems and the condition of the animals that reach the surface in the HSWAC pipe may be quite different. If some of the animals do come up alive, then we are open to the possibility of creating a similar recovery program here, perhaps in collaboration with the Waikiki Aquarium who for years have been interested in establishing a deepwater exhibit but have not had the means to routinely collect deepwater animals in good condition.

The third potential impact is the long-term effect of the pipe as an additional artificial substrate feature. In essence, the pipe and weights will create the equivalent of a relatively low, continuous, very porous ridge several meters high that is oriented perpendicular to the prevailing east-west current flow. As such, it is reasonable to expect some small degree of current acceleration along the top of the pipe and in the spaces between the weights, which will likely attract filter- feeding invertebrates as well as small planktivorous fishes that will use the structure for shelter against predation. Based on the substrate and animal surveys described above, the effect of this new ridge feature on the communities along the pipe route is expected to be zone dependent. For example, the pipe will likely have the least effect on zone 1 where hard bedrock and boulder substrate already predominate and the break-in-slope already provides substantial vertical relief. Based on a diameter of 63 in, the pipe will add an estimated 0.42 ha of hard surface. It is reasonable to expect it will be eventually colonized by species already present such as *Pseudoceratina sp* and *Leptoseris sp* on the top of the terrace where the additional height off the bottom may reduce sedimentation events. Small reef fishes observed there will also find shelter around the weights. However, the expected impact of the pipe in this zone will be relatively minor since the pipe will not be providing a substantial increase to the proportion of hard substrate present.

The pipe will provide a more significant change to the substrate composition in zones 2 and 3 where there is less bedrock, more sediment, and more gradual slopes. With the exception of single polyp scleractinians and a benthic ctenophore, *Lyrocteis sp,* the dredge spoil deposits found in zone 2 were not colonized by attached invertebrates. Furthermore, these loose piles of deposits do not seem to be providing shelter to small fishes. As a result, this zone had by far the lowest density of both fishes and invertebrates in comparison to the other zones. The most concentrated observations of animals were made around a large manmade structure that had numerous cavities clearly being used by a variety of fishes. For lack of other more suitable options, the pipe and weights in zone 2 may attract small fish species as well as bottomfish such as *E. carbunculus* and *E. coruscans*. The estimated increase in hard surface area the pipe alone will provide is 0.92 ha so the increase in species abundance and diversity will likely be modest.

In zone 3, the pipe will provide a structure quite different than anything else currently found at those depths along the route. Without manmade debris, the substrate in this zone would be predominantly sediment with small pebbles. The dumping of manmade debris, particularly metal objects such as ordnance and framework, has provided the majority of hard substrate found at these depths. It follows that the density of hard substrate filter-feeders such as *Brisinga panopla* and *Regadrella sp,* is undoubtedly much higher than it was prior to human perturbation. Most of these hard objects were relatively small, whereas the pipe alone will provide 2.11 ha of continuous hard surface. The pipe will be made of high density polyethylene similar to the NELA pipe, which has been colonized by a large number of attached as well as unattached invertebrates (Fig 17). The HSWAC pipe and weights should experience similar high colonization rates by hard substrate specialists including deep water corals, anemones, and sponges. Given that the total amount of similar habitat within the zone 3 depths of 400-550m south of Honolulu and Pearl Harbor is almost 10,000 ha, the increase in hard substrate by the pipe will be extremely localized and therefore should be insignificant to the community as a whole.

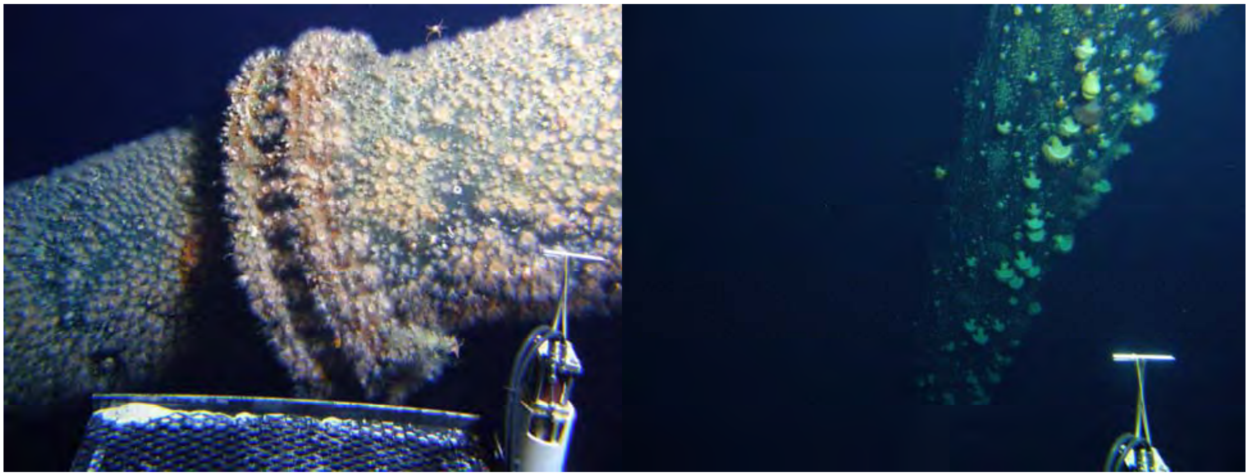

Fig 17: Photos from NELHa pipe survey dives conducted in 2007 a) zoanthids (a type of colonial cnidarians and b)hormathiid anemones.

<u>Potential Impacts on EFH</u>

Table 12 provides the current Essential Fish Habitat (EFH) designations for the Hawaiian Islands. First, the current designation for precious corals is site specific, focusing on locations off Maui and therefore does not apply the area of the pipe route. With respect to the others, two categories of designations are provided for each fishery, one for their pelagic egg and larval stages, and the other for the juvenile and adult phases which may be either benthic or pelagic.

Table 12: EFH Designations for the Hawaiian Islands

Fishery	Eggs/Larvae	Juveniles/Adults
Coral Reefs	0-100m from shore to EEZ	0-100m
Crustaceans	0-150m from shore to EEZ	0-150m
Bottomfish	0-400m from shore to EEZ	0-400m
Pelagics	0-500m from shore to EEZ	0-500m
Precious Corals	Specific to sites off Maui and therefore not applicable	

It's reasonable to assume that the egg and larval stages will only be potentially impacted at the intake (i.e., they can be sucked into the pipe) or the discharge (they can be subjected to lower than normal temperatures and oxygen levels). The intake depth is 540m, which is below the egg and larval EFH depths for all of the fisheries listed. It can therefore be concluded it will have no impact on these stages. The discharge, located at a depth of 45m, is within the egg and larval EFH designation for all 4 fisheries and therefore does need to be evaluated for potential effects, which as mentioned earlier, is outside of the depth range of this report. With that said, the eggs of most pelagic spawning species are positively buoyant and are typically found relatively high in the water column. Assuming the discharge is located on the seafloor, then the cold water should stay close to the bottom and therefore have a minimal effect on eggs and larvae near the surface. However, juveniles and adults of attached invertebrates living on the bottom in or near the discharge will be disturbed. The discharge plume will probably create two disturbance zones. The first zone will be closest to the pipe opening where the temperature will kill all of the attached animals that cannot tolerate the expected 14 C drop in temperature. The second or outer zone where mixing has partially elevated the temperature will have less lethal effects on the benthos, but may cause a suppression or inhibition on maturation and spawning, both of which are temperature dependent. The size of the plume will of course determine the magnitude of this disturbance.

The intake is also below the designated depth ranges for juveniles and adults and therefore is again not a consideration for EFH. The pipe and weights however are within the designations for all 4 fisheries. First, the height of the pipe and weights is expected to be 3 meters off the bottom and therefore is unlikely to have a significant effect on juvenile or adult pelagic species which are generally higher in the water column. Some species (tunas for example) are known to dive to relatively deep depths to forage; however, this deep water feeding is likely taking place more than 3 meters from the bottom. The pipe should therefore not have an impact on the pelagic EFH. The pipe will potentially impact the 50-100m range of the coral reef juvenile and adult EFH. The species and their densities between these depths have already been detailed above. Due to the low numbers of cnidarians, sponges, and other animals found in the surveys, and the already present hard substrate consisting of both natural bedrock and dredge spoil deposits, the impact of the pipe on the coral reef EFH should be minimal. Furthermore, both *Leptoseris sp* and *Pseudoceratina sp* were primarily observed on larger substrate features such as outcrops and boulders which HSWAC is already intending to avoid during the installation.

No crustaceans of any kind were recorded within the 50-150m depth range along the pipe route, although at least some small benthic species as well as larger cryptic species must be present at those depths. In any case, the pipe weight footprint is only 400m^2 within the 50-200m zone 1, the total extent of which is over 1,451 ha south of Honolulu. The pipe and weights are therefore not expected to have a significant impact on this EFH.

Finally, the bottomfish juvenile and adult EFH ranges between 0-400m, encompassing both zones 1 and 2. The juveniles of *Pristipomoides filamentosus* are the only stage and species in this fishery that prefer sediment substrates. All others prefer hard substrates which the pipe provides and have been found in association with manmade objects both in this survey as well as other surveys elsewhere. The author has personally observed *E. carbunculus* and *E. coruscans* using old cars, shipwrecks, dumped refrigerators, and airplanes as shelter. Given the low amount of suitable natural habitat for these species observed along the pipe route, the pipe will likely become populated with the more benthic species in this fishery.

References

Gage, J. & P. Tyler. Deep Sea Biology. Cambridge University Press, Great Britain. 1996. 504pp.

Kelley, C. & W. Ikehara. 2006. The impacts of bottomfishing on Raita and West St. Rogatien Banks in the Northwestern Hawaiian Islands. *Atoll Research Bulletin*. No. 543, 305-318.

Appendix A: Scientific and Common Names by Zone

Zone	Animal Category	Name	Common Name
1	algae	Rhodophyta	red algae
		Halimeda opuntia	green algae
	cnidarians	Leptoseris sp	plate coral
		Hydrozoa	hydroid
	sponges	Pseudoceratina sp	yellow sponge
		Porifera	sponge
	urchins	Asterostomatidae cf	skunk urchin
		unidentified	urchin
		Prionocidaris thomasi	pencil urchin
	seastars	unidentified	seastar
	fishes	unidentified	fish
		Seriola dumerili	amberjack, kahala
		Bodianus albotaeniatus	black spot wrasse
		Chaetodon miliaris	millet seed butterflyfish
		Dasyatis sp	sting ray
		Parapercis schauinslandii	sea perch
		Dascyllus albisella	damselfish
		Scaridae	parrotfish
		Apolemichthys arcuatus	angelfish
		Balistidae	triggerfish
		Canthigaster jactator	puffer
		Heniochus diphreutes	flagfin butterflyfish
		Labridae	wrasse
2	cnidarians	Scleractinia single polyp	cup coral
		Aphanipathes sp1	black coral sp1
		Hydrozoa	hydroid
		Pennatulacea	sea pen
		Stichopathes sp	black coral sp2
		Gardineria hawaiiensis	cup coral
		Antipatharia	black coral
		Swiftia sp cf	sea fan
		unidentified	cnidarian
	ctenophores	Lyrocteis sp	comb jelly
	sponges	Sericolophus hawaiicus	catcher's mitt sponge
		Regadrella sp	glass vase sponge
	urchins	Stylocidaris calacantha	white pencil urchin
		Cidaridae	pencil urchin
		unidentified	urchin
		Stylocidaris rufa	red pencil urchin

Zone	Animal Category	Name	Common Name
	seastars	Goniasteridae	five armed seastar
	crinoids	Antedon sp yellow	yellow sea lily
	barnacles	Cirripedia	barnacle
	crabs	Brachyura	crab
		Galatheidae	squat lobster
		Homola dickinsoni	decorator crab
		Paguridae	hermit crab
		Paramunida hawaiiensis	squat lobster
	shrimps	Decapoda shrimp	shrimp
		Plesionika sp	glass shrimp
	unid crustaceans	unidentified	crustacean
	fishes	Symphysanodon maunaloae	slopefish
		unidentified	fish
		Myctophidae	lantern fish
		Etelis carbunculus	red snapper, ehu
		Pontinus macrocephalus	scorpionfish, hogo
		Scorpaenidae	scorpionfish
		Chlorophthalmus proridens	shortnose greeneye fish
		Roa excelsa	butterflyfish
		Chrionema chryseres	sand diver fish
		Etelis coruscans	longtail snapper
		Holocentridae	squirrelfish
		Ophichthidae	snake eel
		Seriola dumerili	amberjack, kahala
		Symphysanodon typus	slopefish
		Congridae	conger eel
		Odontanthias elizabethae	elisabeth's grouper
		Plectranthias kelloggi	Kellogg's grouper
		Anguilliformes	eel
		Bothidae	left-eye flounder, flatfish
		Canthigaster inframacula	puffer
		Epigonus sp	deepwater cardinal fish
		Gymnothorax nuttingi	moray eel
		Parapercis roseoviridis	rosy green sea perch
		Physiculus sp	deepwater cod
		Satyrichthys engyceros	armored sea robin
		Squalus mitsukurii	dogfish shark
	worms	Annelida	worm
3	cnidarians	Kophobelemnon stelliferum	rock pen
		Pennatulacea white	unidentified white sea pen
		Protoptilum sp	red sea pen

Zone	Animal Category	Name	Common Name
		Hormathiidae sp2	venus flytrap anemone
		Pennatulacea	sea pen
		Pennatula flava cf	white sea pen
		Actiniaria orange	orange anemone
		Actiniaria gray	gray anemone
		Primnoidae	white sea fan
		Actiniaria brown	brown anemone
		Antipatharia	black coral
		unidentified cnidaria	cnidarian
		Acanthogorgia sp	yellow sea fan
		Actiniaria	anemone
		Actiniaria white	white anemone
		Hydrozoa	hydroid
		Keroeides mosaica	sea fan
		Narella muzikae	sea fan
		Gardineria hawaiiensis	cup coral
		Plexauridae	sea fan
		Scleractinia single polyp	cup coral
		Swiftia sp cf	sea fan
	ctenophores	Lyrocteis sp	comb jelly
	sponges	Regadrella sp	glass vase sponge
		Sericolophus hawaiicus	catcher's mitt sponge
		Hexactinellida ribbon	ribbon sponge
		Hexactinellida white	white glass sponge
		Porifera	sponge
	urchins	Aspidodiadema hawaiiense	deepwater urchin
		Histocidaris variabilis	pencil urchin
		Diadematidae	deepwater urchin
		Echinoidea	urchin
		Stereocidaris hawaiiensis	pencil urchin
		Echinothuriidae	deepwater urchin
		Laganum fudsiyama	sand dollar
	seastars	Brisinga panopla	seastar
		Goniasteridae	five armed seastar
		Henricia robusta	seastar
		Mediaster ornatus	seastar
		Plinthaster ceramoidea	seastar
		Sphaeriodiscus ammophilus	seastar
	brittlestars	unidentified	brittlestar
	crinoids	Comatulida	sea lily
		Thalassometridae	sea lily

Zone	Animal Category	Name	Common Name
	barnacles	Heteralepas sp	gooseneck barnacle
	crabs	Sympagurus dofleini	anemone crab
		Cyrtomaia smithi	crab
		Brachyura	crab
		Chirostylidae	squat lobster
		Galatheidae	squat lobster
	shrimps	Plesionika sp	glass shrimp
		Benthesicymus laciniatus	shrimp
		Decapoda shrimp	shrimp
		Heterocarpus ensifer	shrimp
		Heterocarpus laevigatus	shrimp
		Heterocarpus sp	shrimp
	fishes	Hymenocephalus antraeus	rattail fish
		Malacocephalus boretzi	rattail fish
		Chlorophthalmus proridens	shortnose greeneye fish
		Macrouridae	rattail fish
		Synagrops sp	Lanternbelly fish
		Polymixia berndti	deepwater threadfin fish
		Ventrifossa atherodon	rattail fish
		Actinopterygii	fish
		Coelorinchus aratrum	rattail fish
		Setarches guentheri	scorpionfish
		Satyrichthys hians	armored sea robin
		Myctophidae	lantern fish
		Coelorinchus spilonotus	rattail fish
		Satyrichthys engyceros	armored sea robin
		Ophichthidae	snake eel
		Chascanopsetta crumenalis	left-eye flounder, flatfish
		Ventrifossa ctenomelas	rattail fish
		Plesiobatis daviesi	sting ray
		Ventrifossa sp	rattail fish
		Chrionema chryseres	sand diver fish
		Anguilliformes	eel
		Epigonus atherinoides	deepwater cardinal fish
		Scorpaenidae	scorpionfish
		Beryx sp	alfonsino
		Chascanopsetta sp	left-eye flounder, flatfish
		Satyrichthys sp	armored sea robin
		Stethopristes eos	John Dory fish
		Chascanopsetta prorigera	left-eye flounder, flatfish
		Chaunax umbrinus	angler fish

Zone	Animal Category	Name	Common Name
		Cyttomimus stelgis	John Dory fish
		Ijimaia plicatellus	jelly nose eel
		Squalus mitsukurii	dogfish shark
		Synagrops argyreus	Splitfin fish
		Bembrops filifera	sand diver fish
		Bembrops sp1	sand diver fish
		Congridae	conger eel
		Coryphaenoides marginatus cf	rattail fish
		Lophiodes miacanthus	goosefish
		Nezumia burragei	rattail fish
		Nezumia or Kumba	rattail fish
	octopus	Octopus sp	octopus
	squid	Nototodarus hawaiiensis	squid
	gastropod	Pleurobranchidae	sea slug
	animal	unidentified	animal

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APPENDIX J
USACE ESSENTIAL FISH HABITAT ASSESSMENT AND CONSULTATION

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

REPLY TO ATTENTION OF:

February 28, 2013

Regulatory Branch

File No. POH-2004-01141

RESPONSE TO ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

National Marine Fisheries Service
Pacific Islands Regional Office
Attn: Mr. Gerry Davis
1601 Kapiolani Blvd., Suite 1110
Honolulu, HI 96814

Dear Mr. Davis:

By letter dated March 21, 2012, the National Marine Fisheries Service (NMFS) provided conservation recommendations to avoid, minimize and offset impacts to Essential Fish Habitat (EFH) pursuant to the Magnuson Stevens Fishery Conservation and Management Act (MSA) for the proposed construction of the Honolulu Seawater Air Conditioning (HSWAC) project on the south shore of Oahu. The Honolulu District of the U.S. Army Corps of Engineers (USACE) is considering issuance of a Department of the Army (DA) permit to authorize construction of the project. The NMFS conservation recommendations take into consideration the USACE December 5, 2011 EFH Assessment, the March 18, 2011 federal Draft EIS (DEIS), and the following supplementary documents provided by the applicant: Discharge Location Evaluation (dated 12/15/2011); preliminary Final EIS (dated 11/7/2011); Temperature Effect on Coral (dated 1/14//2012); HSWAC Nutrient Impacts (dated 2/7/2012); and Draft Mitigation Plan (dated 2/10/2012).

By letter dated April 23, 2012, we provided preliminary responses to the NMFS EFH recommendations, noting that they were considered to be preliminary because the federal Final EIS (FEIS) and the applicant's proposed mitigation and monitoring proposals were still in development. This letter provides our response to the conservation recommendations, taking into consideration the additional information and action alternatives which will be included in the FEIS.

1. The applicant has conducted new shallow and deep water surveys (FEIS Appendices E and I, respectively) to enable more detailed analysis of the expected impacts to shallow water and deep water marine biota due to construction and operation of the proposed project in Chapter 3.0 of the FEIS. Appendix N provides the applicant's analysis of expected entrainment, including a proposed monitoring plan. In response to resource agency comments and concerns regarding the effects of return water discharge on coral reef resources and EFH under Alternatives 1 and 2, the FEIS incorporates evaluation of two additional action alternatives: Alternative 3, which would locate the proposed return water diffuser structure between the depths of 276 and 300 feet, and Alternative 4 (applicant's preferred alternative) which would locate the proposed return water

diffuser structure between the depths of 326 and 423 feet, placing it almost entirely below the defined lower, 100-meter (328-foot) depth boundary of Coral Reef Ecosystem EFH and HAPC. By locating the discharge of return water deeper and further seaward these alternatives, particularly the applicant's preferred Alternative 4, minimize and avoid potential long-term adverse effects of system operation on Coral Reef Ecosystem Management Unit Species (CRE-MUS) and other MUS.

2. Effects of the project on fishing, including nighttime reef fishing, were addressed in section 3.3.6 of the DEIS and in the preliminary FEIS, which identified temporary access restrictions during construction. Fish may be temporarily attracted to disturbed areas by foraging opportunities. Long term, the additional habitat and shelter provided by pipelines and collars, with increased vertical relief, are expected to enhance local fish populations. Cultural impact assessment of fishing was addressed in section 3.2 of the DEIS. No specific comments regarding effects on fishing were received during public scoping or in responses to the DEIS.

3. Compliance with the Final Rule for Compensatory Mitigation for Losses of Aquatic Resources will be a part of the USACE Record of Decision for the DA permit application. The applicant's proposed mitigation plan was included as Appendix P of the preliminary FEIS and the applicant's current proposal will be included in the FEIS.

4. Any issued DA permit would include appropriate monitoring requirements to document anticipated biological colonization and succession on the authorized structures. The applicant has described monitoring as part of their proposed mitigation plan. Water quality monitoring requirements are anticipated as part of the State of Hawaii Department of Health's Section 401 Water Quality Certification and Section 402 water discharge permit. The applicant has developed a proposed water quality and biota monitoring plan which will be included in the FEIS as Appendix G. As you are aware, conditions of the Section 401 certification become conditions of any USACE authorization.

5. The NMFS-recommended avoidance and minimization measures (a-c) for construction activities would be included, to the extent practicable, in any issued DA permit.

We believe that development and consideration of the additional information and project alternatives in the FEIS, with inclusion of the NMFS-recommended measures for construction activities, addresses your conservation recommendations to avoid and minimize potential adverse effects to EFH. Should you have questions, please contact Mr. Peter Galloway via telephone at 808-835-4306 or via e-mail at *peter.c.galloway@usace.army.mil.*

Sincerely,

George P. Young, P.E.
Chief, Regulatory Branch

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

April 23, 2012

Regulatory Branch

File No. POH-2004-01141

PRELIMINARY RESPONSE TO ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

National Marine Fisheries Service
Pacific Islands Regional Office
Attn: Mr. Gerry Davis
1601 Kapiolani Blvd., Suite 1110
Honolulu, HI 96814

Dear Mr. Davis:

By letter dated March 21, 2012, the National Marine Fisheries Service (NMFS) provided conservation recommendations to avoid, minimize and offset impacts to Essential Fish Habitat (EFH) pursuant to the Magnuson Stevens Fishery Conservation and Management Act (MSA) for the proposed construction of the proposed Honolulu Seawater Air Conditioning (HSWAC) project on the south shore of Oahu. The Honolulu District of the U.S. Army Corps of Engineers (USACE) is considering issuance of a Department of the Army (DA) permit to authorize construction of the project. The NMFS conservation recommendations take into consideration the USACE December 5, 2011 EFH Assessment, the March 18, 2011 federal Draft EIS, and the following supplementary documents provided by the applicant: Discharge Location Evaluation (dated 12/15/2011); preliminary Final EIS (dated 11/7/2011); Temperature Effect on Coral (dated 1/14//2012); HSWAC Nutrient Impacts (dated 2/7/2012); and Draft Mitigation Plan (dated 2/10/2012).

The federal Final EIS and the applicant's proposed mitigation and monitoring proposals are still in development; therefore, the following responses to the NMFS EFH conservation recommendations are considered to be preliminary. A final response will be provided to your office prior to publication of the Final EIS.

1. The Final EIS will include evaluation of an additional project alternative which would locate the proposed return water diffuser structure below the lower (100m) depth boundary of Coral Reef Ecosystem EFH and HAPC in order to avoid and minimize adverse effects.

2. Effects of the project on fishing, including nighttime reef fishing, were addressed in section 3.3.6 of the federal Draft EIS and preliminary Final EIS, which identify temporary access restrictions during construction. Fish may be temporarily attracted to disturbed areas by foraging opportunities. Long term, the additional habitat and shelter provided by pipelines and collars, with increased vertical relief, may enhance local fish populations. Cultural impact assessment of

fishing was addressed in section 3.2 of the EIS. A public scoping meeting was held for preparation of the Draft EIS; no specific comments were received regarding fishing.

3. Compliance with the cited 2008 Final Rule for Compensatory Mitigation for Losses of Aquatic Resources (73 FR 19670-19705) will be addressed separately in the Final EIS.

4. Any issued DA permit would include appropriate monitoring requirements to document anticipated biological colonization and succession on the authorized structures. The applicant's proposed biological monitoring plan is being developed and will be submitted to NMFS for review prior to permit issuance. Water quality monitoring requirements are anticipated as part of the State of Hawaii Department of Health's Section 401Water Quality Certification and Section 402 water discharge permit; as you are aware, any conditions of the Section 401 certification are required to be conditions of any issued Corps' permit.

5. The NMFS recommended avoidance and minimization measures (a-c) for construction activities would be included, to the extent practicable, in any issued DA permit.

Please contact Mr. Peter Galloway via telephone at 808-438-8416 or via e-mail at *peter.c.galloway@usace.army.mil* should you have questions regarding this preliminary response.

Sincerely,

George P. Young, P.E.
Chief, Regulatory Branch

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1601 Kapiolani Blvd., Suite 1110
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MAR 2 1 2012

George Young
District Engineer
U.S. Army Corps of Engineers, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Young:

The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) has reviewed the U.S. Army Corps of Engineers (ACOE) Essential Fish Habitat (EFH) Assessment provided on December 5, 2011 for the proposed Honolulu Seawater Air-conditioning Project (Department of Army permit number POH-2004-01141). The EFH assessment incorporates information provided in the March 18, 2011 Draft Environmental Impact Statement (Draft EIS), and new data and information within reports by Brock (2011) and Kelly (2011). We have also reviewed documents provided by the applicant: the Discharge Location Evaluation (dated 12/15-2011); the preliminary Final EIS (dated 11/7-2011); the Temperature Effect on Coral (dated 1/14-2012); the HSWAC Nutrient Impacts (dated 2/7-2012); and the Draft Mitigation Plan (dated 2/10-2012).

The proposed action entails construction of a seawater air conditioning system on the south shore of Oahu to supply centralized air conditioning for downtown Honolulu buildings. The system will pipe to land, through a 63-inch intake pipe, cold seawater from an intake depth of about 1750 feet located approximately four to five miles offshore from Kakaako. This will be circulated through an on-shore cooling station, heat exchangers, and a network of upland distribution pipes downtown. The seawater is proposed to be returned to the near shore marine environment through a 54-inch return pipe at discharge depths ranging from 120 to 300 feet located about 3500-5200 feet distance off Kakaako.

While NMFS strongly supports the project purpose to provide renewable energy to Oahu, we are concerned about the impacts that project construction activities and operations will have to our trust resources. We offer the following comments in accordance with the EFH provision of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (50 C.F.R. § 600.905 – 930), also the National Environmental Policy Act (42 U.S.C. 4321 et seq.), the FISH AND WILDLIFE COORDINATION ACT (16 U.S.C. § 662(a)), the Coral Reef Executive Order 13089, and the Clean Water Act (33 U.S.C. §1251 et seq.)

Magnuson-Stevens Act

Pursuant to the Magnuson-Stevens Act, the Secretary of Commerce, through NMFS, is responsible for the conservation and management of fishery resources found off the coasts of the United States. *See* 16 U.S.C. 1801 *et seq.* Section 1855(b)(2) of the Magnuson Act requires federal agencies to consult with NMFS, with respect to "any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this Act." The statute defines EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity." 16 U.S.C. 1802(10). Adverse effects on EFH are defined further as "any impact that reduces the quality and/or quantity of EFH," and may include "site-specific or habitat-wide impacts, including individual, cumulative or synergistic consequences of actions." 50 C.F.R. § 600.810(a). The consultation process allows NMFS to make a determination of the project's effects on EFH and provide Conservation Recommendations to the lead agency on actions that would adversely affect such habitat. *See* 16 U.S.C. 1855(b)(4)(A).

Essential Fish Habitat

The proposed project footprint is located in an area, that while stated in the EFH assessment is "among the most historically degraded coastal habitats in the State", supports a variety of life stages for a variety of management unit species (MUS) identified under the Western Pacific Regional Fishery Management Council's Pelagic and Hawaii Archipelago Fishery Ecosystem Plans (FEP). The MUS and life stages found within the area include: eggs, larvae, juveniles and adults of Coral Reef Ecosystem MUS (CRE-MUS); eggs, larvae, juveniles and adults of Bottomfish MUS (BMUS); eggs, larvae, juveniles and adults of Crustacean MUS (CMUS); and juveniles and adults of Pelagic MUS (PMUS).

The EFH assessment states that the "project construction will adversely affect EFH but with incorporation of suitable avoidance and minimization considered during planning and construction, these effects will be minimized", and further that "the operation of the return water diffuser system would create a permanent localized zone of mixing for cool water which would likely inhibit coral growth within it". The ACOE concludes that effects to EFH from the proposed activities "will be more than minimal but less than substantial". Upon review of the EFH assessment and the several reports prepared as a result of the investigation, NMFS cannot concur with this determination.

While environmental impacts will be reduced by the applicant's efforts to modify construction activities, adverse effect to EFH from the project will remain, and include: permanent loss of juvenile and adult benthic habitat for CRE-MUS, BMUS and CMUS as a result of receiving pit excavation and pipe collar installation; temporary and/or permanent loss of juvenile and adult benthic habitat for CRE-MUS, BMUS and CMUS from sedimentation, also temporary disruption and displacement of eggs and larvae for CREMUS, BMUS, CMUS and PMUS due to increased turbidity from the various construction activities (micro-tunneling, barge operations, sheet pile driving, backfill of receiving pit and concrete capping); potential permanent loss of juvenile and adult benthic habitat for CRE-MUS, BMUS and CMUS, also disruption and displacement of eggs and larvae for CRE-MUS, BMUS, CMUS and PMUS within the Zone of Mixing (ZOM) associated with the return-water discharge; and potential permanent disruption and displacement of juveniles and adults of PMUS due to impingement/entrainment at the seawater intake location. We are concerned mostly that the continuous discharge of cold nutrient rich return water will permanently alter the biotic and abiotic conditions in the nearshore environment off Kakaako, driving ecological phase shifts in the ecosystem also altering the dynamics of public resource use.

To avoid/minimize and offset these impacts, NMFS provides the following EFH Conservation Recommendations.

EFH Conservation Recommendations

1. Gather additional biological information and analyze in greater detail the available science to allow determination of the holistic effects of the return water discharge, particularly from nutrients, to the nearshore marine community including EFH. Specifically identify: the coral densities and size classes, and non-coral invertebrate densities that will be directly crushed and/or abraded and indirectly smothered or impaired by sediment re-suspension resulting from construction; coral colony densities and size classes, non-coral invertebrate densities found within the rubble that emerge at night (i.e. to determine impact to CMUS and other invertebrates that provide a food source to CRE-MUS and BMUS) and water quality that will be directly and indirectly impacted by the return water discharge over the life of the project; and the expected taxa and numbers of PMUS that may be entrained at the deep seawater intake point and at return water discharge points. Ensure that the analysis applies to the environment within, but also outside of the ZOM if secondary effects reach beyond, and spans the life of the operations. Ensure that the analysis is relevant to each proposed discharge location, also includes a "new" alternative depth at 500 feet along the pipeline corridor. Based on this analysis, permit the discharge of the return water at the location which is predicted to have the least environmental impact. If the science to fully evaluate the long-term effect at the proposed locations including the new 500 foot depth alternative is not available and impracticable to obtain within a reasonable project timeframe, permit the discharge of the return water at a depth beyond that which coral reef ecosystem species are found (>500 feet, i.e. beyond the start of the steep break-in-slope described in Kelly's 2011 marine biology report).

2. Evaluate how public use of resources within the project footprint will be affected by project construction and operations. Specifically evaluate how fishing in the return water discharge footprint/ZOM, which is likely focused during nighttime, will be impacted (the expectation is that while limited coral resources occur in the return water discharge area, the habitat type is likely to support considerable invertebrate population that emerge at night). Evaluation should include solicitation of public input via one or more public meetings that inform the local community of the project. Based on this evaluation and public input, permit the discharge of the return water at the location which is predicted to have the least impact to public resource use.

3. Ensure that a detailed mitigation plan consistent with the 2008 Rule for Compensatory Mitigation for Losses of Aquatic Resources (FR/Vol. 73, No. 70)) is appropriately developed and implemented. This should be submitted to NMFS for review and concurrence prior to start of construction. The mitigation plan should include a quantitative determination of all predicted direct and indirect unavoidable loss of coral reef resources including EFH, specifically identifying coral densities and size classes, and non-coral invertebrate densities that will be directly crushed and/or abraded and indirectly smothered or impaired by sediment re-suspension resulting from construction; and the coral reef community (benthic and in water column) that will be directly and indirectly impacted by the return water discharge over the life of the project. Based on this determination, the mitigation plan should specify how the predicted loss has been quantitatively scaled to determine the appropriate level and type of replacement to fully offset ecological functions associated with the loss.

4. Condition the permit with specific and detailed monitoring requirements that will trigger project modification to reduce impact if adverse impacts are detected during operations. This monitoring plan should be submitted to NMFS for review and concurrence prior to start of construction. The monitoring plan should focus on identifying changes to the benthic community and water quality at the return water discharge location. Return water discharge site monitoring should start prior to discharge at appropriate impact and reference sites, with sampling occurring regularly for the first 10 years and annually thereafter for the life of the project. Survey/sampling techniques should be fully described in the plan, along with the specifics of analyses that indicate power to detect differences within and between project and reference sites and over time. In the event that unpredicted adverse effects are detected due to the discharge, steps should be taken to modify operations immediately to avoid/minimize these impacts. Measures may include extending the return water pipe to a deeper location. Note that should this occur, the mitigation plan must be updated to ensure that the unpredicted lost resources and associated functions are accounted for and replaced.

5. Prior to and/or during construction implement the following avoidance and minimization measures:
    a. Avoid conducting in-water nearshore construction operations during periods where heights of the front of waves exceed 5 feet to minimize risk of uncontrolled movement of equipment.
    b. Ensure that all materials and structures such as the pipeline, anchor systems, silt curtains, are installed/placed on sand bottom or non-coral covered substrate to avoid to the greatest extent possible coral or macro-invertebrates being crushed and/or abraded. This should include ensuring the lines and tethers allow buffer areas to ensure they do not come in contact with hard surface caused by water movement.
    c. Implement Best Management Practices (BMP's), such as silt curtains, as specified in the State of Hawaii Department of Health Water Quality Certification to minimize turbidity from construction activities including dredging, de-watering, sheet pile driving, and installation of pipes. In the event that the water quality

standard is exceeded outside the project footprint during operations, these should cease until acceptable water quality is restored.

Please be advised that regulations (Section 305(b)(4)(B) of the MSA) to implement the EFH provisions of the MSA require that Federal action agencies provide a written response to this letter within 30 days of its receipt and at least 10 days prior to final approval of the action. A preliminary response is acceptable if final action cannot be completed within 30 days. The final response must include a description of measures to be required to avoid, mitigate, or offset the adverse impacts of the activity. If the response is inconsistent with our EFH Conservation Recommendations, an explanation of the reason for not implementing the recommendations must be provided.

Conclusion

Upon review of the EFH assessment, Draft EIS and other related studies, NMFS cannot concur with ACOE's determination that effects to EFH from the proposed Honolulu Seawater Air-conditioning Project "will be more than minimal but less than substantial". We consider that there will be adverse effect to EFH despite the currently proposed avoidance/minimization measures, and further that there is insufficient data to indicate that this effect will only be minimal. NMFS provides EFH Conservation Recommendations above to help ensure that any adverse impacts to EFH are avoided, mitigated, and offset.

We appreciate the opportunity to comment on this project and look forward to receiving your response. We wish to continue engaging and working with the ACOE and the applicant to support the HSWAC LLC mission, while ensuring the maximum level of protection of NOAA trust resources under applicable law. If you have any questions regarding this determination, contact Danielle Jayewardene at 808 944-2162 (danielle.jayewardene@noaa.gov).

Sincerely,

Michael D. Tosatto
Regional Administrator

cc: Wendy Wiltse, U.S. Environmental Protection Agency
James Munson, U.S. Environmental Protection Agency
Loyal Mehrhoff, U.S. Fish and Wildlife Service, Environmental Services
Alton Miyasaka, State of Hawaii, Department of Health
Mark Tomomitsu, State of Hawaii, Department of Health
Frederic Berg, Honolulu Seawater Air Conditioning LLC

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

December 5, 2011

Regulatory Branch

File No. POH-2004-01141

Gerry Davis, Habitat Conservation
NMFS Pacific Islands Regional Office
1601 Kapiolani Blvd., Suite 1110
Honolulu, HI 96814

Dear Mr. Davis:

Thank you for your letter dated April 26, 2011, which provided your general and specific comments on the Draft Environmental Impact Statement (DEIS) for the proposed Honolulu Seawater Air Conditioning Project, Honolulu, Hawaii. The Honolulu District of the U.S. Army Corps of Engineers is considering issuance of a Department of the Army permit to authorize construction of the project.

Your letter also transmitted your determination that the information provided in section 3.7.5.4 of the DEIS does not satisfy the requirements for EFH consultation pursuant to the Magnuson Stevens Fishery Conservation and Management Act (MSA).

In response to your comments, we have prepared the enclosed Essential Fish Habitat Assessment. As stated in the document, we have determined that the adverse effects of the proposed action will be more than minimal but less than substantial, and we therefore request initiation of consultation under the Magnuson-Stevens Fishery Conservation and Management Act.

Please contact Mr. Peter Galloway via telephone at 808-438-8416 or via e-mail at *peter.c.galloway@usace.army.mil*) regarding this consultation request.

Sincerely,

for

George P. Young, P.E.
Chief, Regulatory Branch

Enclosures

Essential Fish Habitat Assessment

For the Honolulu Seawater Air Conditioning Project

Introduction

The purpose of this document is to present the findings of the Essential Fish Habitat (EFH) assessment conducted for the proposed Honolulu Seawater Air Conditioning Project, Honolulu, Hawai'i. The U.S. Army Corps of Engineers, Honolulu District (USACE) is processing a Department of the Army (DA) permit for the project (DA File No. POH-2004-01141) and is preparing a federal Environmental Impact Statement (EIS) for this action. This EFH assessment incorporates information in the Draft EIS (DEIS) which was transmitted via letter dated March 18, 2011 to the Habitat Conservation Division of the National Marine Fisheries Service Pacific Islands Regional Office (NMFS, PIRO, HCD) requesting initiation of EFH consultation. It also takes into consideration the comments of the HCD relating to EFH which were transmitted to USACE via letter dated April 26, 2011. In addition, this EFH assessment incorporates new original data and information contained within the cited reports by R. Brock (2011) and C. Kelley (2011).

1. Description of the Proposed Action

Honolulu Seawater Air Conditioning, LLC proposes to construct a seawater air conditioning (SWAC) system at Kaka'ako on the south shore of O'ahu, including installation of seawater intake and return pipelines in adjacent coastal waters. This project requires the deployment of seawater intake and return pipes offshore of Honolulu in the area between Honolulu Harbor and Kewalo Basin in order to provide 25,000 tons of centralized air conditioning for downtown Honolulu. As described in the DEIS, the pipelines would consist of a 63-inch diameter seawater intake pipe extending approximately four to five miles offshore from Kaka'ako to a depth of approximately 1,750 feet and a 54-inch diameter seawater return pipe extending approximately 3,500 to 5,200 feet offshore from Kaka'ako to depths of 150 to 300 feet, depending on the alternative. The area traversed by the proposed pipeline route is classified by biotope from the offshore pipeline receiving pit (or "breakout pit") to the end of the diffuser, and by depth zone from the end of the diffuser to the seaward intake, with the quantitative data organized according to these classifications in the analysis below.

2. Analysis of the Potential Adverse Effects of the Action on EFH and the Managed Species

2.1 Essential Fish Habitat Designations

The area of the proposed action (pipeline route offshore of Honolulu between Honolulu Harbor and Kewalo Basin) is within the Hawaii Archipelago Fishery Ecosystem Plan (FEP) boundaries and has been identified as Essential Fish Habitat (EFH) under five former fishery management plans (FMPs) by the Western Pacific Regional Fishery Management Council (the Council). These five species-based FMPs are replaced with the place-based FEP, which uses an ecosystem-based approach with "geographically defined ecosystem plans containing identical fishery regulations."

The FEP identifies as management unit species (MUS) the current MUS known to be present in waters around the Hawaii Archipelago and incorporates all of the management provisions of the Bottomfish and Seamount Groundfish FMP, the Crustaceans FMP, the Precious Corals FMP, and the Coral Reef Ecosystems FMP that are applicable to an area under consideration. The FEP notes that although pelagic fishery resources play an important role in the biological as well as the socioeconomic environment of these islands, they will be managed separately through the Pacific Pelagic FEP.

The FMPs were for pelagics, bottomfish and seamount groundfish, precious corals, crustaceans, and coral reef ecosystems. In addition to EFH designations, the Council identified Habitat Areas of Particular Concern (HAPC) within EFH for all FMPs using [in each case, at least one of] the following four criteria established by the NMFS, or a fifth criterion (protected area) identified by the Council.

- The ecological function provided by the habitat is important.

- The habitat is sensitive to human-induced environmental degradation.
- Development activities are or will be stressing the habitat type.
- The habitat is rare.

Management unit species (MUS) are those "caught in quantities sufficient to warrant management or specific monitoring by NMFS and the Council," and are listed in Table 1. The EFH and HAPC for MUS of the Western Pacific Region (Table 2) are bounded by the shoreline and the seaward boundary of the EEZ, unless otherwise indicated. Asterisks mark the EFH and HAPC potentially impacted by the proposed project.

Table 1. Hawaii Archipelago Management Unit Species (MUS)

Scientific Name	Common Name	Local Name
Bottomfish		
Aphareus rutilans	silver jaw jobfish	lehi
Aprion virescens	gray jobfish	uku
Caranx ignobilis	giant trevally	white papio/ulua au kea
C. lugubris	black jack	ulua la'uli
E. quernus	sea bass	hāpu'upu'u
Etelis carbunculus	red snapper	ehu
E. coruscans	longtail snapper	onaga or 'ula'ula'loa'e
Lutjanus kasmira	blue stripe snapper	ta'ape
Pristipomoides auricilla	yellowtail snapper	kalekale
P. filamentosus	pink snapper	'ōpakapaka
P. seiboldii	pink snapper	kalekale
P. zonatus	snapper	gindai
Pseudocaranx dentex	thicklip trevally	pig ulua, butaguchi
Seriola dumerili	amberjack	kahala
Seamount Groundfish		
Hyperoglyphe japonica	raftfish	NA
Beryx splendens	alfonsin	NA
Pseudopentaceros wheeleri	armorhead	NA
Crustaceans		
Panulirus marginatus	spiny lobster	ula
Panulirus penicillatus	spiny lobster	ula
Family Scyllaridae	slipper lobster	ula papapa
Ramina ranina	Kona crab	papa'i kua loa
Heterocarpus spp.	deepwater shrimp	NA
Precious Corals		
Corallium secundum	pink coral or red coral	NA
Corallium regale	pink coral or red coral	NA
Corallium laauense	pink coral or red coral	NA
Gerardia spp.	gold coral	NA
Narella spp.	gold coral	NA
Lepidisis olapa	bamboo coral	NA
Antipathes dichotoma	black coral	NA
Antipathes grandis	black coral	NA
Antipathes ulex	black coral	NA
Coral Reef Ecosystem		
Acanthuridae (Surgeonfishes)		
Acanthurus olivaceus	orange-spot surgeonfish	na'ena'e
Acanthurus xanthopterus	yellowfin surgeonfish	pualu

Scientific Name	Common Name	Local Name
Acanthurus triostegus	convict tang	manini
Acanthurus dussumieri	eye-striped surgeonfish	palani
Acanthurus nigroris	blue-lined surgeon	maiko
Acanthurus leucopareius	whitebar surgeonfish	maiko or maikoiko
Acanthurus nigricans	whitecheek surgeonfish	NA
Acanthurus guttatus	white-spotted surgeonfish	ʻapi
Acanthurus blochii	ringtail surgeonfish	Pualu
Acanthurus nigrofuscus	brown surgeonfish	maiʻiʻi
Ctenochaetus strigosus	yellow-eyed surgeonfish	kole
Ctenochaetus striatus	striped bristletooth	NA
Naso unicornus	bluespine unicornfish	kala
Naso lituratus	orangespine unicornfish	kalalei or umaumalei
Naso hexacanthus	black tongue unicornfish	kala holo
Naso annulatus	whitemargin unicornfish	kala
Naso brevirostris	spotted unicornfish	kala lolo
Naso caesius	gray unicornfish	NA
Zebrasoma flavescens	yellow tang	lauʻipala
Balistidae (Triggerfish)		
Melichthys vidua	pinktail triggerfish	humuhumu hiʻukole
Melichthys niger	black triggerfish	humuhumu ʻeleʻele
Rhinecanthus aculeatus	picassofish	humuhumu nukunuku apuaʻa
Sufflamen fraenatus	bridled triggerfish	NA
Carangidae (Jacks)		
Selar crumenophthalmus	bigeye scad	akule or hahalu
Decapterus macarellus	mackerel scad	ʻopelu or ʻopelu mama
Carcharhinidae (sharks)		
Carcharhinus amblyrhynchos	grey reef shark	manō
Carcharhinus galapagensis	galapagos shark	manō
Carcharhinus melanopterus	blacktip reef shark	manō
Triaenodon obesus	whitetip shark	manō lalakea
Chaetodontidae		
Chaetodon auriga	butterflyfish	kikakapu
Chaetodon lunula	raccoon butterflyfish	kikakapu
Chaetodon ephippium	saddleback butterflyfish	kikakapu
Holocentridae (Soldierfish/Squirrelfish)		
Myripristis berndti	bigscale soldierfish	menpachi or ʻuʻu
Myripristis amaena	brick soldierfish	menpachi or ʻuʻu
Myripristis chryseres	yellowfin soldierfish	menpachi or ʻuʻu
Myripristis kuntee	pearly soldierfish	menpachi or ʻuʻu
Sargocentron microstoma	file-lined squirrelfish	ʻalaʻihi
Sargocentron diadema	crown squirrelfish	ʻalaʻihi
Sargocentron punctatissimum	peppered squirrelfish	ʻalaʻihi
Sargocentron tiere	blue-lined squirrelfish	ʻalaʻihi
Sargocentron xantherythrum	hawaiian squirrelfish	ʻalaʻihi
Sargocentron spiniferum	saber or long jaw squirrelfish	ʻalaʻihi
Neoniphon spp.	spotfin squirrelfish	ʻalaʻihi
Kuhliidae (Flagtails)		
Kuhlia sandvicensis	Hawaiian flag-tail	ʻaholehole
Kyphosidae (Rudderfish)		
Kyphosus biggibus	rudderfish	nenue
Kyphosus cinerascens	rudderfish	nenue
Kyphosus vaigiensis	rudderfish	nenue
Labridae (Wrasses)		

Scientific Name	Common Name	Local Name
Bodianus bilunulatus	saddleback hogfish	‘a‘awa
Oxycheilinus unifasciatus	ring-tailed wrasse	po‘ou
Xyrichtys pavo	razor wrasse	laenihi or nabeta
Cheilio inermis	cigar wrasse	kupoupou
Thalassoma purpureum	surge wrasse	ho‘u
Thalassoma quinquevittatum	red ribbon wrasse	NA
Thalassoma lutescens	sunset wrasse	NA
Novaculichthys taeniourus	rockmover wrasse	NA
Mullidae (Goatfishes)		
Mulloidichthys spp.	yellow goatfish	weke
Mulloidichthys pfleugeri	orange goatfish	weke nono
Mulloidichthys vanicolensis	yellowfin goatfish	weke‘ula
Mulloidichthys flavolineatus	yellowstripe goatfish	weke‘a or weke a‘a
Parupeneus spp.	banded goatfish	kumu or moano
Parupeneus cyclostomas	yellowsaddle goatfish	moano kea or moano kale
Parupeneus pleurostigma	side-spot goatfish	malu
Parupeneus multifaciatus	multi-barred goatfish	moano
Upeneus arge	bandtail goatfish	weke pueo
Mugilidae (Mullets)		
Mugil cephalus	stripped mullet	‘ama‘ama
Neomyxus leuciscus	false mullet	uouoa
Muraenidae (Moray eels)		
Gymnothorax flavimarginatus	yellowmargin moral eel	puhi paka
Gymnothorax javanicus	giant moray eel	puhi
Gymnothorax undulatus	undulated moray eel	puhi laumilo
Enchelycore pardalis	dragon eel	puhi
Octopodidae (Octopus)		
Octopus cyanea	octopus	he‘e mauli or tako
Octopus ornatus	octopus	he‘e or tako
Polynemidae		
Polydactylus sexfilis	threadfin	moi
Priacanthidae (Big-eyes)		
Heteropriacanthus cruentatus	glasseye	‘aweoweo
Priacanthus harmrur	bigeye	‘aweoweo
Sabellidae		
	featherduster worm	NA
Scaridae (Parrotfish)		
Scarus spp.	parrotfish	uhu or palukaluka
Calotomus carolinus	stareye parrotfish	panuhunuhu
Sphyraenidae (Barracuda)		
Sphyraena helleri	Heller's barracuda	kawele‘a or kaku
Sphyraena barracuda	great barracuda	kaku
Turbinidae		
Turbo spp.	green snails / turban shells	NA
Zanclidae		
Zanclus cornutus	moorish idol	kihikihi

(Source: WPRFMC, 2009)

Table 2. Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) for all Western Pacific FMPs

FMP	EFH (Juveniles and Adults)	EFH (Eggs and Larvae)	HAPC
Pelagics	* Water column down to 1,000 m	* Water column down to 200 m	Water column above seamounts and banks down to 1,000 m
Bottomfish and Seamount Groundfish	[1] Bottomfish: Water column and bottom habitat down to 400 m Seamount Groundfish: (adults only) water column and bottom from 80 to 600 m, bounded by 29°-35°N and 171°E-179°W	[1] Bottomfish: Water column down to 400 m Seamount Groundfish: (including juveniles) epipelagic zone (0 to 200 m) bounded by 29°-35°N and 171°E-179°W	[1] Bottomfish: All escarpments and slopes between 40 and 280 m, and three known areas of juvenile ōpakapaka habitat Seamount Groundfish: not identified
Precious Corals	Keāhole Point, Makapuu, Kaena Point, Westpac, Brooks Bank, 180 Fathom Bank deepwater precious corals (gold and red) beds and Milolii, Au'au Channel and S. Kaua'i black coral beds	Not applicable	Makapuu, Westpac, and Brooks Bank deepwater precious corals beds and the Au'au Channel black coral bed
Crustaceans	* Lobsters: Bottom habitat from shoreline to a depth of 100 m * Deepwater shrimp: The outer reef slopes at depths between 300 and 700 m	* Water column down to 150 m * Water column and associated outer reef slopes between 550 and 700 m	All banks with summits less than 30 m No HAPC designated for deepwater shrimp
Coral Reef Ecosystems	* Water column and benthic substrate to a depth of 100 m	* Water column and benthic substrate to a depth of 100 m	All MPAs identified in FMP, all PRIA, many specific areas of coral reef habitat (see FMP)

(Source: WPRFMC, 2009)
Note: EFH and HAPC potentially impacted by the proposed project are identified by an asterisk (*)
[1] Bottomfish EFH will be modified in the near future to define three new complex EFH designations within the 0-400 m depth range for shallow, mid-water, and deep-water species. Bottomfish HAPC will also be modified so that the depth range is replaced with seven discrete areas around the main Hawaiian Islands, none of which will be impacted by the proposed project.

While pelagic MUS can be found within the Hawaii Archipelago FEP boundary, they are managed under a separate Pelagic FEP, which encompasses all areas of pelagic fishing operations in the EEZ or on the high seas, for any domestic vessels that: fish for, possess, or transship Pacific Pelagic MUS (Table 3) within the EEZ waters of the Western Pacific Region or land Pacific Pelagic MUS within the states, territories, commonwealths, or unincorporated U.S. island possessions of the Western Pacific Region.

Table 3. Pacific Pelagic MUS

Scientific Name	Common Name
Coryphaena spp.	Mahimahi (dolphinfishes)
Acanthocybium solandri	Wahoo
Makaira mazara	Indo-Pacific blue marlin
M. indica	Black marlin
Tetrapturus audax	Striped marlin
T. angustirostris	Shortbill spearfish
Xiphias gladius	Swordfish
Istiophorus platypterus	Sailfish
Isurus oxyrichus	Shortfin mako shark
Isurus paucus	Longfin mako shark
Lamna ditropis	Salmon shark
Thunnus alalunga	Albacore tuna
T. obesus	Bigeye tuna
T. albacares	Yellowfin tuna
T. thynnus	Northern bluefin tuna
Alopias pelagicus	Pelagic thresher shark
A. superciliousus	Bigeye thresher shark
A. vulpinus	Common thresher shark
Carcharhinus falciformis	Silky shark
C. longimanus	Oceanic whitetip shark
Prionace glauca	Blue shark
Katsuwonus pelamis	Skipjack tuna
Euthynnus affinis	Kawakawa
Lampris spp.	Moonfish
family *Gempylidae*	Oilfish
family *Bramidae*	Pomfret
Auxis spp, *Scomber* spp, *Allothunus* spp.	Other tuna relatives
(Source: WPRFMC, 2005)	

Possible effects to EFH include modifications to either the water column or the seafloor in the ROI. The degree to which the EFH is impacted depends on a number of factors:

- The intensity of the impact at the specific site being affected
- The spatial extent of the impact relative to the availability of the habitat type affected
- The sensitivity/vulnerability of the habitat to the impact
- The habitat functions that may be altered by the impact (i.e. shelter from predators)
- The timing of the impact relative to when the species or life stage needs the habitat

In this case, these factors can best be assessed by first examining the context of the current environment, general description of the four biotopes used to classify the ROI, and species diversity and abundance of MUS in the potentially affected EFH identified above.

2.2 Existing Environment

The marine areas in the proposed pipeline corridor are among the most historically degraded coastal habitats in the State, having been subjected to freshwater runoff into Honolulu Harbor, municipal waste dumping, sewage discharge, dredged material dumping, and other waste disposal activities. This area has limited marine biological resources. The nearshore area is maintained in an early successional stage by seasonal high surf events, occasional storm surge, and, near the Honolulu Harbor entrance channel, and dragging of barge tow cables on the bottom.

Commercial fishing catches are reported to the Hawaii Division of Aquatic Resources (DAR) monthly by statistical area. Two areas are relevant to the HSWAC ROI: Area 400 extends two miles offshore from the middle of the Reef Runway to Diamond Head and Area 420 extends seaward from 2 to 20 miles offshore. DAR's 2005 landings summary report shows that 46,428 pounds of fish, shellfish, and seaweed were landed from these two areas, representing 0.02% of the Oahu landings. Landings in 2007 were similar to those of 2005, totaling approximately 34,000 pounds of fish, shellfish and seaweed. The most recent report, for calendar year 2009, showed that approximately 35,500 pounds of fish, shellfish, and seaweed were landed from areas 400 and 420. This represents only 0.14% of Oahu landings. These data verify that the area offshore of Kaka'ako consistently produces a low amount of commercial fishery landings, and is generally not an important fishing ground. Near shore (Area 400), the catch was dominated by akule, ta'ape (an introduced snapper), uhu (parrotfish), and he'e (octopus). Offshore (Area 420), the majority of pelagic species catch consisted of tunas, billfish, mahimahi, and ono (wahoo), along with a small quantity of deep bottomfish (mostly onaga) (Table 4). These fish composition data are only available for the 2005 calendar year, after which the limited number of fisherman for these two areas required that more specific information be confidential.

Table 4: Managed Species Identified in DAR Commercial Catch Data in the HSWAC ROI

Potentially Affected EFH (FMP)	MUS Species Reported	Comment
Water column down to 1,000 m (3,280 ft)for juveniles and adults; down to 200 m (656 ft) for eggs and larvae (Pelagics)	tunas billfish mahimahi ono (wahoo)	**Lack of commercial landings in this area indicates MUS pelagics are not common in ROI** **Yellowfin** – adults more abundant late spring through early fall; juveniles abundant fall and winter **Albacore** – more abundant during summer months **Bigeye** – more abundant late fall through late spring **Skipjack** – most common during spring and summer **Striped marlin**: most abundant in spring and fall **Pacific blue marlin**: most abundant during summer **Shortbill spearfish**: most abundant during winter and early spring Small (up to 5lbs) common in summer; large (30-40lbs) more common in late winter and early spring More abundant late spring through fall
Water column and bottom habitat down to 400 m (1,312 ft) for juveniles and adults; water column down to 400 m (1,312 ft) for eggs and larvae (Bottomfish)	onaga (longtail snapper) ta'ape (bluestripe snapper)	Most onaga were caught during winter
Lobsters: Bottom habitat from shoreline to a depth of 100 m (328 ft) for juveniles and adults; water column down to 150 m (492 ft) for eggs and larvae (Crustaceans)	No lobsters noted	

Potentially Affected EFH (FMP)	MUS Species Reported	Comment
Deepwater shrimp: The outer reef slopes at depths between 300 and 700 m (984 and 2,296 ft) for juveniles and adults; the water column and associated outer reef slopes between 550 and 700 m (1,804 and 2,296 ft) for eggs and larvae (Crustaceans)	No deepwater shrimp noted	
Water column and benthic substrate to a depth of 100 m (328 ft) for adults, juveniles, eggs, and larvae (Coral Reef Ecosystem)	akule (bigeye scad) he'e (octopus) uhu (parrotfish)	
(Source: Hawaii Division of Aquatic Resources, 2005, 2007, 2009; seasonality information from Honebring, 1990)		

Several studies have been conducted to specifically characterize the marine resources in the HSWAC ROI that are relevant to the EFH analysis. Brock (2005) provides an initial, qualitative examination of the marine communities off Kaka 'ako Waterfront Park along with the delineation and description of the four biotopes listed in the next section. Brock (2011) offers a detailed, quantitative assessment of the marine communities associated with the previously described biotopes along the proposed pipe route to a depth of approximately 130 ft (40 m), where the proposed receiving pit (pipeline "breakout point") would be located.

Biological inventories along the proposed pipeline route deeper than 130 ft (40 m) could not be completed using divers and traditional SCUBA equipment. Therefore, multiple studies have also been completed along the proposed pipeline route using submersibles from 160 ft (50 m) to approximately 1,800 ft (550 m), the approximate depth of the proposed intake (Table 5).

Table 5. Submersible Dives

Dive Number	Date	Dive Times	Dive Length (m) / Area (m^2)	Hours of Video	Depth Range (m)
P5-748	10/05/2010	9:50-15:14	3,570 / 10,700	5	499-558
P5-711	2/10/2009	11:38-13:43	937 / 2,811	2	75-209
P4-207	2/10/2009	10:43-16:37	5,116 / 15,348	6	40-408
P5-767	3/28/2011	9:18-16:18	6,742 / 20,226	7	250-559
P4-243	3/28/2011	9:36-15:20	5,989 / 17,967	6	250-559
(Source: Kelley, 2011)					

Dive P5-748 was conducted by HURL along the proposed pipeline corridor after recovering a glider nearby. Kelley (2011) describes the resultant semi-quantitative inventory of marine biota observed on the submersible videotape. However, definitive identification was limited by poor camera resolution and small organism size. Kelley (2011) also describes the four other submersible dives listed in Table 4, for which HD camera systems along with VARS (Video Annotation and Reference System) were used to merge tracking, CTD, and depth data with animal observation records. HURL used the World Register of Marine Species to update the VARS taxonomic database for all deep-water Hawaiian fish and invertebrates, so all identifications from those submersible dives are current. The HD cameras were set to the widest field of view (average 3 m video swath) and scale was provided by mounted lasers. The results of these submersible studies are organized according to depth zone and are also described below.

Biotopes

Brock (2005) presented the progression of habitats in the HSWAC ROI seaward from shore as biotopes of scoured limestone, scattered coral, dredged rubble, and sand. The detailed description of these four biotopes resulted from a marine biological survey of the general vicinity of the proposed breakout point, which is where the greatest potential impact to the marine environment is expected from proposed HSWAC activities. Brock (2011) further describes these biotopes with respect to the proposed pipe route and the marine organisms that could be impacted by establishing seven sampling stations that are (1) located on the midline of the proposed pipeline alignment and (2) representative of the communities present in the biotopes traversed by the proposed pipeline at various depths from 30 to 130 ft.

Scoured Limestone:

The following description of the scoured limestone biotope is based on the description given in the initial survey by Brock (2005) and not the more recent survey (2011) because HSWAC proposes microtunneling beneath the shallow reef platform to avoid impacting those marine resources. Therefore, none of this biotope would be impacted, negating the need for an additional, detailed survey of the scoured limestone biotope.

Located along the entire length of the boulder riprap shoreline fronting Kaka'ako Waterfront Park and the commercial area to the west, the limestone is relatively flat and smooth with little topographical relief, aside from some spur and groove formations in the nearshore area to the far western part of the limestone platform. Areas of sand and coralline rubble are present within this biotope, but their movement by impinging waves creates the scouring action that inhibits the successful establishment and growth of corals. High surf is most common during the summer months when swells arrive from the south. Fish communities are best developed in the far western area, likely resulting from the presence of the spur and groove formations in the limestone there. These fish communities are dominated by the following MUS: surgeonfishes and triggerfishes.

The very low percent coral cover in this biotope (much less than 0.1%) is generally the cauliflower coral (*Pocillopora meandrina)* and rarely, the lobate coral (*Porites lobata)*, neither of which is an MUS. The diversity of diurnally-exposed macroscopic species (greater than 0.8 inches in some dimension) is low and none of the noted species are MUS.

Scattered Corals:

This biotope is the most common feature of the Kaka'ako limestone platform. It occupies a band of approximately 980 ft in width and 3,000 ft in length between the Waikiki Entrance Channel for Honolulu Harbor and the abandoned sewer line near the Kewalo Basin entrance channel at depths of 13 to 60 ft (3.9 – 18.3 m), for a total of about 75 acres. However, the proposed microtunnel for the HSWAC pipeline would bypass the majority of this biotope, emerging at its seaward edge approximately 1,796 ft (547 m) from the shoreline.

Coral cover tends to increase with increasing depth, and in some limited areas (of 220 to 1600 square ft) cover may approach 75%. However, a gross overall mean estimate of coral cover in this biotope is 5%. Corals are commonly seen on the ridges that lie above the sand-scour that occurs during periods of high surf. Common species include the cauliflower coral (*Pocillopora meandrina*), antler coral (*Pocillopora eydouxi*), lobate coral (*Porites lobata*), rice corals (*Montipora capitata, M. patula*), mound coral (*Porites lutea*), and other less dominant species (*Porites compressa, Montipora verrilli, Pavona varians, P. duerdeni, Leptastrea purpurea,* and *Porites rus)*. None of these corals are classified as MUS. Table 6 lists the fish MUS observed during two 25 m transects conducted by Brock (2011) at Station 1 in the biotope of scattered corals.

Table 6. MUS in Biotope of Scattered Corals (Brock, 2011)

Potentially Affected EFH (FMP)	**MUS Species Observed (Brock, 2011)**	**Counts for two 25m transects (Station 1)**
Water column and benthic substrate to a depth of 100 m (328 ft) for adults, juveniles, eggs, and larvae (Coral Reef Ecosystem)	Mullidae	
	Parupeneus multifasciatus	9
	Labridae	
	Bodianus bilunulatus	1
	Novaculichthys taeniourus	1
	Scaridae	
	Calotomus carolinus	7

Potentially Affected EFH (FMP)	MUS Species Observed (Brock, 2011)	Counts for two 25m transects (Station 1)
	Scarus rubroviolaceus	1
	Acanthuridae	
	Acanthurus triostegus	19
	Acanthurus nigrofuscus	11
	Acanthurus nigrosis	1
	Acanthurus blochii	1
	Acanthurus olivaceus	8
	Acanthurus dussumieri	1
	Naso hexacanthus	19
	Naso lituratus	4
	Naso unicornus	2
	Zanclidae	
	Zanclus cornutus	1
	Balistidae	
	Melichthys niger	19

Dredged Rubble:

Ridges or spurs often appear as relatively flat limestone with little coral present, and the intervening channels are filled in with coral rubble. Much of this rubble appears to be angular and ranges from two inches to about 2.5 ft in diameter, but the majority of it is small. This coral rubble remains from the dredging activities in Honolulu Harbor, and the tailings were likely deposited in the area from 1920 through 1960. This biotope is recognizable at depths from about 30 to 40 ft (9.1 to 12.19 m), and extends seaward sometimes as a relatively steep slope or otherwise as a gentle slope from 65 to 200 ft in width.

The relatively unstable nature of this substrate does not promote coral growth – mean coral cover is about 0.01%, most commonly the following non-MUS corals: cauliflower coral (*Pocillopora meandrina*), lobate coral (*Porites lobata*), and rice corals (*Montipora verrucosa* and *M. patula*).

Fish seen in this biotope are small, either juveniles or species that do not attain large sizes. Fish communities are better developed where larger coral pieces or metal/concrete debris are found. MUS species of fish that are commonly seen include moano (*Parupeneus multifasciatus*), puhi laumilo (*Gymnothorax undulatus*), ala'ihi (*Sargocentron xantherythrum*), several surgeonfishes (pualo - *Acanthurus blochii, A. xanthopterus*, palani - *A. dussumieri*, and ma'i'i'i – *A. nigrofuscus*), kala holo (*Naso hexacanthus*), kala lolo (*Naso brevirostris*), humuhumu mimi (*Sufflamen fraenatus*) and a'awa - *Bodianus bilunulatus*. The octopus he'e (*Octopus cyanea*) was also observed here. Table 7 lists the fish MUS observed during five 25 m transects conducted by Brock (2011) at Stations 2, 5, 6, and 7 in the biotope of dredged rubble.

Table 7. MUS in Biotope of Dredged Rubble (Brock, 2011)

Potentially Affected EFH (FMP)	MUS Species Observed (Brock, 2011)	Counts for five 25m transects (Stations 2,5,6, and 7)
Water column and benthic substrate to a depth of 100 m (328 ft) for adults, juveniles, eggs, and larvae (Coral Reef Ecosystem)	Mullidae	
	Mulloides pleurostigma	12
	Parupeneus multifasciatus	8
	Scaridae	
	Scarus rubroviolaceus	1
	Acanthuridae	
	Acanthurus nigrofuscus	1
	Acanthurus olivaceus	9

Sand:

Seaward of the biotope of dredged rubble, the biotope of sand generally occurs at depths greater than 65 ft. However, the biotope of sand also occurred at a depth of approximately 60 ft along the proposed pipeline for approximately 500 ft within the larger biotope of dredged rubble. Offshore (within 330 ft of the rubble slope), there are several mounds of coral rubble that rise up to 16 ft above the surrounding substratum that probably represent one or more barge loads of dredge tailings. The diversity of marine life on the sand/rubble plain seaward of the 100 foot isobath is not well-developed, and was not examined in this study (Brock, 2005) due to depth and bottom time constraints. Table 8 lists the fish MUS observed during four 25 m transects conducted by Brock (2011) at Stations 3 and 4 in the biotope of sand.

Table 8. MUS Species in Biotope of Sand (Brock, 2011)

Potentially Affected EFH (FMP)	MUS Species Observed (Brock, 2011)	Counts for four 25m transects (Stations 3 and 4)
Water column and benthic substrate to a depth of 100 m (328 ft) for adults, juveniles, eggs, and larvae (Coral Reef Ecosystem)	Holocentridae	
	Myripristis amaena	6
	Mullidae	
	Mulloides vanicolensis	3
	Parupeneus multifasciatus	7
	Scaridae	
	Scarus rubroviolaceus	2
	Acanthuridae	
	Acanthurus nigrofuscus	2
	Acanthurus olivaceus	2

The submersible surveys provide a detailed account of marine life and seafloor substrate along the remaining length of the proposed pipe route. The results of dive P5-748 are discussed separately from the remaining four submersible dives, which were analyzed as a group and demonstrated segregation of animal types/species into three depth zones (Table 9).

Table 9. Physical Description of Depth Zones from Submersible Dives (P5-711, P4-207, P5-767, P4-243)

Depth Zone (m)	Substrate	Slope	Dredgespoil	Light Temperature Salinity Oxygen	Notes/Comments
50 – 200	Carbonate bedrock, sediment pockets, pebbles, cobbles, boulders, and manmade debris	Fairly gradual from 50 to 110 m, where a break-in-slope occurred; steep from 110 to 200 m	Prevalent	Mesophotic 18.1-24.5 °C 24.8-25.1 ppt 3.9-4.8 ml/l	
200 – 400	Transition from primarily carbonate bedrock to sediment with pebbles, cobbles, boulders, and manmade debris	Gradual from 200 to 400 m, allowing for increased deposit of sediment	Highly prevalent	Meso-aphotic 8.4-18.1°C 34.0-34.9 ppt 2.8-4.4 ml/l	Characterized as "highly disturbed habitat"
400 – 550	Rippled sediment with pebbles, occasional cobbles, boulders, and blocks (natural landslide debris), and considerable manmade debris; virtually no exposed bedrock	Most gradual of the three zones	Present	Aphotic 6.3-8.6 °C 34.1-34.1 ppt 1.0-3.1 ml/l	Characterized as "highly disturbed habitat"
(Source: Kelley, 2011)					

Dive P5-748 focused on the area around the proposed intake and determined that more than 99 percent of the substratum viewed was comprised of sand. Scattered tailings were seen, probably originating from former Honolulu Harbor dredging operations. Hard substratum (limestone or basalt) was extremely rare, making up an estimated 0.3 percent of the bottom. Anthropogenic debris, primarily metal, made up an estimated 0.5 percent of the bottom.

In general terms of the biology present, dive P5-748 focused on the area around the proposed intake and sighted 419 organisms in 42 taxa. Most organisms were found on or adjacent to hard substratum. Exceptions were glass rope sponges, paneid shrimps, squids and the jellynose eel. The most abundant organism seen was the sea star *Brisinga* sp. (170 individuals). Second most abundant was the glass rope sponge (45 individuals), followed by small unidentified fishes (27 individuals).

The remaining submersible dives found fish were mostly associated with coral reefs in shallower waters, or with deep reefs and sediment flats at mesophotic depths for the 50 – 200 m zone. This zone was stated as having a very low number of species relative to that found at similar depths around the main Hawaiian Islands, as observed by HURL submersibles (Kelley, 2011). No shallow reef fish or invertebrates were observed in the 200 – 400 m zone. This zone instead consisted primarily of invertebrates and fish belonging to the bottomfish habitat community, which were generally associated with metal wreckage away from the proposed pipe route. Again, this zone was stated as having a very low number of species relative to that found at similar depths around the main Hawaiian Islands, as observed by HURL submersibles (Kelley, 2011). The third zone, 400 – 500 m, primarily contained members of the following groups, starting with the most abundant: cnidarians, fish, sponges, seastars, and urchins. MUS observed during these submersible surveys are listed in Table 10.

Table 10. MUS Observed during Submersible Surveys

Potentially Affected EFH (FMP)	Relevant Biotope(s)	MUS Caught/Observed	Counts; Density
Water column down to 1,000 m (3,280 ft)for juveniles and adults; down to 200 m (656 ft) for eggs and larvae (Pelagics)	Scoured Limestone Scattered Coral Dredged Rubble Sand	None	
Water column and bottom habitat down to 400 m (1,312 ft) for juveniles and adults; water column down to 400 m (1,312 ft) for eggs and larvae (Bottomfish)	Dredged Rubble And Sand Zone: 200 – 400 m	Red Snapper Longtail Snapper Soldierfish/Squirrelfish Amberjack * Also: groundfish identified to genus (Beryx)	28; 0.001 m^{-2} 4; 0.000 m^{-2} 3; 0.000 m^{-2} 3; 0.000 m^{-2} 3; 0.000 m^{-2}
Lobsters: Bottom habitat from shoreline to a depth of 100 m (328 ft) for juveniles and adults; water column down to 150 m (492 ft) for eggs and larvae (Crustaceans)	Scoured Limestone Scattered Coral Dredged Rubble Sand	None	
Deepwater shrimp: The outer reef slopes at depths between 300 and 700 m (984 and 2,296 ft) for juveniles and adults; the water column and associated outer reef slopes between 550 and 700 m (1,804 and 2,296 ft) for eggs and larvae (Crustaceans)	Sand Zone: 400 – 550 m	Deepwater shrimp (*Heterocarpus sp*)	43; 0.002 m^{-2}

Potentially Affected EFH (FMP)	Relevant Biotope(s)	MUS Caught/Observed	Counts; Density
Water column and benthic substrate to a depth of 100 m (328 ft) for adults, juveniles, eggs, and larvae (Coral Reef Ecosystem)	Dredged Rubble and Sand Zone: 50 – 200 m	Triggerfish Parrotfish Wrasse	1; 0.000 m^{-2} 2; 0.000 m^{-2} 1; 0.000 m^{-2}
(Source: Kelley, 2011)			

MUS Diversity and Abundance in EFH

While various EFH may be impacted by the proposed actions for this project, in the context of the above information, the potential effect on MUS within each EFH is expected to be minimal if the MUS is not observed to be present, or is rare, in the HSWAC region of influence (ROI) (Table 6). This is especially true if the type of substrate supporting such MUS has low percent cover in the ROI, and if the surrounding habitat is sufficiently similar in nature to support any MUS in the ROI during possible short-term disturbances (e.g., from project construction).

While the western side of the Honolulu Harbor Entrance Channel was also surveyed, the locations of the proposed breakout point and pipeline route were selected to avoid impacting the coral communities found in this area. Alongside and within 260 ft of the western edge of the entrance channel to Honolulu Harbor, there is a relatively well-developed coral community at depths from about 23 to 40 ft. This community is dominated by the cauliflower coral (*Pocillopora meandrina*). Mean coral cover is about 25% through much of this area. Further west is a large barren area of limestone and sand flats, but about 660 ft west where the limestone is elevated, corals are again encountered. Common species in this area include *Porites lobata* and *Pocillopora meandrina* and local cover (over areas from 110 to 1,100 ft^2) may be up to 30%. These more coral rich areas are broken by extensive sand flats so that overall mean coral cover through much of the area is estimated to be less than 5%.

As previously noted, the majority of the scattered coral biotope and the entirety of the scoured limestone biotope would not be impacted by the proposed project because the proposed microtunnel places the pipeline below (not on the surface of) the limestone platform.

Water Quality Effects and EFH

Potential impacts to EFH due to changes in water quality during construction activities would be minimized in various ways. The sheet piles to be used in the construction of the receiving pit would also be used to define the walls of the receiving pit to a point above the sea bottom in order to contain most of the sediment generated by excavation. Turbidity would also be minimized by using a clam shell dredge to transfer materials from within the structure to a barge for transport to land.

Currents in the vicinity of the proposed breakout pit generally follow the trade wind flow, moving water towards the southwest off Kaka 'ako Waterfront Park. This means that turbidity generated by HSWAC construction activities is expected to have a greater impact on benthic marine communities to the southwest. While the receiving pit would be located at the seaward edge of the scattered corals biotope, turbidity generated during its construction would generally flow to the southwest, to the biotopes of dredged rubble and sand, where a much lower abundance and diversity of corals exits, thereby avoiding and minimizing potential impacts.

Once operational, the HSWAC system would return slightly warmed deep seawater to relatively shallow depths. The character of the water would not be changed from that at the intake location except for being warmed approximately 9-13°F. As the ambient condition of the unmodified deep source water is in violation of many of the State's water quality standards, so too would the return water be in violation of those standards. Parameters that would not meet standards for open coastal waters (wet coastline), including those for total nitrogen, nitrate plus nitrite nitrogen, total phosphorus, dissolved oxygen and temperature modification. Consequently, a zone of mixing (ZOM) would have to be approved.

In order to ensure water quality standards would be met outside the ZOM, a diffuser system was designed for the end of the return seawater pipe. Discharging the return seawater through a diffuser situated at a depth of 120-150 feet was modeled to examine potential water quality effects. Alternatively, the location of the diffuser has also been proposed at a depth of 300 ft. The return seawater, while warmed somewhat from its temperature at the intake location, would still be relatively low in temperature and dissolved oxygen content and high in dissolved macronutrient concentrations compared with coastal waters.

Historically, it has been recognized that the distribution of coral reef communities is restricted to low latitudes where water temperatures are relatively warm. Field observations and laboratory experiments established 16°C (60.8°F) as a thermal stress threshold for most reef corals (Mayor, 1915). More recent laboratory studies in Hawai'i have indicated that individual hermatypic (reef-building) corals do not persist at temperatures below 18°C (64.4°F) (Jokiel and Coles, 1977; Coles and Jokiel, 1978). Persistent exposure to temperatures below the thermal threshold (which may vary with species and preconditioning) would result in mortality. Some studies suggest that temperature may not be an absolute, direct limitation to corals. There are many coral reefs in more variable environments where temperatures regularly fall to 13°C (55.4°F) and lower, at least for short periods of time (Coles and Fadlallah, 1991). It is apparent from these and other studies that there is the possibility of selective adaptation or physiological acclimation that permits corals to persist at lower temperatures than previously assumed.

Staging Area EFH

The proposed offshore staging area consists of one portion of the Ke'ehi Lagoon seaplane runway channels and would be about 49.9 acres in size, in use for approximately 10 months. The present shoreline and basins of Ke'ehi Lagoon may be the most altered marine area of Hawai'i. The perimeter of the lagoon is virtually all man-made, altered in this century by landfill of one sort or another. Material claimed from the lagoon was used to extend the shoreline and to reclaim shallow reef flats and marshy areas around the margin of the lagoon. Moanalua and Kalihi Streams empty into the northwest corner of the lagoon. Sediments from these streams are gradually filling the northern portion of the lagoon.

During World War II, the U.S. Navy dredged three intersecting basins across the fringing reef to create seaplane channels. The proposed staging area in Ke'ehi Lagoon is within a previously dredged channel with a soft bottom invertebrate infaunal community with little cover or hard substrate to support corals or fish populations. No adverse effect to any EFH is expected to occur here as a result of HSWAC activities in the staging area.

2.3 Likely Impacts of Proposed Action on EFH and MUS

The likely impacts of the no-action and three action alternatives on EFH are examined below. All action alternatives consist of microtunneling and surface mounting the pipe from the breakout point seaward, as opposed to trenching, to ensure turbidity during construction is minimized as much as possible, especially with regard to the corals to the west of the proposed pipeline.

No Action Alternative

The No Action Alternative would have no direct or indirect, short-term or long-term adverse effects on EFH as there would be no construction of marine facilities.

Alternative 1 (Applicant's preferred alternative)

The applicant selected the proposed pipeline receiving pit (or "breakout point") for Alternative 1 to avoid coral reefs or coral-dominated communities. This breakout point would become a temporary pit (40 by 40 ft and 20 ft deep) and would be placed within the biotope of dredged rubble where corals are sparse. The locations of the anchors or piles to be used to tension the pipes during deployment would be close to and slightly shoreward of the breakout point, but within the same biotope.

The sea bottom at the excavation site would be surrounded by sheet pile to protect the ecosystem around it, but the excavation of the breakout pit would destroy any infaunal organisms resident in the removed sand. Once the connections between the pipeline and jacked casings are complete, the breakout pit would be backfilled with crushed basalt gravel (pre-washed to ensure fines are not introduced). Concrete would be used to cap the filled pit (to be even with surrounding bottom contours), for filling and capping the piles, and for the combination pipe collars. From the location of the receiving pit to the end of the diffuser, 91 Type A pipe collars will be used. Each of these collars would have cover 76 ft^2 of substrate, but would also provide an exposed surface of about 313 ft^2. This is significant because it means that for every square foot of bottom covered by the collars, there is a gain of about 4 square feet of raised hard substratum available for potential colonization by benthic organisms.

The suitability of the proposed new concrete cap and collars, and the HDPE pipe, for colonization by corals and other marine organisms must be considered. Coral colonies may be readily observed growing on old concrete structures in Hawaiian waters. In their experimental study, Fitzhardinge and Bailey-Brock (1989) found that concrete as an epifaunal recruitment surface was almost as good as natural coralline material. It might be anticipated that the HDPE pipes proposed for the HSWAC project would be a lower quality surface for coral colonization than the concrete collars. However, the experience of the Natural Energy Laboratory Authority at Keahole Point, West Hawai'i indicates that HDPE pipe surfaces can support the substantial recruitment and growth of corals (as shown in Figure 30 of Brock, 2011). Both the concrete and HDPE pipe proposed for use in the HSWAC pipeline are expected to provide stable substrata suitable for the settlement and growth of corals and other sessile benthic species. Further, the vertical relief afforded by the collars would be far greater than found on existing hard substratum in the pipeline corridor. This greater vertical relief would provide separation of recruiting corals and other invertebrates from the potential scour caused by the movement of sand and rubble during periods of high surf in the project area. Thus, the presence of the pipes and collars is likely to result in development of an enhanced benthic community in the project area.

Marine structures are well known to attract and concentrate fish, although whether this represents only attraction or an actual increase in biomass production has been the subject of debate and is reviewed by Pickering and Whitmarsh (1997). The addition of material to increase the vertical relief in otherwise barren areas is well-known and usually takes the form of artificial reefs. Artificial reefs in Hawaiian waters may serve to increase fish standing crops to more than 0.2 lb ft^{-2} (Brock and Norris, 1989). The HSWAC pipelines would, in effect, constitute artificial reefs that would be expected to enhance resident fish populations. Recruitment and growth of an epibenthic coral reef community on the structures is likely to attract and support growth of associated fish populations by providing additional food, shelter from predation, and shelter from tidal currents.

Focusing on the area between the entrance channel of Honolulu Harbor and the old sewer pipe just east of the Kewalo Basin entrance channel, rough approximations of the area occupied by the three pertinent biotopes fronting the Kaka'ako Waterfront Park were made. These areas are:

- Biotope of scoured limestone = 33 ac
- Biotope of scattered corals = 74 ac
- Biotope of dredged rubble = 33 ac

Receiving pit to diffuser construction:

To estimate the amount of coral potentially affected by the construction of the receiving pit, the coral cover in that area is estimated to be 0.9% on the channel floor occupied by the receiving pit, but more coral is found surrounding it on the limestone ridges at a mean cover of 7.5%. Assuming all the coral within a 10 m diameter circle die as a result of direct and indirect impacts, a total of 5.9 m^2 of coral would be lost (78.5 m^2 x 7.5%). However, the mitigation measures described above would reduce such impacts on the coral in the area surrounding the receiving pit.

Combination collars (Type A) covering 6,916 ft^2 would be deployed from the receiving pit to the end of the diffuser at a depth of 150 feet. The breakout pit itself would disturb 1,600 ft^2. The total disturbed surface area would therefore be 8,516 ft^2. Under Alternative 1, this would, in its entirety, take place in the biotope of dredged rubble, where live coral cover is a very sparse 1.7%. Assuming an even coral distribution over the biotope, this would result in about 144 ft^2 of live coral being destroyed. Assuming some additional coral loss by construction operations (vessel anchors, etc.), it is still likely that no more than 200 ft^2 of living coral would be destroyed.

While the more abundant corals on the western side of the Honolulu Harbor entrance channel would not be impacted directly, they could possibly be impacted indirectly by turbidity generated by construction activities. At the breakout pit, the applicant would discharge gravel and concrete within an area surrounded by sheet piles (or a combination of sheet piles and silt curtains) extending above the sea bottom to minimize the extent of any turbidity plume outside of the pit. The normal direction of water flow in the area is expected to minimize the potential transport of suspended sediments across the Honolulu Harbor entrance channel to the area of greater coral cover. Currents in the vicinity generally run toward the west/southwest, and, due to the fresh water impacts of Honolulu Harbor, surface currents in the entrance channel tend to flow out of the harbor, regardless of tidal phase. A water quality monitoring program would be implemented during construction, so that activities could be modified or suspended under conditions which would result in excessive turbidity in areas of higher coral cover.

Deep-water pipeline collars:

Based on the relatively low numbers of coral reef organisms (and coral reef ecosystem MUS) observed during the submersible survey from 50 – 200 m depth, along with the prevalence of natural bedrock and dredge spoil deposits as hard substrate, the impact of the pipe on the coral reef EFH is expected to be minimal. Many of the organisms that were observed were associated with large substrate features, such as outcrops and boulders, which the applicant intends to avoid during installation of the pipe.

Overall, the proposed pipeline collars would cover 14,427 ft^2 of substrate, but the collars would create 155,257 ft^2 of new elevated surface and the pipes themselves would create an additional 408,125 ft^2 for potential colonization by sessile benthic organisms, for a net gain of 548,995 ft^2 of hard substrate.

Benthic and fish communities are poorly developed on the rubble slope or sand/rubble, and the deployment of the pipe would have a short-term, direct, adverse effect on these communities. Direct loss to fish populations is not expected. The proposed intake location is approximately five miles offshore at a depth of about 1,755 ft while the euphotic zone (zone of photosynthetic light) typically does not extend beyond the first 330 ft of depth. The intake depth biological productivity is much less than at shallower depths and the lower density of organisms reduces the potential for impingement and entrainment. The relatively low maximum velocity of the intake (approximately 5 ft/sec. or 3.4 miles per hour) is expected to minimize potential entrainment of macro-organisms. The applicant's planned use of variable speed pumps would enable adjustment of flow to the minimum needed to match system requirements.

Construction effects:

Construction activities are described in the DEIS. Effects from construction activities are expected, primarily in the form of temporarily altered water quality, primarily turbidity, in the immediate vicinity of the breakout pit. The type of sediment being excavated (primarily sand) is expected to sink relatively quickly. By surrounding the work area with a sheet pile barrier extending at least 10 feet above the sea bottom, with use of silt curtains and/or additional sheet pile height as needed to control turbidity, the applicant plans to confine effects of the work so as to mitigate impacts on adjacent coral reef habitat. The effects on coral communities of constructing Alternative 1 are also minimized by working in an area where there are relatively few corals present. There would be a direct, short-term effect on nekton as a result of the turbidity generated in the vicinity of the construction operations – some of these organisms would avoid turbid areas while others would be attracted to displaced or exposed benthic organisms. In addition, light available to phytoplankton would be temporarily reduced and filter feeding zooplankton may ingest particulate matter with increased turbidity. Indirect effects may be experienced in adjacent areas to the extent nekton are displaced.

System operation:

Once operational, the HSWAC return seawater discharge would impact water quality and marine biota within a defined zone of mixing located in the biotope of sand. Under worst case conditions, the applicant estimates that ambient water quality standards would be met within about 150 feet of the diffuser. . Within 10 feet from the centerline of the diffuser, the applicant estimates that the dilution will be sufficient to meet water quality standards for temperature, a characteristic of the return water that could have an impact on benthic communities. Within the proposed zone of mixing, coral growth and/or survival may be inhibited by cold water temperatures if the temperature at the sea bottom is reduced below thermal thresholds. Outside this zone, nutrient supplements may enhance coral growth through increased densities of zooxanthellae as a result of bringing increased dissolved inorganic nutrients found in deep water. Therefore, small, negative effects on corals in the area affected by the return seawater plume would likely result, meaning that HSWAC operations would have a direct, long-term adverse effect on EFH in the ZOM. This would be offset by the beneficial effect of the structures (anchor collars and pipes) in terms of creating new, high quality habitat for coral and other sessile benthic organism settlement and growth recruitment and vertical relief for enhancement of fish populations.

The operation of the completed system would create a relatively low-velocity current at the elevated deep-water intake at a bottom depth of approximately 535 m which could potentially entrain pelagics EFH (juveniles and adults) and deepwater shrimp EFH.

Alternative 2

The effects of Alternative 2 would be similar to those described for Alternative 1, with one major exception. The proposed breakout point under Alternative 2 would be in the biotope of dredged rubble, as under Alternative 1; however, unlike the situation offshore of the Alternative 1 breakout point where dredged rubble gives way to sand bottom further off shore, seaward of the Alternative 2 breakout point is a narrow area of relatively high coral cover frequented by recreational divers. The mean coral cover is about 49% and occurs at depths from about 52 feet to 62 feet. Using Alternative 1 plans to estimate the number of collars, 15 Type A collars would be installed from 52 to 62 ft depths. The area of increased coral cover is 150 feet wide where the proposed pipe alignment for Alternative 2 crosses it. Due to an alignment that exposes the pipeline to more physical stress, approximately double the number of collars would be installed for Alternative 2 as for Alternative 1 for a total of 30 collars, each covering 76 ft^2 of substrate. This would result in 1,026 ft^2 of live coral being destroyed just in this one section. Additional live coral would be impacted relative to Alternative 1 because more collars would be installed at depths typically colonized by coral, although a biotope of sand and rubble extends seaward where the mean coral cover is 0.001% beyond the depths of the narrow biotope of high coral cover.

The pipeline collars under Alternative 2 would cover 21,377 ft^2 of substrate, but the collars would create 150,984 ft^2 of substrate and the pipes themselves would create an additional 423,653 ft^2 for colonization by sessile benthic organisms, for a net gain of 559,285 ft^2 of hard substrate. However, the emplacement of the collars supporting the pipes would affect more live coral (882 ft^2 due to direct impacts) under Alternative 2 than under Alternative 1.

EFH designations are the same for receiving pit areas and pipeline routes under both alternatives. Either would require designation of a ZOM, where EFH would potentially be adversely affected.

Alternative 3

The effects of Alternative 3 would be the same as those described for Alternative 1, with one major exception. The diffuser would be located at a depth of 300 ft, rather than at a depth of 150 ft. As for Alternative 1, the concrete and HDPE pipe proposed for use in the HSWAC pipeline would provide substratum types appropriate for the settlement and growth of corals and other sessile benthic species. Overall, the proposed pipeline for Alternative 3 would cover 18,901ft^2 of substrate, but the collars would create 168,589 ft^2 of substrate and the pipes themselves would create an additional 429,854 ft^2 for colonization by sessile benthic organisms, for a net gain of 583,851 ft^2 of hard substrate.

The placement of the collars supporting the pipes would affect more live coral under Alternative 3 than under Alternative 1 because Type A collars would be used for the length of pipeline from the receiving pit to the end of the diffuser. Since the end of the diffuser would be located an additional 1,537 ft further seaward under Alternative 3, it would require use of 101 more Type A collars and 101 less Type B collars. The installation of more Type A collars would result in an additional 7,676 ft^2 of substrate being covered and the reduction of Type B collars would result in 3,201.7 ft^2 less substrate being covered, for a total of 4,474.3 ft^2 of additional substrate being covered for Alternative 3 than for Alternative 1. Brock (2005, 2011) notes that marine resource abundance and diversity tends to decrease with increased depth. On this basis, the difference in amount of substrate covered by the pipeline alignments under Alternatives 1 and 3 at the shallower depths between Alternative 1's proposed diffuser location and that of Alternative 3 would likely outweigh the additional substrate created for the project overall, at depths less likely to support as much biological activity.

Once operational, the HSWAC return seawater discharge would impact water quality and marine biota within a defined zone of mixing located in the biotope of sand. The lack of coral at the greater proposed depth for the diffuser under Alternative 3 (300 ft) means coral growth and/or survival would not be inhibited by cold water temperatures within the proposed zone of mixing. Therefore, the anticipated small, negative effects on corals in the area affected by the return seawater plume under Alternative 1 are not expected under Alternative 3.

No other changes in direct or indirect impacts on EFH are expected as a result of the diffuser being located at a depth of 300 ft under Alternative 3, rather than at 150 ft as proposed under Alternative 1.

The overall loss of more marine substrate under Alternative 3 than under Alternative 1 due to the different type of collars installed outweighs the additional substrate created and the possible effects on coral in the vicinity of the return seawater plume under Alternative 1.

3. Conclusions Regarding the Effects of the Proposed Action on EFH

Based on the information discussed above, adverse effects of the action on EFH will be more than minimal but less than substantial. Project construction will adversely affect EFH but with incorporation of suitable avoidance and minimization considerations during planning and construction, these adverse effects will be minimized. Excavation of the break-out pit would generate substantial turbidity which would be mitigated by isolation of the work site to minimize its movement to EFH. The excavation, backfilling and capping of the breakout pit, and the placement of pre-cast concrete collars for pipeline installation, would destroy relatively small areas of coral reef ecosystem EFH and HAPC, but these losses would be offset by the long-term gains in the availability of elevated, hard substrate which is likely to result in further development of benthic communities at various depths along the pipeline corridor. The operation of the completed system would create a relatively low-velocity current at the elevated deep-water intake at a bottom depth of approximately 535 m which could potentially entrain pelagics and deepwater shrimp. The operation of the return water diffuser system would create a permanent localized zone of mixing for cool water which would likely inhibit coral growth within it.

4. Proposed Mitigation

Avoidance and minimization

In considering possible alternatives for landing the inshore portions of the SWAC pipelines, the applicant has considered and avoided trenching and backfilling methods which would result in substantial adverse effects on nearshore coral reef EFH. Instead, the applicant proposes to use trenchless technology to route pipes beneath the nearshore area.

Appropriate and practicable steps have been taken to avoid or minimize adverse impacts on EFH and HAPC due to installation of the SWAC seawater intake and return pipes by determining the pipeline route after considering the bathymetry, biological characteristics, and benthic substrata. Coral reef and coral-dominated communities were avoided when determining the location for the microtunnel breakout point (a biotope of dredged rubble with minimal coral cover). In planning the alignment of the pipelines, the applicant has considered alternative alignments and proposes an alignment that avoids areas of higher coral cover and concomitant impacts to coral reef EFH.

In considering design and construction of the proposed pipelines, the applicant proposes to utilize a support system of pre-cast concrete collars which would minimize the magnitude and duration of the direct effects of installation activity on EFH. The collars would also function as piles to minimize the footprint of the completed pipelines on EFH.

Impacts to water quality associated with the construction and operation of the HSWAC pipeline would be minimized by:

- Enclosing of the offshore receiving pit in sheet piling to 10 ft above the seabed
- Employing standard BMPs for construction in coastal waters (i.e., daily inspection of equipment for conditions that could cause spills or leaks)
- Utilizing clean equipment prior to deployment in the water
- Ensuring proper location of storage, refueling, and servicing sites
- Preparing adequate spill response and storm weather preparation plans
- Using pre-washed basalt gravel for the receiving pit backfill
- Minimizing any contaminant migration by grouting the microtunnel wall
- Disposing of excavated material on land
- Conducting water quality monitoring during construction and operations
- Outfitting the return seawater pipe with a terminal diffuser

Compensation

Long-term, the proposed action is expected to enhance benthic habitat through the creation of a substantial amount of hard substrate and shelter in the form of concrete structures and pipelines mounted above the seafloor. Given that a relatively small amount of living coral is expected to be affected by implementation of Alternative 1, and that the anticipated net long-term effect of the project is substantial increase in coral settlement and development of coral reef EFH along the proposed corridor, the applicant does not believe that compensatory mitigation is warranted and none is proposed.

5. References Cited

Brock, R. 2005. Preliminary Marine Biological Observations Offshore of the Kaka'ako Landfill in Support of the Honolulu Seawater Air Conditioning Conceptual Design. April 16, 2005. [Included as Appendix D of the Draft Environmental Impact Statement for the Proposed Honolulu Seawater Air Conditioning Project, Honolulu, Hawai'i. USACE, February 2011.]

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Kelley, Christopher. 2011. Analysis of Organisms Recorded on Submersible Video Along the HSWAC Pipe Route.

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Western Pacific Regional Fishery Management Council. 2009. Fishery Ecosystem Plan for the Hawaii Archipelago. September 24, 2009.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1601 Kapiolani Blvd., Suite 1110
Honolulu, Hawaii 96814-4700
(808) 944-2200 · Fax: (808) 973-2941

April 26, 2011

George P. Young, P.E.
Chief, Regulatory Branch
US Army Corp of Engineers Honolulu District
Building 230
Fort Shafter, HI 96858

Dear Mr. Young,

The Habitat Conservation Division (HCD) of the National Oceanic and Atmospheric Administration's (NOAA), National Marine Fisheries Service, Pacific Islands Regional Office has reviewed the draft Environmental Impact Statement (dEIS) for the Honolulu Seawater Air Condition Project (HSWAC), for which your Honolulu District of the U.S. Army Corps of Engineers (USACE) is considering issuance of a Department of Army permit POH-2004-01141. The proposed action involves construction of a seawater air conditioning system on the south shore of Oahu to provide 25,000 tons of centralized air conditioning for downtown Honolulu buildings. The system will involve piping onto land cold seawater from 1600-1800 ft depth four miles offshore of Kakaako, circulating this through an on-shore cooling station, heat exchangers, a network of upland distribution pipes downtown, and returning the warmer seawater into nearshore ocean waters at about 120-150 ft depth about 3500 feet off Kakaako.

NOAA supports the project purpose to provide a renewable energy air conditioning system designed to reduce Hawaii's reliance on the use of fossil fuels. However, HCD has concerns regarding potential impacts to our trust resources including Essential Fish Habitat (EFH). Concerns include: a) in-water construction related impacts to benthos and reduction in water quality from pollutant discharge associated with micro-tunneling, receiving pit excavation, barge operations (including mooring), sheet pile driving, backfill of receiving pit and concrete capping, collar installation on pipe, staging area, pipe installation; and b) operational related impacts associated with impingement/entrainment of organisms during the intake of seawater at depth, and potential water quality reduction and benthic community degradation as the result of the 44,000 gallons per hour of cold and nutrient rich seawater being discharged to the near-shore marine environment. The potential for secondary impingement of organisms also exists as a result of this discharge.

Our general and specific comments addressing these concerns, pursuant to the National Environmental Policy Act (NEPA), are provided in a separate attachment. We request that you respond to these recommendations in the final EIS. Although you have determined that the project "may adversely affect EFH" via a letter dated March 18, 2011, and initiated Essential Fish Habitat (EFH) consultation pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the information that has been provided in section 3.7.5.4 of the dEIS entitled "Essential Fish Habitat", does not satisfy the EFH consultation requirements. The level of detail the section presents is inadequate to be commensurate with the level of threat to EFH from the action: impacts to EFH and measures to eliminate or mitigate such impact have not been adequately described. We request that a more detailed and comprehensive assessment be provided, either submitted within the final EIS in a section of the document clearly labeled as "EFH Assessment", or as a separate document. We will develop EFH Conservation Recommendations within 60 days after receipt of such an EFH Assessment. Under section 305(b)(4)(B) of the MSFCMA, the USACE must provide a written response to NMFS within 30 days after receiving the NMFS EFH Conservation Recommendations.

We look forward to the opportunity to meet with the USACE and the applicant to discuss our concerns regarding the potential impacts to NOAA trust resources resulting from this project. Please contact Danielle Jayewardene at 808-944-2162 or Danielle.Jayewardene@noaa.gov with any questions and/or to coordinate our participation in a meeting.

Sincerely,

Gerry Davis
Assistant Regional Administrator
Habitat Conservation Division

Copies furnished:

- U.S Environmental Protection Agency, Region 9, P.O. Box 50003, Honolulu, HI 96850. Attention: Wendy Wiltse.
- U.S. Fish and Wildlife Service, Environmental Services, P.O. Box 50088, Honolulu, HI 96850. Attention: Kevin Foster.
- State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources, P.O. Box 621, Honolulu, HI 96809. Attention: Alton Miyasaka.

Enclosure

General comments on dEIS

- The alternatives analysis is insufficient providing only one location for the break-out point and return water discharge:
  - Provide alternative locations at greater depths and/or distance from shore for the discharge of return water and identify how the diffusion dynamics, characteristics of return seawater compared to ambient seawater and proximity of discharge to benthic resources such as coral (including mesphotic coral) is different for each option.
  - Identify the probability of being granted authorization to implement a Zone of Mixing (ZOM) at the return water discharge site, and the alternative plan if the authorization is not granted.

- The impact analysis is insufficient with only qualitative surveys of benthic resources in the general nearshore area being presented, and references being made to old studies of entire Mamala Bay:
  - Provide quantitative current water quality and benthic resource data for each area where potential impact may occur including sites of micro-tunneling, receiving pit excavation, barge operations, pipe installation, staging area, intake of seawater, and return water discharge. Importantly, provide coral size frequency-, density of non-coral invertebrates- and biomass of fish- data at and immediately around receiving pit, along pipe up to return water diffuser point and in ZOM. Also identify presence and describe distribution of mesophotic coral along pipe up to 200m depth.
  - Quantify the expected direct and indirect impact to resources described above (it is not appropriate to avoid this characterization by claiming that effect will be temporary and/or minimal in nature, or that impacts will be compensated by the project providing new structure). This would include providing the species, densities and size classes of coral, and densities of non-coral inverts that will be crushed, abraded, smothered etc by construction, as well as descriptions of predicted changes to water quality from operations and further how this might affect algae (phytoplankton and benthic), coral and overall community structure in the nearhshore area influenced by discharge.
  - Identify the expected species and numbers of individuals that may be entrained at the deep seawater intake point and at return water discharge points, and the significance of this.

- Monitoring plans and mitigation plans are not provided:
  - Provide a water quality monitoring plan that will implemented at the return water discharge point.
  - Describe the mitigation measures implemented to avoid and minimize impact to water quality and benthos, and how compensatory mitigation (consistent with the 2008 Environmental Protection Agency and Department of the Army Final Rule:

Compensatory Mitigation for Losses of Aquatic Resources (FR/Vol. 73, No. 70)) will be implemented to address unavoidable impacts to coral.

- Maps:
  - Provide an illustration where the drilling routes break out point for pipes, the point of return water discharge and the proposed ZOM around diffuser, the route of the entire pipe, points anchoring the pipe, and the intake point are as superimposed on a map of biological resources located in the area. Provide GPS coordinates for all construction activity and operational structure locations.

- The EFH section is insufficient to satisfy an EFH consultation as it is weak in content and scope and does not allow evaluation of effect to EFH:
  - Fully characterize impact to all EFH from construction and operational activities (will overlap with information in Water Quality and Marine Biota sections) and describe measures that will be implemented to mitigate these impacts.

Specific comments on dEIS

p. iv Ensure that index page numbering is correct (some pages have been shifted).

Chapter 2

p.2-5 Provide correct coordinates (N and W interchanged) and in common GPS coordinate form.
p.2-7 Provide coordinates of offshore receiving pit, mooring points for barge and all construction related activities.
p.2-9 Correct distance from jacking pit on shore to receiving pit: it seems to only be about 1200 ft from shore, instead of about 1700 ft as stated. Also clarify distance away from shore, and from receiving pit, that the first port of diffuser starts.
p.2-12 Clarify if collars are only sectional, i.e. whether along entire pipe, hence if pipe lays across bottom or hovers above due to collars.
p.2-17 Clarify how much of staging area is in versus out of water.
p.2-50 State how micro-tunneling, the preferred non-trenching option- may affect benthic resources and water quality.
p.2-53 Clarify if the jacking shaft is the same as the receiving pit. If not, clarify if the jacking shaft is on land, or in water.
p.2-54 Clarify if microtunneling activity can extend to 80ft depth to avoid impacts to water quality and benthos from installing pipes from 20-40 ft break-out point.
p.2-55 Clarify the character of pollutants of the HECO condenser cooling discharges of 187MGD into Honolulu Harbor. Clarify if it has equivalent low temp, nutrient level etc as the HSWAC discharge. If not, these two should not be compared, i.e. do not state that HSWAC discharge is 1/3 of HECO amount.
p.2-56 Define shallow coastal waters. Explain the significance of differences in temp 53-58 C vs. 77 C, density 64.09 C vs. 63.88C, and do same for DO and DIN etc.
p.2-57 Explain CORMIX analysis, e.g. assumptions etc.

Chapter 3

Water quality 3.7.4

p.3-75 Describe the exact difference in return water compared to ambient water for temperature, salinity, density, pH, dissolved gases and inorganic nutrients, and characterize environmental consequences from these differences (positive and negative) occurring nearshore off Kakaako.
p.3-92 Characterize and quantify impacts: from (I) construction related activities (Receiving pit excavation, barge operations, sheet pile driving, mooring, backfill of receiving pit and concrete capping, collar installation on pipe), and from (II) operational activities (discharge and impingement). It is stated that (I) will be temporary and mitigated to less than significant, and that (II) will require mixing zone permit thus mitigated to less than significant. Both involve flawed logic and inappropriate conclusions.
p.3-95 Clarify if COMIX program analysis accounts for duration at different current velocities.
p.3-96 Provide water quality monitoring design plan.
p.3-96 Justify how it is appropriate to compare 84MG year sewage versus 23360 MG year (64 MG day) , i.e. 280 times greater amount of water.

Marine Biota 3.7.5

p.3-98 Provide references supporting statement that pipeline corridor is the most degraded coastal habitat in the State and provide that there are in fact limited resources.
p.3-99 Provide analysis whether 44 MGD of return water might cause marine community phase shifts as the Mamala study clearly states that this happened in the past due to effect to water quality from untreated sewage
p.3-100 Provide updated studies beyond Grigg (1995) which are now over 15 years old.
p 3-101 Provide up to date and high resolution benthic maps. The NOAA benthic maps in the Atlas are not always accurate and of low resolution.
p.3-102 Provide quantitative and detailed comprehensive benthic survey data for each of the potential impacts sites (both construction and operation related). This data is qualitative, helpful in focusing quantitative work but not for assessing impacts to resources and/or making final decisions as to where construction should be located to avoid and minimize impact.
p.3-105 Clarify that 75% coral coverage as reported for some areas in the project footprint is very high.
p.3-108 Remove statement that there are no stony corals below 100m as there is evidence that indicates otherwise (see e.g. Rooney et al. 2010).
p.3-110 Remove the statement that alternative 1 will have "long-term less than significant impact" as there is inadequate information provided to support this statement.
p.3-110 Clarify how the proposed break-out point was chosen to avoid coral reef as the data provided in reports is qualitative. Clarify if other data was used.
p.3-112 Describe in greater detail, using scientifically valid up to date research, the potential positive and as well as negative impacts to the biological community in the ZOM from 44 MGD discharge and also outside ZOM, both short-, mid- and long-term. Remove or support with scientifically valid data, statements that consequences will be positive long-term.

Essential Fish Habitat 3.7.5.4

p.3-130 Correct the water column EFH depth designation: is 200m not 100m.
p.3-131 Modify statement and remove the word "possible" from "possible effects to EFH...". Effects will very likely occur.
p.3-131 Include assessment of impacts to EFH nearshore as coral reef EFH is all substrate down to 100m depth.
p.3-131 Describe in far greater detail the impacts to all EFH, including coral reef EFH nearshore. Justify any statements that effects will only be temporary or minimal. Any injury to coral is permanent effect.
p.3-132 Describe how benthic algal communities might be influenced by nutrient influx within return water and if this might lead to phase shifts to algal dominance.
p.3-132 Provide a detailed and comprehensive EFH assessment labeled "EFH assessment" in the final EIS if the wish is to use the NEPA document for EFH consultation with NOAA.

Groundwater 3.8.4.2

p.3-142 State whether and if so how the marine environment might be impacted if the groundwater levels will be affected when dewatering occurs.

Cumulative impacts 3.9

Marine Resources 3.9.6

p.3-147 Revise this section as the analysis is inadequate and flawed in its approach and scope. A NEPA cumulative impacts analysis requires a comprehensive assessment of how this proposed action will, in combination with past, present and future actions in the area (even if unrelated to this action), affect the marine environment. For e.g. it is stated that the nearshore environment has been heavily impacted by action previously, hence identify how this project action might contribute to further degradation of the environment, also in light of other projects in the area. Refer to basic NEPA guidelines to approach this analysis appropriately.

Chapter 4

Unavoidable adverse impacts 4.8

p.4-2 Revise this section by providing far more detail and a comprehensive quantification based analysis of what unavoidable impacts will be.

Potential Mitigation Measures...4.9

p.4.2 Revise this section and provide a comprehensive vetted mitigation plan consistent with the 2008 Environmental Protection Agency and Department of the Army Final Rule: Compensatory Mitigation for Losses of Aquatic Resources (FR/Vol. 73, No. 70).
p.4-3 Clarify whether break-out point is around sand or rubble (described as sand elsewhere).

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

March 18, 2011

Regulatory Branch

File No. POH-2004-01141

Gerry Davis, Habitat Conservation
NMFS Pacific Islands Regional Office
1601 Kapiolani Blvd., Suite 1110
Honolulu, HI 96814

Dear Mr. Davis:

The Honolulu District of the U.S. Army Corps of Engineers is considering issuance of a Department of the Army permit to authorize construction of the Honolulu Seawater Air Conditioning project at Kaka'ako, Island of Oahu, Hawaii (DA File No. POH-2004-01141). Enclosed is a Draft Environmental Impact Statement (DEIS) prepared for this federal regulatory action. We have enclosed one hard copy and one compact disk copy.

As described in section 3.7.5.4 of the DEIS, we have determined that the proposed action "may adversely affect" Essential Fish Habitat (EFH) and we therefore request initiation of consultation under the Magnuson-Stevens Fishery Conservation and Management Act.

Please contact Mr. Peter Galloway via telephone at 808-438-8416 or via e-mail at *peter.c.galloway@usace.army.mil*) regarding this consultation request.

Sincerely,

George P. Young, P.E.
Chief, Regulatory Branch

Enclosure

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APPENDIX K
RESERVED

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APPENDIX L
IMPACT OF NITRATE NITROGEN FROM THE PROPOSED HSWAC DISCHARGE ON CORAL REEF BIOTA

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IMPACT OF NITRATE NITROGEN FROM THE PROPOSED HSWAC DISCHARGE ON CORAL REEF BIOTA

R. Brock
6 February 2012

PURPOSE

Concerns have been raised regarding the release of HSWAC return water at depths from 36 to 46 m depth offshore of Kaka'ako Waterfront Park and the impact this high-nutrient water may have on resident biota. This summary first presents water quality data pertinent to understanding the problem which includes data from the area HSWAC has proposed for use as well as from the the Kailua Wastewater Treatment Plant (WWTP). A short literature review of impact that high nutrient water may have on corals reefs is given followed by the results of biological studies carried out around the Kailua WWTP. If the HSWAC project moves forward, this information should assist in understanding the possible impacts that nutrients may have on the coral reefs offshore of Kaka'ako Waterfront Park.

Water Chemistry

Table 1 presents means of water quality data collected from three locations; (1) a station sampled by the City & County located about 400 m southwest of the proposed HSWAC return water diffuser(49 m depth), (2) further offshore at three deep ocean sites in the vicinity of the proposed HSWAC intake (536 m deep) and (3) the secondary treated effluent generated by the Kailua WWTP (depth 32 m). The City & County samples representing ten years of data and were collected at a comparable depth as the proposed HSWAC diffuser thus provide information on the quality of the ambient water into which the proposed discharge would occur. The three deep ocean water quality samples provide information as to the inorganic nutrient content of the intake water thus are representative of the quality of proposed discharge water and the Kailua WWTP samples (collected over a three year period) lend insight to the nutrient load of the treated wastes discharged in outer Kailua Bay.

Referring to Table 1, data from the long term City & County monitoring program at Station D-4 shows the typical relatively low concentrations of nitrate nitrogen, ammonia nitrogen, total nitrogen and total phosphorus in near shore Hawaiian waters. Concern has focused on nitrate nitrogen and the long term mean (0.91 ug/l) from this location is well below the Hawai'i State Department of Health open coastal water quality standard which is 5.00 ug/l for "wet" coastlines. Deep ocean water has a considerably higher nitrrate concentration (~472 ug/l) while the treated effluent discharging from the Kailua WWTP has a mean nitrate nitrogen concentration of (15,000 ug/l). If higher concentrations of nitrate nitrogen are a problem on coral reefs, one might expect that the release of the deep sea water with concentrations close to 500 times greater than ambient in proximity to corals could cause an impact but the concentration of nitrate nitrogen in the treated sewage effluent is approximately 32 times greater in concentration than the deep ocean water and more than 16,600 times greater than the ambient near shore water.

Coral Growth Under High Nutrient Conditions

Atkinson *et al.* (1995) reported on the growth of reef corals held at the Waikiki Aquarium utilizing high nutrient seawater drawn from an on-site well. Aquarium water is characterized by concentrations of inorganic nutrients that are high relative to most natural reef systems; mean concentrations were as follows: orthophosphorous ~19.20 ug/l, nitrate+nitrite nitrogen ~ 70.00 ug/l and ammonia nitrogen ~28.00 ug/l. Rates of nutrient uptake into aquaria coral communities were similar to nutrient uptake by natural reef communities. Coral growth rates were near the upper rates reported from the field, demonstrating coral can and does flourish in relatively high nutrient water. Furthermore as noted in this paper, *"Statements implying that corals can only grow in low nutrient oligotrophic seawater are therefore oversimplifications of processes that govern growth of these organisms."*

These conclusions were again reiterated by Atkinson and Falter (2003) where they noted the following:

"Nutrient loading and its subsequent impact is one of the more important issues concerning conservation and protection of coral reefs. It is widely believed that any nutrient input to coral reefs is deleterious. The argument is actually based on an incorrect, historical view of how coral reefs recycle nutrients. Nutrient concentrations were observed to change very little across the relatively narrow reef flats of the Indo-Pacific (100-300m). Scientists chose to believe that nutrients were recycled rapidly through the water column, on scales of several meters (see Hearn el al. 2001). The notion developed that reefs recycle their nutrients through biologically-mediated mechanisms, and any input of nutrients altered, or perturbed, these processes. Corroborating this view were early results that nutrients, in particular phosphate, affected community metabolism (Kinsey and Davies 1979); and elevated nitrate and ammonia retard coral growth. More recently, nutrient loading appears to alter the reproductive patterns in corals (Ward and Harrison 2000; Koop et al. 2001). Furthermore nutrients actually stimulate the specific growth rate of many macro-algae, so sustained nutrients add to algal growth, with the possible overgrowth of coral. Thus nutrients are presently recognized as deleterious.

The above conclusion, that nutrients are deleterious to a reef ecosystem, is simply incorrect. First, it is now known, based on the rate constants for mass-transfer limitation of nutrient uptake, that nutrients can not be recycled through the water column on such small scales of a reef flat; it is simply physically impossible. Thus, it is very difficult to perturb any biogeochemical cycles or biologically mediated mechanism with relatively small additions of nutrients to the water column. The reef barely can take up these nutrients. Reef communities must also take up very large quantities of nutrients to change the amount of nutrients in the biomass...

Impacts to coral reefs from nutrients are probably indirect and long-term, on an ecosystem *scale (Smith and Buddemeier 1992). Higher nutrient loading probably stimulates net production, creating ever-increasing pools of organic matter and detritus. If not removed from the system by waves and currents, it is plausible that nutrients encourage a bacterial fauna that promotes disease vectors, increasing susceptibility and spread of disease...Some reefs experience high nutrients, high net production and high transport of organic matter to the shelf (notably fringing reefs of Japan and Western Australia) whereas other reef tracts receiving large amounts of nutrients collect organic matter (Florida Keys). Thus, the effects of nutrients must be interpreted on a local scale with respect to local biogeochemical and hydrodynamic budgets; and making sweeping conclusions that all nutrient input is deleterious is simply irresponsible."*

Summarizing the above, high nutrient concentrations may not cause the negative impacts to coral reefs as formerly thought. However, there will be concentrations above which impacts will occur. As noted by Atkinson and Falter (2003) in their last sentence above, key to understanding effects that elevated nutrient concentrations may have on coral reef biota requires an understanding of the local hydrodynamics and some knowledge of the local biogeochemical budgets. The current data in the vicinity of the proposed HSWAC diffuser suggests that mixing is relatively high. However, in the absence of detailed information about local hydrodynamics and biogeochemical budgets in the area of the proposed HSWAC diffuser, we must rely on empirical information from other Hawaiian coral reefs to address concerns on the possible negative impacts from nutrient loading that may occur to the biota with the deployment and operation of the HSWAC discharge.

Sewage Outfall Studies

A possible proxy for addressing some of these concerns may be through an examination of existing data collected around Oahu's sewer outfalls. Information from the Kailua Wastewater Treatment Plant (WWTP) is discussed below. The rationale for utilizing information from the Kailua WWTP discharge established in water approximately 32 m deep rather than use information from either of the two deep (70 m +) ocean discharges (Barbers Point or Sand Island) is given below:

1. The deep ocean diffusers are established at or below the average thermocline depth and the proposed depth of the HSWAC discharge (from 36 to 46 m deep) is above the thermocline. The Kailua WWTP discharge is located at a depth of ~32 m, again above the thermocline.

2. The two deep ocean diffusers discharge a either advanced primary treated effluent (Sand Island) or a mix of advanced primary treated material along with some secondary treated effluent (Barbers Point). Sewage effluent treated to the advanced primary level has a higher particulate load which serves as an important source of food for both deposit feeding invertebrates and a large number of particulate feeding fishes and invertebrates. Sewage treated to a secondary level has a lower particulate (but high nutrient) load which is more comparable to HSWAC's proposed discharge of deep high-nutrient seawater comprised largely of dissolved nutrients (i.e., lesser particulate load).

3. Finally, acquisition of quantitative biological information is more difficult to obtain from the marine communities around the deep outfalls because of the greater depth requiring the use of indirect sampling methodologies relative to the shallow outfalls (here Kailua) where divers may make direct in-water observations.

The Kailua WWTP has been operational since 1977, releases a little more than 13 mgd of secondary treated sewage through a 1.55 km-long discharge pipe at a depth of 32 m offshore and east of the Mokapu Peninsula in outer Kailua Bay. Brock (1999) studied the fish and coral communities on and away from the Kailua WWTP diffuser. The working hypothesis in the study was that impacts are greater to the coral reef communities in proximity to the diffuser relative to those occurring at more distant locations. To discern impacts, stations were established on (Transect T-1; see Figure 2) and 15 m away from the diffuser and parallel to it (Transect T-2; see Figure 1) in water from 29.6 to 32 m depth, a second pair of transects (T-3 and T-4) about 2.7 km south-southwest and 400 m south of Mokolea Rock at a depth of 20 m (approximately 1.8 km from shore) and a single station (T-5) located about halfway between Mokolea Rock and the shore of Kailua Bay in water ranging from 5.2 to 6.7 m in depth.

RESULTS AND DISCUSSION

1. Coral Growth Around the Kailua Outfall

In summarizing the results Brock (1999) noted the following:

*"The results...indicate that the marine communities in the study area are diverse, with well-developed fish and coral components. This is particularly evident on the Mokapu Ocean Outfall diffuser where a high-biomass, diverse fish community occurs. This well-developed fish community is related to the shelter created by the diffuser pipe and basalt armor rock, as well as to the release of organic particles in the treated effluent which serve as a food resource for some fish (*and invertebrate*) species. The development of corals as measured in terms of live coverage in the diffuser pipe community is about half that found at more distant sampling sites. However, a second sampling site located parallel to and 15 m away from the diffuser has coral coverage very similar to that found elsewhere in Kailua Bay. These data suggest that if the operation of the Kailua Regional WWTP is having an impact on marine communities, it is very limited in scope and scale."*

The quantitative data from this study are summarized in Table 2. Algae encountered on transects T-1, T-2 and T-4 were all encrusting coralline species (see Figure 3); the only macrothalloid algae were encountered on Transect T-5. As noted above, coral coverage on the diffuser was about one-half of that measured at other locations but the biomass and number of individual fish were considerably higher than at the other transect sites. The better development in the fish community is probably related to the significantly greater cover afforded by the basalt armor rock on the diffuser (see Figures 2, 3, 4) as well as to the food resource present (particulate materials from the discharge; see Figures 4 and 5). The lower coral coverage seen on the diffuser was not seen at Transect T-2, which is located within 15 m of the discharge (see Figure 1). Instead, coral coverage at T-2 is similar to that seen at the more distant transect sites, suggesting that the discharge is having little negative impact on corals in the immediate vicinity. On the discharge, coral coverage is less suggesting that either the high nutrient loading or the freshwater that comprise the WWTP discharge is having a negative impact on the success of corals in the near vicinity. Furthermore, it is important to note that the diversity of coral species is greatest on transects located away from the diffuser (Transect T-3, 7 species; Transect T-4, 7 species and Transect T-5, 8 species) relative to the two transects on the diffuser (Transect T-1, 2 species) and 15 m away (Transect T-2, 4 species). On the diffuser (Transect T-1 where mean coverage is 16.1%) the dominant coral is the lobe coral (*Porites lobata*) comprising 99% of the cover which suggests that this species is probably the most tolerant of the high nutrient loading as well as discharge of freshwater from the diffuser. However just 15 m away from the discharge (Transect T-2), four coral species are present having a mean overall coverage of 40.3% and *Porites lobata* comprises 14% of this coral cover, the cauliflower coral (*Pocillopora meandrina*) makes up 1% of the cover, the rice coral *Montipora capitata* adds 29% to the coverage and the sandpaper rice coral (*Montipora patula*) contributes 56% to the total coverage on Transect T-2. The greater coral coverage at Transect T-2 relative to the diffuser suggests that local mixing is high which serves to dilute nutrient loading but more importantly, lessen the negative impact of freshwater on coral growth. Coles and Jokiel (1992) summarize the deleterious effects and high mortality to corals caused by freshwater entering the coral reef ecosystem. The experimental results on salinity tolerances of corals suggest that salinities at about one-half of normal (~15 ppt) with exposure times of days to weeks will cause mortality. Since the Kailua WWTP outfall has been in continuous operation for 35 years and corals are growing within about one meter of the discharge ports, the mixing processes at this outfall must be substantial.

2. Expected Outcome at the HSWAC Diffuser

The empirical information above has application to understanding the expected biological response to the operation and discharge of deep, high nutrient water through the proposed HSWAC diffuser located between 36 to 46 m depth.

Three transects sampled the deeper waters on the proposed HSWAC pipeline alignment offshore of Kaka’ako Waterfront Park. These transects were established at 27, 35 and 40 m depths. Utilizing the transect data from these sample sites, overall coral coverage is 1.1% (Brock 2011). Four coral species were noted; these were *Porites lobata* which comprises 92% of the coverage present, *Montipora capitata* contributes 6% to this coverage and *Leptastrea* sp. as well as *Leptoseris* sp. each making up 1% of the coral coverage present. Albeit overall coral coverage is low at these deeper stations (1.1%), the dominant coral species is *Porites lobata* which is the most abundant (by coverage) and tolerant of high nutrient water at the Kailua WWTP outfall. These data suggest that deployment of the HSWAC return-water diffuser at depths from 36 to 46 m and discharging high nutrient seawater (with nitrate concentrations ~32 times lower than found at the Kailua outfall) will have little negative impact to the dominant coral present in the area. Indeed, the presence of a stable hard substratum (HDPE pipes and concrete collars) will provide suitable substratum for the recruitment of corals. Furthermore, corals recruiting anywhere on this substratum other than the exposed top of the pipes would not be subject to the rare negative impact of cables dragging across the seafloor as tug and barge operators prepare to enter Honolulu Harbor. Thus with reduced physical disturbance, coral colonies protected from dragging cables would presumably be able to attain greater sizes and make a greater contribution to the ecological services in the area than presently occurs.

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TABLE 1. Water quality data presented as means (all in ug/l unless otherwise noted) from three locations: Station D-4 located in proximity to the proposed HSWAC diffuser in Mamala Bay routinely sampled by the City & County thus representing ambient conditions at the proposed HSWAC return water discharge, deep ocean samples collected in proximity to the proposed HSWAC intake representing the nutrient loading of the proposed for discharge water and the Kailua WWTP data from the effluent waste stream showing the nutrient loading of this discharge.

Station	Depth (m)	Location (N= #Samples)	NO_3	NH_4	TN	TP	Turb (NTU)	Salinity ppt
D-4	49	406 m SW of proposed diffuser (10 yrs data)	0.91	1.34	94.41	6.66	0.24	unknown
Deep Ocean	536	Vicinity of HSWAC Intake (n=3)	472.36	0.21	517.44	70.58	0.18	34.182
Kailua WWTP	32	Outfall (n=36)	15,000	9,900	22,000		13.10	~0.0

TABLE 2. Summary of biological parameters measured at five transects in Kailua Bay, O'ahu. Transect T-1 is located on the midline of the Kailua WWTP diffuser pipe, T-2 is located 15 m north of but parallel to the diffuser in an area of natural hard substratum elevated no more than 1 m above the otherwise sand/rubble substratum, T-3 and T-4 are located along the base of a large area of hard substratum and corals and T-5 in an area of hard bottom and corals inshore of T-3 and T-4. Each transect samples 80 m^2 of substratum for fishes and invertebrates other than corals. Coral and algal data (given in percent cover) are from 5 m^2 of substratum sampled on each transect. Table is from Brock 1999, Table 6.

	TRANSECT				
	T-1	T-2	T-3	T-4	T-5
Distance From Diffuser (m)	0	15	2700	2700	2,200
Depth (m)	29-30	31-32	20	20	5-6
No. Algal Species*	2	0	2	2	2
% Algal Cover	19.2	0	12.2	10.8	0.2
No. Coral Species	2	4	7	7	8
% Coral Cover	16.1	40.3	40.6	50.4	53.7
No. Diurnally Exposed Macroinvertebrate Species	5	4	4	3	5
No. Diurnally Exposed Macroinvertebrate Individuals	39	15	12	15	5
No. Fish Species	34	28	28	23	32
No. Fish Individuals	1481	184	212	206	151
Fish Biomass (g/m^2)	1124	62	140	127	138

***NOTE:** all algae sampled were encrusting coralline species except those found at Station 5.

Below are photographs taken in 2008 at the Kailua WWTP diffuser.

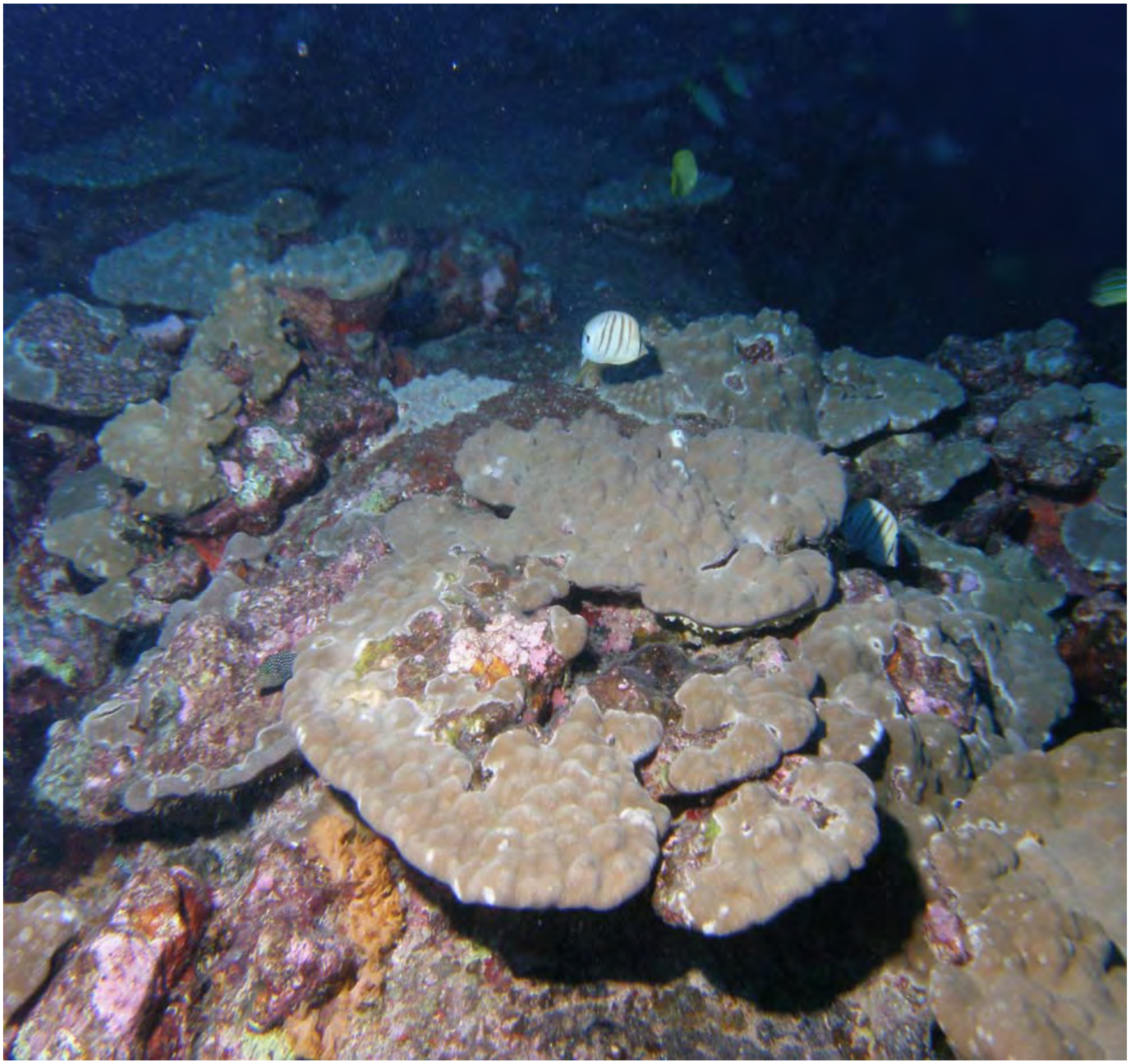

FIGURE 1. Photo taken on Transect T-2 showing the development of *Porites lobata* coral, coralline algae and fishes. A colony of the bryozoan *Reteporellina denticulata* is present in the left foreground (orange color). The diffuser lies ~15 m away (to the left).

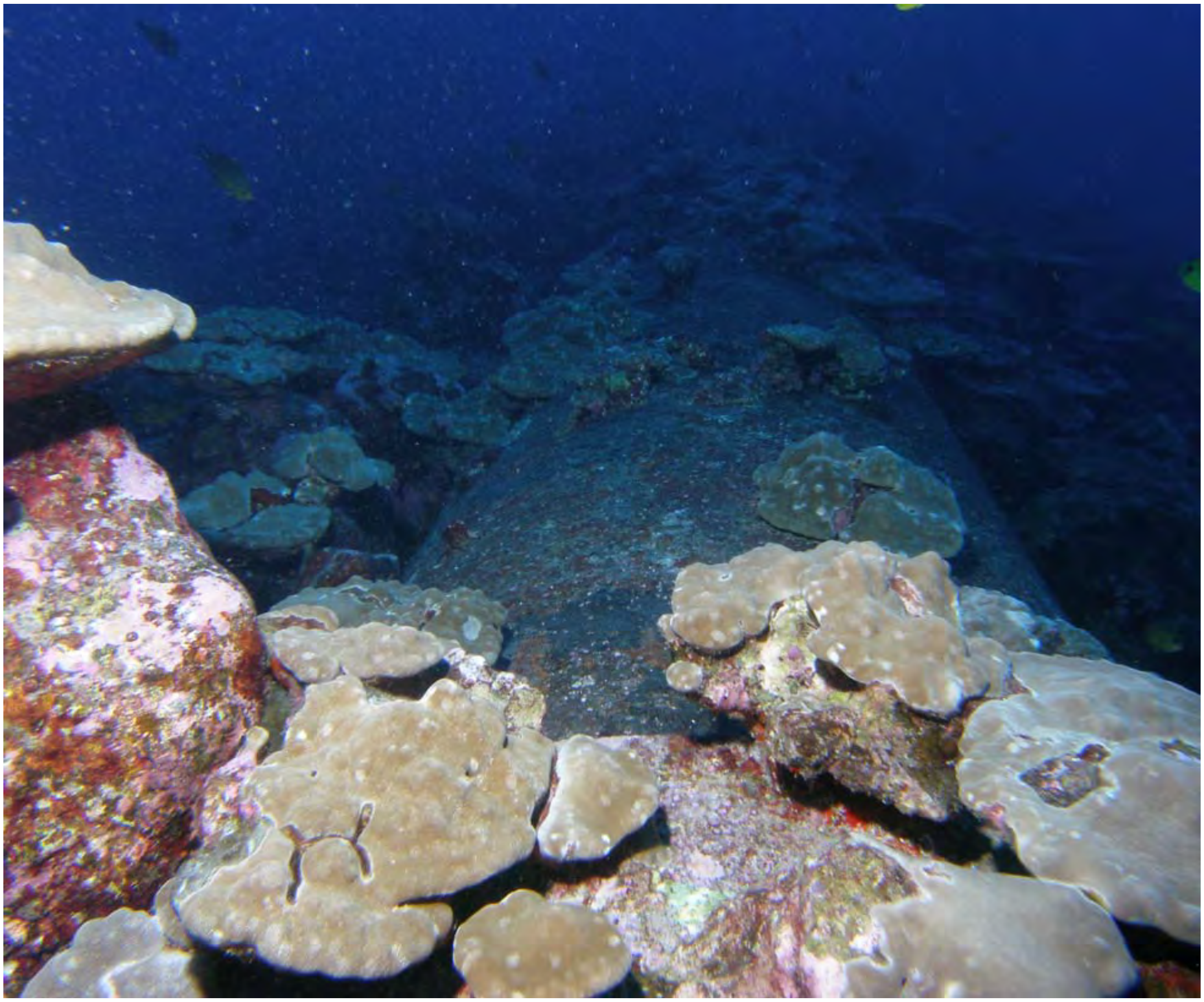

FIGURE 2. Overview of the diffuser pipe showing the development of *Porites lobata* corals. Diffuser ports (not visible here) are located to the right and left sides of the pipe at the springline (about 3 m seaward of the camera).

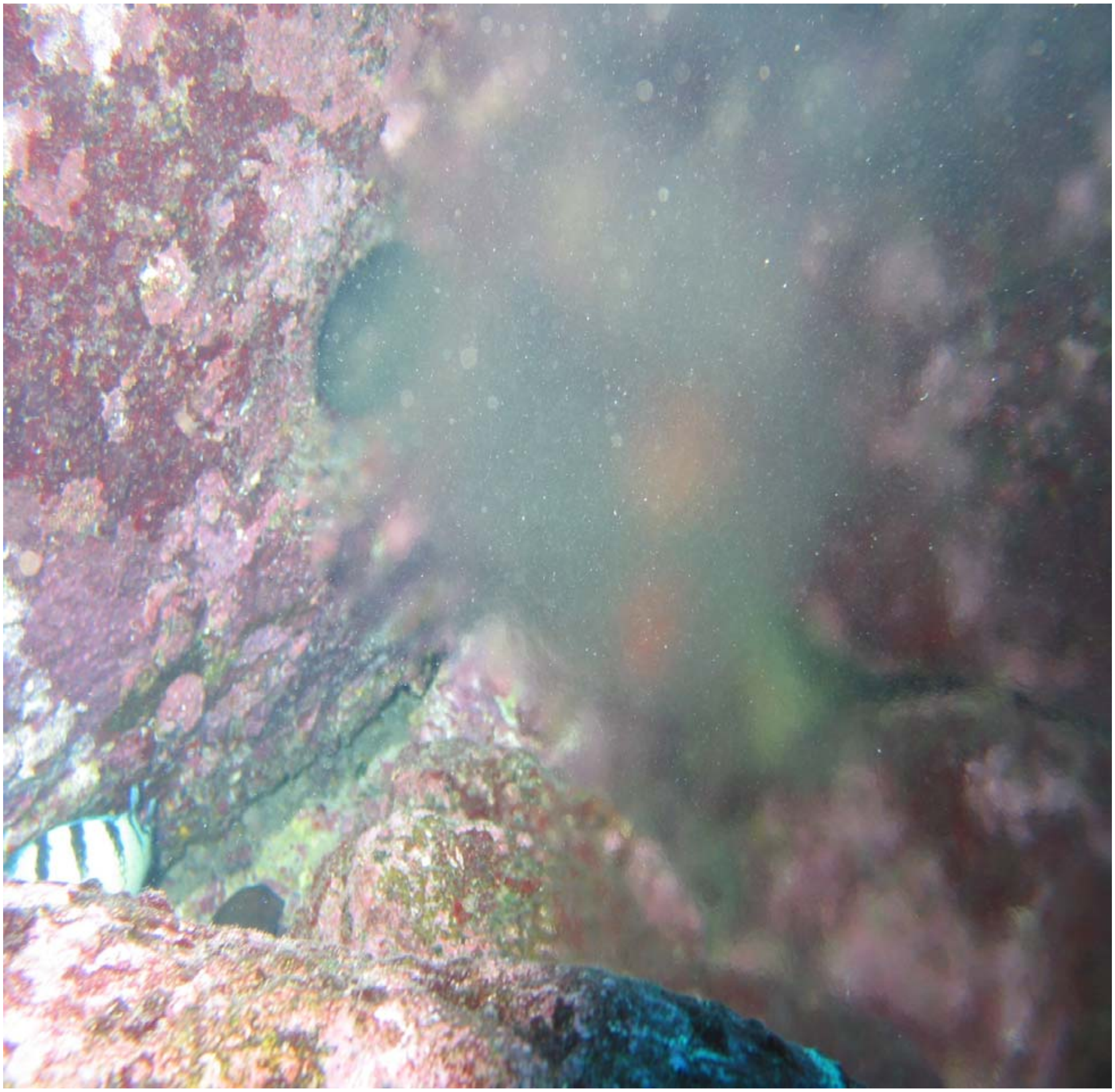

FIGURE 3. Photo showing effluent discharging through a 4-inch port. Note the growth of encrusting coralline algae over most surfaces.

FIGURE 4. Effluent waste stream on the left (appears as blurry water with particles) and *Porites lobata* corals on the right. The diffuser is in the background. Fishes present include the milletseed butterfly fish or lau wiliwili (*Chaetodon miliaris*), goldring surgeonfish or kole (*Ctenochaetus strigosus*) and saddleback wrasse or hinalea lauwili (*Thalassoma duperrey).*

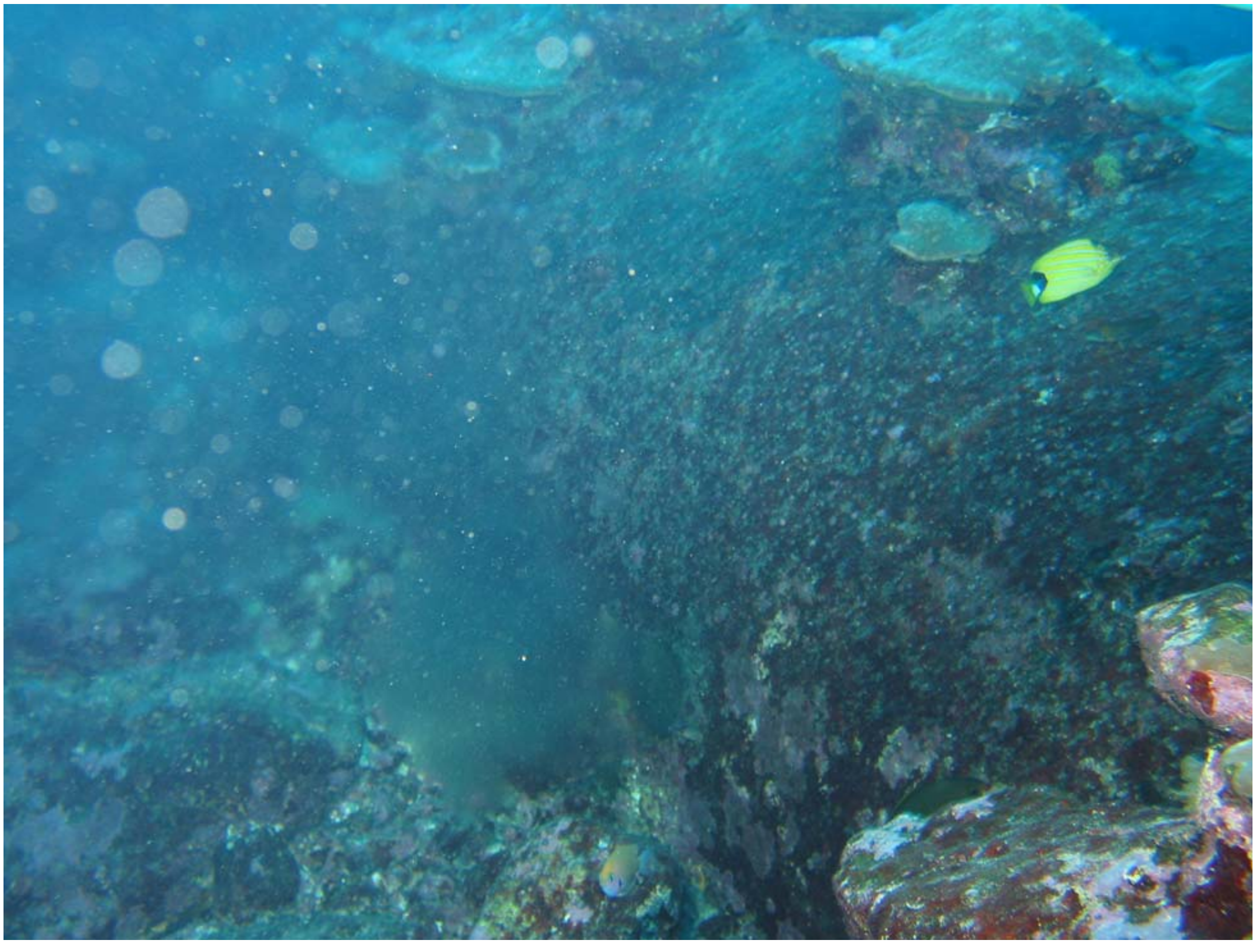

FIGURE 5. Photo showing discharging effluent, a single bluestriped butterfly fish (*Chaetodon fremblii)* and *Porites lobata* corals located about one meter above the discharge port.

APPENDIX M
NOAA BIOLOGICAL OPINION FOR THE HSWAC PROJECT

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Endangered Species Act – Section 7 Consultation

Biological Opinion

Action Agency:	United States Department of the Army, U.S. Army Corps of Engineers (USACE), Honolulu District
Activity:	Issuance of a Department of the Army Permit to Honolulu Seawater Air Conditioning, LLC for their Proposed Seawater Air Conditioning Project at Kakaako, Honolulu, Hawaii (POH-2004-01141)
Consulting Agency:	National Marine Fisheries Service, Pacific Islands Region
NMFS File No. (PCTS):	F/PIR/2011/06432
PIRO Reference No.:	I-PI-11-966-LVA

Approved By: [signature]

Michael D. Tosatto
Regional Administrator, Pacific Islands Region

Date Issued: 09/13/12

Table of Contents

Figures and Tables

Acronyms

BA	Biological Assessment
BMP	Best Management Practices
CFR	Code of Federal Regulations
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
cm	Centimeter
dB	Decibel
ESA	Endangered Species Act
FAO	Food and Agricultural Organization of the United Nations
FR	Federal Register
FSM	Federated States of Micronesia
GBR	Great Barrier Reef (Australia)
Hz	Hertz (a measurement of frequency equivalent to cycles per second)
ITS	Incidental Take Statement
km	Kilometer
m	Meter
MHI	Main Hawaiian Islands
mm	Millimeter
NA	Nesting Aggregation(s)
NMFS	National Marine Fisheries Service (also NOAA Fisheries)
NOAA	National Oceanic and Atmospheric Administration
PIFSC	Pacific Islands Fisheries Science Center
PIRO	Pacific Islands Regional Office
PNG	Papua New Guinea
PRD	Protected Resources Division (PIRO)
PTS	Permanent Threshold Shift
RL	Received Level
rms	Root-Mean-Square
SL	Source Level
SST	Sea Surface Temperature
TTS	Temporary Threshold Shift
US	United States
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service

Introduction

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1539(a)(2)) requires each Federal agency to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. To "jeopardize the continued existence" means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). A Federal agency is required to consult formally with the National Marine Fisheries Service (NMFS) for marine species or their designated critical habitat or with the United States Fish and Wildlife Service (USFWS) for terrestrial and freshwater species or their designated critical habitat when that agency's action "may affect" an ESA-listed species. Federal agencies are exempt from the requirement for formal consultation if they have received from NMFS or USFWS written concurrence with a determination that an action "may affect, but is not likely to adversely affect" ESA-listed species or their designated critical habitat (see ESA Section 7 Implementing Regulations; 50 CFR 402).

This document represents NMFS' biological opinion (Opinion) of the effects on marine species protected under the ESA that may result from the implementation of the Honolulu Seawater Air Conditioning Project, at Kakaako, Honolulu, Hawaii. This Opinion is based on the review of: the Department of the Army Corps of Engineers' June 2012, Administrative Draft Final Environmental Impact Statement (ADFEIS) for the project (USACE 2012); the USACE December 2, 2011, Biological Assessment (BA) for this action; the July 24, 2012, Proposed Incidental Harassment Authorization (IHA) for the project (77 FR 43259); recovery plans for U.S. Pacific populations of listed marine mammals and sea turtles; published and unpublished scientific information on the biology and ecology of threatened and endangered marine species, as well as of other species of concern in the action area; monitoring reports and research in the region; biological opinions on similar actions; and relevant scientific and gray literature (see Literature Cited).

1 Consultation History

Honolulu Seawater Air Conditioning, LLC (HSWAC) first approached the NMFS Pacific Islands Regional Office (PIRO) in 2009 to request our technical assistance concerning the development of the project. On March 16, 2011, the USACE issued a special public notice to announce that HSWAC had applied for a permit and that the draft EIS was available for public review and comment. In November 2011, the USACE Proposed FEIS was made available to federal review and resource agencies for information and consultation purposes. On December 2, 2011, NMFS PIRO received the USACE request for formal consultation, which stated their determination that the proposed action would be likely to adversely affect humpback whales (*Megaptera novaeangliae*); Hawaiian monk seals (*Monachus schauinslandi*); green sea turtles (*Chelonia mydas*); and hawksbill sea turtles (*Eretmochelys imbricata*), but would be not likely to adversely affect, or have no effect, on the remaining ESA-listed marine species in the region. Between December 2011 and March 2012, numerous meetings were held between the applicant and the regulatory agencies to discuss and refine project details and provide assessments of expected impacts. On or about March 1, 2012, PIRO informed HSWAC that an Incidental Harassment Authorization (IHA) under the Marine Mammal Protection Act (MMPA) was required for the proposed action, and HSWAC began the application process with NMFS Office of Protected Resources' Permits and Conservation Division (OPR) on March 12. On or about April 10, 2012, HSWAC announced that, based on the recommendations of state and federal resources agencies, their proposed action would be modified in that the discharge pipe would be installed at a depth well below the depth originally proposed. Between March and the end of May, 2012, HSWAC expressed variations to their planned work schedule and mitigation plan, which were finalized on or about May 30, 2012. PIRO determined at that time that it had the information required to complete ESA consultation, and Formal consultation was initiated on that date for humpback whales, Hawaiian monk seals, and green and hawksbill sea turtles, resulting in this Opinion. NMFS PIRO and OPR coordinated their efforts throughout the consultation process to ensure that impacts on marine mammals were properly assessed under both the ESA and the MMPA and that, with regard to all ESA-listed marine species, issuance of the IHA would have no impacts that were not considered in this opinion.

2 Description of the Proposed Action and Action Area

The proposed action consists of the USACE issuing a permit to HSWAC to authorize the installation of a seawater air conditioning project at Kakaako, Honolulu, Hawaii. The project is described in the ADFEIS, the BA, and in the Proposed IHA. In summary, the project consists of the operation of land-based and barge-mounted heavy equipment to: install a 63-inch diameter seawater intake pipe that would extend about 25,000 feet (7,620 m) offshore and a 54-inch diameter seawater return pipe that would extend about 5,225 feet (1,593 m) offshore; construct a land-based pump station; and construct a chilled water distribution system between the pump station and customer buildings. The intake pipe would terminate at a depth of about 1,755 feet, and end in an elbow, such that the open-ended (unscreened) 63-inch diameter intake would be oriented toward the surface about 14 feet above the seafloor. The seawater return pipe would terminate in a 25-port diffuser that would be deployed on a steep submarine slope between the depths of 330 and 425 feet. Of concern for this consultation would be the in-water work to install the pipelines, as well as the operation of the system.

HSWAC would begin offshore work by installing about 15 20-inch (51-cm) diameter steel pipe "test piles" along the alignment between the planned receiving pit and diffuser location, out to a depth of about 150 feet (46 m), about 3,700 feet (1,128 m) south of the shore. HSWAC's contractors would use a barge-mounted impact hammer to drive the test piles, and each pile is expected to take about 15 minutes to drive. All test piles would be removed (pulled out) immediately after installation. The test-pile component would begin during October 2012, and is expected to take 1 to 2 weeks to complete.

Following test-pile work, HSWAC's contractors would dig an onshore jacking pit as well offshore receiving pit. The receiving pit would be located in about 30-foot (9-m) deep water about 1,600 feet (488 m) from shore. Work would include the use of a barge-mounted vibratory pile driver to install about 80 24-inch (61-cm) steel sheet piles around the perimeter of the 40-foot (12-m) by 40-foot (12-m) by 20-foot (6-m) deep receiving pit, as well as a barge-mounted excavator to dig the pit. A combination of the sheet piles and a floating silt curtain would be used to contain suspended sediments expected to result from the digging the pit and the follow-on tunneling. Dredge spoils would be barged to shore for disposal. Receiving Pit work is expected to start in November 2012, last about one month, and include about 16 10-hour days of pile driving. However, this work may be delayed until April 2013. To avoid peak humpback whale season, no vibratory pile driving would be done between December 1, 2012 and March 31, 2013.

HSWAC's contractor would operate a micro-tunneling machine to bore tunnels for onshore pipelines, as well as offshore tunnels for the intake and return pipelines. The offshore tunnels would run from the onshore jacking pit out to the receiving pit where the machine would be recovered. Alternatively, a single tunnel capable of accommodating both pipelines may be drilled. Tunnel spoils would be extracted via the jacking pit and disposed of on land. Working from the jacking pit; reinforced concrete (or steel) pipe outer casing(s) would be installed through the tunnel(s), fiberglass pipelines would be installed inside the casing(s), and the resulting annuli around the pipes would be grouted. Micro tunneling and installation of the outer casing(s) would take 6 to 7 months. Installation of the carrier pipelines and annulus grouting would take an additional 1 to 2 months.

During about the same time, HWSAC's contractors would construct the high density polyethylene (HDPE) pipelines that would extend seaward from the receiving pit. Working on land, adjacent to the seaplane runway at Keehi Lagoon, the applicant would operate an HDPE fusion machine that uses heat and pressure (no glues) to join the ends of pipe sections to create sections that are typically about 3,300 ft (1,006 m) long. The pipe sections would be temporarily closed with a blind flange on each end, and would float. The sections would be deployed onto the water of the seaplane runway as they are constructed. Operating from a barge, stiffeners and concrete collars would be attached to the pipes while they float, and the finished pipe sections would be stored in Keehi Lagoon until installation time.

Offshore pipeline installation would be timed to avoid the summer south shore surf season. If construction proceeds quickly enough, the pipeline would be deployed between March and April 2013. Should work be delayed, this component would be completed during October 2013. Just prior to deployment of the off shore pipelines, multiple barges and work boats would begin joining the floating pipe sections into a single assembly. The shoreward end of the pipe lines would consist of the intake and discharge pipes held together, in parallel, by shared concrete collars. The remaining length of intake pipe would consist of the intake pipe and its concrete collars.

Once all segments are joined, the entire length of pipe would be towed into place during a single day. The pipe would be sunk at night to avoid the effects of sunlight-induced differential heating of the pipe. Using controlled flooding, the shoreward end of the pipeline would be sunk close to the receiving pit where it would be held in place with anchors or piles while the seaward end is held under tension by a minimum of three tugboats. The pipeline would be lowered to the seafloor, shallow to deep, by continued controlled flooding. The blind flange would be removed from the seaward end of the intake pipe, and the pipe would be lowered to the bottom with a lowering cable threaded through the last collar. A remotely operated vehicle (ROV) would monitor the pipe's deployment on the seafloor to confirm its proper location and condition prior to the retrieval of the lowering cable.

Divers would bolt "spool pieces" between the nearshore ends of the offshore pipelines and the pipe ends in the receiving pit to complete the connection. The sheet piles around the pit would be extracted or cut-off just below the existing seafloor. The pit would be backfilled with pre-washed crushed basalt gravel, and capped by pouring tremie-concrete. This work would take about a week to complete.

From the receiving pit, out to a depth of about 150 feet (46 m), the pipeline would be held down by a combination of the weight of about 91 concrete collars and the installation of 113 20-inch diameter steel pipe piles that would be impact driven though the sleeves of some of the concrete collars. Fifty-two collars would have 2 piles each. Nine more collars would have a single pile. An airlift siphon would be used to remove the top 6 feet of substrate from inside the piles. Spoils would be barged to shore for proper disposal. Tremie concrete would be used to fill and cap each pile. Each pile would take about 15 minutes to drive, and the applicant estimates that 4 piles would be driven per day over 4 to 6 weeks. Beyond the 150-foot depth, the pipeline would be held in place by the weight of about 873 concrete collars alone.

The issuance of an IHA to HSWAC is a federal action to be taken by NOAA OPR, much as the USACE authorization of the proposed action is. As such, that action is subject to compliance requirements under Section 7 of the ESA in that NMFS OPR must ensure that its issuance of an IHA under the MMPA would not jeopardize the continued existence of any ESA-listed species. The issuance of the IHA would be a purely administrative action that would parallel the issuance of an incidental take statement (ITS) under the ESA, with the difference being that the IHA focuses on marine mammals alone, and would include ESA-listed marine mammals as well as certain other marine mammals that are not listed as threatened or endangered under the ESA. Because the planned issuance of the IHA would authorize no actions that are not considered in this biological opinion, that issuance would have no affects on ESA-listed species under NMFS jurisdiction that are not considered herein. As such, this opinion is intended to cover the issuance of the IHA as well as the permitting of the action by the USACE.

Appropriate conditions, conservation measures, and best management practices (BMP) that would be applied to this action are detailed in the ADFEIS, the BA, and the Proposed IHA. These protective measures would include requirements to maintain constant vigilance for the presence of ESA-listed marine species during all aspects of the proposed action, to postpone or halt work (particularly pile driving) when protected species are within 50 yards (46 m) of the work, to properly install and maintain silt curtains and erosion controls, to employ ramp-up techniques for pile driving (soft-start), to minimize the introduction of pollutants into the marine environment, and to conduct acoustic monitoring of pile driving operations to validate or correct acoustic estimates, and to adjust safety ranges accordingly. Additional measures resulted during the consultation with OPR for the issuance of the IHA. Those measures include the temporal exclusion against operation of the vibratory pile driver between December 1 and March 31 to avoid the peak humpback whale season, and to employ additional boat-based observers during the operation of the vibratory hammer. The exclusion zone for marine mammals would be extended to 100 yards (91 m) around impact pile driving, except during December 1 through March 31, when it would be further extended to 1,094 yards (1,000 m) to ensure that no large whales enter that zone.

2.1 Interrelated/Interdependent Actions

The proposed action would result in the installation and operation of a new seawater air conditioning system that would provide service to a currently heavily developed area. Although some of the currently existing buildings in the service area could conceivably be replaced by new construction, the proposed action is not expected to cause or encourage any new construction or development in the area. It is possible that the nearshore section of the pipeline could become a destination for recreational divers and fishermen as the structure becomes populated by marine organisms. This could increase recreational and charter boat operation in the area, and could also result in increased anchor damage to the surrounding substrate. Although the new submarine structure could provide an additional option for divers and fishermen, it is not expected to cause increased diving or fishing activity at large. Any increased activity in this area would likely be the result of redistribution of activities that are already taking place in the adjacent waters along the south shore of the island. Any future increase in vessel traffic, diving, or fishing along the south shore of Oahu would be result from population increases on the island that is unrelated to the action under consideration here. Based on this, NMFS expects no significant interrelated or interdependent actions to result from the proposed action.

2.2 Action Area

With regard to ESA-listed marine species under NMFS jurisdiction, the action area for this project is limited to the marine waters south of Oahu, Hawaii (Figure 1). For all work, other than pile driving, the action area is estimated to be the in-water area within 50 yards (46 m) of project activities, and the down-current extent of any plumes that may result from mobilized sediments or discharges of wastes or toxic chemicals such as fuels and lubricants associated with the machinery used for this activity. During the proposed pile driving, the action area is extended seaward out to 4,700 meters from the proposed marine receiving pit, to include the waters that may be ensonified by pile-driving noise capable of eliciting behavioral response in ESA-listed marine species. During the operation of the proposed seawater air conditioning system, the action area would include the in-water extent of the pipeline, and also include the down-current extent of the discharge plume where the temperature, nutrients, and oxygen concentration differ from ambient levels, expected to be within 600 feet of the diffuser.

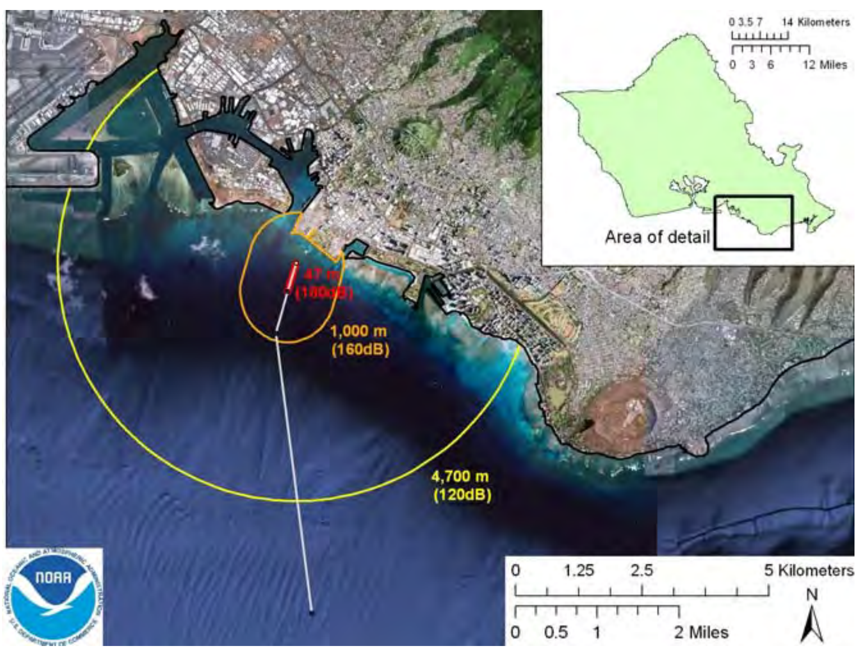

Figure 1. Action Area: South shore of Oahu, with the pipeline in white, and the in-water areas expected to be ensonified by pile driving.

3 Status of the Species

The USACE determined that the proposed action is likely to adversely affect green and hawksbill sea turtles, humpback whales, and Hawaiian monk seals, but is not likely to adversely affect any other marine species under NMFS jurisdiction (Table 1). Green and hawksbill sea turtles, humpback whales, and Hawaiian monk seals are the subject of this Opinion.

Table 1. ESA-listed marine species that may be affected by proposed action.

Species	Scientific Name	ESA Status	Listed	Federal Register
Species not likely to be adversely affected by the proposed action.				
Blue Whale	*Balaenoptera musculus*	Endangered	12/02/1970	35 FR 18319
Fin Whale	*Balaenoptera physalus*	Endangered	12/02/1970	35 FR 18319
Sei Whale	*Balaenoptera borealis*	Endangered	12/02/1970	35 FR 18319
Sperm Whale	*Physeter macrocephalus*	Endangered	12/02/1970	35 FR 18319
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	06/02/1970	35 FR 8491
Loggerhead Sea Turtle	*Caretta caretta*	Threatened	07/28/1978	43 FR 32800
Olive Ridley Sea Turtle	*Lepidochelys olivacea*			
Nesting aggregations on west coast of Mexico		Endangered	07/28/1978	43 FR 32800
All other Olive Ridley Sea Turtles		Threatened	07/28/1978	43 FR 32800
Species likely to be adversely affected by the proposed action.				
Humpback Whale	*Megaptera novaeangliae*	Endangered	12/02/1970	35 FR 18319
Hawaiian Monk Seal	*Monachus schauinslandi*	Endangered	11/23/1976	41 FR 51611
Green Sea Turtle	*Chelonia mydas*			
Nesting aggregations in Florida and Mexico		Endangered	07/28/1978	43 FR 32800
All other Green Sea Turtles		Threatened	07/28/1978	43 FR 32800
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered	07/28/1978	43 FR 32800

This section presents biological or ecological information for humpback whales and Hawaiian monk seals, as well as green and hawksbill sea turtles affected by the proposed action relevant to formulating the Opinion. Subsections 3.1 through 3.4 provide species-specific descriptions of distribution and abundance, life history characteristics (especially those affecting vulnerability to the proposed action), threats to the species, major conservation efforts, and other relevant information. Factors affecting those species within the action area are described in more detail in the Environmental Baseline (Section 4). No critical habitat has been designated for any of these species in the action area. Therefore, this project would have no effect on designated critical habitat under NMFS jurisdiction.

3.1 Humpback Whales

The Global Review of Humpback Whales (NMFS 2011a), the humpback whale Stock Assessment Reports (NMFS 2011b), and the humpback whale recovery plan (NMFS 1991) report that humpback whales are distributed in all ocean basins of the world. As shown above in Table 1, in 1970, all humpback whales were listed as endangered under the ESA.

3.1.1 Distribution and Abundance

Humpback whales in the north Pacific migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they socialize, give birth, and mate) and cooler, temperate or sub-Arctic waters in summer months (where they feed). In their summer foraging areas and winter calving areas, humpback whales tend to occupy shallower, coastal waters; during their seasonal migrations, however, humpback whales disperse widely in deep, pelagic waters. Breeding areas in the North Pacific Ocean include regions offshore of mainland Central

America; mainland Baja California, and the Revillagigedos Islands, Mexico; Hawaii; and Asia, including Ogasawara and Okinawa Islands, and the Philippines. About half of the humpback whales in the North Pacific Ocean breed and calve in the U.S. territorial waters off Hawaii, and more than half feed in U.S. territorial waters (NMFS 2011a). In the North Pacific Ocean, population structure is complex with mixing between feeding grounds and breeding grounds. Until recently, humpback whales in the north Pacific were considered to be one population. However, based on complexities observed through the Structure of Populations, Levels of Abundance and Status of Humpback Whales in the north Pacific (SPLASH) study, which analyzed genetics and photographs, it appears that there is likely more than one population (NMFS 2011a). Stock structure of humpback whales is defined based on feeding areas, and at least three stocks make up the north Pacific population(s). They are: 1) the California, Oregon, Washington, and Mexico stock, consisting of winter/spring populations in coastal Central America and Mexico which migrate to California and British Columbia; 2) the central North Pacific (CNP) stock that migrates between the Hawaiian Islands and northern British Columbia/Southeast Alaska, Gulf of Alaska, and the Bering Sea/Aleutian Islands; and 3) the western North Pacific stock, consisting of winter/spring populations off Asia which migrate primarily to Russia and the Bering Sea/Aleutian Islands (NMFS 2011b).

The annual growth rate for the North Pacific population over the last several decades is estimated at 4.9 to 6.8 percent, depending on which area and time frame are considered (Calambokidis et al. 2008). In 2010, the North Pacific population was estimated at about 21,000 individuals, with 7,469 to 10,103 humpback whales in the central North Pacific stock (NMFS 2011a).

3.1.2 Life History Characteristics Affecting Vulnerability to Proposed Action

In Hawaii, humpback whales have been sighted as early in the season as October and as late as June, with most mating and calving occurring from December to April. They are generally found in water less than 600 ft (182 m) deep, and cow-calf pairs appear to prefer even shallower water. Adult humpback whales of both sexes, as well as calves are occasionally observed in the action area south of Honolulu, Oahu. However, humpback whale surface sighting data from 1993 through 2003, suggests that their density is low in the action area (Figure 2) (HIHWNMS 2012), preferring other areas around the MHI, particularly the 4-Island area of Kaho'olawe, Lanai, Maui, and Molokai, and Penguin Banks southwest of Molokai. The proposed action area is not expected to overlap with the Hawaiian Islands Humpback Whale National Marine Sanctuary on the south shore of Oahu.

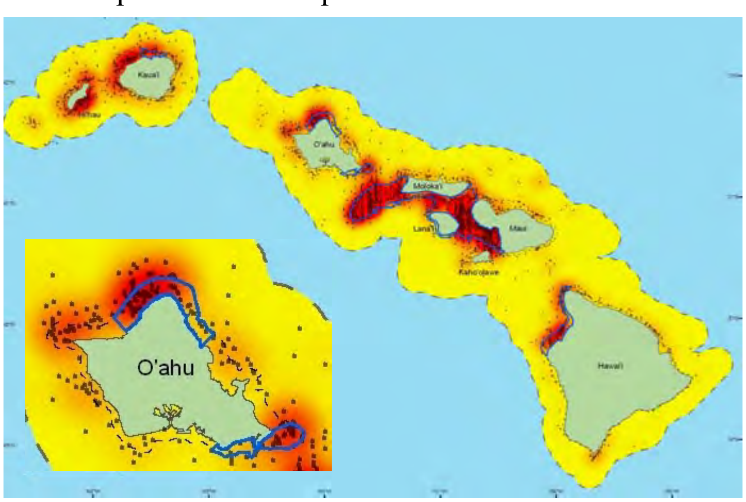

Figure 2. Humpback whale surface sightings and estimated surface density around Oahu (inset). Sanctuary boundaries are outlined in blue. Density is rated low to high, yellow to red, and is based on survey data collected between 1993 and 2003. Taken from the Hawaiian Islands Humpback Whale National Marine Sanctuary's Surface Sightings and Estimated Surface Density Map.

Humpback whales that pass through the action area may be exposed to elevated noise due to the proposed pile driving for this action. As with other cetaceans, humpback whales rely heavily on the acoustic environment to communicate, avoid predators, and to locate prey. The range of their acoustic sensitivity, 7 Hz to 22 kHz (Southall *et. al.* 2007), overlaps with the expected frequency range of the planned pile driving signals. As such, NMFS considers it likely that humpback whales can hear and respond to pile driving noise.

3.1.3 Threats to the Species

Prior to 1965, commercial whaling was the most serious threat to the species (NMFS 2011a, NMFS 1991, NMFS 2011b, and Calambokidis *et al.* 2008). Nearly 30,000 humpback whales were taken in Pacific Ocean whaling operations between 1900 and 1965. Hunting humpback whales has been prohibited in the Atlantic since 1965 and in the Pacific since 1966. Current threats include hookings and entanglement in fishing gear, ship strikes, tourism, noise, and potentially the effects of anthropogenic climate change.

Humpback whales are likely hooked or entangled by fishing gear throughout their global range, but data are scarce outside the U.S., especially in the Pacific. Reports of entangled humpback whales found swimming, floating, or stranded with fishing gear attached have increased in recent years in both Alaskan and Hawaiian waters. A total of 95 entanglement reports were confirmed in Hawaii from 2002 to 2011. Thirty-eight confirmed reports occurred during the 2008-2009 and 2009-2010 field seasons alone (Lyman 2011). Many of the entangled whales that are reported in Hawaiian waters most likely brought the gear with them from higher latitude feeding grounds.

While the whales are not typically at risk from drowning or immediate death, they are at increased risk of starvation, infection, physical trauma from the gear, and ship strikes as a result of entanglement. Available evidence from entangled humpback whales indicates that while it is not possible to predict whether an animal will free itself of gear, many are believed to extricate themselves based on scarring observed among apparently healthy animals. A study of the CNP humpback whale stock in southeast Alaska estimated that about 71% showed evidence of past entanglement that was survived, which exceeds the number of reported disentanglements (Neilson *et al.* 2009).

From 2003 through 2007, a total of 17 confirmed serious injuries and mortalities (16 in Alaska, 1 in Hawaii) resulted from interactions between commercial fishing operations and the CNP stock, resulting in an annual average take of 3.6 animals. In addition, nine whales were observed entangled in Hawaiian waters with injuries that could be serious, which is an annual mean of 1.8 over the 5-year period. The gear entangling these whales did not originate in Hawaiian waters; therefore, some of these whales may be included among the entangled humpback whales seen and documented in Alaska. Based on this information it is estimated that there were 5.6 commercial fishery-caused mortalities or serious injuries of CNP humpback whales per year over the period 2003-2007 (NMFS 2010a). Interactions with humpback whales in the Hawaii-based shallow-set fishery accounted for 0.2 of the 5.6 mortalities during that time period (NMFS 2011b).

Many humpback whales are killed by ship strikes throughout the world, including along both coasts of the U.S. On the Pacific coast, one humpback whale is killed about every other year by ship strikes. Worldwide records of vessel collisions and stranding information indicate that humpback whales are one of the species more commonly struck by ships (Jensen and Silber 2003, Laist *et al.* 2001). Humpback whales, especially calves and juveniles, are highly vulnerable to ship strikes and other interactions with non-fishing vessels. Younger whales tend to be closer to shore, spend more time at the surface, and are less visible than adults, thereby making them more susceptible to collisions. Humpback whale distribution overlaps significantly with the transit routes of large commercial vessels in Alaskan waters. Records of vessel collisions with large whales in Alaska indicate that strikes have involved cruise ships, recreational cruisers, whale watching catamarans, fishing vessels, and skiffs. Vessel lengths associated with these records ranged from approximately 20 feet to over 250 feet, indicating that all types and sizes of watercraft pose a threat of collision for whales. Between 2001 and 2005, reports of vessel collisions with humpback whales indicate an average of five whales struck per year in Alaska, whereas in Hawaii three to four vessel collisions with humpback whales were reported per year in 2001 through 2006. Reported vessel collisions with humpback whales in Hawaii between 2007 and 2011 increased to an average of 6.8 whales struck annually. During the 2009 humpback whale season in Hawaii, 13 ship-strikes with humpbacks were reported; ten of these reports were confirmed (Lyman 2011).

Several other threats affect humpback whales throughout their range. For example, the CNP stock is the focus of a large whale watching industry in both Hawaii and Alaska. The growth of the whale watching industry is a concern for humpback whales since harassment may occur, preferred habitats may be abandoned, and fitness or survivability may be compromised if disturbance levels are too high. Also humpback whales seem to respond to moving sound sources, such as whale-watching vessels, fishing vessels, recreational vessels, and low-flying aircraft. Their responses to noise are variable and have been correlated with the size and behavior of the whales when the noise occurs. Anthropogenic sound has increased in all oceans over the last 50 years and it is thought to have doubled each decade in some areas of the ocean over the last 30 years. Low-frequency sound comprises a significant portion of this and stems from a variety of sources including shipping, hydrographic research, naval activities, and oil and gas exploration (NMFS 2006; NMFS 2008b; NMFS 2011a).

Although humpback whales are probably beginning to be affected by impacts associated with anthropogenic climate change (described in more detail in the Environmental Baseline section below), no significant climate change-related impacts to humpback whale populations have been observed to date.

3.1.4 Conservation of the Species

To minimize the possibility of collision and the potential for harassment in Hawaii and Alaska, NMFS implemented regulations that prohibit approaching humpback whales within 100 yards (90 m) when on the water or within 1,000 feet (300 m) when operating an aircraft (50 CFR 224.103). The regulations also make it unlawful to disrupt the normal behavior or prior activity of whales, which may be manifested in several specific ways that include but are not limited to interruptions to breeding, nursing, or resting activities.

The Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) also protects the winter breeding, calving and nursing range of the largest Pacific population of the humpback whale. The U.S. Congress designated the HIHWNMS on November 4, 1992, and the Hawaiian

Islands National Marine Sanctuary Act designated the Sanctuary for the primary purpose of protecting humpback whales and their habitat within the Hawaiian Islands marine environment. It is the only National Marine Sanctuary dedicated to a species of whale and its habitat. The Sanctuary works collaboratively to conserve, enhance and protect humpback whales and their habitat by promoting and coordinating research, enhancing public awareness, and fostering traditional uses by native Hawaiians. It is jointly managed by the sanctuary manager, the state of Hawaii co-manager, and other field staff via a cooperative federal-state partnership. The Sanctuary is a series of five noncontiguous marine protected areas distributed across the main Hawaiian Islands (MHI). The total area of the Sanctuary is 1,370 square miles. Encompassing about half of the total Sanctuary area, the largest contiguous portion is delineated around Maui, Lanai, and Molokai. The four smaller portions are located off the north shore of Kauai, off Hawaii's Kona coast, and off the north and southeast coasts of Oahu (www.hawaiihumpbackwhale.noaa.gov).

The Hawaiian Islands Disentanglement Network is a community based network that was formed in 2002 in an attempt to free endangered humpback whales and other marine animals from life threatening entanglements and at the same time gather valuable information that will help mitigate the issue of marine debris and future entanglements (www.hawaiihumpbackwhale.noaa.gov). From 2002 to 2011, the network received over 356 reports of animals in distress; approximately 186 of those represented entangled animals including humpback whales. The network and partnering agencies have mounted at least 63 (on-the-water or in-the-air) responses to these reports. To date, ten humpbacks reported entangled in Hawaii have been confirmed to have gear from Alaska; nine of these represent commercial pot gear. The mean distance traveled with this gear is at least 2,150 nm. The greatest known straight line distance a whale may have carried gear is 2,450 nm (between North shore of Etolin Island, approx 9nm SW of Wrangell Alaska, where the gear was lost and the island of Maui where the animal was first reported) (Lyman 2011).

3.2 Hawaiian Monk Seal

Hawaiian monk seals consist of a single population that is distributed throughout the Hawaiian Archipelago and Johnston Atoll (74 FR 27988). However, groups of individuals that occupy specific islands or atolls are treated as sub-populations for the purposes of research and management activity. They are found primarily in the Northwest Hawaiian Islands (NWHI), but sightings are becoming increasingly more common in the MHI and births have been documents on most of the major islands (NMFS 2007). Unconfirmed sightings of Hawaiian monk seals have also been reported at Palmyra Atoll, Wake Island, and at Bikini Atoll and Mejit Island in the republic of the Marshall Islands, but evidence is insufficient to include these sites within the species' range (74 FR 27988). As shown above in Table 1, Hawaiian monk seals were listed as endangered under the ESA in 1976.

3.2.1 Distribution and Abundance

The Hawaiian monk seal is in crisis. The population has been in decline for more than 20 years. The 2007 recovery plan estimated the population at about 1,200 individuals, and stated that there is concern for the long term maintenance of genetic diversity (NMFS 2007). The recovery plan further reported the annual rate of decline at 3.9%. In 2008, the population was estimated at

1,161 seals, with minimum population estimates of 913 seals in the NWHI and 113 seals in the MHI (NMFS 2009).

The population's six main reproductive sites are French Frigate Shoals, Kure Atoll, Laysan Island, Lisianski Island, Midway Islands, and Pearl and Hermes Reef, all in the NWHI, where the population is declining at an annual rate of 4.5% (NMFS 2009). Smaller breeding groups also occur on Necker and Nihoa Island, and monk seals have been observed on Gardner Pinnacles and Maro Reef (NMFS 2007). The current population decline in the NWHI seems to be driven by food limitation and other sources of mortality that disproportionately impact the survivorship of juvenile seals. This in turn affects recruitment to the breeding age classes, and is expected to result in NWHI declines continuing for at least the next decade (Baker *et al*. 2010).

Sightings confirm at least occasional presence in the MHI since 1900, Niihau residents reported that seals appeared regularly after 1970 (Baker and Johanos 2004), and by the mid 1990s a small naturally occurring Hawaiian monk seal population has existed in the MHI. Since then, documented sightings and annual births continue to rise as the MHI portion of the population increases (Baker and Johanos 2004). Based on systematic surveys or sightings of uniquely identified individuals, the estimated seal population within the MHI was 45 in 2000, 77 in 2005, and 113 in 2008 (NMFS 2007, NMFS 2009), suggesting an annual increase of about 5.6%. Unpublished NMFS data for 2011, estimates the MHI population at about 150 monk seals (Johanos-Kam Pers. Comm.).

Recent tagging studies have shown individuals sometimes travel between breeding populations in the NWHI, between islands in the MHI, and on rare occasions, between the NWHI and the MHI (NMFS 2009, Littnan *et al*. 2006). However, since regular tagging was started in the 1980s, only 5 seals have been documented to migrate to the MHI from the NWHI (Baker *et al*. 2010). This supports the understanding that increases in the MHI population is mostly the result of increased births and dispersal of individuals from under documented areas, such as Niihau (Baker and Johanos 2004), vice the migration of seals from the NWHI. In general, monk seals in the MHI are in better physical condition than those in the NWHI; with earlier years of first birth and higher birth rates (Baker *et al*. 2010), more robust pups (Baker and Johanos 2004, Baker *et al*. 2006), and a higher estimated rate of survival from weaning to age 1 (77% in the MHI vs. 42-57% in the NWHI, Baker *et al*. 2010). Between the years of 2002 and 2011, a total of 1,194 monk seal sightings have been reported within a 10 mile (16.1 km) radius of Honolulu Harbor, with 812 (68%) of those sightings attributed to 28 uniquely identifiable seals, and over half (480) of those attributed to 2 individuals (NMFS 2012 Internal Report). Based on beach count information, a maximum of four monk seals have been reported along the south shore of Oahu at the same time. The PIFSC estimates the population by multiplying beach counts by 3; as such we estimate that a maximum of 12 monk seals may be present along the south shore of Oahu at any given time.

3.2.2 Life History Characteristics Affecting Vulnerability to Proposed Action

Hawaiian monk seals spend the majority of their time in the ocean, and may remain at sea for several consecutive days or more. They utilize the marine aquatic environment to forage, socialize, mate, rest and travel. They can travel hundreds of miles in a few days (Littnan *et al*. 2006), and can dive to depths of more than 1,600 feet (500 m) (Parrish *et al*. 2002). They also rely on terrestrial habitats to rest, avoid predators, molt, give birth (pup), and nurse young. Unlike many other pinnipeds that often haul out in large groups, Hawaiian monk seals are considered solitary, both on land and in the water, most often hauling out singly or in small groups. Their life span in the wild is about 30 years (NMFS 2007). Adults can reach lengths of 7.5 feet (2.3 m) and weights of 600 pounds (273 kg), with males typically smaller than females (NMFS 2007). Adult monk seals undergo annual catastrophic molts, where the entire pelage layer (skin and hair) is shed. They stay ashore for 10 to 14 days during molting. The first molt occurs for pups at about the same time as weaning.

Hawaiian monk seals mate at sea, and gestation lasts about 11 months. Females give birth on land, bearing single pups, most commonly between February and August, but pupping has been documented during all times of the year (Johanos *et al*. 1994). Pups are able to swim at birth, but normally stay on land for the first few days. Mothers stay in close proximity to their pups during nursing, which occurs on land. Mothers and pups gradually begin swimming together in protected shallows, and mothers are protective of their young. Mother-pup pairs spend increasing amounts of time swimming and venturing farther from shore as weaning approaches.

Weaning is abrupt. After about 6 weeks, mothers leave their pups and return to the sea to forage (Johanos *et al*. 1994). Mothers will mate about 3 to 4 weeks after weaning, and haul out to molt about 5 to 6 weeks after that (NMFS 2007). Pups typically spend several more weeks near the nursing area before they venture out into deeper forage areas. Weaned pups live off their fat stores while they learn to forage for themselves, during which time they experience considerable weight loss. Juveniles in the NWHI are typically 2 years old before they regain their post-weaning weight (Johanos *et al*. 1994).

Hawaiian monk seals are considered foraging generalists, consuming a wide range of prey species. Preferred forage consists of small eels, wrasses, cephalopods, and other benthic species that are usually less than 8 inches long (20 cm). They forage at depths anywhere from one meter to 500 meters or more. A large portion of their effort is spent in bank and slope habitats between 164 and 984 feet (50 and 300 m). Preferred forage habitat appears to be low relief substrates such as sand and talus areas where prey are afforded limited shelter once flushed (Parrish and Littnan 2007). Adult seals have been observed flipping large, loose talus fragments to flush prey (Parrish *et al*. 2000). Adults may forage at 1,000 to 1,600 feet (300 to 500 m), but are expected to be able to exceed 1,800 feet (550 m). Juveniles appear to feed in shallow atoll lagoons at 30 to 100 feet (10 to 30 m), as well as on sandy deep reef slopes between 160 and 325 feet (50 to 100 m). Juveniles are capable of similar dive depths as adults, but seem to lack the strength and experience to successfully engage in the large talus forage behaviors of adults (Parrish *et al*. 2005). Because adult Hawaiian monk seals are known to dive to and forage near the sea floor at depths equal to or greater than those planned for the intake and exhaust pipes, NMFS considers it likely that adult monk seals may encounter the pipes along their entire length, and as such may be exposed to the effluent plume as well as to inflow at the intake.

The information on the hearing capabilities of Hawaiian monk seals is somewhat limited. Southall *et al.* (2007) report that in-air hearing sensitivity is between 75 Hz and 30 kHz for pinnipeds in general, while in-water hearing is between 75 Hz and 75 kHz. Thomas *et al.* (1990) reported the results of underwater audiograms for a single Hawaiian monk seal that suggest their in-water hearing range may be narrower than other pinnipeds. The in-water hearing range of the tested monk seal was about 2 kHz to 48 kHz. The most sensitive hearing was between 12 kHz and 28 kHz, with sensitivity dropping off sharply below 8 kHz and above 30 kHz. However, in the absence of more information to support the possibility that monk seal hearing is as suggested by Thomas *et al.* (1990), NMFS assumes for this consultation that the hearing range of Hawaiian monk seals is closer to that suggested by Southall *et al.* (2007). Because that range overlaps with the expected frequency range of the pile driving signals, NMFS considers it possible that Hawaiian monk seals can hear and respond to pile driving noise.

Based on the description of the proposed action and on the life history characteristics of Hawaiian monk seals, all life stages except pre-weaned pups could be affected by the high intensity noise expected from the proposed pile driving during construction, whereas juveniles and adults could be affected by the intake and exhaust during the operation of the system.

3.2.3 Threats to the Species

Due to their very small population, Hawaiian monk seals are severely vulnerable to natural and anthropogenic threat factors. The 2007 recovery plan grouped threats according to their severity. Food limitation, entanglement, and shark predation are considered crucial. Infectious diseases, habitat loss, fishery interactions, male aggression, and human interaction are considered serious; and biotoxins, vessels groundings, and contaminants are considered moderate threat vectors.

As mentioned above, food limitation plays a primary role in the population decline in the NWHI, most importantly through the failure of sufficient numbers of pups surviving to recruit into the reproductive age classes. Monk seals also have one of the highest rates of entanglement. Derelict fishing gear, such as nets, lines, straps, and rings are the material most commonly involved with monk seal entanglement, but many other sources of marine debris also cause entanglement. Minimally, entanglement would result in energetic costs due to increased drag. However, injury and death, both direct and indirect, are likely to result unless a seal can free itself. Proportionally, newly weaned pups are the age class most commonly observed entangled (NMFS 2007). Injuries and scars of past shark attacks have been observed on seals of all age classes, and occasionally, active predation has been observed directly. Most of the attacks have been attributed to tiger sharks. However, in recent years, there has been a marked increase in the observed targeting of pre-weaned pups by Galapagos sharks at French Frigate Shoals (FFG). Pup mortality peaked between 1997 and 1999, at 18 to 28 probable annual mortalities. This may be a "learned behavior", and appears to be limited to FFG (NMFS 2007).

Disease effects on Hawaiian monk seal demographic trends are uncertain, and no infectious disease epidemics have yet been documented. However, there is concern that monk seals may be vulnerable to infectious diseases for which they may have no natural antibodies. Diseases of most concern include leptospirosis, toxoplasmosis, and West Nile virus, all of which may be spread by domestic and feral animals and by humans (NMFS 2007). Infectious diseases could also be spread to Hawaiian monk seals though other pinnipeds species with documented epidemics, such as Northern elephant seals, which have been periodically documented in the Hawaiian Islands. Exposure to numerous viruses and other pathogens has been confirmed in Hawaiian monk seals, including caliciviruses, herpesviruses, *Toxplasma gondii*, *Salmonella spp*.

and *Escherichia coli*., while gastrointestinal tape worms and nematodes are the predominant sources of parasitic infection in these seals (NMFS 2007).

Loss of terrestrial habitat is an issue of concern. Many of the islands, atolls, and sand bars used by monk seals are low-lying and vulnerable to erosion. Recent loss of Whaleskate Island in FFS reduced available parturition sites, dramatically increasing the density of mother-pup pairs at Trig Island. It has been speculated that the frequent female to female interactions that resulted on Trig Island, may have contributed to the high levels of pup predation by Galapagos sharks that occurred there. Environmental factors such as storms and sea level rise could further exacerbate this problem (NMFS 2007). Most of the MHI beaches that would be used by monk seals are now used to some degree by humans for recreational purposes. Additionally, many coastal areas are being developed or are under consideration for development. Although a small number of monk seals have successfully pupped at popular MHI beaches, Hawaiian monk seals typically avoid areas where human disturbance occurs often. This could limit available preferred habitat for monk seals in the MHI, and displace them to less optimal areas (NMFS 2007).

Monk seals are injured and killed as the result of direct interactions with fisheries, predominantly in the MHI, and although the impacts of indirect interactions are unproven to date, they cannot be ruled out. Between 1982 and 2006, 48 hookings, 5 gillnet entanglements, 1 entanglement with a lobster pot, and 1 bait stealing were recorded throughout the Hawaiian archipelago. Thirty-eight hookings and all 5 gillnet entanglements occurred in the MHI, and since the creation of the Papahānaumokuākea Marine National Monument (PMNM) in 2006, virtually all commercial and recreational fishing has been eliminated in the NWHI. A response system is in place to respond to hooked and entangled seals in the MHI. However, injury and mortality due hooking and net entanglement continues to occur in the MHI (NMFS 2007).

Male aggression has caused the injury and death of adult females and pups of both sexes in the NWHI. Multiple-male-aggression or "mobbing" is thought to result from the imbalance in the adult sex ratio, where males outnumber females. The attacks involve a number of males repeatedly attempting to mount and mate with a single seal (an adult female or a juvenile of either sex), often resulting in the death of the assaulted animal. Attacks by single adult males range from normal adult male pinniped harassment of younger animals to aberrant levels of focused aggression directed toward weaned pups, and have resulted in several mortalities, most notably at FFS (NMFS 2007).

Human interactions have ranged from unintentional disturbances at haul-out sites, to the deliberate injuring and killing of Hawaiian monk seals. They were briefly but heavily commercially exploited in the 1800s, and were harvested for food by shipwreck victims and other transient visitors to the NWHI at least though World War II. The Federal government maintained facilities (US Coast Guard and US Navy) at FFS through 1979, at Kure through 1992, and at Midway through 1997. The US Fish and Wild Life Service now manages Midway, and research activities continue on several NWHI. As mentioned above, monk seals are prone to abandon or avoid preferred haul-out or pupping areas if sufficiently disturbed (NMFS 2007). In the MHI, unintentional disturbance is increasingly common due to co-occurrence at beaches used as haul-out or pupping habitat, and numerous malicious interactions including shootings have been documented and continue. Although uncommon, vessel strikes of monk seals have also been documented in the MHI. Biotoxin-induced mortality has not been confirmed in monk seals, and is considered a less serious threat. However, ciguatoxin, maitotoxin, and domic acid are all known to cause mortality in pinnipeds, and are documented to occur in Hawaiian waters, and both ciguatoxin and maitotoxin have been detected in the tissues of dead monk seals (NMFS 2007).

3.2.4 Conservation of the Species

The recognized range of Hawaiian monk seals is completely within the jurisdiction of the United States, and more specifically limited to the Hawaiian Archipelago and Johnson Atoll. Much effort has been made to conserve Hawaiian monk seals since their listing under the ESA in 1976. Critical habitat was first designated for monk seals in 1986, and was initially limited to several islands in the NWHI, to include habitat from the inland extent of beach crest vegetation, outward to the 10 m depth contour. The first recovery plan was completed in 1983, and in 1988, designated critical habitat was expanded to include more NWHI islands, and to laterally extend the range out to the 20 m depth contour.

Mitigation of known threats includes the removal of entanglement hazards, marine debris, and derelict fishing gear (marine debris) from the shores and reefs of the NWHI since 1980. Between 1996 and 2006, over 511 metric tons of marine debris was removed by the multi-agency team that is lead by Pacific Islands Fishery Science Center's (PIFSC) Coral Reef Ecosystem Division (CRED). Between 2000 and 2003, PIFSC field staff removed 10 Galapagos sharks from Trig Island, FFS. Subsequently, the take of pups was reduced from a high of 28 in 1997 to lows of 3 for both 2002 and 2003. The PIFSC reviewed the available literature and conducted epidemiological, hematological, and biochemistry studies of monk seals, resulting in a comprehensive epidemiological plan in 1999, and the 2004 contingency plan for monk seal unusual mortality events.

In addition to designating critical habitat, as described above, in 2000, Executive Order (EO) 13178 established the NWHI Coral Reef Ecosystem Reserve in the Federal waters between 3 and 50 nautical miles (nm) around the NWHI. The Governor of Hawaii then designated the NWHI as a state refuge in 2005. In 2006, the PMNM was established. In the MHI, outreach, workshops, and monk seal program coordinators are employed on different islands to ensure that haul-out beaches are available. Additionally, in June 2011, NMFS proposed revising monk seal designated critical habitat to include occupied habitat throughout the archipelago (with certain exclusions), and to extend from 5 m inland from the highest wave wash at high tide, out to the 500-m depth contour.

To reduce fisheries interaction with the Hawaii-based longline fishery, NMFS established the Protected Species Zone in 1991, which permanently prohibited longline fishing within 50 nm of the NWHI and the corridors between the islands. The State's 2005 refuge designation banned all fishing in state waters (from the shore out to 3nm) around the NWHI, and the establishment of the PMNM in 2006, required the phase out of commercial fishing in Federal waters around the NWHI, which has subsequently occurred. Recreational fisheries around the MHI continue to impact monk seals, most particularly the slide bait nearshore ulua fishery and the lay gillnet fishery. The identification and treatment of hooked seals has become increasingly successful, and in 2007, the State amended the rules that regulations lay gillnet fishing. However, monk seal interactions with these fisheries continue.

Since 1984, NMFS has taken action on a total of 40 adult males that were observed attacking females or pups. Thirty-two were translocated to Johnson Atoll or to the MHI; 5 were placed in permanent captivity; 2 died during translocation; and 1 was euthanized. These efforts have successfully reduced the frequency of male aggression-related injuries and deaths of females and pups (NMFS 2007). Human interaction in the NWHI has been greatly reduced with the closure of the former Coast Guard and Naval facilities in the area. Outreach is ongoing around the MHI to increase monk seal awareness, and a growing volunteer network provides around the clock monitoring, protection of seals on the beach, and communication with beach goers (NMFS 2007). Efforts are ongoing under the current monk seal recovery plan, as well as in the PIFSC to investigate the presence of biotoxins in monk seal prey and to respond to unusual mortality events should they occur. The Navy and Coast Guard performed clean-up operations at their NMHI facilities. For example, the Navy spent $90 million on contamination remediation at Midway Atoll as part of the base closure. However, PCB contamination remains in landfills at Midway and at the former USCG Station at Tern Island FFS. These sites are being monitored, and may require further remediation actions. An Area Contingency Plan is in place for oil spill response within Hawaiian monk seal range, including the NWHI (NMFS 2007).

Additionally, numerous efforts designed to improve the survival of female pups in the NWHI have been ongoing since the 1980s. The specific goal of these efforts is to increase the number of females that subsequently recruit into the adult breeding population. A total of 104 pups have undergone some level of care under these management efforts, and many of these animals have successfully survived to reproduce. For example, during the 2001 beach count at Kure Atoll, 9 of the 10 identified parturient females had received care, or were the progeny of pups that received care (NMFS 2007).

3.3 Green Sea Turtles

The most recent green turtle 5-year status review (NMFS & USFWS 2007a) reports that green turtles are distributed across the Pacific, Indian, and Atlantic Oceans as well as in the Mediterranean Sea. As shown above in Table 1, in 1978, all green turtles were listed as threatened under the ESA, except for the breeding populations in Florida and on the Pacific coast of Mexico, which were listed as endangered.

3.3.1 Distribution and Abundance

Globally, most green sea turtle nesting populations declined substantially during the 20th century. Conservation efforts over the past 25 years or more appear to have had some positive results, as indicated below. However, threats and impacts persist for many green sea turtle populations (NMFS & USFWS 2007a). Following are brief descriptions of distribution and abundance of green turtles in the three major ocean basins, with more detail provided for Oceania in the Pacific Basin where the action area is located. These descriptions are based on the numbers of nesting females, or their nests, because those are the best available methods for confirming sea turtle distribution or for estimating density and population trends.

Indian Ocean

There are numerous nesting sites for green sea turtles in the Indian Ocean. One of the largest nesting sites for green sea turtles worldwide occurs on the beaches of Oman where an estimated 20,000 green sea turtles nest annually. Based on a review of 32 index sites, declines in green turtle nesting were evident for many of the Indian Ocean index sites (Seminoff 2004). While several of these had not demonstrated further declines in the more recent past, Comoros Island and the Seychelles are the only index sites in the western Indian Ocean that showed evidence of increased nesting (NMFS & USFWS 2007a).

Atlantic Ocean / Mediterranean Sea

The 5-year status review for the species identified nine geographic areas considered to be primary sites for green sea turtle nesting in the Atlantic/Caribbean, and four in the Mediterranean and reviewed the trend in nest count data for each (NMFS and USFWS 2007a). Atlantic areas include: (1) Florida, USA; (2) Yucatán Peninsula, Mexico; (3) Tortuguero, Costa Rica; (4) Aves Island, Venezuela; (5) Galibi Reserve, Suriname; (6) Isla Trindade, Brazil; (7) Ascension Island, United Kingdom; (8) Bioko Island, Equatorial Guinea; and (9) Bijagos Archipelago (Guinea-Bissau). Mediterranean sites include: (1) Turkey; (2) Cyprus; (3) Israel/Palestine; and (4) Syria. Nesting at all of the Atlantic sites was considered to be stable or increasing with the exception of Bioko Island and the Bijagos Archipelago where the lack of sufficient data precluded a meaningful trend assessment for either site. Lack of sufficient data also precluded meaningful trend assessments for the Mediterranean sites. The most important nesting concentration for green turtles in the Atlantic is at Tortuguero, Costa Rica, where nesting has increased since the 1970s. Nest count data from 1999-2003 suggest nesting by 17,402- 37,290 females per year. These sites are not inclusive of all green sea turtle nesting in the Atlantic or Mediterranean. However, other sites support lower levels of nesting and contribute a much smaller proportion to the total number of green turtles in these areas (NMFS and USFWS 2007a).

Pacific Ocean

Green turtles occur in the eastern, central, and western Pacific. Foraging areas are found throughout the Pacific, including along the southwestern U.S. coast (NMFS and USFWS 1998a). Nesting is known to occur at hundreds of sites throughout the Pacific, with major nesting occurring in Indonesia, Malaysia, the Philippines, Australia, Micronesia, Hawaii, New Caledonia, Mexico, the Galapagos Islands, and other sites (NMFS & USFWS 2007a). Oceania is a subset of the Pacific, and includes Micronesia, Melanesia, and Polynesia. In this opinion, Oceania is defined as also including Australia's Great Barrier Reef (GBR), because a high proportion of green turtles occurring in Oceania nest on the GBR. Based on the best information currently available, about 18,000 to 38,000 green turtles nest annually in Oceania (Figure 3) (NMFS 2010b).

However, about 90% of nesting takes place among two Australian nesting aggregations (NA) (Northern GBR and Southern GBR which includes the Coral Sea Platform), with over half of all the nesting occurring on a single island; Raine Island in the Northern GBR (Chaloupka *et al*. 2008a, Limpus 2009). Nesting trends appear stable at Raine Island, and are increasing at Heron Island in the Southern GBR, as well as at Chichi-jima in the Ogasawara Islands (Chaloupka *et al*. 2008a). However, these trends do not necessarily correlate with a stable or increasing total number of turtles because of low nesting success and hatchling production at Raine Island, where the majority of nesting for Oceania occurs (Limpus *et al*. 2003; Limpus 2009). Also, NA with small numbers of nesting females, like those throughout the islands and atolls of central and south Pacific, may be of greater importance than their proportional numbers indicate. Many of these NA are geographically isolated, and likely harbor unique genetic diversity, which may be lost if these small NA or their components become extirpated (Avise & Bowen 1994).

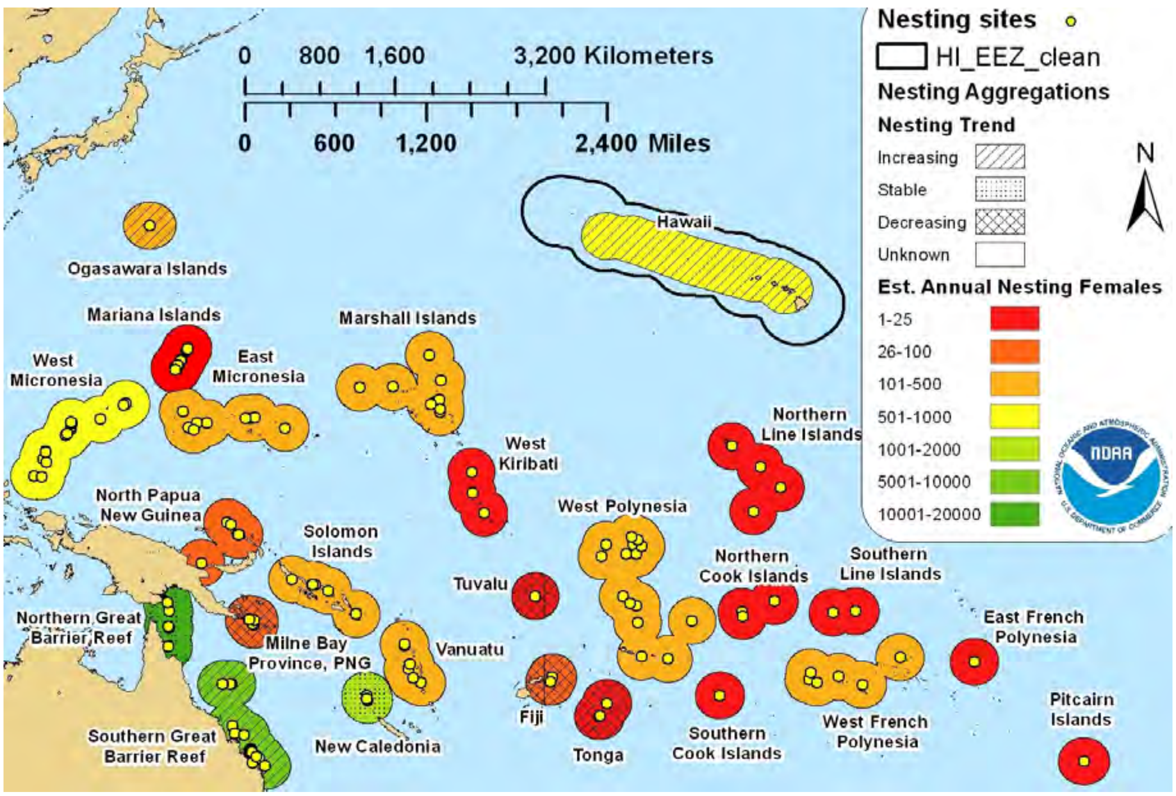

Figure 3. Green turtle nesting aggregations in Oceania.

<u>Hawaiian Archipelago</u>

Green turtles of the Hawaiian NA nest exclusively within the Hawaiian Archipelago, with over 90 percent of the nesting occurring at French Frigate Shoals (FFS) in the Northwestern Hawaiian Islands (NWHI). Adults migrate more than 621 miles (1,000 km) between foraging areas in the Main Hawaiian Islands (MHI) and the FFS nesting area (Balazs *et al*. 1994). Long-term monitoring and tagging studies have shown that turtles nesting at FFS come from numerous foraging areas throughout the Hawaiian Archipelago, where they reside with a strong degree of island fidelity (Balazs 1976, 1980, 1983; Dutton *et al.* 2008). This linkage has been firmly established through genetics, satellite telemetry, flipper tagging and direct observation (Balazs 1983, Balazs *et al.* 1994; Leroux *et al.* 2003; Dutton *et al.* 2008).

Annual nesting activity has been variable at the FFS index beach since initial nesting surveys began in 1973 (as is typical of green turtle nesting dynamics), but has markedly increased from a low of 67 nesters in 1973 to a high of 808 nesters observed during the 2011 sampling period (NMFS-PIFSC unpublished). Chaloupka et al. (2008a) reported a near-linear annual increase of about 5.7 percent. The long-term positive trend in nesting has been attributed to increased survivorship (since harvesting of turtles in foraging grounds was prohibited in the mid-1970s) and cessation of habitat damage at the FFS rookery since the early 1950s (Balazs and Chaloupka, 2004). In-water abundance of green turtles is consistent with the increased nesting (Balazs 1996; Balazs and Chaloupka 2004; Chaloupka et al. 2007), and there has been a dramatic increase in the number of basking turtles in the MHI and throughout the NWHI (Balazs 1996; Balazs and Whittow 1982; Parker and Balazs 2011). Although the number of green sea turtles around the MHI appears to be increasing, and resident juveniles and adults are considered ubiquitous in local waters, data are insufficient to estimate their density within the action area.

3.3.2 Life History Characteristics Affecting Vulnerability to Proposed Action

Following hatching at their natal beaches, green turtle hatchlings spend several years of early development in the oceanic (pelagic) zone followed by recruitment to coastal areas where post-recruitment juveniles and adults forage and mature in shallow coastal areas, feeding primarily on algae and seagrass. When on their foraging grounds, post-recruitment green turtles are often referred to as residents. Most resident green turtles show strong long-term site fidelity (over years) to preferred nearshore foraging and sheltering habitats, often until the habitat can no longer support their increasing size (Balazs and Chaloupka 2004; Balazs *et al*. 1987 and 1998; Chaloupka and Limpus 2001; Godley *et al*. 2003; Grant *et al*. 1997; Seminoff *et al*. 2003). The majority of sea turtles in coastal areas spend their time at depths less than 16 feet (5 m) below the surface (Schofield *et al.* 2010, Hazel *et al.* 2009). Upon reaching sexual maturity, adult greens typically undertake long migrations between their resident foraging grounds and their natal nesting areas (FFS for 90 percent of the Hawaiian NA), where they mate and females nest. Nesting females are referred to as "nesters", which distinguishes them from "resident" turtles that regularly forage in that area. Although males also make mating migrations, because they do not crawl out on the beach as the females do, those males are nearly impossible to distinguish from the resident males.

Sea turtle hearing research is limited, but available information about sea turtle sensory biology suggests that they are low frequency specialists, with greens thought to be most acoustically sensitive between 200 and 700 hertz (Hz) (Ridgway *et al.* 1969). Because the hearing range of green turtles overlaps with the expected frequency range of the pile driving signals, NMFS considers it likely that greens can hear and respond to pile driving noise. Existing information also suggests that sea turtles rely more heavily on visual cues, rather than auditory, to initiate threat avoidance (Hazel *et al*. 2007).

Based on the description of the proposed action and on green turtle life history characteristics, post-recruitment juvenile and adult green turtles sheltering and foraging near Honolulu Harbor are the life stages most likely to be affected by the expected high intensity noise from pile driving. Because the green turtles found around Oahu are unlikely to migrate outside of the archipelago, the proposed action is expected affect the Hawaiian NA alone (Figure 2).

3.3.3 Threats to the Species

Global threats to green turtles are described in the 5-year review (NMFS & USFWS 2007a). The major threats to the species are alteration of nesting and foraging habitat, fishing bycatch, and direct harvest, which are briefly described below. Climate change also appears to be a growing threat to this species, and is also mentioned below.

Destruction and alteration of green turtle nesting and foraging habitats is occurring throughout the species' global range, especially through coastal development, beach armoring, beachfront lighting, vehicular/ pedestrian traffic, invasive species, and pollution from discharges and runoff. Under natural conditions, beaches can move landward or seaward with fluctuations in sea level. However, extensive shoreline hardening (e.g., seawalls) inhibits this natural process. Beach armoring is typically done to protect the coastal development from erosion during storms, but armoring blocks turtle nesting and often leads to beach loss. Coastal development also increases artificial lighting, which may disorient emerging hatchlings, causing them to crawl inland towards the lights instead of seaward. Coastal development also improves beach access for humans, resulting in more vehicular and foot traffic on beaches, causing compaction of nests and thereby reducing emergence success. Adult green turtles are opportunistic feeders, but are considered primarily herbivores that forage on seagrass and algae in shallow nearshore areas and coral reefs. Contamination from effluent discharges and runoff has degraded these habitats, and invasive species may reduce native algae species preferred by green turtles or could exacerbate susceptibility to, or development of disease (NMFS & USFWS 2007a; Guimaraes dos Santos *et al*. 2010).

Green turtles are susceptible to fisheries bycatch, particularly in nearshore artisanal fisheries. These fisheries use a diverse variety of gears, including long-lining, drift gillnets, set-nets, pound-nets, trawls, and others. Despite operating in the areas with the greatest density of adult green turtles, artisanal fisheries are typically the least regulated of all fisheries (NMFS & USFWS 2007a). Industrial fisheries such as the Hawaii-based deep-set and American Samoa longline fisheries also interact with green turtles, especially juveniles. Harvest of green turtles for their meat, shells, and eggs has been a major factor in the past declines of green turtles. Although reduced from previous levels, legal and illegal harvest of adults and eggs continues in most of the NA described above, and remains a major factor in some parts of the species' range, including in the Marianas.

Although green sea turtles are probably beginning to be affected by impacts associated with anthropogenic climate change (described in more detail in the Environmental Baseline section below), no significant climate change-related impacts to hawksbill turtle populations have been observed to date.

3.3.4 Conservation of the Species

Green turtles nesting in the US have benefited from both State and Federal laws passed in the early 1970s banning the harvest of turtles and their eggs. Protection and management activities since 1974 throughout the Hawaiian Archipelago and habitat protection at the French Frigate Shoals nesting area since the 1950's have resulted in increased population trends of both nesting and foraging turtles (Balazs and Chaloupka 2004). Elsewhere, the protection of nesting beaches against large-scale egg harvest appears to have reversed some downward nesting trends. Using long-term data sets, encouraging trends in green turtle nester or nest abundance over the past 25 years has become apparent in at least six locations including Hawaii, Australia, Japan, Costa Rica and Florida (Chaloupka *et al*. 2008a).

Efforts to reduce fisheries bycatch, such as the improvements made in the Hawaii-based longline fishery since the 1990s, has reduced green turtle interactions (NMFS & USFWS 2007a).

Internationally, the conservation and recovery of green turtles is facilitated by a number of regulatory mechanisms at international, regional, national and local levels, such as the Food and Agricultural Organization of the United Nations (FAO) Technical Consultation on Sea Turtle-Fishery Interactions, the Inter-American Convention for the Protection and Conservation of Sea Turtles, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and others. As a result of these designations and agreements, many of the intentional impacts on sea turtles have been reduced: harvest of eggs and adults have been slowed at several nesting areas through nesting beach conservation efforts and an increasing number of community-based initiatives are in place to slow the take of turtles in foraging areas (Gilman *et al*. 2007; NMFS & USFWS 2007a).

3.4 Hawksbill Sea Turtles

Hawksbill turtles are distributed around the world, and can be found in the Pacific, Indian, and Atlantic Oceans, but not in the Mediterranean Sea, as described in the most recent hawksbill turtle 5-year status review (NMFS & USFWS 2007b). As shown above in Table 1, in 1978, all hawksbill turtles are listed as endangered under the ESA. Hawksbills are the most tropical sea turtle species, ranging from approximately 30° N latitude to 30° S latitude. They are closely associated with coral reefs and other hard-bottom habitats, but are also found in other habitats including inlets, bays, and coastal lagoons. There are only five remaining nesting aggregations with more than 1,000 females nesting annually. These nesting aggregations are in the Seychelles, Mexico, Indonesia, and two in Australia (NMFS and USFWS 2007b). The global population has declined by more than 80 percent over the last three generations. Hawksbills face many of the same threats affecting green sea turtles. In addition, there continues to be a commercial market for hawksbill shell products, despite protections afforded to the species under U.S. law and international conventions (NMFS and USFWS 2007b).

3.4.1 Distribution and Abundance

Globally, most of the important hawksbill sea turtle nesting populations declined substantially during the 20th century. Hawksbill turtles are distributed across three major ocean basins; the Atlantic, the Indian, and the Pacific. Following are brief descriptions of distribution and abundance of hawksbill sea turtles in the three major ocean basins, with more detail provided for the Pacific Basin and the Hawaiian Archipelago where the action area is located.

Atlantic Ocean

In the western Atlantic, the largest hawksbill nesting population occurs on the Yucatán Peninsula of Mexico. Nesting also occurs in Antigua, Barbados, Costa Rica, Cuba, and Jamaica. Within the U.S., nesting occurs in Puerto Rico, the U.S. Virgin Islands, and along the southeast coast of Florida. At the two principal nesting beaches in the U.S. Caribbean where long-term monitoring has been carried out, populations appear to be increasing (Mona Island, Puerto Rico) or stable (Buck Island Reef National Monument, St. Croix, USVI) (NMFS and USFWS 2007b).

Indian Ocean

Of the approximately 83 nesting rookeries that have been identified for hawksbill sea turtles, 31 occur in the Indian Ocean. Many of those nesting areas are relatively small hosting 100 or fewer nesting females annually. However, some nesting rookeries in Madagascar, Iran, and Western Australia may have as many as 1,000 to 2,000 nesting females annually. Based on the number of nesting females the population trends at the 31 nesting rookeries over the recent past (last 20 years) have remained stable in two locations, declined at five, and are unknown for 24. Historically (20 to 100 years ago), population trends at these nesting rookeries were in decline at 17 sites and are unknown for 14 (NMFS and USFWS 2007b).

Pacific Ocean

Hawksbill turtles nest broadly in the Pacific, including on the islands and mainland of Southeast Asia, from China to Japan, and throughout the Philippines, Malaysia, Indonesia, Papua New Guinea (PNG), the Solomon Islands, and Australia, with the largest nesting concentration occurring on remote islands in the GBR area. However, along the eastern Pacific Rim where nesting was common in the 1930s, hawksbills are now rare or absent (NMFS and USFWS 2007b). Hawksbill nesting information is available for eight locations within Oceania: GBR, PNG, Solomon Islands, Vanuatu, Fiji, Micronesia (Federated States of Micronesia (FSM) and Palau), the Samoan Islands (Western Samoa and American Samoa), and the Mariana Islands. Hawksbill nesting may occur elsewhere within the range of this population, but little to no information is available, and nesting activity at those sites is thought to be very low. Based on the best information currently available, about 5,400 to 6,100 hawksbill turtles nest annually in Oceania, (NMFS 2010b) and the overall trend is downward (NMFS & USFWS 2007b).

Hawaiian Archipelago

Nearly all hawksbill nesting and foraging in Hawaii occurs in the MHI. Although there has been no directed monitoring for hawksbills in the NWHI, there have been at least six recorded observations of hawksbills and two potential historic records of hawksbill nesting from that area (Van Houtan *et al*. 2012). It is difficult to determine the full extent of hawksbill nesting in Hawaii, including the identification of new nesting beaches. Females nest in a variety of habitats including black and white sand beaches, small pocket coves covered in cobbles or rugged lava, and up in beach vegetation. Tracks are often difficult to detect on some of the beach substrates favored by Hawaii's hawksbills, and nesting may occur at sites that are difficult to access. Also, not all sites are active every year, and the annual nesting activity at each site fluctuates.

Since monitoring began in 1989, hawksbill nesting activity has been confirmed at 22 sites in the MHI; 13 on the Island of Hawaii, 8 on Maui, and 1on Molokai. There also may be occasional nesting on the windward coast of Oahu. Since flipper tagging began in 1991, over 100 individual nesting females have been tagged on Hawaii and seven on Maui. Over 90% of the documented hawksbill nesting activity in Hawaii occurs along the Kau Coast of the Island of Hawaii. Between 5 and 15 females likely nest annually on Hawaii's beaches. Regular nesting also occurs on Maui and Molokai. In Hawaii, the average hawksbill clutch size is 175 eggs, and incubation typically lasts about two months (Seitz et al. 2012). According to satellite tracking, the Hamakua Coast of the Island of Hawaii appears to be an important foraging area for hawksbill sea turtles that nest on Hawaii's beaches.

Although more samples are required to establish a conclusive baseline, genetic samples collected and analyzed thus far (n = 47) suggest that Hawaii's hawksbill sea turtles may be genetically and geographically distinct from other populations in the Pacific (Dutton and Leroux 2008). Parker *et al*. (2009) report that the tracks of nine post-nesting tagged females have all remained within the MHI, further supporting the possibility that Hawaii's hawksbill sea turtles may be a discrete central Pacific population. Data are insufficient to estimate hawksbill density in Hawaiian waters and within the action area. However, hawksbill sea turtles are much less common than greens.

3.4.2 Life History Characteristics Affecting Vulnerability to Proposed Action

As with green turtles, hawksbills hatch at their natal beaches, hatchlings spend several years of early development in the oceanic (pelagic) zone. At about 35 cm carapace length, juveniles recruit to coastal areas where post-recruitment juveniles and adults forage and mature in shallow coastal areas, feeding primarily on sponges, but also on other benthic invertebrates, coral, and algae. Hawksbills in Hawaii have been documented foraging on a variety of prey including octopus, various algal species, fire worms, black sponges, fish roe, and urchins (King 2011). When on their foraging grounds, post-recruitment hawksbill turtles are often referred to as "residents". While in coastal areas, the majority of sea turtles spend their time at depths less than 16 feet (5 m) below the surface (Schofield *et al.* 2010, Hazel *et al.* 2009).

Upon reaching sexual maturity, adult hawksbills typically undertake long migrations between their resident foraging grounds and their natal nesting areas, where they mate and females nest. As with greens, nesting females are referred to as "nesters", which distinguishes them from "resident" turtles that regularly forage in that area. Although males also make mating migrations, because they do not crawl out on the beach as the females do, those males are nearly impossible to distinguish from the resident males. As with green turtles, hawksbill forage grounds and natal nesting areas are frequently located in different island groups, and residents at a given island group may originate from multiple natal nesting areas (NMFS & USFWS 2007b). Two post-nesting hawksbills were fitted with satellite tags on Tutuila, American Samoa; one migrated several hundred km to Western Samoa, and the other migrated more than 1,000 km to the Cook Islands (Tagarino *et al*. 2008). Post-nesting hawksbills on the GBR are reported to migrate more than 2,000 km (Miller *et al*. 1998). However, as discussed above in the Hawaiian Archipelago subsection, tagging studies suggest that hawksbills nesting in Hawaii remain within the MHI to forage. As such hawksbills in the Hawaiian Archipelago may be a discrete central Pacific population that does not undertake the long migrations between resident foraging grounds and natal nesting areas that are common for other populations (Parker *et al*. 2009).

Research into turtle hearing is limited, and no specific information is available for hawksbills. However, based on the similarity in hearing between greens and loggerheads, and the hawksbill's close taxonomic relationship to these species, NMFS considers it likely that hawksbill hearing is also similarly specialized for low frequencies. As described above, green turtles are thought to be most acoustically sensitive between 200 and 700 Hz (Ridgway *et al.* 1969). Loggerhead (*Caretta carreta*) hearing is very similar to that of greens, being most sensitive between 250 and 1,000 Hz (Bartol *et al*. 1999). Because the hearing range of hawksbill sea turtles likely overlaps with the expected frequency range of the pile driving signals, NMFS considers it likely that hawksbills can hear, and respond to pile driving noise. Existing information about sea turtle sensory biology also suggests that sea turtles rely more heavily on visual cues, rather than auditory, to initiate threat avoidance (Hazel *et al*. 2007).

Based on the description of the proposed action and on hawksbill turtle life history characteristics, post-recruitment juvenile and adult hawksbill turtles sheltering and foraging near

Honolulu Harbor are the life stages most likely to be affected by the expected high intensity noise from pile driving. It is currently uncertain if the hawksbill turtles found around Oahu would migrate outside of the archipelago. However, NMFS expects that they would remain within the Hawaiian Archipelago.

3.4.3 Threats to the Species

Global threats to turtles are described in the 5-year review. As discussed for green turtles (Section 3.1.3), destruction and alteration of habitat, as well as direct harvest are considered the major threats to hawksbills. Climate change also appears to be a growing threat. Destruction and alteration of hawksbill nesting and foraging habitats is occurring throughout the species' global range, especially through coastal development, beach armoring, beachfront lighting, vehicular/ pedestrian traffic, invasive species, and pollution from discharges and runoff. The adverse impacts of these threats described for greens, are virtually the same for hawksbills (NMFS & USFWS 2007b), so they are not repeated here. Although hawksbills interact with some fisheries, their bycatch rates are much lower than for the other sea turtle species, particularly with industrial fisheries.

Harvest of hawksbill shells and eggs continues to be a major threat. Due to the beauty of their shells, hawksbill adults may be harvested more heavily than other sea turtle species. Despite protections under CITES, the "tortoiseshell" trade continues in many areas. As with other sea turtle species, egg harvest continues unabated in parts of the Pacific, including Southeast Asia, Melanesia, and Polynesia (NMFS & USFWS 2007b). Kinch (2007) estimates that about 250 hawksbill turtles are sold annually in Port Moresby, but this may represent only a small fraction of the overall subsistence and semi-commercial take of hawksbills in PNG. It is estimated that large numbers of hawksbill turtles from Australian rookeries are being harvested in neighboring countries including Indonesia, PNG, Solomon Islands and Fiji to supply meat and/or tortoiseshell for use locally or for export.

Although hawksbill sea turtles are probably beginning to be affected by impacts associated with anthropogenic climate change (described in more detail in the Environmental Baseline section below), no significant climate change-related impacts to hawksbill turtle populations have been observed to date.

3.4.4 Conservation of the Species

Numerous conservation programs are being implemented around the world to protect nesting habitat and reduce harvesting and fisheries bycatch of all sea turtle species, and numerous regulatory mechanisms are in place at international, regional, national and local levels to protect sea turtles (Section 3.3.4 above). Many of these programs likely benefit hawksbills. However, hawksbills continue to decline rapidly in the Pacific and Indian Ocean areas (NMFS & USFWS 2007b).

4 Environmental Baseline

The environmental baseline for a biological opinion includes: past and present impacts of all State, Federal, or private actions and activities in the action area; the anticipated impacts of all proposed Federal projects in the action area that have already undergone Section 7 consultation; and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The Consultation Handbook further clarifies that the environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area (USFWS & NMFS 1998). The purpose of describing the environmental baseline in this manner within a biological opinion is to provide the context for the effects of the proposed action on the listed species. As described in Section 2 above, the action area for this consultation consists of the nearshore waters within 4.7 kilometers of Honolulu Harbor on Oahu (Figure 1). The past and present impacts of human and natural factors leading to the status of humpback whales, Hawaiian monk seals, as well as green and hawksbill sea turtles within the action area include coastal development, fishing interactions, vessel strikes, direct take, marine debris, and climate change.

Oahu is a subtropical island of volcanic origin that is surrounded by coral reefs. It is the third largest island in the Hawaiian Islands, with a land area of about 600 $miles^2$ (1,554 km^2), and is the most populated, with a population of about 1 million residents, and about 5 million visitors annually. In its greatest dimensions, it is about 44 miles (71 km) long by about 30 miles (48 km) across, with about 112 miles (180 km) of shoreline. The island has two mountain chains; the Ko'olau along the eastern (windward) coast, and the Waianae along the western (leeward) coast, where the highest point, 4,000 ft (1,220 m) Mt. Kaala is located. Between these chains lays a saddle of rick volcanic soil (red dirt).

Honolulu is located near the middle of Oahu's southern shore. The city is the State's Capitol and business center. The surrounding area is highly developed, and is home to about 75% of the island's population. Much of the existing adjacent shoreline, from Pearl Harbor on the west to Diamond Head on the east, is manmade; the result of massive dredge and fill operations that started before 1900. Evidence of this work is clearly visible in aerial/satellite imagery of the area, and includes Honolulu Harbor, the reef runway at Honolulu International Airport, and the famous Waikiki area.

The nearshore marine environment off Honolulu, Mamala Bay, has been degraded by impacts from: shoreline development; sediment-laden runoff; and pollution from run-off and years of poorly treated wastewater effluent. Sewage has been pumped into Mamala Bay since the 1930s. The early effluents consisted of raw sewage released in shallow water (about 20 feet in depth). Currently, three main wastewater treatment plants (WWTP) (Sand Island, Fort Kamehameha, and Honouliuli) discharge effluent into Malama Bay. The present Sand Island deep-water outfall was constructed in 1978; discharging an average of about 70 million gallons per day, at a depth of about 235 feet, about 9,000 feet from shore. All three WWTP discharge into deep water now, but provide only primary level treatment of wastewaters. Other notable discharges to Mamala Bay include runoff from the Ala Wai Canal (into which Manoa Stream discharges); Nuuanu, Kapalama, Kalihi, and Moanalua Streams; other small streams and drainage channels; and Pearl Harbor, which receives runoff from five perennial and three intermittent streams. The south shore is also seasonally impacted by high surf that is generated by southern hemisphere storms during the summer. High surf mobilizes rubble and sand resulting in the scour of benthic sessile species such as corals.

Mamala Bay has been used as a dumping ground for dredged materials from both Pearl Harbor and Honolulu Harbor. Until about 1960, dredge spoils were dumped at a variety of locations just outside of Honolulu Harbor (Brock 2011). The remaining active dump site for dredged materials in Mamala Bay is the South Oahu Site, which was approved for use by the U.S. EPA in 1980. That site is about 1.5 miles west of the proposed HSWAC seawater intake site. In addition to disposal of dredged spoils, parts of Mamala Bay have been used as deep-water munitions disposal sites for discarded military munitions (DMM).

The action area continues to be impacted by vessel traffic and commercial shipping. As the state's main commercial harbor, large freighters, tugs and barges, commercial fishing boats, and US Coast Guard vessels regularly enter and leave Honolulu Harbor. Large commercial ships regularly anchor at the off shore anchorages south of the entrance channel. Commercial fishing boats, charter vessels, and recreational craft operate out of the Kewalo Basin Marina (to the east), and US Navy vessels from Pearl Harbor (to the west) regularly transit the area. Tow cables between tugs and barges droop and regularly drag across the seafloor as at the harbor's entrance, scouring the benthic environment (Brock 2011). Similarly, the seafloor is regularly scoured by mooring chains as vessels anchored off shore swing around their anchors. The propulsion and machinery noise, as well as the fathometers from the near constant vessel traffic increases the in-water background noise level of Malama Bay.

The shoreline at Kakaako, under which the microtunneler would bore, consists of rock riprap. From the shoreline, out to between 50 and 100 m from shore (out to a depth of about 6 m), the seafloor consists primarily of scoured limestone. Beyond the scoured zone, the seafloor supports scattered live corals in a band that ends between about 500 and 1,000 m from shore, at a depth of about 33 feet (10 m). Limestone ridges and channels (spur and groove habitat), oriented roughly perpendicular to the shore, characterizes the inner reaches of this zone, with sand and rubble in the grooves. Corals are commonly seen on the ridges and other hard structures and outcrops that are above the sand-scour that occurs during high surf. Coral cover tends to increase with depth and distance from shore, and may reach as high as 75% in some areas, but is estimated to be about 15 to 20% on the ridges close to the proposed receiving pit. Octopus, gastropod and bivalve mollusks, sea stars and sea cucumbers, worms, and crustaceans, along with common Hawaiian reef fishes, such as parrotfish, jacks and goatfish are commonly found in this zone.

The spur and groove habitat becomes less pronounced with distance from shore, typically sloping seaward to coalesce with the sloping seafloor, giving way to open expanses of dredged coralline rubble and sand that starts at a depth of about 33 feet (10 m), extends as a near-continuous feature to a depth of at least 200 feet (61 m). Coral and benthic communities are much less developed in this zone, with mean coral coverage at less than 0.1% (Brock 2011). Scattered concrete rubble and metallic debris provide sporadic areas of shelter where fish communities are better developed. Macro invertebrates include sea urchins, sea stars, oysters, and some sponges. At a depth of about 60 to 70 feet, the slope of the seafloor steepens, forming ledge that ends at about 100. The seafloor slopes gently beyond that until it reaches a depth of about 320 feet, where it again breaks steeply, down to a depth of about 600 feet before it again slopes gently downward.

Nearshore fisheries on Oahu consist of a mix of subsistence and recreational fishing, and relatively small-scale commercial fisheries for coral reef, bottomfish, and pelagic species. Contemporary methods include: boat-based and land-based hook-and-line fishing (handline or rod-and-reel), net fishing (cast, gill, drag, and surround net), spear fishing, hook and gaff, and gleaning (Hensley and Sherwood 1993). Nearshore fisheries occasionally result in the hooking or entanglement of monk seals and sea turtles. Gillnets are the most problematic for seals and turtles, because the nets are left untended, and entangled animals often drown. Hook-and-line fishing also hooks or entangles monk seals and turtles, but the chance of survival is higher than if caught in a gillnet. As described in the status of the species section above, 38 hookings and 5 gillnet entanglements involving monk seals were reported in the MHI between 1982 and 2006. In a study of stranded green turtles in Hawaii (stranded turtles are injured, sick, or dead turtles found on shore), the second and third most common known causes of stranding were fishing related. Hook-and-line fishing gear-induced trauma accounted for 7%, and gillnet fishing gear-induced trauma was responsible for 5% (Chaloupka *et al*. 2008b). However, because most turtles drowned in fishing gear probably sink rather than strand, it is very difficult to estimate the total number of green turtles killed annually by nearshore fishing interactions (NMFS 2008a).

As described in the status of the species section, many humpback whales are killed each year by ship strikes around the world, with calves and juveniles being especially vulnerable. Vessel collisions with humpback whales in Hawaii are on the rise. Collisions in Hawaii have risen from about 3 or 4 collisions annually in 2001, to an average of just under 7 in 2011, with a high of 13 collisions reported during the 2009 humpback whale season (Lyman 2011). Hazel *et al*. (2007) report that vessel collision is a significant source of anthropogenic mortality for marine turtles. Based on data for the period of 1998 to 2007, NMFS (2008a) estimated total number of green turtles killed annually by boat collisions in the MHI was between 25 and 50. The estimated number of hawksbills similarly killed was much lower; between 0.2 and 0.4 turtles annually. Marine debris continues to accumulate in the ocean and along shorelines within the action area. Turtles may become entangled and drown, and ingested trash may cause intestinal blockage and death. Between October 2004 and September 2008, the American Samoa Department of Marine and Wildlife Resources (DMWR) necropsied 4 green turtles that stranded on Tutuila. Two of those turtles had plastic and aluminum in their guts (Tagarino *et al*. 2008). However, because only a small percent of dead or dying sea turtles strand, little information is available to adequately quantify the impacts on green and hawksbill turtles that may result from ingestion of marine debris. It is reasonable to expect that turtles here and elsewhere are equally likely to ingest marine debris they encounter as are turtles in American Samoa. Accumulated marine debris on nesting beaches can also impede nesting success by altering nest excavation and through potential entrapment of hatchlings under debris that is inadvertently buried over them when the nesting female covers the clutch. Although the NWHI is outside of the action area, marine debris often accumulates heavily on the nesting beaches at FFS and other locations in the NWHI, which can directly impact the green turtle population found in action area.

Climate refers to average weather conditions within a certain range of variability. The term climate change refers to distinct long-term changes in measures of climate, such as temperature, rainfall, snow, or wind patterns lasting for decades or longer. Climate change may result from: natural factors, such as changes in the Sun's energy or slow changes in the Earth's orbit around the Sun; natural processes within the climate system (e.g., changes in ocean circulation); and human activities that change the atmosphere's makeup (e.g., burning fossil fuels) and the land surface (e.g., cutting down forests, planting trees, building developments in cities and suburbs, etc.), also known as anthropogenic climate change (U.S. Environmental Protection Agency). The global mean temperature has risen 0.76°C over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (Solomon *et al.* 2007). Sea level rose approximately 17 cm during the 20th century (Solomon *et al.* 2007) and further increases are expected. Climate change is a global phenomenon so resultant impacts have likely been occurring in the action area. However, scientific data describing impacts in the action area are lacking, and no climate change-related impacts on ESA-listed marine species within the action area have been reported to date.

Climate change is likely beginning to affect marine mammals found in the action area through the impacts of changes in ocean temperature and chemistry, and possibly by rising sea level. The ranges of cetaceans and pinnipeds may be affected by the resulting changes in water temperature, and they may encounter changes in prey availability in current foraging areas. Highly mobile species, such as oceanic cetaceans, can respond to effects of climate change more rapidly than their terrestrial counterparts (Harwood 2001). The most likely impact of climate change on cetaceans will be changes in range related to migration, expansion, or contraction of the geographic thermal niche populations currently occupy, or changes in the distribution of prey species with particular thermal requirements, or changes in prey availability due to changes in ocean productivity. MacLeod (2009) suggests that thermal and prey limitations related to anthropogenic climate change are unlikely to impact the range of humpback whales throughout the world's oceans.

Oceanic cetaceans are unlikely to be directly affected by sea level rise. However, important habitats for coastal species and species that require coastal bays and lagoons for breeding, such as humpback whales, could be affected in the future (Simmonds and Elliot 2009). The loss of shoreline and shallow coastal habitats could impact Hawaiian monk seal reproduction through their dependence on low-lying beach areas and shallow inshore waters to give birth and wean their young. As described in the status of the species section above, loss of terrestrial habitat in the NWHI is an issue of concern. Many of the islands, atolls, and sand bars used by monk seals are low-lying and vulnerable to erosion due to increased storms and sea level rise (NMFS 2007).

Climate change is likely beginning to affect green and hawksbill sea turtles found in the action area through the impacts of rising sand temperatures, rising sea level, and changes in ocean temperature and chemistry. Turtle gender determination is affected by nest temperatures; with higher temperatures producing more females, and lower temperatures producing more males. While sex ratios vary naturally within and among seasons and nesting locations, several turtle species exhibit female bias throughout their major rookeries worldwide (Chan and Liew 1995; Godfrey *et al.* 1996; Marcovaldi *et al.* 1997; Binckley *et al.* 1998; Godfrey *et al.* 1999; Godley *et al.* 2001; Oz *et al.* 2004; Kaska *et al.* 2006). However, monitoring data over a long enough timescale to discern climate change related trends in sex ratio have not been collected in the action area. There are several predictions for potential future sea turtle nesting habitat loss due to sea level rise (Fish *et al*. 2005; Baker *et al*. 2006; Fuentes 2009). However, available data are insufficient to determine an existing correlation between past sea level rise and sea turtle population dynamics (Van Houtan 2010).

Climate change-induced elevated water temperatures, altered oceanic chemistry, and rising sea level may be contributing to changes to coral reef and seagrass ecosystems that provide resting and foraging habitat for some sea turtles, although it is difficult to distinguish impacts of climate-related stresses from other stresses that produce more prominent short term effects (Parry *et al*. 2007). Climate change-induced shifts in ocean productivity linked to temperature changes (Harwood 2001; Edwards and Richardson 2004; Hays *et al*. 2005) may affect foraging strategies and therefore reproductive capacity for sea turtles (Solow *et al*. 2002; Chaloupka *et al*. 2008c, Van Houtan and Halley 2011; Van Houtan 2010), similar to what has been observed during El Nino events in the Pacific (Limpus and Nicholls 1994; Chaloupka 2001; Saba *et al*. 2007; Reina *et al*. 2008). These shifts in abundance of foraging resources are also directly linked to observed modifications in phenology for sea turtles such as longer re-migration intervals and temporal shifts in nesting activity (Weishampel *et al*. 2004; Hawkes *et al*. 2007). However, at this time it is only possible to speculate as to the implications of such impacts, as findings raise numerous follow up questions (Weishampel *et al*. 2004) including whether earlier nesting will affect overall fecundity, clutch size, incubation length, hatch success, mating synchrony, and sex ratio. Changes in reproductive capacity and temporal shifts of nesting activity associated with changing environmental conditions have not been studied specifically in the action area.

Climate change may affect sea turtles through range expansion or reduction and changes in migration routes (Robinson et al. 2008). For example, leatherbacks have extended their northern range in the Atlantic by 330 km in the last 17 years as warming has caused the northerly migration of the 15°C sea surface temperature (SST) isotherm, the lower limit of their thermal tolerance (McMahon and Hays 2006). Similar studies on changes in migration routes have not been done for greens and hawksbills in the Pacific. Therefore, it is not possible to say with any degree of certainty whether or not, or to what degree their migration routes and ranges have been or may be affected.

Attempting to determine whether recent biological trends are causally related to anthropogenic climate change is complicated because non-climatic influences dominate local, short-term biological changes. However, the meta-analyses of 334 species and the global analyses of 1,570 species show highly significant, nonrandom patterns of change in accord with observed climate warming in the twentieth century. In other words, it appears that these trends are being influenced by climate change-related phenomena, rather than being explained by natural variability or other factors (Parmesan and Yohe 2003). However, the implications of these changes are not clear in terms of population level impacts, and data specific to the action area are lacking. Over the long-term, climate change-related impacts could influence the biological trajectories of ESA-listed species on a century scale (Parmesan and Yohe 2003). However, due to a lack of scientific data, the specific effects climate change could have on these species in the future are not predictable or quantifiable to any degree that would allow for more detailed analysis in this consultation.

5 Effects of the Action

In this section of a biological opinion, NMFS assesses the probable effects of the proposed action on threatened and endangered species. Effects of the Action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that would be added to the environmental baseline. Direct effects are caused by exposure to the action related stressors that occur at the time of the action. Indirect effects are those that are likely to occur later in time (50 CFR 402.02). The effects of the action are considered within the context of the Status of the Species, together with the Environmental Baseline and Cumulative Effects sections of this Opinion to determine if the proposed action can be expected to have direct or indirect effects on threatened and endangered species that appreciably reduce their likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (50 CFR 402.02), otherwise known as the jeopardy determination. Since no critical habitat has been designated for marine species in the MHI, critical habitat will be discussed no further in this analysis.

Approach. NMFS determines the effects of the action using a sequence of steps. The first step identifies potential stressors associated with the proposed action with regard to listed species. NMFS may determine that some potential stressors result in insignificant, discountable, or beneficial effects to listed species, in which case these potential stressors are considered not likely to adversely affect listed species, and subsequently are considered no further in the opinion. Those stressors that are expected to result in significant negative (i.e., adverse) effects to listed species are analyzed via the second, third, and fourth steps described below.

The second step identifies the magnitude of the stressors (e.g., how many individuals of a listed species would be exposed to the stressors; *exposure analysis*). In this step of our analysis, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to a proposed action's effects, and the populations or subpopulations those individuals represent.

The third step describes how the exposed individuals are likely to respond to the stressors (*response analysis*). In this step, NMFS determines if the stressors are likely to result in any of the components of take as defined under the ESA (e.g., harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct).

The final step in determining the effects of the action is to establish the risks those responses pose to listed resources (*risk analysis*). The risk analysis is different for listed species and designated critical habitat. However, the action area does not include designated critical habitat, thus it is not considered in this opinion. Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (probability of extinction or probability of persistence) of listed species depends on the viability of their populations. Thus, this final step first determines the risk to affected populations posed by the proposed action, then relates that risk to the species as listed.

5.1 Stressors

The following 8 potential stressors may occur due to the proposed action: exposure to elevated noise levels; entrainment; collision with vessels; direct impact by heavy equipment; disturbance from human activity and equipment operation; loss or degradation of sheltering and forage habitat; exposure to elevated turbidity; and exposure to wastes and discharges. NMFS has reviewed each of the stressors to determine if their effects are expected to be significant (e.g. intensity of the impact), discountable (how likely it is to occur), or beneficial (positive effect). Those that are insignificant, discountable, or beneficial will not be discussed further in this opinion.

5.1.1 Elevated Noise Levels

Project construction is expected to involve about 10 weeks of in-water pile driving that would cause high-intensity in-water noise. Exposure to this noise may impact marine mammal and turtle hearing and may result in behavioral impacts. These impacts are considered adverse effects. Because the potential for adverse effects from exposure to pile driving noise is considered greater than discountable, the effects of this stressor will be addressed below in the exposure-response-risk analyses. Operation to the HSWAC would require the operation of pumps that are expected to have a combined source level of 104 dB re 1 μPa (Berg pers. Comm. 2012). Because the pumps would be located well inland, and the combined source level is well below the threshold for behavioral affects in marine mammals, NMFS expects that exposure to operational noise from the HSWAC would have insignificant affects on marine mammals and sea turtles. As such, operational noise will be discussed no further in this opinion.

5.1.2 Entrainment

The proposed action would include the installation of an open-ended (unscreened) 63-inch diameter pipe that would intake water at about 1,755 feet below the surface. The intake would be oriented vertically with aperture about 14 feet above the sea floor. The maximum intake flow velocity would be about 5 feet per second (3.4 miles per hour) (USACE 2012). Based on habitat preferences and diving abilities, NMFS considers it discountable that green or hawksbill sea turtles as well as humpback whales would encounter the intake. However, Hawaiian monk seals are known to dive to and forage at depths equal to or greater than the planned intake's depth. As such, monk seals may encounter the intake.

The applicant's initial design planned for an open (unscreened) intake. However, due to input from NMFS and other stakeholders, the applicant considered the installation of a screening device, and engaged NMFS Protected Resources Division and the NMFS PIFSC monk seal team to assess the issue. The size of the screen openings was a significant concern. Screen openings would need to be fairly large, otherwise flow would be restricted, but if the holes are large enough, seals could get their heads stuck in the screen. Smaller holes would restrict flow, and clog faster due to fouling. Constricted flow across the screen would require pumps to operate harder, increasing costs and reducing system efficiency. It would also increase the suction effect at the screen because the water would have to move faster though the constriction in order to maintain desired flow volumes. Based on the best information available, NMFS considers it likely that the presence of a screen could increase the probability of a seal becoming impinged (pinned against the screen) by the inflow, as compared to being able to freely swim out of the inflow of an open-ended intake. NMFS also believes that fouling organisms on the screen could entice seals to investigate the intake more closely than they may have otherwise.

NMFS expects that exposure to inflow would discourage seals from closer approach, and that based on the maximum expected flow velocity, as well as monk seal swimming speed and agility, any monk seal that might encounter the in-flow would be able to swim away from the open intake. Thus, NMFS considers that the risk of monk seal entrainment in the intake is discountable, and this stressor will be discussed no further in this opinion.

5.1.3 Collision with vessels

The proposed action would involve the use vessel operations in the nearshore waters south of Oahu. Marine mammals and sea turtles must surface to breathe, and they are known to rest or bask at the surface. Therefore, when at or near the surface, they are at risk of being struck by vessels or their propellers as project-related vessels transit to and from the project site. Potential injuries and their severity will depend on the speed of the vessel, the part of the vessel that strikes the animal, and the body part impacted. Injuries from boat strikes may include bruising, broken bones or carapaces, and lacerations. The recovery plan for humpback whales reports that collision with ships is an increasing threat for these whales, and that the incidence of collision is expected to increase as vessel size, speed, and traffic density increases, or as animal density increases (NMFS 1991). The website for the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) reports 38 confirmed vessels strikes of humpback whales in Hawaiian waters from 1975 to 2007, with 13 of those occurring during the 2006 and 2007 whale seasons alone (HIHWNMS 2012). The recovery plan for green sea turtles also reports that boat collision is a major threat around the MHI (NMFS & USFWS 1998a). Although not identified as a significant risk for monk seals or hawksbill sea turtles, the recovery plans for both animals report that collisions have occurred (NMFS & USFWS 1998b, NMFS 2007).

Vanderlaan and Taggart (2007) report that the severity of injury to large whales is directly related to vessel speed. They found that the probability of lethal injury increased from 21%, for vessels traveling at 8.6 kts, to over 79% for vessels moving at 15 kts or more. Additionally, since collisions with whales have been reported for both slow and fast moving craft, it appears that, in at least some situations, whales may either be unaware of a vessel's presence or unable to resolve its proximity and/or vector of travel based on available acoustic cues. Existing information about sea turtle sensory biology suggests that sea turtles rely more heavily on visual cues, rather than auditory, to initiate threat avoidance. Research also suggests that sea turtles cannot be expected to consistently notice and avoid vessels that are traveling faster than 2 knots (kts) (Hazel et al., 2007). Consequently, vessel operators must be responsible to actively watch for and avoid marine mammals and sea turtles, and to adjust their speed based on expected animal density and on visibility conditions to allow adequate reaction time to avoid marine animals. Based on the expectation that the project would require a relatively low number of vessel trips, and on the expectation that the vessels would be operated in accordance with BMP that require vessel operators watch for and avoid protected marine species and to operate at reduced speeds, NMFS considers that the risk of collisions between project-related vessels and marine mammals and sea turtles is discountable, and this stressor will be discussed no further in this opinion.

5.1.4 Direct Impact by Heavy Equipment

Should a marine mammal or a sea turtle be directly beneath pile driving equipment, an anchor, or the pipeline as it is deployed, they could be struck by that equipment when it is sent to the seafloor. Potential injuries and their severity would depend on the animal's proximity to the bottom when struck, the angle of the strike, and the body part impacted. Injuries could include cuts, bruises, broken bones, cracked or crushed carapaces, and amputations, any of which could result in the animal's death. However, the proposed work would involve relatively stationary activity that would be restricted to a small area or would proceed slowly as the pipeline was carefully lowered to the seafloor. NMFS expects that marine mammals and sea turtles in the vicinity of project activities would most likely avoid the area due to the high level of in-water noise and human activity. Based on the information above, NMFS believes that marine mammals and sea turtles are both capable and likely to avoid the area, and we are unaware of any information that contradicts this conclusion. Also, the applicant has committed to watch for marine mammals and sea turtles, starting 30 minutes prior to commencing work, with work being postponed or halted when those animals are within 50 yards (46 m). As such, we have determined that the likelihood of a marine mammal or sea turtle being affected by direct impact with heavy equipment is discountable, and this stressor will be discussed no further in this opinion.

5.1.5 Disturbance from Human Activity and Equipment Operation

This stressor refers to construction-related disturbances other than exposure to elevated noise levels. Exposure to construction activities may startle marine mammals and sea turtles should they encounter them. As described above, marine mammals and sea turtles typically avoid human activity. NMFS expects that the most likely effect of this interaction would be a temporary avoidance behavior leading to an exposed animal leaving the project area without injury. Additionally, the contractor would reduce the likelihood of this interaction by watching for and avoiding marine mammals and sea turtles before commencing work and by postponing or halting operations when protected species are within 50 yards (46 m). Based on the information above, we expect that disturbances from human activity and equipment operation would be infrequent and non-injurious, resulting in insignificant affects on marine mammals and sea turtles. As such, this stressor will be discussed no further in this opinion.

5.1.6 Loss or Degradation of Sheltering and Forage Habitat

Humpback whales rest at or near the water's surface. They feed in the water column, and their feeding activity in Hawaiian waters is thought to be insignificant. Green and hawksbill sea turtles forage and shelter in relatively shallow water in areas with hard substrate, such as coral reefs and rocky shorelines that support forage resources and provide small caves and overhangs to shelter within; typically at depths less than 150 feet (46 m). Conversely, Hawaiian monk seals often forage in deep water habitats such as offshore talus fields and sandy areas.

The proposed marine receiving pit would result in the excavation of about 1,600 ft^2 (149 m^2) of marine substrate that is predominantly dredged coralline rubble at a depth of about 30 feet (9 m). This would be replaced with a concrete cap through which the intake and discharge pipes would emerge. About 964 concrete collar pedestals would be placed on the sea floor to support and anchor the pipelines between the receiving pit and the end of the intake pipe. The concrete collars would cover about 20,541 ft^2 (1,908 m^2) of benthic habitat. Of that area, about 6,913 ft^2 (643 m^2) would be impacted at depths of 150 feet or less, with 1,141 ft^2 (106 m^2) occurring in scattered coral habitat, and the remainder in dredged coralline rubble and/or sand. With the exception of the break-in-slope between 360 and 656 feet (110 and 200 m), the pipeline would transverse relatively flat and featureless areas.

Forage resources within the footprint of the receiving pit and under the footprint of the concrete collars, such as epibenthic macroalgae and sponges, and small fish and invertebrates that may be under rubble, would be lost. However, those resources currently occur at low densities in the majority of the affected area (Brock 2011, Kelley 2011). Also, out to the depth of about 150 feet, the pipes and collars would provide more than 84,000 ft^2 (7,800 m^2) of new hard substrate available for benthic recruitment. The pipes and collars would provide a total of about 604,000 ft^2 (56,100 m^2) of new hard substrate along the pipeline's entire length. Along much of its length, the pipeline would also increase structural complexity and provide increased shelter for small fish and invertebrate species in an area that currently provides limited vertical structure. Based on the best information available, we expect that the loss or degradation of sheltering and forage habitat due to the construction of the pipeline would be relatively small in scope and temporary in duration.

Operation of the system would result in returning seawater in the region of the discharge diffuser that would be colder, higher in nutrients, and lower in dissolved oxygen (O^2) than the receiving water. The applicant used the USEPA-approved CORMIX model to predict plume behaviors. The thermal plume model was based on the maximum discharge rate, the coolest expected discharge temperature (53° F/11.7° C), and an estimated minimum current velocity of 5 centimeters per second (cps) (10 feet per minute) (for slack tide periods), and an ambient temperature of 74.5° F at a depth of 300 feet (deepest depth modeled). Under these conditions, the CORMIX modeling suggests that the discharge plume would warm to 67.1° F before it contacts the seafloor. The plume would reach 72.7° F within 22 feet of the ports, and achieve 74.4° F within 600 feet (Berg 2012). Under mean current conditions, the plume would reach 72.7° F within 2 feet of the ports, but would still require about 600 feet to achieve ambient temperature.

The applicant also modeled the dilution of the elevated nutrients and reduced O^2, but did so based on the perceived need to meet State water quality standards for surface waters within a specified zone of mixing, and with the diffuser at a depth between 145 and 150 feet (former preferred alternative). As such, no specific information is available to describe distances from the diffuser where particular parameters of the effluent would approach ambient concentrations at the proposed diffuser location; on a steep slope between the depths of 326 and 423 feet. For the plume at 150 feet and a 5 cps current, the CORMIX model suggests that nitrate+nitrite nitrogen (the factor that would require the greatest dilution) would reach required dilution within 525 feet of the diffuser. The distance is reduced to 285 feet for mean current velocity.

In summary, the proposed action would place the discharge on a steep slope, at a depth near the bottom of the mixing layer, and well away from most known forage resources. The plume would tend to sink toward more similar water during its dilution. At its greatest distance, the plume is expected to dilute to ambient levels within 600 feet of the diffuser, but would more often reach ambient levels well within that range. Based on the best information available, the footprint of impact due to the operation of the HSWAC would be the benthic area within 600 feet of the diffuser. Within that area, low densities of marine organisms would be exposed to a gradient of elevated nutrient concentrations, and reduced O^2 saturation and temperatures that would be most intense at the diffuser. It is not possible to predict exactly how benthic resources would respond to this exposure over time, but NMFS expects that detectable impacts would be limited to the area immediately adjacent to the diffuser. As such, any degradation or reduction of forage resources due to HSWAC operation would be limited to an insignificantly small area.

Based on the information above, we expect that the impacts of HSWAC on sheltering and forage habitat would have insignificant affects on green and hawksbill turtles, as well as Hawaiian monk seals, and no effect on humpback whales. As such, this stressor will be discussed no further in this opinion.

5.1.7 Increased Turbidity

Since sea turtles and marine mammals breathe air instead of water, exposure to increased turbidity should not adversely affect their respiration or other biological functions. Although it is impossible to predict how individual animals might react to plumes of elevated turbidity, some may avoid dense turbidity plumes in favor of clearer water. The applicant would install a combination of a sheet pile wall and silt curtains around the marine receiving pit to contain sediments mobilized by the in-water excavation and backfill of the pit. As such, we expect that turbidity plumes would be small (limited to the area immediately adjacent to the work) and virtually undetectable outside of the silt curtains. Areal avoidance due to other project activities would likely extend beyond the extent of detectable plumes of elevated turbidity, and it is unlikely that any sea turtles or marine mammals would approach close enough to the work area to be exposed to project-related elevated turbidity. Based on this information, we expect that exposure to elevated turbidity would have insignificant impacts on sea turtles and marine mammals, and this stressor will be discussed no further in this opinion.

5.1.8 Wastes and Discharges

Construction wastes may include plastic trash and bags that may be ingested and cause digestive blockage or suffocation, or if large enough, along with discarded sections of ropes and lines, may entangle marine life. Equipment spills, discharges, and run-off from the project area could contain hydrocarbon-based chemicals such fuel oils, gasoline, lubricants, hydraulic fluids and other toxicants, which could expose protected species to toxic chemicals. Depending on the chemicals and their concentration, the effects of exposure may range between animals temporarily avoiding an area, to death of the exposed animals. Local and Federal regulations prohibit the intentional discharge of toxic wastes and plastics into the marine environment. Additionally, the applicant has incorporated into their proposed action conservation measures intended to prevent the introduction of wastes and toxicants into the marine environment. Based on the information above, we expect that construction-related discharges and spills would be infrequent, small, and quickly cleaned if they do occur. Therefore, we have determined that exposure to construction-related wastes and discharges would result in insignificant effects on sea turtles and marine mammals, and this stressor will be discussed no further in this opinion.

In summary, 1 of the 8 stressors associated with the proposed action (exposure to elevated noise levels) is considered likely to adversely affect humpback whales, Hawaiian monk seals, green sea turtles, and hawksbill sea turtles. This stressor is addressed in the exposure-response-risk analyses below. The other 7 stressors (entrainment, collision with vessels, direct impact by heavy equipment, disturbance from human activity and equipment operation, loss or degradation of sheltering and forage habitat, exposure to increased turbidity, and exposure to wastes and discharges) were determined to be not likely to adversely affect any of these species and are addressed no further in this opinion.

5.2 Exposure

This section analyzes the proposed action's potential for exposing green and hawksbill sea turtles, humpback whales, and Hawaiian monk seals to adverse levels of sound energy during pile driving operations.

5.2.1 Exposure to Elevated Noise Levels during Pile Driving

This analysis is based on the pile types, the method of driving, the expected substrate, and the duration of work as described in the ADFEIS for the proposed action (USACE 2012) and the expected source levels for similar pile driving actions, based on the California Department of Transportation's (CALTRANS) Compendium of Pile Driving Sound Data (Compendium) (CALTRANS 2007). The exposure analysis is organized as follows:

1: Estimate the in-water source level for the pile type.

2: Estimate the ranges where in-water sound energy would fall to current thresholds for expected effects.

3: Estimate the number of humpback whales, monk seals, and sea turtles potentially exposed to adverse levels of sound energy.

5.2.1.1 Estimate the in-water source level for each piling type:

As described in Section 2, the project would include three distinct periods of pile driving. Up to 2 weeks of impact pile driving would occur during October 2012 to test drive up to 12 20-inch (51-cm) diameter steel pipe piles. About 16 days of vibratory pile driving would be done during November 2012 or April 2013, to install 80 24-inch steel sheet piles around the marine receiving pit. During March to April 2013, up to six weeks of impact pile driving would done install 113 20-inch diameter steel pipe piles into concrete collars along the pipeline between the receiving pit and the 150-foot depth curve. The applicant estimates about 15 to 60 minutes of actual impact driving per day, with the rest of the time spent moving between locations and setting-up. Vibratory pile driving is expected to require several hours per each work day.

Acoustics Background. Sound is a mechanical disturbance consisting of minute vibrations that travel through a medium, such as air or water, and is generally characterized by several variables. Frequency describes the sound's pitch and is measured in hertz (Hz) or kilohertz (kHz), while sound level describes the sound's loudness and is measured in decibels (dB). Sound level increases or decreases exponentially with each dB of change. For example, 10 dB yields a sound level 10 times more intense than 1 dB, while a 20 dB level equates to 100 times more intense, and a 30 dB level is 1,000 times more intense. Sound levels are compared to a reference sound pressure, based on the medium, and the unit of measure is the micro-Pascal (μPa). The reference pressures are 20 μPa and 1 μPa, respectively for air and water. Root mean square (RMS) is the quadratic mean sound pressure over the duration of an impulse. RMS is used to account for both positive and negative values so that they may be accounted for in the summation of pressure levels (Hastings and Popper 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units rather than by peak pressures. For brevity, all further references to sound level assume dB_{rms} re 1 μPa, unless specified differently.

Sound Transmission in Water. Transmission loss (attenuation of sound intensity over distance) varies according to several factors in water, such as water depth, bottom type, sea surface condition, salinity, and the amount of suspended solids in the water. Sound energy dissipates through mechanisms such as spreading, scattering, and absorption (Bradley and Stern 2008). Spreading refers to the apparent decrease in sound energy at any given point on the wave front because the sound energy is spread across an increasing area as the wave front radiates outward from the source. In unbounded homogenous water, sound spreads out spherically, losing as much as 7 dB with each doubling of range. Toward the other end of the spectrum, sound may expand cylindrically when vertically bounded, such as by the surface and substrate, losing only about 3 dB with each doubling of range. In addition to spreading, sound energy can be lost through scattering and absorption. Scattering refers to the sound energy that leaves the wave front when it “bounces” off of an irregular surface or particles in the water. Absorption refers to the energy that is lost through conversion to heat due to friction. Irregular substrates, rough surface waters, and particulates and bubbles in the water column increase scattering and absorption loss. Soft substrates, such as mud and silt also increase absorption loss. Shallow nearshore waters, such as those south of Honolulu where pile driving would be done, are considered poor environments for acoustic propagation because sound typically dissipates rapidly due to increased scattering and absorption.

Accurately predicting received noise levels at a given range (isopleth) requires complex equations and detailed information that is rarely available. The equation RL = SL – 20LogR estimates spherical spreading loss, and RL = SL – 10LogR estimates cylindrical spreading loss (RL = received level; SL = source level; and R = range in meters (m)). Actual spreading loss is thought to be somewhere between the two, with absorption and scattering increasing the loss. In the absence of site specific transmission loss data, the practical spreading loss equation, RL = SL – 15LogR, is often used to estimate the RL for actions in shallow nearshore marine waters. That formula was used in this analysis to account for the acoustic environment expected along the south shore of Oahu. Beyond the shelf off of Oahu, the sea floor drops away quickly and transmission loss likely approaches that of spherical spreading.

Pile Driving Noise. The in-water SL is the sound energy at 1 m from the source. The SL of impact pile driving is typically high, sometimes in excess of 200 dB (CALTRANS 2007). Frequencies vary according to several factors, including the pile type, the substrate, and the intensity of impact. The SL is also affected by pile type and the substrate (typically, the harder and larger the piling, the louder; the harder the bottom, the louder), as well as the impact energy (the harder the impact, the louder). However, measured sound levels for individual pile driving events may vary over time.

Neither the USACE nor NMFS has site-specific noise measurements for pile-driving along the south shore of Oahu. Consequently, both agencies referred to the CALTRANS Compendium, with the expectation that reported sound levels and signal analyses would closely approximate the acoustic signatures of similar piles, driven in a similar manner for this action. Signal analysis information for impact driving 20-inch pipe piles is limited. However, impact driving 24- and 36-inch pipe piles produced relatively broadband signatures with the majority of the energy occurring below 2,000 Hz, and received levels of 190 dB at 10 m. Signal analysis of vibratory-driving 24-inch steel sheet piles indicates continuous broadband sound between 400 and 2,500

Hz, and a received level of 160 dB at 10 m (CALTRANS 2007). Back-calculations from the levels measured at 10 m from representative pile types and drivers (based on RL = SL -15logR), suggest the source levels and isopleth ranges given below in Table 2.

5.2.1.2 Estimate the ranges where in-water sound energy would fall to current threshold for expected effects:

The effects on marine life from exposure to high intensity noises vary with the frequency, intensity, and duration of the sound source, and the hearing characteristics of the exposed animal. Exposure to very high levels of sound can cause soft tissue injuries that could directly result in fatality. Exposure to lower levels may cause injury in the form of permanent hearing damage, also referred to as permanent threshold shift (PTS). Exposure to even lower levels may cause behavioral effects that may include temporary threshold shifts (TTS), temporarily masked communications and/or acoustic environmental cues, alteration of ongoing behaviors, and areal avoidance. The cetacean PTS threshold for exposure to in-water sounds is ≥ 180 dB. The same threshold for pinnipeds is ≥ 190 dB. Exposure to impulsive in-water sounds at ≥ 160 dB is the TTS threshold for all marine mammals, whereas the TTS threshold for exposure to non-impulsive sound (continuous noise) is ≥ 120 dB.

Humpback whales, Hawaiian monk seals, and green and hawksbill sea turtles are the only ESA-listed marine animals expected to occur within the action area where pile driving noise may reach levels capable of causing adverse effects. As described above in Section 3, NMFS expects that the hearing ranges of these animals overlap with the expected frequency range of the sounds expected to result from pile driving. Consequently, NMFS expects that those animals can hear and respond to pile driving noise. Currently, no acoustic thresholds have been established for sea turtles. However, existing research into sea turtle sensory biology suggests that sea turtles are less acoustically sensitive than cetaceans, relying more heavily on visual cues, rather than auditory input (Hazel, *et al*. 2007, Ridgeway *et al*. 1969). The U.S. Navy described recent surveys at Guam where one of its biologists reported green turtles behaving normally on a reef within ~100 m of dredging-related chiseling of a fossilized reef (USN 2011). Although no sound levels were recorded, the biologist reported that he could feel his body physically vibrate due to the concussion of the chisel drop. Despite this, the turtles appeared undisturbed by the activity. This anecdotal evidence supports the idea that sea turtles may be relatively unresponsive to some acoustic stimuli, particularly when compared to marine mammals. Thus, NMFS considers application of the marine mammal thresholds conservative for sea turtles.

Estimating attenuation based on RL = SL - 15logR suggests that the longest ranges to the 180, 160, and 120 dB isopleths would occur at ranges of 47, 1,000, and 4,700 meters, respectively for the proposed pile types (Table 2).

Table 2. Estimated source levels and ranges to effects threshold isopleths for proposed pile driving.

Piling	Driver	SL	190 dB	180 dB	160 dB	120 dB
20” Pipe	Impact	205 dB	10 m	47 m	1,000 m	N/A
24” Sheet	Vibratory	175 dB	N/A	N/A	N/A	4,700

5.2.1.3. Estimate the number of humpback whales, monk seals, and sea turtles potentially exposed to adverse levels of sound energy:

The project BMP require that pile driving be postponed or halted when marine mammals and/or sea turtles are within 50 yards (46 m). As described above, sound levels approaching 180 dB could occur just beyond that range (47 m) for impact driving pipe piles (Table 2). The estimated received level at 50 yards would be 180.06 dB. Marine mammals are very easy to detect, and are unlikely to be close to the 50 yard stand-off range, as such sea turtles are the only ESA-listed species that NMFS thinks might occur at ranges approaching 50 yards. Because turtles are understood to be less acoustically sensitive than marine mammals, and because the expected exceedance of the threshold at 50 yards is less than 0.1 dB, NMFS expects that no marine mammals or sea turtles would be exposed to injurious sound levels.

As described in Section 3 above, the best model estimates the central North Pacific humpback whale stock at 10,103, and data from multiple studies suggest that the current population trend for the stock is increasing (Mobley *et al*. 2001; Mizroch *et al*. 2004; Calambokidis *et al*. 2008). Low-level socializing, breeding and/or calving, and some migration through the area occurs off the south shore of Oahu. Based on NMFS' recommendation, HSWAC would not conduct any vibratory pile driving during the peak humpback whale season for Hawaii (December 1 through March 31). The intent of this is to minimize exposure of humpback whales to non-impulsive sound levels ≥ 120 dB, which could extend out 4,700 m from the marine receiving pit. However, there is a possibility that low numbers of humpback whales may be in the MHI during November or April. NMFS estimates that on average; no more than one humpback whale would be within or near the 4,700-meter exclusion zone on any given day during those months. This is based on the expectation that humpback whale density in the MHI would be low during those months, that humpback whale density in the action area is low even during the peak season, that humpback whales outside of the zone would tend to avoid the area vice moving toward the sound, on the use of vessel-borne observers to monitor the 4,700-meter exclusion zone, and on the requirement to shut-down vibratory pile driving when any large cetacean is observed within or near the 4,700-meter exclusion zone. Given that there would be a maximum of 16 days of vibratory pile driving, NMFS estimates that up to 16 humpback whales may be exposed to single exposures of non-impulsive sound levels ≥ 120 dB due to vibratory pile driving. Although HSWAC may conduct impact pile driving during the humpback whale season, they would establish and carefully monitor a 1,000-meter exclusion zone around that work (Proposed IHA). As such, NMFS expects that no humpback whales would be exposed to impulsive sound levels ≥ 160 dB during the impact driving of pipe piles.

As described above in Section 3, at any given time, a maximum of 12 monk seals are estimated to be present within 10 miles (16.1 km) of Honolulu Harbor. The in-water area within a 10-mile arc from the center of the Kakaako waterfront would have an area of 163.5 $mile^2$ (423.5 km^2). With 12 monk seals within that area, the density would be 0.07 seals per $mile^2$ (0.03 seals/km^2). Vibratory pile driving would ensonify an area of about 16.8 $mile^2$ (43.6 km^2). Multiplying the area by the density yields 1.2 seals per day, which NMFS would round up to 2 seals. Therefore, NMFS estimates that no more than two monk seals would be within the action area for vibratory pile driving on any given day. Given that there would be a maximum of 16 days of vibratory pile driving, NMFS estimates that up to 32 exposures of Hawaiian monk seals to non-impulsive sound levels ≥ 120 dB may occur due to vibratory pile driving. Similarly, impact driving pipe piles is expected to ensonify an area of 1.4 mile^2 (3.6 km^2). Multiplying the area by the density yields 0.1 seals per day which NMFS would round up to 1 seal. Therefore, NMFS estimates that no more than one monk seal would be within the action area for impact pile driving on any given day. Given that there would be a maximum of 8 weeks (56 days) of impact pile driving, NMFS estimates that up to 56 exposures of Hawaiian monk seals to impulsive sound levels ≥ 160 dB may occur due to impact pile driving.

Green and hawksbill sea turtles reside year-round to rest and forage in nearshore waters along the south shore of Oahu. Sightings confirm that green sea turtles are numerous and widespread in the action area, particularly in water depths less than 150 feet (46 m). Low numbers of hawksbills are also expected to occasionally occur in the action area at similar depths as the greens. However, available information is insufficient to estimate the density of either species in the MHI or the action area. Due to the current inability to quantify the number of turtles likely to be within the action area, NMFS expects that undeterminable numbers of green and hawksbill sea turtles would be within 5,140 yards (4,700 m) of vibratory pile driving, and as such exposed to non-impulsive sound levels ≥ 120 dB. NMFS expects that green and hawksbill sea turtles within 1,094 yards (1,000 m) of impact pile driving would be exposed to impulsive sound levels ≥ 160 dB. Those numbers are also undeterminable, but likely be about 1/3 the number of animals exposed to the sound of vibratory pile driving.

5.3 Response

This section analyzes the responses of humpback whales, Hawaiian monk seals, as well as green and hawksbill turtles exposed to adverse levels of sound energy during pile driving operations. As described above in Section 2, the proposed action involves three periods of daylight pile driving. The first period would be 1 to 2 weeks of impact driving test-piles during October 2012. The applicant estimates that each test-pile would require about 15-minutes to drive. Although unspecified, NMFS expects that 1 to 4 test-piles might be driven during any given work day, because the plan calls for 15 test-piles, with each pile being pulled, and the barge being repositioned to a new test point after each drive. The applicant would drive steel sheet piles with a vibratory hammer over 16 10-hour days during November 2012 or April 2013 to avoid the peak humpback whale season. The applicant intends to impact drive pipe piles, to anchor the upper reaches of the pipeline, between March and April 2013. Should work be delayed, this component would be completed during October 2013. Each pipe pile would take about 15 minutes to drive, and the applicant estimates that 4 piles would be driven per day over 4 to 6 weeks. As described above, impact pile driving is expected to cause potentially adverse levels of in-water sound that may radiate outward to about 1,000 m, whereas the vibratory hammer is expected to cause potentially adverse levels of in-water sound that may radiate outward to about 4,700 m.

5.3.1 Response of Marine Mammals to Elevated Noise Levels during Pile Driving

The potential responses of marine mammals exposed to pile driving noise are expected to be context-specific and highly variable. Marine mammal hearing plays a critical role in communication with conspecifics and in interpretation of environmental cues for purposes such as predator avoidance and prey capture. Marine mammals may experience hearing impairment when exposed to loud sounds. PTS is considered auditory injury (Southall *et al.* 2007) and occurs in a specific frequency range and amount. Irreparable damage to the inner or outer cochlear hair cells may cause PTS; however, other mechanisms are also involved, such as exceeding the elastic limits of certain tissues and membranes in the middle and inner ears and resultant changes in the chemical composition of the inner ear fluids (Southall *et al.* 2007). There are no empirical data for when PTS first occurs in marine mammals; therefore, it must be estimated from when TTS first occurs and from the rate of TTS growth with increasing exposure levels. PTS-onset is assumed to occur under conditions causing a threshold shift of ≥ 40 dB beyond the onset of TTS (Southall *et al.* 2007). As stated above at 5.2.1.2, PTS is expected for cetaceans exposed to in-water sound levels of ≥ 180 dB, and for pinnipeds exposed to in-water sound levels of ≥ 190 dB. Based on the expected source levels and proposed mitigation measures, NMFS expects that no marine mammals would be exposed to sound intensity at or above the level required for the onset of PTS.

TTS is the mildest form of hearing impairment that can occur as the result of exposure to a loud sound, and NMFS considers TTS a non-injurious impact. While experiencing TTS, a sound must be louder in order to be heard, but the effect is temporary. TTS is highly variable. It typically occurs in specific frequency ranges, varies in degree of impaired sensitivity, and can last minutes, hours, or days. For sound exposures at or just above the TTS-onset threshold, hearing sensitivity recovers rapidly after exposure to the sound ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals. Southall *et al.* (2007) considers a 6 dB elevation of the baseline threshold sufficient to be recognized as an unequivocal deviation and thus a sufficient definition of TTS-onset. Depending on the degree of threshold elevation, the duration, and frequency range affected and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious. For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that takes place during a time when the animal is traveling through the open ocean, where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during a time when communication is critical for successful mother/calf interactions could have more serious impacts if it were in the same frequency band as the necessary vocalizations and of a severity that it impeded communication. The fact that animals exposed to levels and durations of sound that would be expected to result in this physiological response would also be expected to have behavioral responses of a comparatively more severe or sustained nature is also notable and potentially of more importance than the simple existence of a TTS.

Behavioral disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Marine mammal reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson *et al*. 1995; Wartzok *et al*. 2004; Southall *et al*. 2007). If a marine mammal reacts briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant.

5.3.1.1 Response of Humpback Whales to Elevated Noise Levels during Pile Driving

There are no data, direct or indirect, on levels or properties of sound that are required to induce TTS in baleen whales. The frequencies to which baleen whales are most sensitive are assumed to be lower than those to which odontocetes are most sensitive, and natural background noise levels at those low frequencies tend to be higher. As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies. From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales (Southall *et al*. 2007).

Southall *et al*. (2007) summarizes the behavioral responses of low-frequency cetaceans to impulsive and non- impulsive anthropogenic noise as reported across current literature. For bowhead whales, the onset of behavioral disturbance from multiple pulses occurred at received levels of about 120 dB, while the onset for all other low-frequency cetaceans was between 140 and 160 dB. The most severe behaviors reported that might occur from exposure to the proposed action's expected acoustic signals was one case where exposure to impulsive (single airgun) sounds at received levels between 150 and 160 dB elicited extensive or prolonged aggressive behavior in a migrating humpback whale. The rest were mild to moderate avoidance of the sound source; brief or minor separation of females from offspring; extended cessation or modification of vocal behaviors; visible startle responses; and brief cessation of reproductive behavior. Generally, the data suggests no or limited responses to non-impulsive sounds at received levels of 90 to 120 dB and an increasing probability of behavioral effects in the 120 to 160 dB range. However, differences in source proximity, novelty of the sound, operational features, etc. seem to be at least as important as exposure level when predicting behavioral response (Southall *et al*. 2007).

It is possible that humpback whales could experience some low-level of TTS as the result of exposure to the project's pile driving noise. However, based on the best information available, the limited amount of pile driving over a 1-year period; the motility of free-ranging marine mammals in the water column; the propensity for marine mammals to avoid obtrusive sounds; and the applicant's proposed mitigation measures, NMFS expects that humpback whale TTS is improbable, and that any impact on hearing sensitivity would recover rapidly after exposure to the sound ends. NMFS further expects that behavioral responses in the form of mild alert and startle responses, avoidance of the project area, and brief or minor modification of vocal behaviors are the most probable humpback whale responses to exposure to the in-water sounds of pile driving, with no measurable impacts expected to occur on their ability to forage, shelter, navigate, reproduce, and avoid predators and other threats such as vessels.

5.3.1.2 Response of Hawaiian Monk Seals to Elevated Noise Levels during Pile Driving

Information to describe in-water sound exposures required to elicit TTS in pinnipeds is limited. Only one study has been done on in-water TTS-onset in pinnipeds exposed to impulsive sounds. Finneran *et al*. (2003) showed no measureable TTS in two California sea lions following exposures to a transducer. Exposures to non-impulsive sound showed a difference in TTS-onset, with harbor seals experiencing TTS at a lower sound exposure level than other pinnipeds. Data suggest that TTS-onset occurs in harbor seals at a received level of 183 dB sound exposure levels (SEL; dB re 1 μPa^2-s), while TTS-onset for California sea lions and northern elephant seals occurred at SEL values 10 to 20 dB higher (Kastak *et al*. 1999, 2005).

Quantitative data on reactions of pinnipeds to impulsive in-water sounds is limited, but include data related to several sources, including: small explosives, impact pile driving, and airgun arrays. The general finding is that exposures between 150 and 180 dB have limited potential to induce avoidance behavior (Southall *et al*. 2007). Limited data are available on the behavioral effects of non-impulsive in-water sound (e.g., vibratory pile driving) on pinnipeds. However, field and captive studies to date collectively suggest that pinnipeds exhibit subtle behavioral changes (i.e. mild avoidance and slight changes in diving parameters) when exposed to non-impulsive sound between 90 and 140 dB (Southall *et al*. 2007).

It is possible that Hawaiian monk seals could experience some low-level of TTS as the result of exposure to the project's pile driving noise. However, based on the best information available, the limited amount of pile driving over a 1-year period; the motility of free-ranging marine mammals in the water column; the propensity for marine mammals to avoid obtrusive sounds; and the applicant's proposed mitigation measures, NMFS expects that TTS would be improbable for exposed Hawaiian monk seals, and that any impact on hearing sensitivity would recover rapidly after exposure to the sound ends. NMFS further expects that behavioral responses in the form of mild alert and startle responses, avoidance of the project area, and alteration in diving patterns are the most probable Hawaiian monk seal responses to exposure to the in-water sounds of pile driving. NMFS is unaware of specific information that would support an estimate of the lateral movement that would be expected for monk seals under these circumstances. However, NMFS expects that the movement would have no adverse impact on the quantity or quality of available shelter or forage habitat. After initially moving away, some exposed seals may move back toward the area as they become habituated to the new stimulus, with no measurable impacts expected to occur on their ability to forage, shelter, navigate, reproduce, and avoid predators and other threats such as vessels.

5.3.2 Response of Green and Hawksbill Sea Turtles to Elevated Noise Levels during Pile Driving

Data regarding the potential response of sea turtles exposed to pile driving noise are limited. Although sea turtles are thought to be less dependent on acoustic input, and less sensitive to acoustic stimuli than marine mammals, like marine mammals, their responses to sound are expected to be context-specific and highly variable. For instance, an exposed turtle in close proximity to a loud source may become startled by onset of the activity. At greater distances, a reaction that would be best described as awareness is likely. Information on the onset of TTS in sea turtles is limited. Moein *et. al.* (1995) held juvenile loggerhead turtles within a net enclosure, and exposed them to in-water airgun bursts of 175, 177, and 179 dB. The authors reported temporary shifts in the auditory thresholds of half of the exposed turtles, but gave no received levels nor quantified the threshold shift. The hearing capabilities of all exposed turtles returned to normal within 2 weeks. They also reported that upon first exposure, the turtles demonstrated avoidance behaviors that decreased as the experiment proceeded, suggesting that the turtles habituate to the stimuli and/or experienced a threshold shift, which reduced their sensitivity (Moein *et. al.* 1995). McCauley *et. al.* (2000) focused on the onset of behavioral responses. They reported their own work on green and loggerhead turtles, and commented on the work of O'Hara (1990) and Moein *et. al.* (1995), which both focused on loggerheads. In summary, they reported that all three works were largely in agreement that the onset of behavioral modification (increased swimming activity) occurred at received levels ≥ 166 dB, and avoidance behavior occurred at $\geq$ 175 dB (McCauley *et. al.* 2000). Lenhardt (2002) reported that adult loggerheads initially increase swimming speed and avoided impulsive sounds generated by airguns when received levels between 151 and 175 dB, and they eventually habituated to the sound.

It is possible that green and hawksbill sea turtles could experience some low-level of TTS as the result of exposure to the project's pile driving noise. However, based on the best information available, the limited amount of pile driving over a 1-year period; the motility of free-ranging sea turtles in the water column; the propensity for sea turtles to avoid obtrusive sounds; and the applicant's proposed mitigation measures, NMFS expects that sea turtle TTS is improbable, and that any impact on hearing sensitivity would recover rapidly after exposure to the sound ends. NMFS further expects that behavioral responses in the form of mild alert and startle responses, avoidance of the project area, and alteration in swimming and diving patterns are the most probable responses of green and hawksbill turtles that are exposed to the in-water sounds of pile driving. NMFS is unaware of specific information that would support an estimate of the lateral movement that would be expected for sea turtles under these circumstances. However, NMFS expects that the movement would have no adverse impact on the quantity or quality of available shelter or forage habitat. After initially moving away, some exposed turtles may move back toward the area as they become habituated to the new stimulus, with no measurable impacts expected to occur on those turtles' ability to forage, shelter, navigate, reproduce, and avoid predators and other threats such as vessels.

5.4 Risk

This section analyzes how the expected responses of humpback whales, Hawaiian monk seals, as well as green and hawksbill turtles that are exposed to the effects of the proposed action would impact their respective populations to determine the risk posed by the proposed action on the continued existence of those species as listed under the ESA.

5.4.1 Risk to Humpback Whales Exposed to Elevated Noise Levels during Pile Driving

Based on the best available information, as described in the exposure and response analyses above, we expect that up to 16 humpback whales may experience behavioral modification in the form of mild alert and startle responses, avoidance of the project area, and brief or minor modification of vocal behaviors due to exposure to project-related pile driving noise. Further, NMFS expects that none these animals would be injured or killed by this stressor, and exposure would have no measurable impact on their ability to communicate, navigate, forage, shelter, reproduce, or avoid predators and other threats. As described above in the Status of Listed Species section, the exposed animals would belong to the central North Pacific stock, which numbers 7,469 to 10,103 individuals, and is a subset of the North Pacific humpback whale population, which is estimated at about 21,000 individuals; both of which groups are growing. In summary, the exposed animals would represent a small subset of the CNP stock and of humpbacks in the North Pacific, and exposure would have no measurable impact on the ability of exposed individuals to communicate, navigate, shelter, reproduce, or avoid predators and other threats. Thus, project-related elevated noise is expected to have no adverse effects at the level of the population. Based on this, NMFS considers the risk of project-related elevated noise reducing the likelihood of survival and recovery of humpback whales as a species is negligible.

5.4.2 Risk to Hawaiian Monk Seals Whales Exposed to Elevated Noise Levels during Pile Driving

Based on the best available information, as described in the exposure and response analyses above, we expect that the proposed action may result in up to 88 events of Hawaiian monk seal exposure to pile driving noise. These exposures would be spread across the 12 individuals that are expected to occur in and near the action area at any given time. Assuming that the exposures would be uniformly distributed, on average, each seal would experience 7.3 exposures over the duration of the proposed in-water construction work (about one year). Behavioral responses in the form of mild alert and startle responses, avoidance of the project area, and alteration in diving patterns are the expected effects of those exposures. Further, NMFS expects that none these animals would be injured or killed by this stressor, and exposure would have no measurable impact on their ability to communicate, navigate, shelter, reproduce, or avoid predators and other threats. As described above in the Status of Listed Species section, there are less than 1,200 monk seals in total, with about 150 in the Main Hawaiian Islands, where the population is growing. Thus, these 12 animals would represent a relatively sizable subset of the number of monk seals in the MHI (about 8%). However, because exposure would have no measurable impact on the ability of exposed individuals to communicate, navigate, forage, shelter, reproduce, or avoid predators and other threats, exposure to project-related elevated noise is expected to have no adverse effects on the MHI population. Based on this, NMFS considers the risk of project-related elevated noise reducing the likelihood of survival and recovery of Hawaiian monk seals as a species is negligible.

5.4.3 Risk to Green and Hawksbill Sea Turtles Exposed to Elevated Noise Levels during Pile Driving

Based on the best available information, as described in the exposure and response analyses above, we expect an indeterminable number of green and hawksbill sea turtles may be affected due to exposure to pile driving noise through behavioral modification in the form of mild alert and startle responses, avoidance of the project area, and alteration in swimming and diving patterns. Further, NMFS expects that none the exposed turtles would be injured or killed by this stressor, and exposure would have no measurable impact on their ability to forage, shelter, reproduce, or avoid predators and other threats. As described above in the Status of Listed Species section, green and hawksbill sea turtles around Oahu are likely geographically isolated and genetically distinct from the other NA of their species located elsewhere in Oceania. As such, any impacts on green and hawksbill turtles in Hawaii are unlikely to impact any of the NA of these species elsewhere in Oceania. Although we do not know the exact number of turtles that would be exposed, those turtles would represent a small subset of their respective species in Hawaiian waters, and the number of exposed turtles would be extremely small in comparison to the number of individuals of the affected species found across Oceania, and even smaller when compared to green and hawksbill turtles around the world. In summary, the exposed animals would represent small subsets of their populations in Hawaii, and exposure would have no measurable impact on the ability of exposed individuals to forage shelter, navigate, reproduce, or avoid predators and other threats. Thus, project-related elevated noise is expected to have no adverse effects at the level of the population. Based on this, NMFS considers the risk of project-related elevated noise reducing the likelihood of survival and recovery of green and hawksbill sea turtles at the species level is negligible.

5.5 Cumulative Impacts

"Cumulative Impacts" are the additive, synergistic, multiplicative, and/or antagonistic effects that may result from interactions between and among the stressors produced by an action and other pre-existing stressors. As discussed in the environmental baseline section, marine mammals and sea turtles within the action area and adjacent marine habitats are routinely exposed to numerous environmental stressors that include: elevated ambient noise levels due to shipping and in-water construction and maintenance, shoreline development, poor water quality, frequent close proximity to human activities, vessel collisions, fisheries interactions, exposure to marine debris, and climate change.

The proposed action would be result in temporary additional human activity and a non-continuous temporary change in the acoustic environment along the south shore of Oahu. However, the expected impacts would be similar to those of past and on-going activities in the area. As such, the effects of the proposed action would constitute more of a continuation of environmental baseline conditions vice a change in those conditions. The most significant expected effects of exposure to the proposed action's impacts would be temporarily modified behaviors and possible TTS that are expected to return to normal levels shortly (within hours) after work stops each day, and as such no additive, synergistic, multiplicative, and/or antagonistic effects are expected to result from interactions with pre-existing stressors. Based on the best information available, the effects of the proposed action are not expected to result in any cumulative impacts on ESA-listed marine species.

6 Cumulative Effects

"Cumulative effects," as defined in the ESA implementing regulations, are limited to the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion (50 CFR 402.02). Cumulative effects, as defined in the ESA, do not include the continuation of actions described under the Environmental Baseline, and future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

The impacts of coastal development, fisheries interactions, vessel strikes, direct take, marine debris, and climate change (as described in the Environmental Baseline section) are not only expected to continue on Oahu, but are likely intensify over time, causing cumulative effects on humpback whales, Hawaiian monk seals, as well as green and hawksbill sea turtles. The continued growth of the human population on Oahu, as well as across the rest of the Pacific region, would likely result in increased coastal development, fishing pressure, vessel traffic, and pollution of the marine environment. Impacts may include accelerated degradation or loss of forage, resting, and nesting habitats; increased take in fisheries; increased vessel strikes; and increased entanglement in, and ingestion of, marine debris.

Global climate change is expected to continue and will therefore continue to impact ESA-listed marine species and their habitats in the future, especially those species that are dependent on shallow coastal reefs and shorelines, such as monk seals and sea turtles.

Humpback whales found in the action area migrate seasonally between Hawaii and northern waters near Alaska and northwestern Canada. As such they may be increasingly impacted by the effects of climate change in both regions, as well as along their migratory path. Important coastal habitats for humpback whales, such as coastal bays and lagoons for breeding could be adversely affected in the future (Simmonds and Elliot 2009), and they may encounter reduced prey. The range of Hawaiian monk seals is effectively limited to the Hawaiian Archipelago, and as such they are effectively restricted to a limited amount of shoreline habitat. Although the potential effects of sea level rise are uncertain (see discussion below for sea turtles), climate change may reduce available suitable shoreline habitats in the future through the combined effects of rising sea level and coastal development. Altered ocean productivity may also reduce future prey availability for monk seals.

The majority of the turtles that occur in the action area are "resident" foragers that nest elsewhere. However, the ranges of both species are effectively limited to the Hawaiian Archipelago. Most of the green turtles that occur at Oahu likely originate from the NA at FFS, and other sites in the NWHI, while a small number may nest in the MHI. Hawksbills in the action area are believed to be from isolated nesting areas in the MHI, located mostly on the Islands of Hawaii and Maui. As such, turtles off Oahu may be affected by impacts on their nesting habitats elsewhere in the Hawaiian Islands. Rising temperatures at nesting beaches may exacerbate a female bias and could increase embryonic mortality if beaches exceed thermal tolerances for sea turtle nests (Matsuzawa *et al*. 2002). The potential effects of sea level rise are uncertain. Fish *et al.* (2005), Baker *et al.* (2006), and Fuentes (2009) predict that sea level rise may result in further loss of available turtle nesting area by 2100. However, evidence presented by Webb & Kench (2010) suggests that changes will not be uniform or predictable and sea level rise may or may not result in beach loss.

Recent studies have shown that several sea turtle population trends are correlated with climate variability over long periods of time (Van Houtan 2010; Del Monte-Luna et al. 2011). The Pacific Decadal Oscillation (PDO) and the Atlantic Multidecadal Oscillation (AMO) are climactic patterns that have been linked, through ocean productivity, to nesting trends for several species of sea turtles (Van Houtan 2010, Van Houtan and Halley 2011). The studies help predict how present or recent conditions may affect the number of nesting females in the future. However we are unable to predict the frequency or intensity the PDO or AMO events in the future, and we are currently unable to predict what influence anthropogenic climate change and increasing temperatures may have on those climatic patterns.

Alterations to foraging habitats and prey resources, changes in phenology and reproductive capacity that correlate with fluctuations in SST, and potential changes in migratory pathways and range expansion (all discussed previously in Environmental Baseline) are additional ways in which sea turtles, humpback whales, and Hawaiian monk seals may be impacted in the future by climate change. Many marine species, including humpback whales and the pelagic life stages of sea turtles, forage in areas of nutrient rich oceanic upwelling, the strength, location, and predictability of which may change with increasing global temperatures (Harwood 2001).

There is uncertainty associated with the analysis of potential impacts of climate change on species and ecosystems (Barnett 2001). Effects of climate change will not be globally uniform (Walther *et al.* 2002) and information regarding the magnitude of future climate change is speculative and fraught with uncertainties (Nicholls and Mimura 1988). In particular, there is no comprehensive assessment of the potential impacts of climate change within the action area or specific to ESA-listed marine species.

In addition to the uncertainty of the rate, magnitude, and distribution of future climate change and its associated impacts on temporal and spatial scales, the adaptability of species and ecosystems are also unknown. Impact assessment models that include adaptation often base assumptions (about when, how, and to what conditions adaptations might occur) on theoretical principles, inference from observed observations, and arbitrary selection, speculation, or hypothesis (see review in Smit *et al.* 2000). Impacts of climate change and hence its 'seriousness' can be modified by adaptations of various kinds (Tol *et al.* 1998). Ecological systems evolve in an ongoing fashion in response to stimuli of all kinds, including climatic stimuli (Smit *et al.* 2000). Humpback whales, monk seals, and sea turtles may exhibit a variety of adaptations to cope with climate change impacts although it will likely take decades to centuries for these shifts to occur (Limpus 2006) making it increasingly difficult to predict future impacts of climate change on those species in the action area. For example, sea turtles are known to be highly mobile and in the past have shown the ability to adapt to changes in their environment and relocate to more suitable foraging and nesting sites over the course of multiple generations. Similar adaptive mechanisms are nearly certain to occur among marine mammal populations. Given the short temporal scale of the proposed action's expected impacts (about 2 years), any synergistic impacts of the effects of the proposed action and future climate change that might interact in the action area with are considered insignificant.

7 Integration and Synthesis of Effects

The purpose of this Opinion is to determine if the proposed action is likely to jeopardize the continued existence of listed species (50 CFR 402.02). "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. This opinion considers the Effects of the Action within the context of the Status of the Species, the Environmental Baseline, and Cumulative Effects as described in Section 5 under "Approach."

We determine if reduction in fitness to individuals of listed species resulting from the proposed action are sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). In order to make that determination, we use the population's base condition (established in the Status of Listed Species and Environmental Baseline sections of this opinion), considered together with Cumulative Effects, as the context for the overall effects of the action on the affected populations. Finally, our Opinion determines if changes in population viability are likely to be sufficient to reduce the viability of the species those populations comprise or impair long term recovery of those species, consistent with recovery objectives, as set forth in the species' recovery plan and other sources. The following discussions summarize the probable risks the proposed action poses to the four listed species addressed by this opinion.

7.1 Humpback Whales

As described in the Effects of the Action section, we expect that up to 16 exposures of humpback whales to elevated noise levels could result due to the proposed action's vibratory pile driving. Exposed whales are expected to experience behavioral responses in the form of mild alert and startle responses, avoidance of the project area, and brief or minor modification of vocal behaviors. However, no mortality, injury, or reduction in fitness or reproduction is expected to result from this exposure.

As discussed in the Status of Listed Species, the North Pacific population of humpback whales is estimated at about 21,000 individuals, with 7,469 to 10,103 humpback whales in the central North Pacific (CNP) stock that winters in Hawaiian waters. The annual growth rate for the North Pacific population over the last several decades is estimated at 4.9 to 6.8 percent. The number of humpbacks that occur in the action area is currently unknown, but thought to be low, and comprised mostly of individuals migrating past the area to preferred habitats elsewhere in the MHI as depicted in Figure 2.

As discussed more fully in the Environmental Baseline and Cumulative Effects sections, the effects of coastal development, fisheries interactions, vessel strikes, marine debris, and climate change within the action area are expected to continue, and likely worsen, in the future. However, the impact and time scale of these effects on the trajectory of the CNP stock, and the North Pacific humpback whale population is currently uncertain, and those impacts are expected to occur on a time scale, against which the impacts of the proposed action would be indistinguishable.

Because the proposed action is anticipated to result in no mortality, injury, reduction in fitness, or reduction in reproduction for humpback whales in the action area (at the level of the individual), the impacts of the proposed action are not expected to reduce the abundance of the CNP stock, or of humpback whales in the North Pacific population. As such, the proposed action is not expected to negatively affect the survival or recovery of the North Pacific humpback whale population. Therefore, when taken in context with the status of the species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of this species, as listed under the ESA.

7.2 Hawaiian Monk Seals

As described in the Effects of the Action section, we expect that up to 88 exposures of Hawaiian monks seals to elevated noise levels could result due to the proposed action's pile driving (32 during vibratory pile driving, and 56 during impact driving). Exposed seals are expected to experience mild alert and startle responses, avoidance of the project area, and alteration in diving patterns. However, no mortality, injury, or reduction in fitness or reproduction is expected to result from this exposure.

As discussed in the Status of Listed Species, in 2008, the entire population of Hawaiian monk seals was estimated at about 1,161 individuals and declining at an annual rate of about 3.9%. However, that trend is reversed in the MHI, where the population was estimated at 113 in 2008, with an annual growth rate of about 5.6%. Unpublished NMFS data for 2011, estimates the MHI population at about 150 monk seals. Twelve monk seals are estimated to occur at any given time within 10 miles of the project site. Seals typically use the area to haul out along the shoreline, but they may also forage to some degree as well as use the area as a corridor to swim to and from offshore habitats and other areas around the island. The area is not considered an important pupping area, but one pupping has been documented in the area.

As discussed more fully in the Environmental Baseline and Cumulative Effects sections, the effects of coastal development, fisheries interactions, marine debris, and climate change within the action area are expected to continue, and likely worsen, in the future. However, the impact and time scale of these effects on the trajectory of the Hawaiian monk seal's population is currently uncertain, and those impacts are expected to occur on a time scale, against which the impacts of the proposed action would be indistinguishable.

The proposed action is anticipated to result in no mortality, injury, reduction in fitness, or reduction in reproduction for Hawaiian monk seals in the action area (at the level of the individual). Thus, the impacts of the proposed action are not expected to reduce the abundance of the Hawaiian monk seal population/species. Therefore, when taken in context with the status of the species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of this species, as listed under the ESA.

7.3 Green Sea Turtles

As described in the Effects of the Action section, we expect that an indeterminable number of green turtles could be exposed to elevated noise levels due to the proposed action's pile driving. Exposed green sea turtles are expected to experience mild alert and startle responses, avoidance of the project area, and possible alteration in swimming and diving patterns. However, no mortality, injury, harassment, or reduction in fitness or reproduction is expected to result from this exposure.

As discussed in the Status of Listed Species, about 18,000 to 38,000 green turtles nest annually in Oceania (adult females only). Green turtles in Hawaii appear to be both geographically isolated, and genetically distinct from other populations in Oceania, with residents also nesting within the archipelago, and vice-versa. About 90% of green turtle nesting in Hawaii occurs at French Frigate Shoals (FFS) in the NWHI. Annual nesting activity at FFS has increased at about 5.7 % since the 1970s (Chaloupka et al. 2007), reaching a high of 808 observed nesters in 2011. Although the number of green sea turtles around the MHI appears to be increasing, and resident juveniles and adults are considered ubiquitous in local waters, data are insufficient to estimate their density within the action area.

As discussed more fully in the Environmental Baseline and Cumulative Effects sections, the effects of coastal development, fisheries interactions, vessel strikes, marine debris, and climate change within the action area are expected to continue, and likely worsen, in the future. However, the impact and time scale of these effects on the trajectory of the Hawaiian green turtle population is currently uncertain, and those impacts are expected to occur on a time scale, against which the impacts of the proposed action would be indistinguishable.

The proposed action is anticipated to result in no mortality, injury, harassment, reduction in fitness, or reduction in reproduction for green turtles in the action area (at the level of the individual). Thus, we expect that the impacts of the proposed action would not reduce the reproduction, abundance, distribution, or recovery of green turtles in the Hawaiian population, and as such, the proposed action is not expected to negatively affect the survival or recovery of the green sea turtles across Oceania. Therefore, when taken in context with the status of the species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of this species, as listed under the ESA.

7.4 Hawksbill Sea Turtles

As described in the Effects of the Action section, we expect that a low but indeterminable number of hawksbill sea turtles could be exposed to elevated noise levels due to the proposed action’s pile driving. Exposed hawksbill sea turtles are expected to experience mild alert and startle responses, avoidance of the project area, and possible alteration in swimming and diving patterns. However, no mortality, injury, harassment, or reduction in fitness or reproduction is expected to result from this exposure.

As discussed in the Status of Listed Species, about 5,400 to 6,100 hawksbill sea turtles nest annually in Oceania (adult females only), and nesting trends are generally decreasing. Hawksbill turtles in Hawaii appear to be both geographically isolated, and genetically distinct from other populations in Oceania, with residents also nesting within the archipelago, and vice-versa. The majority of hawksbill nesting and foraging in Hawaii occurs in the MHI, and over 107 individual nesters have been tagged there since 1991. The majority of the nesting occurs on the island of Hawaii, where about 5 to 15 females nest annually. Regular nesting also occurs on Maui and Molokai. Although data are insufficient to estimate hawksbill density in Hawaiian waters and within the action area, hawksbill sea turtles are much less common than greens.

As discussed more fully in the Environmental Baseline and Cumulative Effects sections, the effects of coastal development, fisheries interactions, vessel strikes, marine debris, and climate change within the action area are expected to continue, and likely worsen in the future. However, the impact and time scale of these effects on the trajectory of the Hawaiian hawksbill turtle population is currently uncertain, and those impacts are expected to occur on a time scale, against which the impacts of the proposed action would be indistinguishable.

The proposed action is anticipated to result in no mortality, injury, harassment, reduction in fitness, or reduction in reproduction for hawksbill turtles in the action area (at the level of the individual). Thus, we expect that the impacts of the proposed action would not reduce the reproduction, abundance, distribution, or recovery of hawksbill turtles in the Hawaiian population, and as such, the proposed action is not expected to negatively affect the survival or recovery of the hawksbill sea turtles across Oceania. Therefore, when taken in context with the status of the species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of this species, as listed under the ESA.

8 Conclusion

After reviewing the current status of the ESA-listed species considered in this opinion, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' opinion that the issuance of a permit by the USACE and an Incidental Harassment Authorization by NMFS to authorize the construction and operation of Honolulu Seawater Air Conditioning, LLC's proposed Honolulu Seawater Air Conditioning project at Honolulu, Hawaii is not likely to jeopardize the continued existence of humpback whales, Hawaiian monk seals, or of green and hawksbill sea turtles.

As described above in Section 3, no critical habitat has been designated for any ESA-listed marine species in the action area. Therefore, the proposed action would have no effect on designated or proposed critical habitat under NMFS jurisdiction.

9 Incidental Take Statement

Section 9 of the Endangered Species Act (ESA) and protective regulations pursuant to Section 4(d) of the ESA prohibit the take of endangered and threatened species without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the reasonable and prudent measures and terms and conditions of the Incidental Take Statement (ITS).

In order to provide take exemption under the ESA for endangered or threatened marine mammal species, Section 7(b)(4) of the ESA requires that any incidental take be authorized pursuant to section 101(a)(5) of the Marine Mammal Protection Act (MMPA). As described above in section 1 of this biological opinion, consultation for the proposed action was conducted simultaneously under both the ESA and the MMPA, and the conclusions of this opinion that concern marine mammals are in agreement with the findings expressed in the proposed incidental harassment authorization (IHA). However, NMFS may not authorize take for marine mammals without an IHA issued under the terms of the MMPA.

On July 24, 2012, NMFS published a notice in the Federal Register regarding the proposed issuance of an MMPA incidental take authorization to Honolulu Seawater Air Conditioning, LLC (HSWAC) for the harassment of small numbers of several species of marine mammals incidental to pile driving activities conducted during construction of the Honolulu Seawater Air Conditioning project (77 FR 43259). In the proposed IHA, NMFS concluded that the taking will not result in more than the incidental harassment (as defined by 16 U.S.c. § 1362(18)) of small numbers of certain species of marine mammals (including humpback whales and Hawaiian monk seals), would have no more than a negligible impact on these stocks, would not have an unmitigable adverse impact on the availability of these stocks for subsistence uses, and would result in the least practicable impact on the stocks. The 30-day comment period on the application is now closed, and NMFS expects that the requirements of MMPA section 101 (a)(5)(D) would soon be met, and issuance of a one-year IHA to HSWAC is eminent.

Consequently, take authorization under this ITS is considered valid only after NMFS issues the IHA for the proposed action, and only for the 1-year period following that issuance. Should the proposed action require a subsequent IHA for delayed work, this ITS would be considered valid only after issuance of the subsequent IHA, and only if the level of expected take remains unchanged or less than expressed in this opinion.

9.1 Anticipated Amount or Extent of Incidental Take

Based on the analysis in the accompanying biological opinion NMFS concludes that the proposed construction and operation of the Honolulu Seawater Air Conditioning project at Honolulu, Hawaii would result in take, in the form of harassment, of Humpback Whales (*Megaptera novaeangliae*) and Hawaiian Monk Seals (*Monachus schauinslandi*) (Table 3). NMFS expects that 16 humpback whales would experience behavioral disturbance and possible low-level TTS, and that 88 occurrences of monk seal behavioral disturbance and possible low-level TTS would occur as the result of the proposed action (Level B Harassment under the MMPA for bothspecies). In the unlikely event of TTS, NMFS expects full recovery within hours or days of exposure.

Table 3. Expected take of ESA-listed marine species due to the Honolulu Seawater Air Conditioning project.

Common Name	Scientific Name	Take from Vibratory Pile Driving	Take from Impact Pile Driving
Humpback Whale	*Megaptera novaeangliae*	16	N/A
Hawaiian Monk Seal	*Monachus schauinslandi*	32	56

Based on the best information available, implementation of the proposed action is expected to cause some level of behavioral disturbance for an indeterminable number of green and hawksbill sea turtles. Although NMFS has determined that these impacts constitute adverse effects for green and hawksbill sea turtles, we have also determined that the expected effects would not rise to the level of take because the turtles' expected response to the stressors are expected to cause no measurable harm to or harassment of those animals. Because no take of sea turtles is expected, no incidental take is authorized for those animals.

9.2 Effect or Impact of the Take

In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in the jeopardy of humpback whales or Hawaiian monk seals, or in the destruction or adverse modification of critical habitat.

9.3 Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures (RPM), as implemented by the terms and conditions, are necessary and appropriate to minimize impacts of the proposed action and monitor levels of incidental take. The measures described below are non-discretionary and must be undertaken in order for the incidental take statement to apply.

1. USACE shall reduce impacts on ESA-listed marine species and their habitats through the employment of BMP and conservation measures.
2. USACE shall monitor and report to NMFS any take of ESA-listed marine species that results from the proposed action.

9.4 Terms and Conditions

USACE must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To meet reasonable and prudent measure 1 above, USACE shall ensure that HSWAC and/or their contractors comply fully with the BMP and conservation measures identified in the Administrative Draft EIS, the HSWAC Mitigation Plan, and the Mitigation Plan outlined in the Proposed IHA.
    a. All workers associated with this project, irrespective of their employment arrangement or affiliation (e.g. employee, contractor, etc.) shall be fully briefed on the required BMP and conditions, and their requirement to adhere to them for the duration of their involvement in this project.
    b. The USACE shall periodically inspect the off-shore project site to ensure that appropriate BMP and conservation measures are in place or enacted.
    c. The USACE shall ensure that HSWAC establishes and complies with appropriate protected species exclusion zones around pile driving.
    d. The USACE shall ensure that no vibratory pile driving takes place between December 1 and March 31.

2. To meet reasonable and prudent measure 2 above, USACE shall ensure that HSWAC and/or their contractors comply fully with the monitoring and reporting plans identified in the Administrative Draft EIS, the HSWAC Mitigation Plan, and the Mitigation Plan outlined in the Proposed IHA.
    a. The USACE shall ensure that HSWAC performs acoustic monitoring at the onset of both pile driving types (impact and vibratory) to ensure that the acoustic estimates used in the consultation are appropriate.
    b. The USACE shall ensure that HSWAC reports the preliminary results of acoustic monitoring in a timely manner so that NMFS and USACE can confirm the efficacy of the exclusion zones for the protection of marine mammals, or to adjust them as necessary.
    c. USACE shall ensure that HSWAC employs vessel-borne protected species observers as described in the IHA.
    d. In addition to compliance with the monitoring and reporting requirements set forth in the IHA, the USACE shall require HSWAC to:
        i. Document and immediately report to the USACE all protected species interactions, such as any observation of humpback whales within the 4,700-meter exclusion zone around sheet pile driving, any humpback whales or monk seals within the 1,000-meter exclusion zone around pipe pile driving, and any sea turtles within the 46-meter zone around pipe pile driving.
        ii. Report any dead or injured sea turtles to the Sea Turtle Stranding Hotline at 808-983-5730.
    e. USACE will in turn report interactions to NMFS Protected Resources Division (PRD) at 808-944-2233/2242 and by e-mail to *Donald.Hubner@noaa.gov* and *Patrick.Opay@noaa.gov*. Notification of an injurious protected species

interaction shall be done within 24 hours. Weekly notification of NMFS PRD shall suffice for non-injurious protected species interaction reports.

f. The USACE shall track all incidences of take in a manner that would allow them to recognize the potential for exceeding the level of take authorized in this ITS, and so that corrective measures might taken to prevent an exceedance.

g. Within 180 days of the completion of project construction, the USACE shall submit a report to NMFS. That report shall include: 1) The dates and times of site visits, with the name and title of the inspecting person, the findings of the inspection, and any corrective measures taken to ensure compliance with the required BMP and conservation measures; 2) The results of acoustic monitoring; and 3) The results of protected species monitoring efforts.

10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or develop information.

The following conservation recommendations are provided pursuant to Section 7(a)(1) of the ESA:

1. The USACE is strongly encouraged to perform acoustic studies in the region to collect data on local acoustic environments. The goal of the study should include the development of a database that describes: 1) The characteristics of ambient noise in and near our harbors, and in nearshore waters; 2) The characteristics of commonly practiced in-water construction such as pile driving, drilling, and excavation in the region; and 3) sound propagation qualities at various areas around the region.
2. The USACE is strongly encouraged to use outreach, such as signage, educational programs, and their webpage to improve the public awareness of protected species in ther region and how they might be impacted, or how they should be considered as part of the Corps' permitting processes.

11 Reinitiation Notice

This concludes formal consultation on the USACE proposal to authorize HSWAC LLC, to construct and operate the Honolulu Seawater Air Conditioning Project, Honolulu, Hawaii. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law, and if:

1. The amount or extent of anticipated incidental take is exceeded;
2. New information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion;
3. The agency action is subsequently modified in a manner that may affect listed species or critical habitat to an extent, or in a manner not considered in this Opinion; or
4. A new species is listed or critical habitat designated that may be affected by the action.

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APPENDIX N
HSWAC ENTRAINMENT ANALYSIS

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HSWAC Entrainment Analysis and Monitoring Plan

Introduction

One of the primary environmental concerns to arise from any proposed ocean intake system is entrainment, or the incidental trapping of marine organisms in the intake flow. The marine biota classes most susceptible to entrainment include phytoplankton, zooplankton (including larvae), micronekton, and small fish (Myers et al., 1986). The proposed deep ocean location for the HSWAC intake, far below the photic zone and coral reef or mesophotic ecosystems will minimize the entrainment of marine organisms. The proposed site for the HSWAC intake is approximately 4.68 miles (7.5 km) offshore from Honolulu at a depth of 1,741 ft (531 m). This depth is well below the photic zone where most of the biological productivity in the ocean takes place. There are no living reefs or corals at this depth. The physical conditions at this depth are challenging, including cold temperatures, low oxygen concentrations and enormous pressures. The lack of sunlight precludes photosynthesis; primary producers are absent. Species present at this depth are limited to detritivores that feed on organic debris falling through the water column from above, other scavengers, and some carnivores. The scarcity of energy resources produces feeding strategies adapted to minimize movement.

The HSWAC intake pipe would be about 5.25 feet (1.6 m) in diameter and would rest in a series of collars that would elevate the pipe about 2.5 to 4.5 feet (0.8 to 1.4 m) above the seafloor. The terminal end of the pipe would bend upward to position the open end about 14 feet (4.3 m) above the seafloor. The proposed project is not a power plant - its function and, by extension, engineering design, precludes some of the best technology available (BTA) options typically recommended for minimizing entrainment in power plant cooling water intake structures, which are always in very shallow water close to shore where biological activity is concentrated. The following analysis demonstrates how entrainment of marine organisms would be minimized in an off-shore, deep ocean intake, one of the BTA options recognized by the EPA for the minimization of adverse environmental impacts in the form of entrainment.

Clean Water Act Requirements

For power plants, Clean Water Act §316(b) requires that "the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." The EPA (2002a) has since interpreted "location" to mean the water body or segment of the water body in which the intake is located (41 FR 17390; April 26, 1976), including its location within the water column, relative to the shoreline or point of thermal discharge, and relative to any particularly sensitive areas in the water. Additionally, the EPA 1976 Development Document states that the “most important location factor influencing the intake design is the nature of the water source from which the supply is taken,” and that many adverse environmental impacts can be avoided by not placing the intake in an area of high environmental importance. Of particular note, the EPA stated in the Decision of General Counsel (No. 63, p.381, no. 10) that:

> *Since the magnitude of entrainment damage is frequently a function of the amount of water withdrawn, the only way that massive entrainment damage can be minimized in many circumstances is by restricting the volume of water withdrawn or by relocating the intake structure away from the endangered larvae. The latter approach is often not feasible. Thus, in certain cases, the only means of minimizing serious entrainment damage is to restrict the volume of water withdrawn.*

As noted in the quotation above, larvae are particularly susceptible to entrainment. One EPA study found that literally trillions of fish eggs, fish larvae, and adult and juvenile fish were being injured or killed annually in Narragansett Bay in Somerset, Massachusetts by the Brayton Point Power Station alone. After converting eggs and larvae to “Age 1 equivalent” fish, millions of Age 1 fish species of significant commercial, recreational, and environmental value were killed or injured annually (EPA, 2002b). HSWAC will be able to restrict the volume of water being withdrawn by using variable speed pumps, but flow volume will depend on customer demand and this will not be a primary method of reducing entrainment. However, the location of the intake in deep ocean water will minimize entrainment of marine larvae and other biota. In considering technologies to minimize entrainment, EPA recognizes that “…locating the facility’s intake to a less biologically rich area in a water body, usually further from shore and/or at greater depths…can be effective at entrainment reduction” (76 FR 22198; April 20, 2011).

HSWAC Entrainment Expectations

The primary entrainment concern is fish eggs and larvae, and the effect of their removal on commercial, recreational or other uses. The proposed depth of the HSWAC intake (1,741 feet [531 m]) is comparable in terms of possible interaction with marine larvae with that typically assumed for an OTEC cold water intake (1,000 m), for which it was determined that the entrainment of larvae and eggs in Hawaiian waters would be unlikely, of low significance, and not a regulatory priority. This is in contrast to an intake at 20 m, for which it was determined entrainment of larvae and eggs in Hawaiian waters would be likely, of high significance, and a regulatory priority (Coastal Response Research Center, 2010). Hirota (1977) found that tuna larvae are more abundant in the neuston layer (top 1 m) than from 1-200 m, that fish larvae found at depths from 1-200 m are generally mid-water species, and that very few fish larvae occur between 200-1,000 m in the mid-Pacific. Therefore, the proposed intake is much deeper than the typical vertical distribution of fish larvae and any danger of entrainment posed by the intake can be considered negligible. Most fish eggs are extremely buoyant due to their oil content and also are generally found in the neuston layer.

The distribution of larvae of other marine organisms, such as corals and crustaceans, has more variability depending on the organism in question and its life strategy. For most coral and crustacean larvae, however, the larval recruitment process starts with planktonic larvae that then settle onto the seafloor and achieve their first benthic life stage. Some larvae are fully developed upon release and settle within hours, while others require substantial development (or even fertilization, like corals) before settlement occurs, which can range from days to months. The composition of crustacean larvae approximately 7.5 km offshore of Honolulu - the proposed location of the intake - is unknown, but according to Smith and Parnell (1995), larval traps at a 50 m depth off Sand Island, Oahu in water with a bottom depth of 72 m primarily collected bivalve, gastropod, polychaete, and ascidian larvae. Coral larvae generally remain in the upper 5 m, but their horizontal distribution after release is not well understood (Hodgson, 1985). In conclusion, most marine larvae remain in the top five meters of the ocean prior to settling, hundreds of meters above the proposed HSWAC intake. It is possible, albeit doubtful given all the chemical and tactile cues necessary to initiate settlement, for the occasional larvae to be entrained by the intake during the actual release or settlement process; however, the lack of "parent" reefs and general paucity of organisms near the proposed intake makes entrainment of competent larvae (especially coral or coral reef associated larvae) during actual release or settling improbable. Therefore, compared with a hypothetical shallow water intake the HSWAC intake is expected to entrain few if any larvae. The percentage reduction is expected to approach 100%.

Another class of marine biota found in euphotic waters that would be susceptible to entrainment due to their limited mobility would be phytoplankton, photoautotrophic organisms that form the foundation of the marine food web, and as such, are now incorporated into ecosystem-based management plans. However, the proposed intake is located well below the limit of the photic zone (200 +m), so there is no expected entrainment of phytoplankton for a reduction of entrained phytoplankton biomass from shallow coastal waters to the HSWAC intake depth of 100%.

Zooplankton are weak swimmers that tend to flow with the current, and are therefore also subject to entrainment. Often categorized according to size, generally as microzooplankton and macrozooplankton, zooplankton also play a major role at the base of the marine food web. Microzooplankton are heterotrophic and mixotrophic organisms less than 200 µm in size (e.g., ciliates, foraminiferans, copepod nauplii and some copepodites, and some meroplanktonic larvae) that are major consumers of phytoplankton (Calbet and Landry, 2004), thereby forming the link between phytoplankton and copepods (Calbet, 2008), and are key components in marine biogeochemical cycles and the microbial loop (Sherr and Sherr, 2002). Microzooplankton are not expected to occur below the euphotic zone (200 m), so no microzooplankton are expected to be entrained at the proposed intake location. This results in an expected reduction of entrained microzooplankton biomass from a shallow coastal intake to the HSWAC intake depth of 100%.

Macrozooplankton include temporary (meroplankton) and permanent (holoplankton) members of the zooplankton community that are between 200 µm and 2,000 µm in size (visible to the naked eye) and include such organisms as copepods, arrowworms, decapod shrimp, ctenophores, siphonophores, amphipods, mysids, tunicates, ostracods, and cladocerans (Peterson, 1969). Macrozooplankton are found below the euphotic zone, but at a lower abundance than at shallower depths. The estimated biomass of macrozooplankton in surface waters off Kahe Point was obtained by Myers et al. (1986) by converting their mean dry weight for the upper 200 m from two separate cruises to near-surface zooplankton carbon according to Wiebe et al. (1975) to obtain 1.3 mg C/m. After factoring in the proposed flow rate for the HSWAC system, this would result in 170.68 kg C/year of entrained macrozooplankton. In contrast, only 34.14 kg C/year of macrozooplankton would be entrained at depths from 700-1000 m (a depth ecologically similar to that of the proposed intake) according to the reported average macrozooplankton biomass of 0.26 mg C/m^3 by Uchida (1983). Therefore, entrained macrozooplankton would be reduced by 80% and entrained zooplankton in general (micro and macro) would be reduced by 93 percent from a shallow intake to the proposed intake depth. This is consistent with the observation by Noda et al. (1981) that there is an approximate tenfold difference between zooplankton surface samples and those from 600-1,000 m off Kahe Point.

Micronekton are the next largest size class to be considered susceptible to possible entrainment. They range from 2-10 cm in size and are between plankton and larger nekton in terms of swimming ability, meaning they swim actively but are still affected by currents (Brodeur and Yamamura, 2005). The micronekton are primarily composed of cephalopods (squid and octopi), crustaceans (large euphausiids, decapods [shrimp], and mysids), and fish (myctophids, gonostomatids, and bathylagids) (Pakhomov and Yamamura, 2010). As major consumers of zooplankton, and primary prey items themselves for tuna, billfish, and spinner dolphins (Lammers et al., 2006), micronekton are a crucial link between zooplankton and higher trophic levels (Clark, 1973 and Benoit-Bird and Au, 2006).

Micronekton are a primary component of the mesopelagic boundary community. Therefore, the results of acoustic sampling performed by Benoit-Bird et al. (2001) with a modified echosounder off the leeward coast of Oahu to measure mesopelagic boundary community organism density are used as a proxy to estimate potentially entrained micronekton at deep and shallow locations. Mesopelagic boundary community organism density ranged from zero to 1,800 organisms/m^3 for 20 sampling locations in inshore waters (20-50 m depth, 1-1.3 km from shore) and 20 locations in offshore waters (175-200 m depth, 2.8-3 km from shore) at night from July 5-30, 1999. The mean density for the measured water column varied from zero to 23 organisms/m^3. These density estimates were calculated for the top 200 m at night, but they indicate possible densities at the depth of the proposed intake as the organisms migrate there from these shallower waters.

In contrast, a submersible video transect conducted at the actual site of the proposed intake resulted in a total of 27 shrimp (22 unknown panaeid and 5 *Heterocarpus laevigatus*), 3 cephalopods (2 squid, 1 octopus), and 38 possible mesopelagic boundary community fishes (unidentified fish categorized as 4 cm or less [27] and greater than 4 cm [11]). That is a total of 68 possible mesopelagic boundary community organisms observed over a 3.57 km length track covering an area of approximately 10,700 m^2. For a very rough approximation of the density of possible mesopelagic boundary organisms from this data, the 3m by 3m camera viewing area is assumed along the 3,570 m track to obtain a volume of 32,130 m^3 for a rough density estimate of 0.002 possible mesopelagic boundary organisms/m^3, far less than the density of mesopelagic boundary organisms measured by the acoustic sampling methodology described above or by other camera and submersible-based studies of mesopelagic communities in Hawaiian waters. For comparison purposes, the mesopelagic boundary organism density at the depth of the return seawater pipe off the leeward coast of Oahu (and at the proposed depth of the intake since these organisms have a diel migration between the two depths) is assumed to be the median of the range given as zero to 23 organisms/m^3, or 11.5 organisms/m^3. This is a reduction of 99.9% from the leeward side of Oahu (1,509,891,120 organisms/year) to the proposed site of the intake for the HSWAC system (262,589 organisms/year) in terms of possibly entrained micronekton (assuming mesopelagic boundary community organism density is an accurate proxy).

Other, larger fish were also observed during the submersible video transect. Once fish reach a certain size, they are generally able to avoid entrainment due to the associated increase in swimming speed. However, for a more conservative estimate, all other observed fish (except jellynose eels, which can reach 6 feet in length and are not expected to be entrained) are included for a total count of 80 organisms, which corresponds to an increase in concentration of 0.0003 organisms/m^3, which is an additional 39,388 possible entrained organisms/year. Even with this more conservative estimate, however, the HSWAC system would be expected to achieve a 99% reduction in possible entrained micronekton and fish from the leeward side of Oahu to the proposed location on the southern side of Oahu.

Such estimates of low entrainment rates are consistent with the lack of problems associated with entrainment at the Natural Energy Laboratory Authority (NELHA) at Keahole Point, Hawaii. Ocean water has been drawn from similar depths through three separate pipe systems at depths from 548 m (1,800 ft) to 915 m (3,000 ft) since 1981-82, and problems with excessive entrainment and impingement of organisms have not been encountered. It is acknowledged, however, that the HSWAC system flow rate would be about ten times greater than the NELH flow rates.

In conclusion, the expected entrainment of marine biota would be reduced from 93% to 100% for different taxonomic groups with an overall reduction rate of 98% from other locations around Oahu or surface waters to the proposed location of the HSWAC intake.

Hawaiian Electric Company Entrainment Monitoring Program

While the above data give a theoretical basis for the expectation of a 90% or greater reduction in entrainment between a nearshore, shallow intake and the HSWAC offshore, deep water intake, Hawaiian Electric Company's (HECO) impingement and entrainment monitoring programs at their three Oahu generating stations provide some empirical data for future comparison of shallow versus deep entrainment off Oahu.

In 2006 Hawaiian Electric Company began a program of impingement and entrainment monitoring of their cooling water intake structures at the Honolulu, Waiau and Kahe generating stations on Oahu, and this has continued through 2011. The results of the five years of monitoring are summarized in the respective year 5 reports for each plant.[1] Each of these three generating stations uses seawater from shallow coastal intakes for cooling purposes. As the intent of the HSWAC entrainment monitoring program is to compare the entrainment from a deep ocean intake with that of a comparable shallow water intake, the HECO data provide a valuable shallow water intake baseline.

Each of the generating stations has a unique intake structure and location. The Honolulu generating station intake is in Honolulu Harbor; the Waiau intake is in Pearl Harbor; and the Kahe intake is in open coastal waters, but within a small embayment formed by two rock jetties that extend in a seaward direction. Nevertheless, the impingement and entrainment data for the three monitoring programs are representative of large-volume, shallow coastal intakes around Oahu, and arithmetic means of their entrainment results will be used as the baseline for comparisons with the HSWAC intake entrainment results.

[1] The annual reports for each plant are attached to Hawaiian Electric Company's "Comments Regarding the Clean Water Act Section 216(b) Notice of Data Availability Related to Impingement Mortality Control Requirement: National Pollutant Discharge Elimination System – Proposed Regulation to Establish Requirement for Cooling Water Intake Structures at Existing Facilities." EPA Docket No. EPA-HQ-OW-2008-0667-2602. July 11, 2012. Accessed through www.regulations.gov on October 23, 2012.

The intakes at each of these plants include a 2-inch screen or rack at the entrance to exclude floating trash from the intake. The intake flow is then routed to a traveling screen with 1 cm square mesh where impinged organisms are collected. In each case, the entrainment data are generated indirectly by dragging a plankton net equipped with a flow meter in front of the intake and making the appropriate volumetric extrapolations based on actual and design flows through the cooling water system. The HECO monitoring programs were originally modeled after those underway in California. Initial sampling frequency was weekly, then biweekly and finally monthly, when it became clear over time that entrainment in the Oahu intake systems was very much lower than in California intake systems. While there are obvious differences in methodologies between the HECO program and the proposed HSWAC program described below, the HECO data are the most comparable local data available. Table 1 summarizes the five years of data from each of the generating stations. HECO's entrainment monitoring focuses solely on larval fish, and in addition to number of larvae entrained, taxonomic data are collected. Impingement monitoring from the traveling screens focuses on fish and "shellfish," defined as shrimp, lobster, crabs, octopus and squid. Wet weight and taxonomic data are collected from impinged organisms.

Table 1. Summary of Data from HECO's Impingement and Entrainment Monitoring Programs

Location	**Number of Larval Fish Entrained/ 1000 m^3 (Design Flow)**	**Biomass Impinged (lb/mgd)**
Kahe	563	0.0010
Waiau	2,551	0.0015
Honolulu	1,471	0.0010
Mean	1,528	0.0012

Given the above mean values, we can calculate what a 90% reduction of entrainment by the HSWAC system would be. At the HSWAC design flow of 44,000 gpm, the 24-hour flow volume would be 63.36 mgd or approximately 240,000 m^3/day. At the mean entrainment rate of the HECO generating stations of 1,528 larval fish/1,000 m^3, 366,481 larval fish would be entrained per day in the HSWAC intake. With a target deep ocean entrainment rate of no more than 10% of the shallow water rate, the not-to-exceed entrainment rate for the HSWAC intake is about 36,650 larval fish per day. Given the above discussion of larval abundance in the deep ocean, it would be surprising for the HSWAC intake to entrain this many larval fish.

In the HECO monitoring programs, organisms that pass through the 1 cm square traveling screens are not included in the impingement data. Only organisms that pass through the 2 inch trash screen and are caught on the 1 cm traveling screen are considered impinged. At the HSWAC design flow rate of 63.36 MGD and applying the HECO mean impingement rate, about 0.076 lb/day would be impinged on a 1 cm HSWAC screen. To accomplish the desired 90% reduction would mean no more than about 0.008 lb/day should be collected on or in a 1 cm mesh screen or basket. Because this measure is so sensitive to individual organisms entering the system, a longer monitoring period will be necessary than for larval fish.

The HSWAC entrainment monitoring program described below has been designed to provide data as comparable as possible with results of the HECO monitoring programs so as to verify the 90% reduction in entrainment.

The HSWAC Entrainment Monitoring Plan

Monitoring Plan Objectives

The objectives of the HSWAC entrainment monitoring plan are:

- To demonstrate a 90% or greater reduction in entrainment compared to comparable shallow seawater intakes around the island of Oahu,
- To use a methodology as close as possible to what previously has been used in the coastal waters around Oahu,
- To provide taxonomic information about entrained organisms,
- To include appropriate QA/QC procedures, and
- To provide empirical data for use in design of future SWAC and OTEC systems.

Monitoring Plan Design

The HSWAC entrainment monitoring program would consist of the following components:

- Collection of entrained organisms,
- Identification and enumeration of organisms,
- QA/QC procedures,
- Estimation of total entrainment losses in numbers and weight, and
- Comparison with the 90% reduction expectations.

The following paragraphs explain these components in more detail. Exclusion or diversion of entrained organisms is important biologically, but also for preservation of maintenance-free operation of equipment in the cooling station. Various types of equipment could be affected by different sizes of organisms and therefore collection of different sized organisms will take place at different points in the intake flow. The first type of equipment encountered in the intake flow will be the seawater pumps themselves. These heavy-duty pumps would be affected only by larger, nektonic organisms, so the first collection point will be on the suction side of the seawater pumps where a vault containing a mesh basket with a mesh size of 1 cm will be positioned before each of the three pumps. One of the pumps will be redundant, so the baskets can be emptied as necessary without loss of flow. These baskets will collect nekton and larger micronekton. Flow meters will be positioned after each of these pumps. The choice of the 1 cm mesh was made so that data comparable to the HECO "impingement" data may be collected.

The next type of equipment of concern is the heat exchangers, which have much smaller ducts than the pumps and could be affected by smaller organisms. Therefore, before each heat exchanger there will be a strainer for micronekton and larger macrozooplankton. The mesh size for these strainers will be 2 mm. There are no comparable HECO data for this size fraction of entrained organisms. Nevertheless, data on taxonomy and weight will be collected for comparison with the theoretical reductions described above and for use in designing future SWAC and OTEC systems.

Plankton, including larval fish, can pass through the HSWAC system without harming any of the equipment. Because power plant monitoring on Oahu (and in California) focuses on entrainment of larval fish, that also will be the focus of the HSWAC monitoring program. To monitor entrained larval fish, provision for a separate, partial stream shunt will be added to the system. This shunt will be located between the seawater pumps and the heat exchangers, circumventing the heat exchangers and going directly to the discharge. Because the micronekton screens will be an integral part of the heat exchangers, it will be necessary to have a separate micronekton screen in place before the plankton net to avoid predation and/or physical destruction of larval fish by micronekton in the net. The plankton shunt will have a valve leading to a chamber containing a flow meter and a removable plankton net with a mesh size of 335 µm. This mesh size was selected to match that used in the HECO studies. Macrozooplankton in the size range of 335 µm to 2 mm will be collected there. After sampling, the net will be washed down from the outside of the net to avoid the introduction of plankton from the wash-down water. Samples then will be transferred to pre-labeled jars with pre-printed internal and external labels. The samples will be preserved in either a 5-10 percent formalin-seawater solution or 95 percent ethanol. Sampling will be monthly for a 24-hour period.

Samples will be transported returned to laboratory and transferred into 70-80 percent ethanol or left in 95 percent ethanol prior to the removal of the larval fish in the laboratory. Samples will be examined under a dissecting microscope and all fish larvae removed and placed in labeled vials. All larvae will be enumerated and identified to the lowest practical taxon. A qualified marine biologist will be retained to conduct the taxonomic identifications and enumerations. HSWAC, LLC has discussed with marine science faculty the possibility of using a graduate student from the University of Hawaiʻi in this capacity, and received an enthusiastic positive response. If an appropriately trained student can be identified, this will be done.

A QA/QC program will be applied to all laboratory processing. The first 10 samples sorted by an individual will be re-sorted by a designated quality control (QC) sorter. A sorter will be allowed to miss one target organism if the total number of target organisms in the sample was less than 20. For samples with 20 or more target organisms, the sorter will be required to maintain a sorting efficiency of at least 90 percent. After a sorter completes 10 consecutive samples with equal to or greater than 90 percent efficiency, the sorter will have one of their next 10 samples randomly selected for a QA/QC check (‘1 sample in 10’ QC program). If the sorter fails to achieve an efficiency level of at least 90 percent then their next 10 samples will be re-sorted by the QA/QC sorter until they meet the required level of efficiency. If the sorter maintains the required level of efficiency, then random QA/QC checks will resume at the level of ‘1 sample in 10’.

Estimates of daily larval entrainment for the sampling period will be calculated from the above data and data on the facility’s daily cooling water flow. Estimates of average larval concentration for the day when entrainment samples were collected will be extrapolated across the days between surveys to calculate entrainment during the days when no samples were collected. The total estimated daily entrainment for the survey periods and across the entire year then will be summed to obtain estimates of total survey and annual entrainment, respectively. The data on entrainment will also be extrapolated to estimate total entrainment if the system had run at design capacity for the entire year and this result will be compared to the HECO mean value above to verify the 90% reduction of entrainment of larval fish in the deep ocean intake.

The nekton and micronekton strainers will operate continuously to protect the equipment. Entrained organisms will be removed as frequently as necessary. Quantitative monitoring will take place as follows. After cleaning out the nekton or micronekton strainer, collection of entrained organisms in the respective size ranges will proceed for a 24-hour period. The volume of water that passes through the strainer during this period will be recorded to allow estimates of organism density and annual losses due to entrainment.

All fishes and shellfishes will be collected, identified, enumerated, measured, and weighed. Data will be recorded on water proof datasheets. A QA/QC review of the field collection and laboratory processing will be conducted. The review will verify that the sampling and processing is being conducted following the written procedures including verifying that all the collected organisms were removed from the impinged material and that the identifications, measuring, and weighing of the individuals was completed properly and that the data were recorded correctly.

As noted above, the frequency of sampling will be monthly for a year. 40 CFR 125.87 specifies bimonthly sampling for two years where there is a distinct reproductive period. The lack of seasonal or lunar periodicity of spawning in the deep ocean is expected to result in very stable and reproducible entrainment numbers, which justifies the reduced sampling frequency. Mean values of annual entrainment rates for larval fish and the weight of larger organisms will be calculated and extrapolated to rates and weights at maximum design flows for comparison with the HECO data presented above.

An annual report will be prepared and submitted to the USACE and EPA. The intention of the report will be to quantify entrainment in terms of larval fish numbers and larger fish and "shellfish" weights, and to use these data to validate the assumption of at least 90% reduction of entrainment compared to what would be entrained at a shallow, coastal intake location.

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APPENDIX O
HSWAC PROPOSED CORAL TRANSPLANTATION AND MONITORING PLAN

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Coral Transplantation and Monitoring Plan

December 6, 2013

DRAFT

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Introduction

Honolulu Seawater Air Conditioning, LLC (HSWAC) has applied for a Department of the Army Corps of Engineers (Corps) permit to construct a seawater air conditioning system to serve downtown Honolulu on the island of Oahu, Hawaii. To minimize unavoidable losses of coral aquatic resources to the maximum extent practicable, HSWAC proposes to implement this Coral Transplantation and Monitoring Plan.

This report will consist of a description of the HSWAC seawater air conditioning project, an assessment of the affected coral community, considerations for avoidance and minimization of impacts to corals, and a description of the coral transplantation and monitoring plan.

Project Description

The proposed project would emplace large-diameter, high density polyethylene (HDPE) pipes cradled in concrete collars on the sea floor offshore of Kakaako, Oahu, Hawaii. See Figure 1 for the proposed pipeline alignment of the preferred alternative..

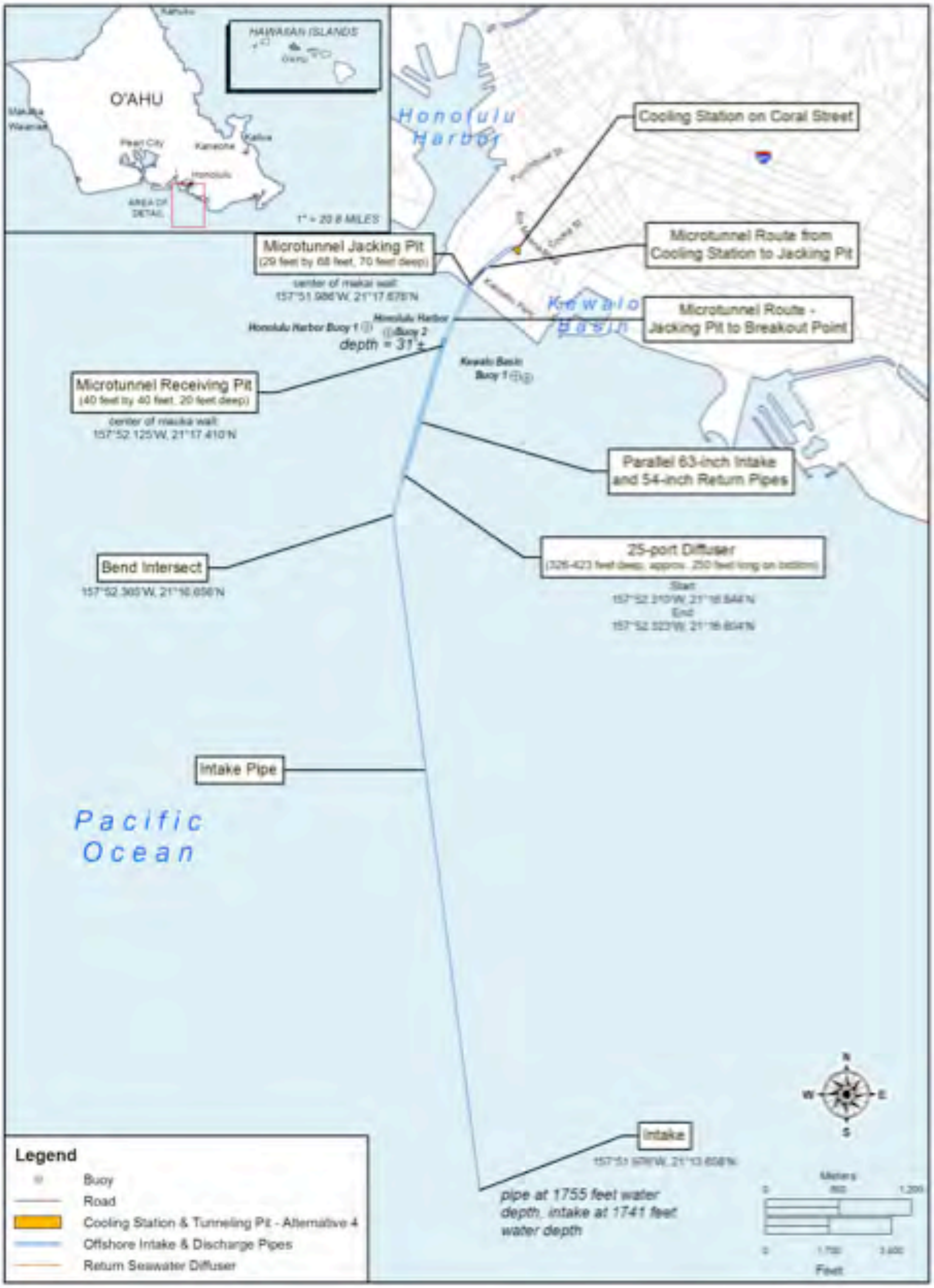

Figure 1 HSWAC Piping - Cooling Station to Intake

The seawater pipes would be micro-tunneled across the shoreline to a breakout point, approximately 548 m. (1,800 ft.) off-shore to 9.5 m. (31 ft.) depth to avoid impact to the shallow limestone reef fronting Kakaako. The micro-tunnels would terminate in a receiving pit with approximate dimensions 12.2 m. by 12.2 m. (40 ft. by 40 ft.) and a depth of 6.1 m. (20 feet) below the seafloor. See Figure 2 for details of the connection between the micro-tunneled pipes and concrete collar anchored pipes. To minimize the amount of coral disturbed, the receiving pit would be created in a coral rubble and sand filled channel naturally formed in the limestone substratum.

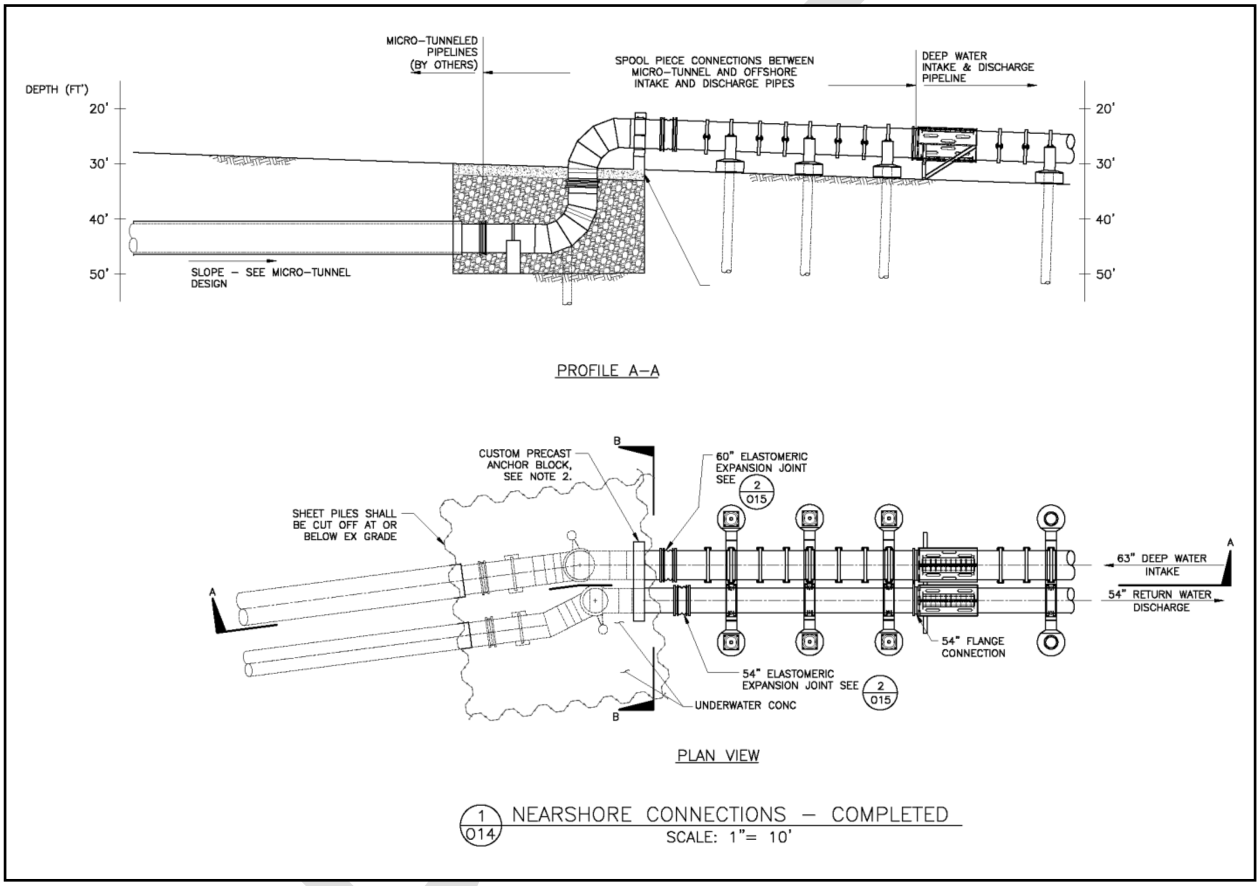

Figure 2 Details of Receiving Pit and Connection Between Microtunneled and Intake and Return Seawater Pipes

Affected Coral Species

A marine survey was performed in 2011 along the seawater pipe alignment (Brock, 2011) and an additional coral survey of the receiving pit was performed in 2013 (HSWAC, 2013) to augment the 2011 report in the area of substratum directly impacted by the construction of the proposed receiving pit offshore of Kakaako. A total of 29 coral colonies presented in Table 1 were observed within the 148.6 m^2 (1,600 ft^2) footprint of the proposed receiving pit. There were 16 Pocillopora meandrina colonies, 10 Porites lobata colonies, and single colonies of Montipora capitata, Montipora patula, and Porites lutea observed within the pit footprint.

Of the 29 total coral colonies, there were 15 corals with diameters larger than the 10 cm. (3.9 in.). The other 14 corals, comprising 48% of the total, were smaller than the 10 cm. (3.9 in.) size class.

	Size class (cm.)							
Taxa	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	**Total**	**Percent of total**
Montipora patula						1	1	3%
Montipora capitata				1			1	3%
Pocillopora meandrina		9	2	3	2		16	55%
Porites lutea				1			1	3%
Porites lobata	1	4	2	3			10	34%
Total	1	13	4	8	2	1	29	
Percent of total	3%	45%	14%	28%	7%	3%		

Table 1 Number of species of coral colonies in each size class and percent of total coral.

Avoidance and Minimization

To minimize losses of coral colonies within the receiving pit footprint, 15 coral colonies in size class equal to or larger than the 10 cm. (3.9 in.) are proposed to be transplanted 15 m. (49.2 ft.) inshore of the receiving pit. Corals below 10 cm have a lower success in transplantation than do larger corals (Gulko 2013). Transplantation would occur outside of peak spawning periods. The peak spawning periods for Montipora capitata occurs during June to July, two days after the new moon between the hours of 8 p.m. to 10 p.m. (Gulko, 2001). Peak spawning periods for Montipora patula occurs during July to September, between 10:05 p.m. to 11:10 p.m. on the new moon's first quarter and third quarter phases (Kolinski and Cox, 2003). Porites lobata has a peak spawning period from June to August, two days after the full moon between 9 p.m. to 11 p.m. (Gulko, 2001). Pocillopora meandrina has a peak spawning period from April to May, during the last quarter moon from early to mid-morning (Gulko, 2001). The peak spawning period for Porites lutea (formerly Porites evermanni) is from August to September, during the new moon's full and fourth quarter phases (Kolinski and Cox, 2003).

The marine contractor selected to install the seawater pipes would perform a detailed pre-construction survey of the conditions at the offshore receiving pit and along the intended pipeline alignment to minimize adverse impacts to coral colonies to the maximum extent practicable. Based on the findings of the pre-construction survey, minor adjustments to the location of the receiving pit and/or concrete cradle anchors may be proposed to avoid coral colonies and/or minimize the potential for inadvertent and/or temporary impacts of adjacent coral resources during construction activities.

Coral Transplantation Plan

This coral transplantation and monitoring plan considers techniques developed by the Coral Reef Targeted Research & Capacity Building for Management Program (Edwards, 2010) to improve survivability and follows agency accepted protocols used in the transplantation plan for the Ma'alaea Small Boat Harbor on the island of Maui, Hawaii (AECOS, 2013).

Coral Transplant Receiving Site Selection

The proposed coral transplant receiving site is located 15 m. (49.2 ft.) inshore of the proposed receiving pit. The proposed relocation site is within the same biotope of rubble and sand where the receiving pit is proposed to be located and would avoid impacts from construction and minor adjustments to the receiving pit location. This receiving site was selected based on its similar depth, light quality, and substratum composition as the donor site at the micro-tunnel receiving pit footprint.

Donor and Receiving Site Preparation

The proposed coral colonies for transplantation would be marked with numbered metal tags for identification. Prior to removal from the receiving pit footprint, the diameter (greatest length) of each proposed transplant coral colony would be measured and photographed. The location of each transplant colony within the proposed micro-tunnel receiving pit footprint would also be recorded. Prior to transplanting the corals at the receiving site, a wire brush would be used to clear bare limestone of all algae and debris at the attachment site. In receiving site areas where bare limestone is covered by rubble and sand, the transplanted corals can be attached to a secured block of Portland cement to provide a fixed base with vertical relief from scouring along the seafloor. Underwater adhesives would be used to attach the transplanted corals to the bare limestone or secured cement block.

Coral Removal Methods

Hammers, bladed chisels, or similar tools would be used to loosen the proposed transplantation coral in a single piece from the substratum with careful attention to avoid contact and damage to the coral skeleton or live tissue. If the removal of a coral colony in a single piece cannot be achieved, then coral fragments at least 5 cm. (2.0 in.) in length from the same colony would be transplanted together.

Coral Transplant Attachment Methods

The area of attachment at the coral receiving site would be shaped to fit the area of attachment at the base of the coral colony with the use of chisels and hammers. To prepare the coral transplant for attachment, the base of the coral colony would be cleared of debris. Marine epoxy would be applied to the receiving site where the coral colony would be affixed. The epoxy would cover as much of the coral skeleton as possible while avoiding contact with living coral tissue. The transplanted colonies would be grouped by species with sufficient spacing to photograph each colony from all sides.

Control Corals

Control colonies of similar species of the transplanted colonies would be selected in the sand channel where the transplant receiving site is located. A total of 10 control colonies, with similar size and species composition would be marked with tags for identification during monitoring.

Monitoring and Reporting

Baseline Report

A survey report would be provided to the Hawaii Department of Land and Natural Resources (DLNR) and the Corps after each monitoring event with compiled information of the baseline and monitoring parameters. The baseline report would include the locations of the transplanted and control coral colonies by using GPS coordinates or a reference to a fixed marker of known GPS coordinates. Each transplanted and control coral colony would be photographed with its identification tag and a scaled reference object for measurements. A description of the health condition of the transplanted and control coral would include the maximum diameter and the percentage of living tissue.

The baseline report would also include an additional coral survey report detailing findings from the pre-construction survey performed by the marine contractor. The coral survey report would be produced to quantify unavoidable coral aquatic resource losses as well as propose minor adjustments in the locations of the receiving pit and/or pipeline concrete cradle anchors to further minimize impacts to aquatic resources. The additional coral survey report would also address any changes to the potential area of impact due to the selected method of construction.

Monitoring Plan

Assessments of the transplanted and control coral colonies, as well as any coral growth on the seawater pipes and concrete collars to 150 ft. (45.7 m.) depth, would occur at 6 months, 1 year and 2 years after transplantation. Transplanted corals, control corals, and new coral growth on the seawater pipe and concrete collars would be photographed and measured for its maximum diameter (size class), maximum dimensions (area), and percent live tissue coverage. The coral species, morphology, and indications of coral health, such as pigment loss, bio-fouling, and predation, would also be recorded.

If degradation of transplanted corals occurs, a comparison with the health of the control corals would be conducted to determine factors contributing to the degradation. Any physical changes to the recipient site caused by nature or otherwise would also be recorded and included in the monitoring report.

Transplantation Success Criteria

The transplantation would be considered successful when the cumulative growth (measured in both size class and live tissue coverage) of the transplantation and/or new coral on the seawater pipes and concrete collars equal or exceed the unavoidable coral losses that occur from the construction of the receiving pit and deployment of the seawater pipe. Following a determination of success by the Corps, no further monitoring would be required. If the live coral percentage in the control colonies declines over the monitoring period, the coral survivorship of the transplanted corals would be scaled by an amount equal to the decline in the control colonies. Should transplanted corals exhibit degradation in excess of any degradation exhibited in the control corals, opportunities for improving survivability would be sought and implemented following Corps approval.

Implementation and Management

HSWAC is responsible for implementing and managing the coral transplantation plan. HSWAC and its selected contractors would coordinate the surveying and reporting tasks with DLNR and the Corps to fulfill the transplantation and reporting commitments.

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Gulko, David, Interview with David Gulko, September 2013

Appendix A

Coral Survey of Honolulu Seawater Air Conditioning Proposed Offshore Receiving Pit

Coral Survey of Honolulu Seawater Air Conditioning Proposed Offshore Receiving Pit

Kakaako, Hawaii

DRAFT

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Introduction

Honolulu Seawater Air Conditioning, LLC (HSWAC) has applied for a Department of the Army (DA)permit to construct a seawater air conditioning system to serve downtown Honolulu. To quantify the scale of anticipated coral impacts associated with the proposed construction of the offshore receiving pit, HSWAC conducted an additional coral dive survey to augment previous surveys. The coral survey is supplemented by an earlier marine biology study (Brock, 2011) in the area of substratum potentially impacted by the construction of the HSWAC system offshore of Kakaako. The marine contractor selected to install the seawater pipes would perform a detailed pre-construction survey of the conditions at the offshore receiving pit and along the intended pipeline alignment to avoid and minimize adverse impacts to corals by the receiving pit and concrete cradle anchor placements to the maximum extent practicable. At that time, an additional coral survey report would be produced to quantify unavoidable coral aquatic resource losses as well as propose minor adjustments in the locations of the receiving pit and/or pipeline concrete cradle anchors to further minimize impacts to aquatic resources. The additional coral survey report would also address any changes to the potential area of impact due to the selected method of construction. For the purposes of this report, the discussion on coral resources and mitigation of coral loss is limited to the footprint of the proposed receiving pit of the preferred alternative.

Project Description

This project would emplace large-diameter, high density polyethylene (HDPE) pipes cradled in concrete collars on the sea floor offshore of Kakaako; Oahu, Hawaii. See Figure 1 for the proposed pipeline alignment.

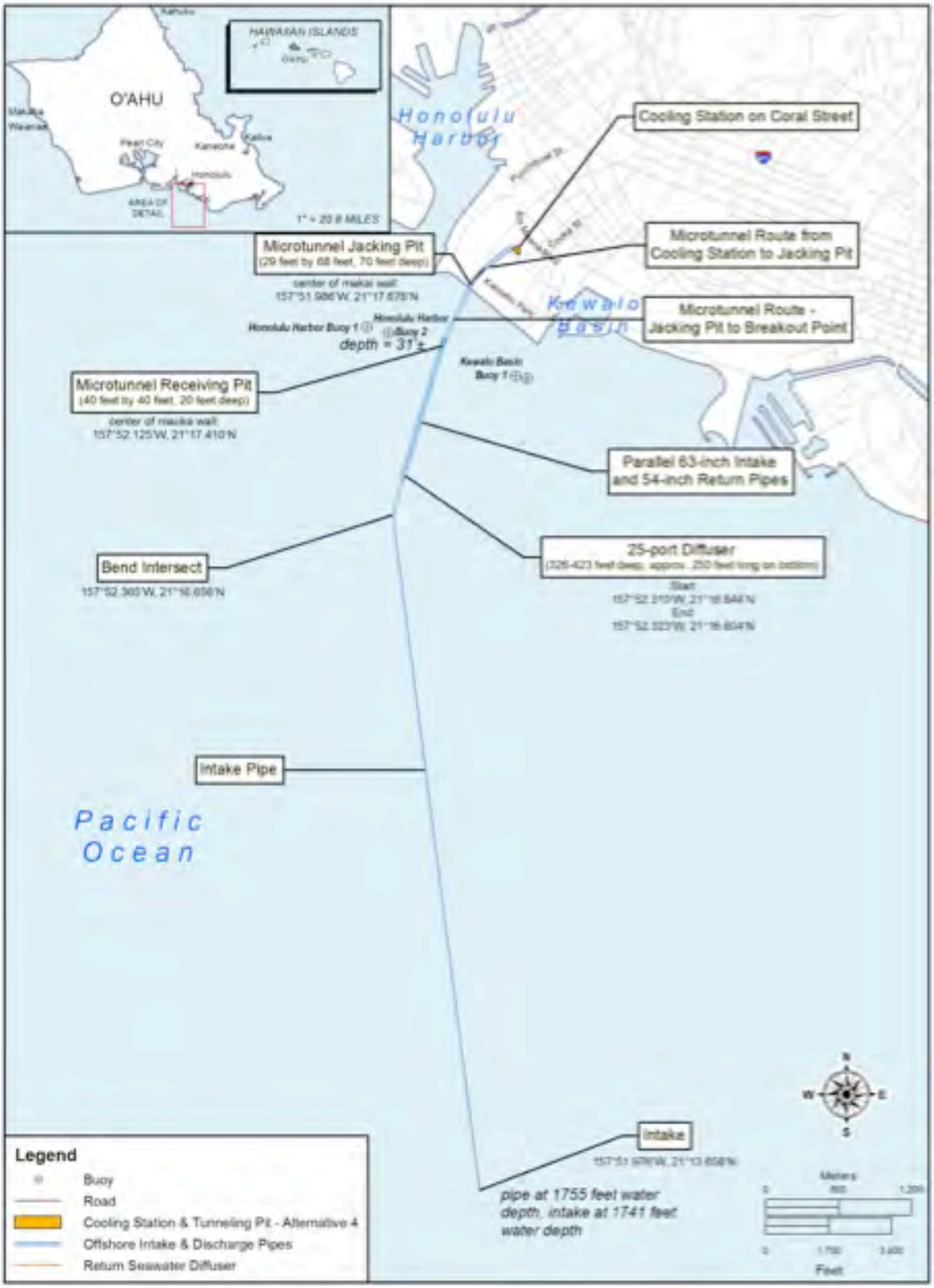


Figure 1 HSWAC Piping - Cooling Station to Intake

In the preferred alternative, the seawater pipes would be micro-tunneled across the shoreline to a breakout point, approximately 548 m. (1,800 ft.) off-shore to 9.5 m. (31 ft.) water depth to avoid impact to the shallow limestone reef fronting Kakaako. The micro-tunnels would terminate in a receiving pit with approximate dimensions 12.2 m. by 12.2 m. (40 feet by 40 feet) and a depth of 6.1 m. (20 feet) below the seafloor. The construction of the receiving pit is proposed to be completely isolated and contained from the seafloor to the sea surface by installing sheet piles extending above the seafloor or a combination of sheet piles and silt curtains. A crane barge, held in position using four point mooring and tugboats, would be used for the driving of sheet piles and excavation operations. The pit would be used to recover the micro-tunneling boring machine and to connect the micro-tunneled pipes to the seawater pipes mounted along the seafloor. See Figure 2 for details of the connection between the micro-tunneled pipes and concrete collar anchored pipes. After the connections are completed, the receiving pit would be backfilled with pre-washed basalt gravel and covered with a concrete cap. The sheet piles would be removed or cut below the seafloor grade. To minimize the amount of coral disturbance, the receiving pit location is proposed in a channel naturally formed in the limestone substratum that is filled with coral rubble and sand. Algae (Lyngbya majuscula), sponges (Spirastrella coccinea), and colonial anemones (Palythoa caesia) make up less than 0.7% cover within the channel (Brock, 2011).

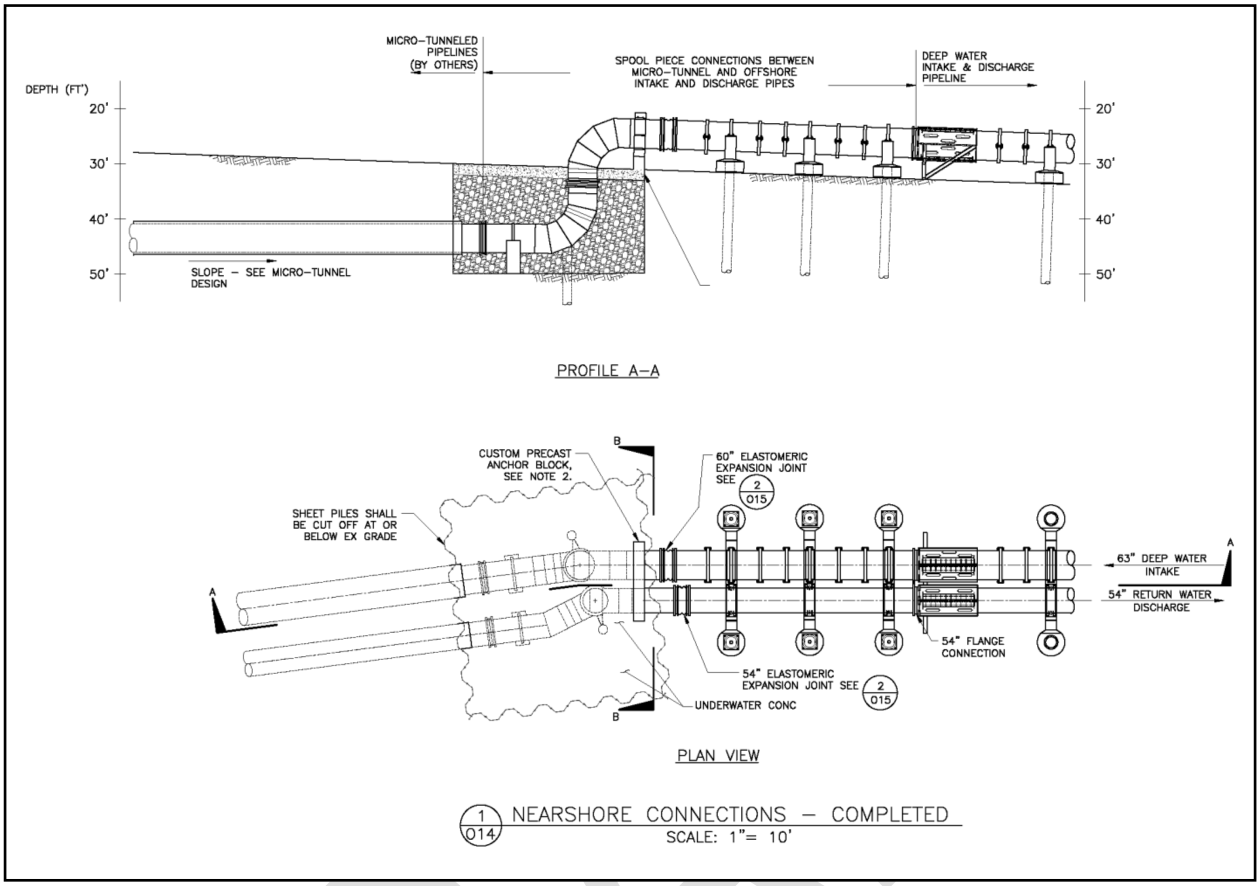


Figure 2 Details of Receiving Pit and Connection Between Microtunneled and Intake and Return Seawater Pipes

Methods

On October 1, 2013, GPS was used to mark the corners of the proposed 12.2 m. by 12.2 m. (40 ft. by ft.) offshore receiving pit and outline the receiving pit footprint. Divers photographed all coral colonies observed within the footprint of the receiving pit. See Appendix A for photos of the coral colonies. A marine biologist identified the taxa of the coral colonies that were observed during the survey and recorded its size and growth form.

Two metrics were used to describe the amount of coral in the receiver pit, size classification and footprint area. Size classification is determined by the widest breadth of the coral colony and is used by the marine biology community in describing a single colony size. The footprint area is determined either by multiplying width and length for rectangular shaped coral or calculating πr^2 with r being the widest breadth of more spherical shaped coral. The footprint area is used to compare the area of coral coverage in the receiving pit relative to the overall area of the receiving pit.

The area of live coral was estimated by multiplying the area of the coral colony with the percent of live coral observed on the colony.

Live coral cover within the receiving pit footprint was calculated by dividing the area of estimated live coral by the total area of the proposed receiving pit.

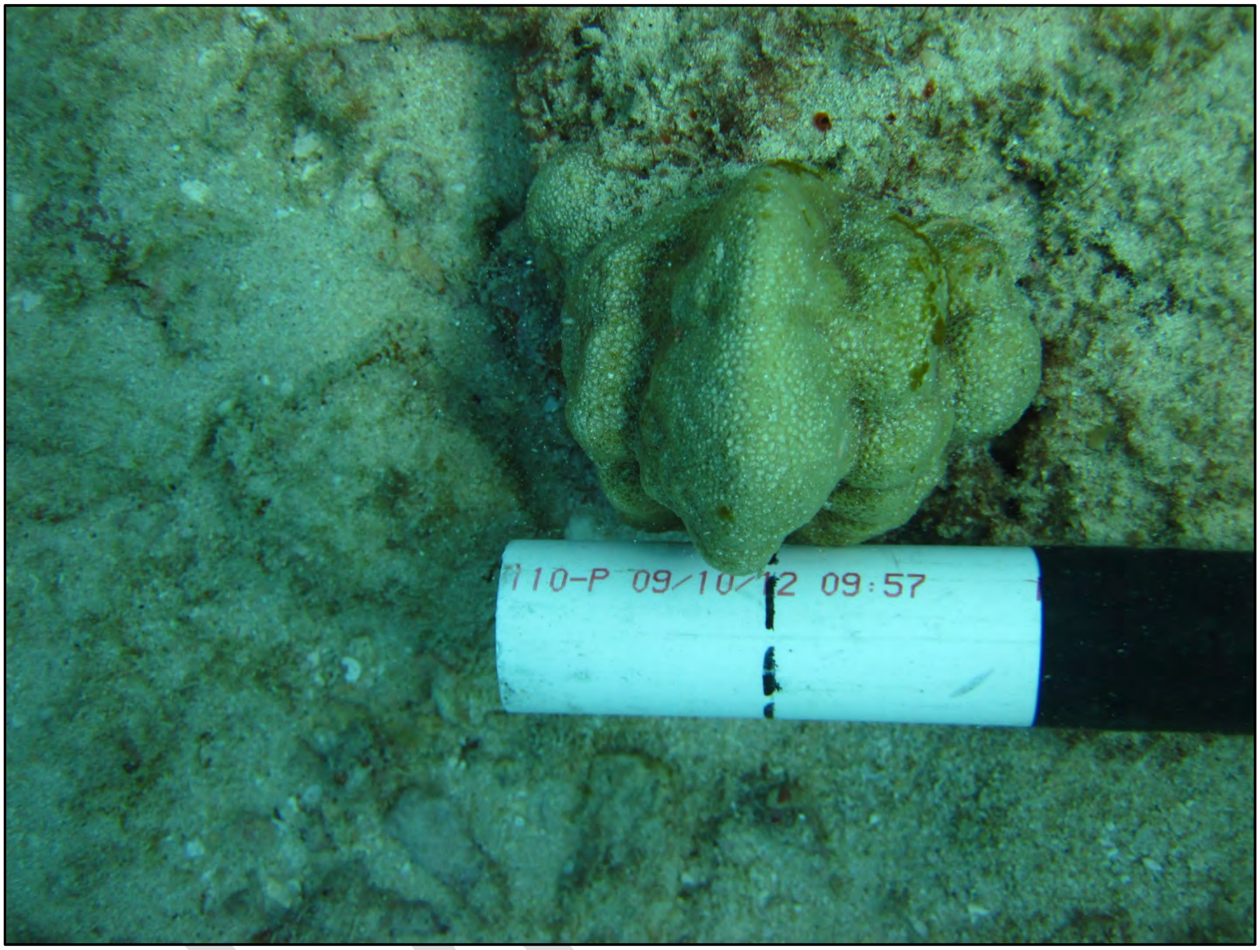


Figure 3 Porites lobata approximately 10 cm. (3.9 in.) wide in the receiving pit footprint.

Results and Discussion

Potentially Impacted Corals

A total of 29 coral colonies (presented in Table 1) were observed within the 148.6 m^2 (1,600 ft^2) footprint of the proposed receiving pit. Pocillopora meandrina and Porites lobata were the most common corals observed and comprised 55% and 34% of the total coral, respectively, within the pit footprint. There were also single colonies of Montipora capitata, Montipora patula, and Porites lutea.

Of the 29 total coral colonies, there were 15 corals with diameters larger than the 10 cm. (3.9 in.). The other 14 corals, comprising 48% of the total, were smaller than the 10 cm. (3.9 in.) size class.

	Size class (cm.)							
Taxa	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	**Total**	**Percent of total**
Montipora patula						1	1	3%
Montipora capitata				1			1	3%
Pocillopora meandrina		9	2	3	2		16	55%
Porites lutea				1			1	3%
Porites lobata	1	4	2	3			10	34%
Total	1	13	4	8	2	1	29	
Percent of total	3%	45%	14%	28%	7%	3%		

Table 1 Number of species of coral colonies in each size class and percent of total coral.

Each coral, with its size and contribution to live coral cover is presented in Table 2. The total live coral cover within the receiving pit footprint is 0.323% equating to a total area of 0.43 m^2 (4.63 ft^2) live coral that is within the 148.6 m^2 (1,600 ft^2) footprint area.

Coral Number	Taxa	Diameter (cm.)	Length (cm.)	Width (cm.)	Coral Area (m^2)	Live Tissue (%)	Live Coral Area (m^2)	Live Coral Cover (%)
1	Porites lobata	10			0.008	50	0.004	0.003
2	Porites lobata	10			0.008	100	0.008	0.005
3	Pocillopora meandrina	20			0.031	50	0.016	0.011
4	Pocillopora meandrina		10	5	0.005	100	0.005	0.003
5	Pocillopora meandrina		10	8	0.008	100	0.008	0.005
6	Porites lobata	6			0.003	100	0.003	0.002
7	Porites lobata	5			0.002	100	0.002	0.001
8	Pocillopora meandrina		10	5	0.005	100	0.005	0.003
9	Porites lobata	10			0.008	100	0.008	0.005
10	Montipora patula		30	20	0.060	100	0.060	0.040
11	Pocillopora meandrina	8			0.005	100	0.005	0.003
12	Montipora capitata		20	15	0.030	100	0.030	0.020
13	Pocillopora meandrina		5	3	0.002	100	0.002	0.001
14	Pocillopora meandrina		20	20	0.040	100	0.040	0.027
15	Pocillopora meandrina		10	8	0.008	100	0.008	0.005
16	Porites lobata		15	10	0.015	100	0.015	0.010
17	Porites lutea		20	10	0.020	100	0.020	0.013
18	Porites lobata		20	12	0.024	100	0.024	0.016
19	Porites lobata		15	8	0.012	100	0.012	0.008
20	Pocillopora meandrina		10	8	0.008	100	0.008	0.005
21	Pocillopora meandrina		25	15	0.038	20	0.008	0.005
22	Pocillopora meandrina		10	8	0.008	100	0.008	0.005
23	Porites lobata		20	15	0.030	100	0.030	0.020
24	Pocillopora meandrina		25	15	0.038	100	0.038	0.025
25	Pocillopora meandrina		15	10	0.015	100	0.015	0.010
26	Pocillopora meandrina	10			0.008	100	0.008	0.005
27	Porites lobata		20	10	0.020	100	0.020	0.013
28	Pocillopora meandrina	10			0.008	100	0.008	0.005
29	Pocillopora meandrina		15	10	0.015	100	0.015	0.010
				Totals	0.480		0.430	0.323

Table 2 Live coral cover in receiving pit footprint.

Within the survey area of the receiving pit footprint and surrounding area within the channel, there is a near absence of coral along the channel floor. However, the elevated limestone ridges along the eastern and western side of the proposed receiving pit location were populated by more developed coral communities. At its closest point, the ridges come within 2 m. (6.56 ft.) of the eastern and western boundary of the receiving pit footprint. Further measurement and surveying along the adjacent ridges outside of the receiving pit footprint was restricted due to limited bottom time. Coral coverage from a previous survey estimated the coral coverage of the eastern ridge to be 15% and 21% on the western ridge (Brock 2011). Based on proposed construction methodologies, which may extend direct and indirect impacts to coral resources beyond the 148.6 m^2 (1,600 ft^2) receiving pit footprint, minor adjustments to the receiving pit location may be necessary to further minimize losses. Final adjustments, if necessary, to the proposed locations of the receiving pit and collar anchors, to minimize coral aquatic resource losses to the maximum extent practicable, would be identified in a preconstruction survey report and submitted to the Corps.

Coral Transplantation

To mitigate adverse impacts to corals within the receiving pit footprint, the identified 15 coral colonies equal or larger than 10 cm. (3.9 in.) are proposed to be relocated 15 m. (49.2 ft.) inshore of the receiving pit. Corals below 10 cm have a lower success in transplantation than larger coral (Gulko 2013). Of the total 0.430 m^2 (4.63 ft^2) of live coral within the receiving pit footprint, 0.342 m^2 (3.68 ft^2) of live coral is equal to or larger than the 10 cm. (3.9 in.) size class and proposed for relocation. The proposed relocation site is within the same biotope of rubble and sand where the receiving pit is proposed to be located and will avoid impacts from construction and possible adjustments to the receiving pit location. The transplanted coral can be placed on hard substratum with vertical relief from scouring along the seafloor to improve their survivability. The coral transplantation operation will follow the procedures outlined in the Honolulu Seawater Air Conditioning Coral Transplantation and Monitoring Plan.

Alternative relocation sites are within adjacent sand channels to the east of the proposed receiving pit location. The alternative relocation sites will be in the same biotope of rubble and sand.

Conclusion

The proposed receiving pit offshore of Kakaako is located in a sand channel with a sparsely developed coral cover of 0.323%. To mitigate unavoidable loss of corals within the receiving pit footprint, coral colonies equal to or larger than the 10 cm. (3.9 in.) size class are proposed to be removed and transplanted onto hard substratum with vertical relief from scouring along the channel floor 15 m. (49.2 ft.) inshore of the receiving pit.

Following the contractor's preconstruction survey of the offshore receiving pit and pipeline alignment, the contractor will make adjustments to the location of the receiving pit and/or collar anchors to the maximum extent practicable to minimize potential adverse impacts to coral aquatic resources in the project area.

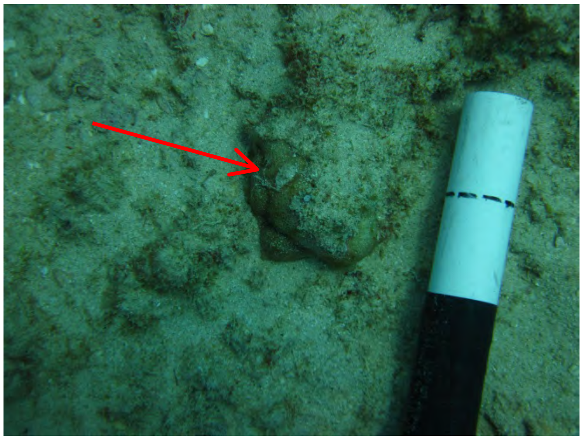
References

Brock, R.E., 2011. Honolulu Seawater Air Conditioning Project: Impacts to Shallow Water Marine Biota With Construction and Operation. Prepared for Honolulu Seawater Air Conditioning, LLC. Prepared by Environmental Assessment, LLC., Report No. 2011-18. 82p.

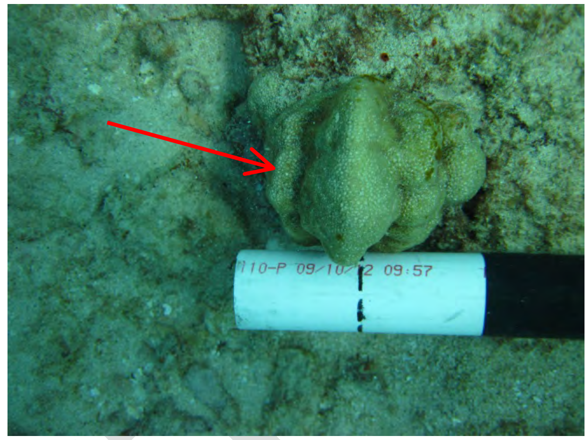
Gulko, David, Interview with David Gulko, September 2013

APPENDIX A

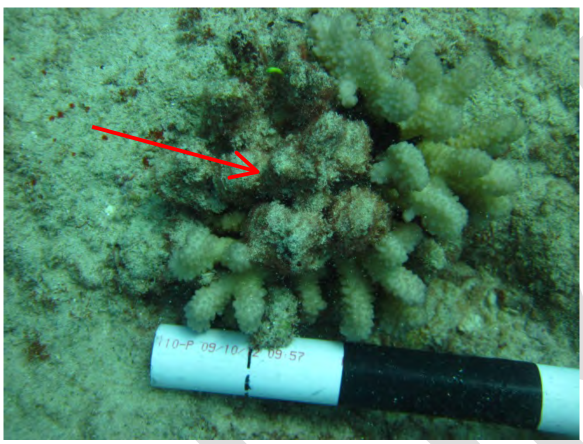
Photographs of Surveyed Coral Colonies Within the Offshore Receiving Pit Footprint



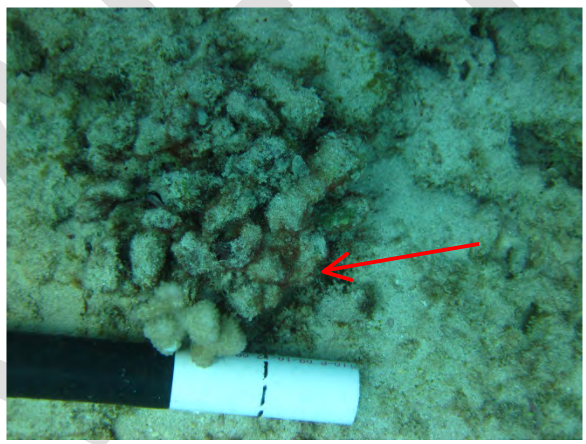
Coral 1. Porites lobata



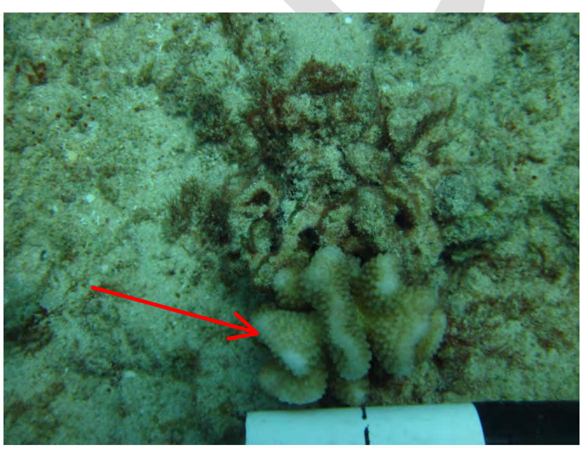
Coral 2. Porites lobata



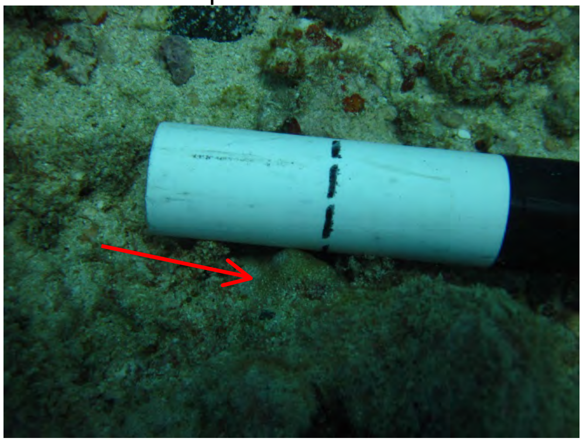
Coral 3. Pocillopora meandrina



Coral 4. Pocillopora meandrina



Coral 5. Pocillopora meandrina



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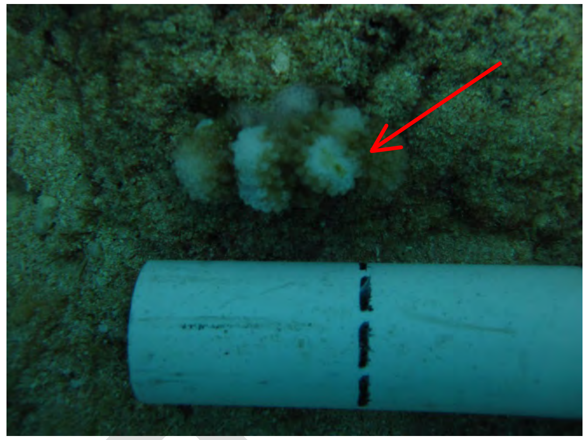
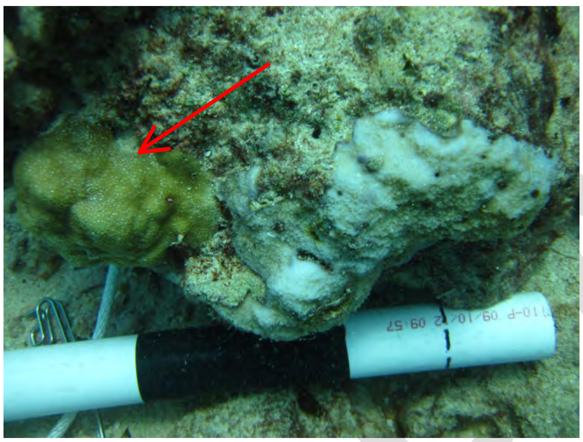
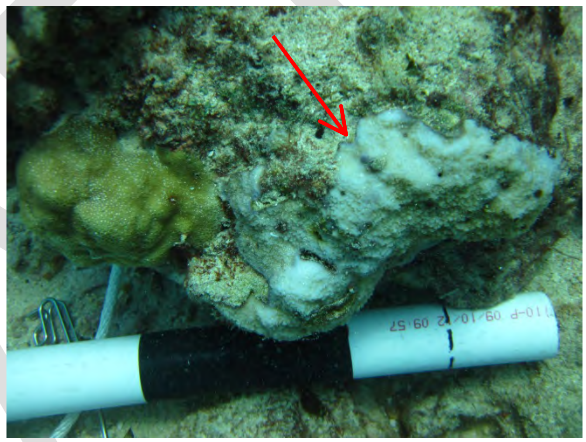


Coral 7. Porites lobata

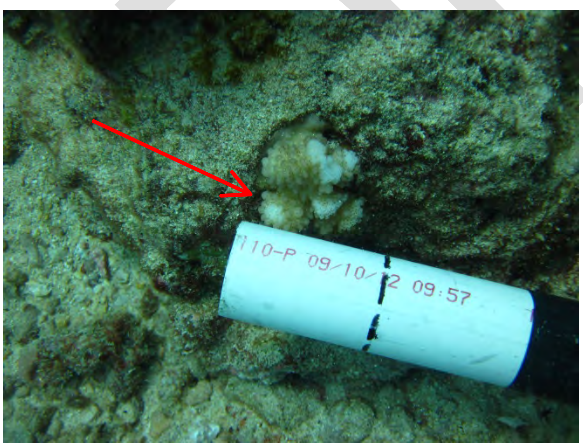
Coral 8. Pocillopora meandrina

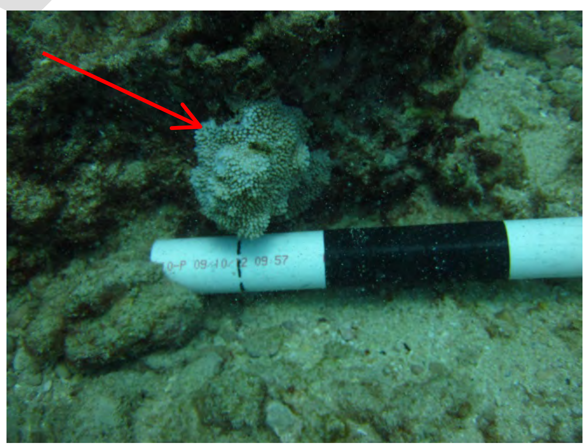




Coral 9. Porites lobata

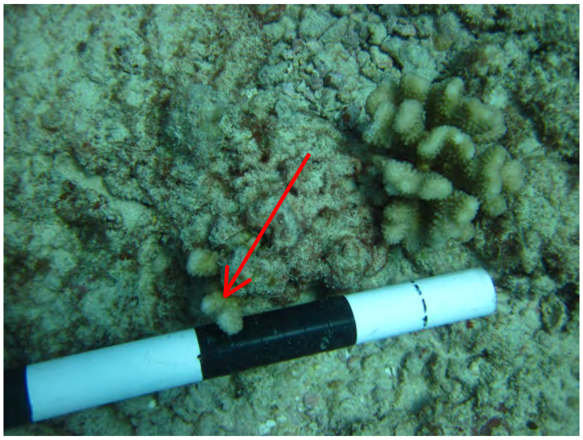
Coral 10. Montipora patula





Coral 11. Pocillopora meandrina

Coral 12. Montipora capitata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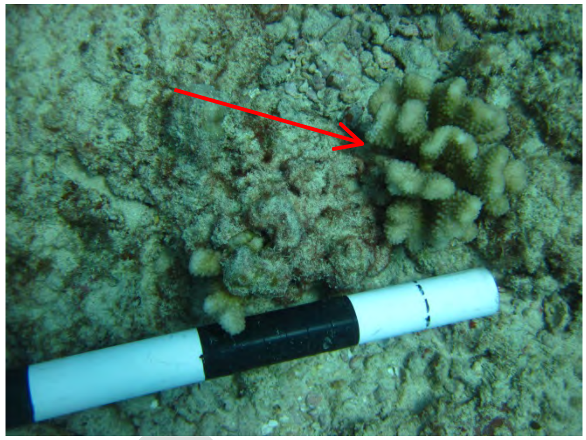
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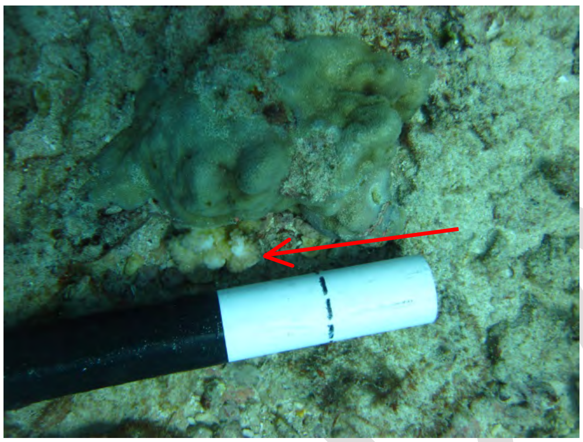
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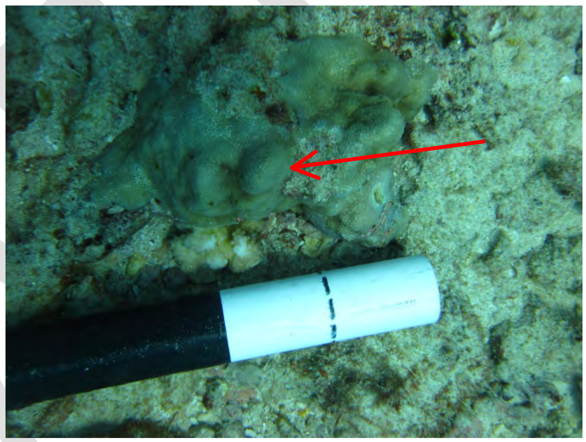
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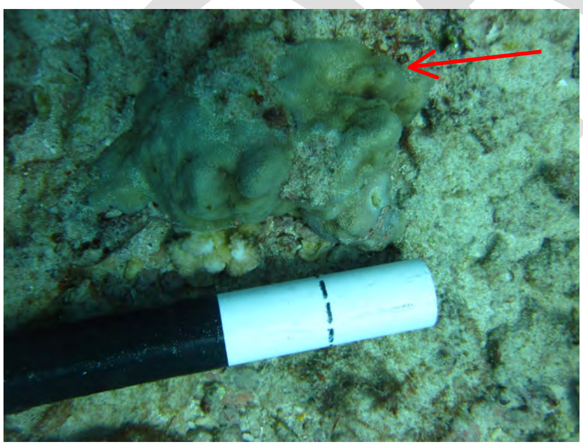
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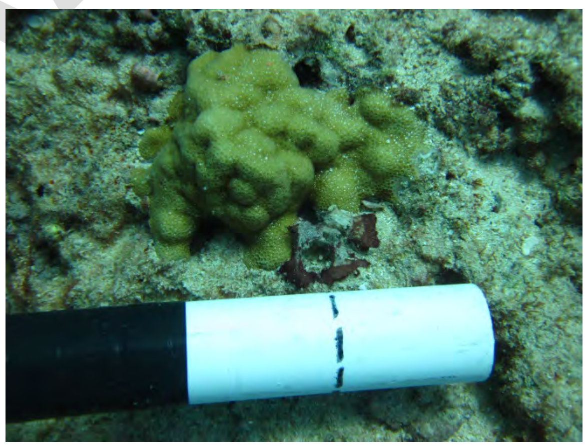
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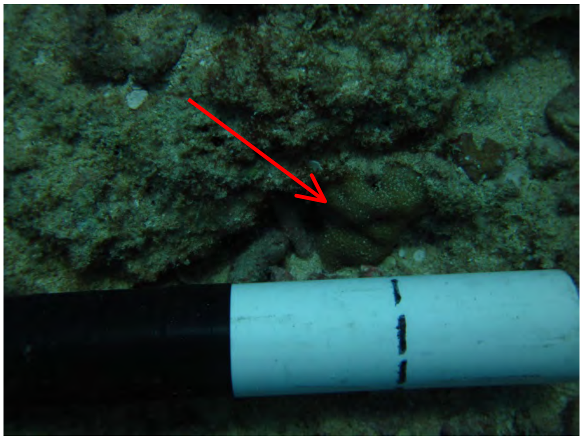
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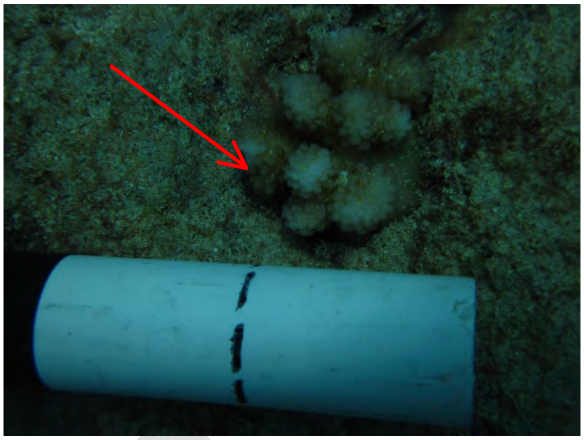
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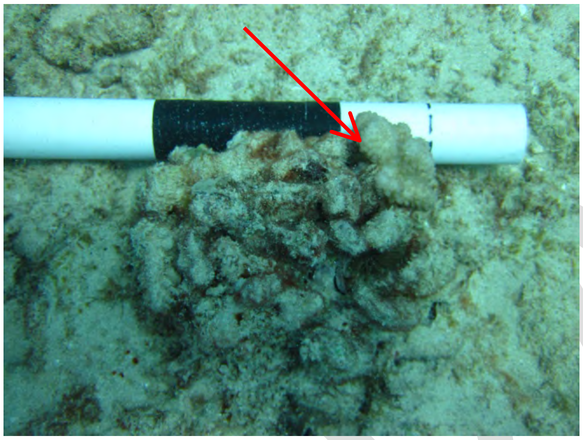
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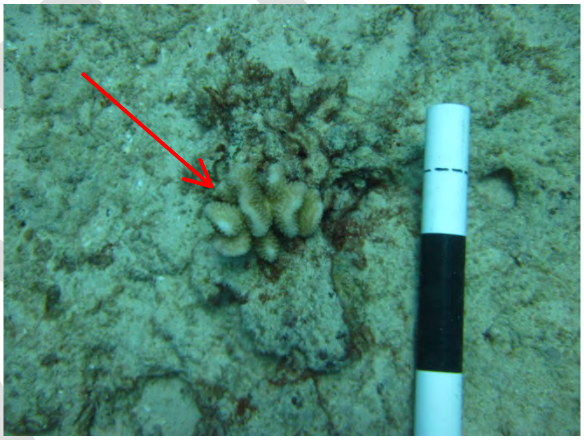
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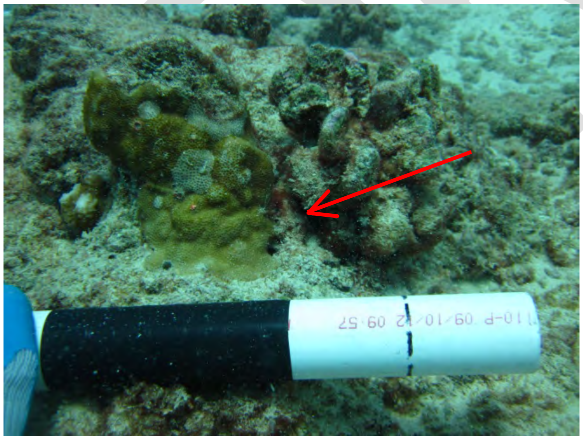
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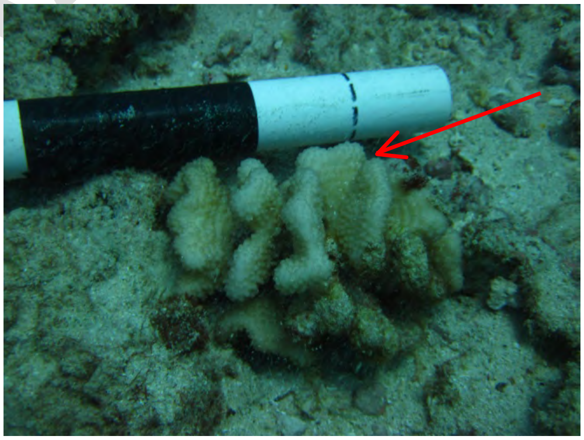
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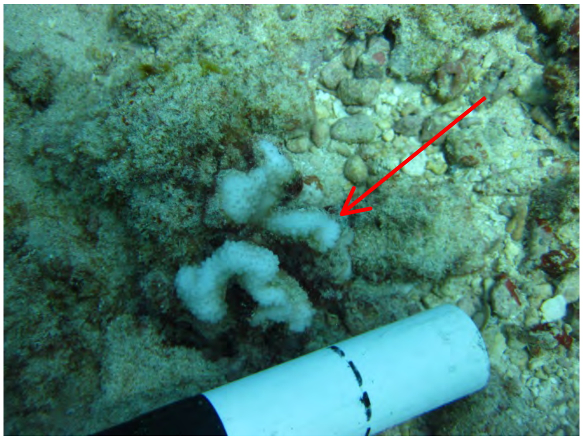
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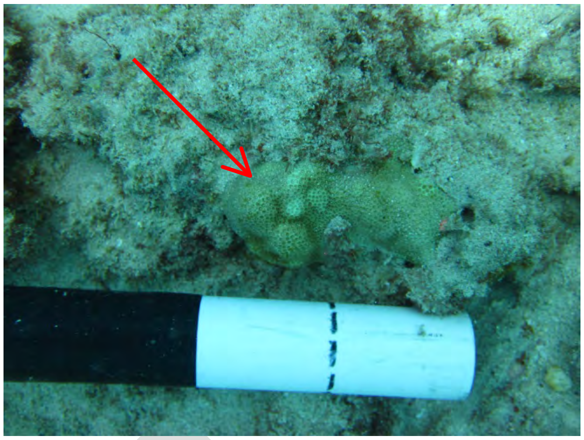
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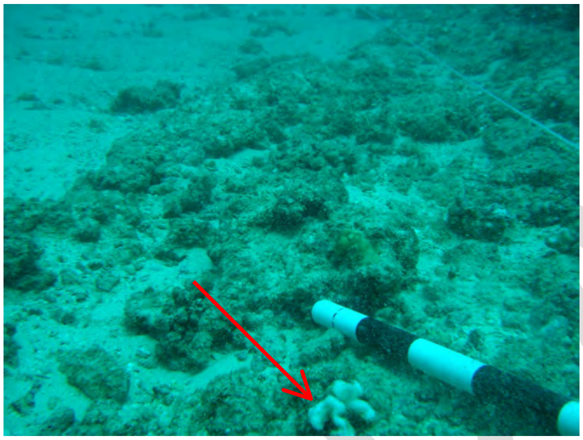
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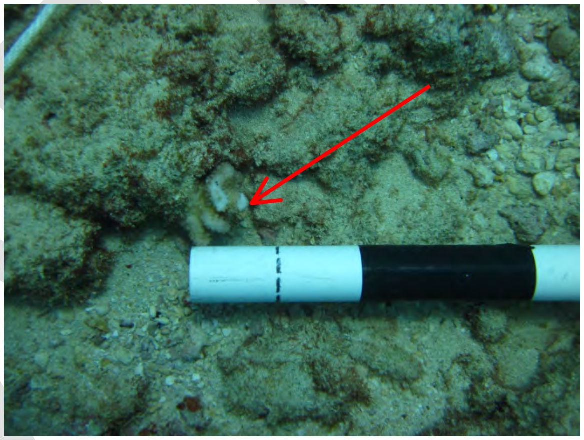
Coral 28. Pocillopora meandrina


Coral 29. Pocillopora meandrina

APPENDIX P
COMMENTS RECEIVED ON THE DEIS

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NEIL ABERCROMBIE
GOVERNOR
RICHARD C. LIM
DIRECTOR
JESSE K. SOUKI
INTERIM DIRECTOR
OFFICE OF PLANNING

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING
235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone: (808) 587-2846
Fax: (808) 587-2824

Ref. No. P-13245

March 22, 2011

RECEIVED
MAR 25 2011

Mr. Ingvar Larsson
Vice President for Engineering
Honolulu Seawater Air Conditioning, LLC
7 Waterfront Plaza, Suite 407
500 Ala Moana Boulevard
Honolulu, Hawaii 96813

Dear Mr. Larsson:

Subject: Hawaii Coastal Zone Management (CZM) Program Federal Consistency Review Required for the Honolulu Seawater Air Conditioning Project, Kakaako Makai Area, Honolulu, Oahu;
Department of the Army Permit File No. POH-2004-01141

This is to inform you that a CZM federal consistency review is required for the proposed Honolulu Seawater Air Conditioning project in the Kakaako Makai Area, Honolulu, Oahu. The U.S. Army Corps of Engineers issued a Special Public Notice (March 10, 2011) notifying us of the availability of the Draft EIS (NEPA) for the subject proposal, for which a Department of the Army Permit application was submitted to the Corps. Applications for the Department of the Army Permit must be reviewed and approved for consistency with the Hawaii CZM Program as a prerequisite to the Corps of Engineers' authorization, pursuant to federal regulations at 15 CFR 930.

The following information is required to complete the CZM federal consistency application and to be accepted for processing; these informational requirements were conveyed by CZM staff to your consultant TEC, Inc., at a meeting on November 1, 2010.

1. CZM federal consistency application form, signed original required.
2. CZM federal consistency assessment form.
3. Supplemental documents or information, such as the EIS (NEPA).
4. Detailed project description.
5. Project site and the exact pipeline route location maps.

CPCE
POH-2004-01

6. Project plans and drawings.

7. Copy of the Department of the Army Permit application to the U.S. Army Corps of Engineers.

8. Copy of the Section 401 Water Quality Certification application to the Department of Health.

9. Copy of the National Pollutant Discharge Elimination System (NPDES) Permit application to the Department of Health.

10. Copy of the Conservation District Use Application (CDUA) to the Department of Land and Natural Resources.

11. Copy of the Special Management Area (SMA) Use Permit and Shoreline Variance application to the State Office of Planning for the Kakaako Makai Area.

12. Copy of the SMA Permit and Shoreline Variance application or approval from the City and County of Honolulu Department of Planning and Permitting, for the Keehi Lagoon/Sand Island staging and storage use and area.

13. Mitigation proposals and plans.

15. Monitoring plans for water quality and aquatic resources impacts.

16. Hazardous materials evaluation from the Department of Health, Office of Hazard Evaluation and Emergency Response, regarding the potential for hazardous materials which are present throughout the Kakaako Waterfront Park and adjacent areas to enter the ocean through tunneling, excavation, and installation of the pipelines.

17. Information and plans for all associated facilities and activities (pursuant to 15 CFR 930.11(d), 930.58) located on the Kakaako land side and at Keehi Lagoon/Sand Island.

NOTE:

(1) The CZM federal consistency application and assessment forms, as well as information about CZM federal consistency requirements, are available at the Hawaii CZM Program web site: http://hawaii.gov/dbedt/czm/program/fed_con.php.

(2) For items 4, 5, 6, 13, 15, and 17, above, if the necessary information is contained in the EIS, then it does not have to be submitted separately.

(3) Submittal of applications for State and County permits is required pursuant to 15 CFR 930.58.

The information identified above as necessary to complete the CZM federal consistency application, pursuant to 15 CFR 930.58, is independent of any substantive information that may be required to fully evaluate the proposal and which may be identified during the CZM review or by public comments received. Upon receiving all of the information necessary to complete the CZM application, the official review timeframe will commence and a public notice of the CZM review will be published in the State Office of Environmental Quality Control's publication, "The Environmental Notice," and the public will be provided an opportunity to review and comment on the proposed action.

If you have any questions, please call John Nakagawa of our CZM Program at 587-2878.

Sincerely,

Jesse K. Souki
Interim Director

c: Mr. Frederic Berg, HSWAC
Mr. George Krasnick, TEC, Inc.
✓ Mr. Peter Galloway, U.S. Army Corps of Engineers, Regulatory Branch
Department of Health, Clean Water Branch
Department of Health, Office of Hazard Evaluation and Emergency Response
Department of Land and Natural Resources,
Office of Conservation and Coastal Lands
Department of Planning and Permitting, City and County of Honolulu

U.S. Department of Homeland Security
FEMA Region IX
1111 Broadway, Suite 1200
Oakland, CA. 94607-4052

FEMA

RECEIVED
APR 1 2011

March 30, 2011

Peter C. Galloway, Regulatory Project Manager
U S Army Corps of Engineers, Honolulu District
Regulatory Branch (CEPOH-EC-R), Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Galloway:

This is in response to your request for comments on the USACE Special Public Notice dated March 10, 2011 – Notice of Availability of Draft Environmental Impact Statement for Proposed Honolulu Seawater Air Conditioning Project in Honolulu, Hawaii.

Please review the current effective countywide Flood Insurance Rate Maps (FIRMs) for the City and County of Honolulu (Community Number 150001), Maps dated January 19, 2011. Please note that the City of Honolulu, Honolulu County, Hawaii is a participant in the National Flood Insurance Program (NFIP). The minimum, basic NFIP floodplain management building requirements are described in Vol. 44 Code of Federal Regulations (44 CFR), Sections 59 through 65.

A summary of these NFIP floodplain management building requirements are as follows:

- All buildings constructed within a riverine floodplain, (i.e., Flood Zones A, AO, AH, AE, and A1 through A30 as delineated on the FIRM), must be elevated so that the lowest floor is at or above the Base Flood Elevation level in accordance with the effective Flood Insurance Rate Map.

- If the area of construction is located within a Regulatory Floodway as delineated on the FIRM, any ***development*** must not increase base flood elevation levels. **The term *development* means any man-made change to improved or unimproved real estate, including but not limited to buildings, other structures, mining, dredging, filling, grading, paving, excavation or drilling operations, and storage of equipment or materials.** A hydrologic and hydraulic analysis must be performed *prior* to the start of development, and must demonstrate that the development would not cause any rise in base flood levels. No rise is permitted within regulatory floodways.

- All buildings constructed within a coastal high hazard area, (any of the "V" Flood Zones as delineated on the FIRM), must be elevated on pilings and columns, so that the lowest horizontal structural member, (excluding the pilings and columns), is elevated to or above the base flood elevation level. In addition, the posts and pilings foundation and the structure attached thereto, is anchored to resist flotation, collapse and lateral movement due to the effects of wind and water loads acting simultaneously on all building components.

- Upon completion of any development that changes existing Special Flood Hazard Areas, the NFIP directs all participating communities to submit the appropriate hydrologic and hydraulic data to FEMA for a FIRM revision. In accordance with 44 CFR, Section 65.3, as soon as practicable, but not later than six months after such data becomes available, a community shall notify FEMA of the changes by submitting technical data for a flood map revision. To obtain copies of FEMA's Flood Map Revision Application Packages, please refer to the FEMA website at http://www.fema.gov/business/nfip/forms.shtm.

Please Note:

Many NFIP participating communities have adopted floodplain management building requirements which are more restrictive than the minimum federal standards described in 44 CFR. Please contact the local community's floodplain manager for more information on local floodplain management building requirements. The City and County of Honolulu floodplain manager can be reached by calling Mario Siu-Li, NFIP Coordinator, at (808) 768-8098.

If you have any questions or concerns, please do not hesitate to call Sarah Owen of the Mitigation staff at (510) 627-7050.

Sincerely,

Gregor Blackburn, CFM, Branch Chief
Floodplain Management and Insurance Branch

cc:
Mario Siu-Li, NFIP Coordinator, Planning and Permitting Department, City and County of Honolulu, Hawaii
Carol L. Tyau-Beam, NFIP State Coordinator, Hawaii Department of Land and Natural Resources
Sarah Owen, Floodplanner, CFM, DHS/FEMA Region IX
Alessandro Amaglio, Environmental Officer, DHS/FEMA Region IX

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

April 14, 2011

Mr. Peter C. Galloway, Regulatory Project Manager
U.S. Army Corps of Engineers, Honolulu District
Regulatory Branch, Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Galloway:

Subject: Your Email Dated March 16, 2011 Requesting Comments on the Draft Environmental Impact Statement for the Proposed Honolulu Seawater Air Conditioning Project

Thank you for the opportunity to comment on the proposed Seawater Air Conditioning Project.

We have the following future projects proposed for the area of the Seawater Air Conditioning Project:

1. Honolulu District 42-Inch Mains, Phase II
   Tentatively scheduled for construction in Fiscal Year 2016
   Conflicting limits: Intersection of Punchbowl Street and Miller Street

2. Kakaako Water System Improvements
   Construction to be done by Board of Water Supply, Field Operations Division
   Conflict limits: Along Keawe Street from Pohukaina Street to Auahi Street

The construction schedule should be coordinated with the Board of Water Supply to minimize the impact to existing customers.

The construction drawings should be submitted for approval.

When water is made available, the applicant will be required to pay our Water System Facilities Charges for resource development, transmission and daily storage.

If you have any questions, please contact Robert Chun at 748-5443.

Very truly yours,

PAUL S. KIKUCHI
Chief Financial Officer
Customer Care Division

Galloway, Peter C POH

From: Christina Comfort [ccomfort@hawaii.edu]
Sent: Tuesday, April 05, 2011 3:54 PM
To: Honolulu SWAC, POH
Subject: Comment regarding DEIS for Seawater Air Conditioning in Hawaii

Mr. Galloway,

Good afternoon! I'm writing in regards to the DEIS which was recently released for the proposed seawater air conditioning operation on south Oahu. I am a graduate student at University of Hawaii in Oceanography, and one of my focus areas is the oceanographic and environmental impact of new ocean thermal energy conversion (OTEC) plants which will be implemented near Barber's Point and Kahe Point. This DEIS caught my attention because of the similar technology and environmental considerations to electricity-generating OTEC plants.

After a brief read, I felt the draft statement was very thorough in most regards. I was surprised, however, that the Hawaiian mesopelagic boundary community wasn't mentioned in the section regarding deep water pipe entrainment. The deep water pipe for this project was compared to NELHA on the Big Island, which is a great resource and valuable starting point. However, there is a crucial ecological difference between the location of the NELHA pipe (about 900m/3000ft) and the proposed air conditioning pipe (about 500m/1700ft): the Hawaiian mesopelagic boundary community. This is a community of fishes, shrimps and squids (nekton) which is distinct from the oceanic community (Reid, 1991, 1994). This group exhibits daily vertical and horizontal migrations along the slope of the islands, and provides the foraging base for organisms such as tuna and spinner dolphins.

The daytime residence depth of the mesopelagic boundary community is between 200 and 700m depth in Hawaii, with the majority of animals in the 400-700m zone (Reid, 1991, 1994; Benoit-Bird et al., 2001). At night, they move shoreward and shallower to about 400m-50m. At NELHA, the intake pipe is below the daytime (deep) residence depth, and therefore is not very likely to entrain animals from this important migrating community. This proposed pipe, however, is at a depth at which animals both reside during the day and pass through during migrations, and I think it would be valuable to address this topic in the final EIS. The compelling potential impact is a locally depleted food source for foraging species, some of which are protected or commercially important.

Perhaps the mesopelagic boundary community has already been considered and was deemed to be of little importance based on trawl or acoustic surveys of the the area, but if not, I think it is important to survey the area to determine the site-specific distribution of this community. Acoustic surveys have been very effective in determining relative density, characteristic depths, and patchiness of this community at various sites in Hawaii (see Benoit-Bird et al., 2001).

Thank you for your consideration and I appreciate any feedback about this topic!

Christina Comfort
Graduate Student, Department of Oceanography University of Hawaii at Manoa
ccomfort@hawaii.edu
484-553-4205

References:

Benoit-Bird, K. J., W. W. L. Au, et al. (2001). "Diel horizontal migration of the Hawaiian mesopelagic boundary community observed acoustically." Marine Ecology-Progress Series 217: 1-14.

May 9, 2011

US Army Corps of Engineers
Honolulu District
Regulatory Branch
Building 230
Fort Shafter, HI 96858-5440
Attn: Mr. Peter C. Galloway

Regulatory File Number: POH-2004-01141

Subject: Safety Concerns, Underwater Conditions

Re: DRAFT ENVIRONMENTAL IMPACT STETEMENT - PROPOSED HONOLULU SEAWATER AIR CONDITIONING PROJECT, HONOLULU, HAWAIʻI

1. Comments may be mailed to: Mr. Peter C. Galloway, Regulatory Project Manager; U.S. Army Corps of Engineers, Honolulu District; Regulatory Branch (CEPOH-EC-R); Building 230; Fort Shafter, HI 96858-5440. Comments may also be submitted electronically via e-mail to *honoluluswac@usace.army.mil*.

2. Concerns.

- The Hawaii Undersea Military Munitions Assessment (HUMMA) Study Area did not include the entire estimated extent of the Sea Disposal Site Hawai'i (HI-05) area.

- From the scale of the report figures, I cannot determine if there is overlap between the HUMMA Study Area, the entire estimated extent of the HI-05 area and the proposed Honolulu Seawater Air Conditioning System underwater project area (seawater pipelines).

- Construction project or NPDES permit information from the Sand Island waste water treatment plant (WWTP) outfall pipeline and diffuser system installation may provide additional information regarding potential military munitions found on the bottom in Mamala Bay, if any.

- The Office of the Deputy Assistant Secretary of the Army for Environment, Safety and Occupational Health is reportedly completing a circulation study for Oahu and Mamala Bay, as part of the HUMMA study.

2. Hawaii Undersea Military Munitions Assessment (HUMMA).

- Internet Website: http://www.hummaproject.com/

- PowerPoint Presentation Located at: http://www.hummaproject.com/pdfs/HUMMA_Surveys.pdf

- HUMMA Overview:

"Historical research shows that the Armed Forces disposed of conventional military munitions in Hawaiian waters off O'ahu between 1920 and 1951. It also shows that the Armed Forces disposed of chemical munitions and containers of bulk chemical agent (referred to as chemical warfare material or CWM) off O'ahu between 1933 and 1946. The Department of Defense (DoD) is interested in developing an understanding of the potential impact of sea-disposed military munitions, including CWM on human health and the environment. In support of this DoD interest, the Office of the Deputy Assistant Secretary of the Army for Environment, Safety and Occupational Health (ODASA-ESOH) under the National Defense Center for Energy and Environment (NDCEE), issued Concurrent Technologies Corporation (CTC) Task No.: 0496 under Contract W74V8H-04-D-0005 for the Hawai'i Undersea Military Munitions Assessment (HUMMA). CTC contracted the University of Hawai'i at Manoa (UH) to perform the required assessment. The contract was awarded in October 2007.

ODASA-ESOH is the technical monitor for the HUMMA Program. HUMMA's objectives are to (a) develop a cost efficient and effective survey and assessment strategy for evaluating whether sea-disposed military munitions have had or have the potential to significantly impact human health and the environment; and (b) test the survey and assessment strategy at a single site. HUMMA's goals include determining the location of discarded military munitions (DMM) at a sea-disposal site (Site HI-05) that is located approximately 5 miles south of Pearl Harbor, and evaluating the environmental conditions of the area.

The Armed Services had policies and regulations that governed the sea-disposal of excess, obsolete or unserviceable military munitions. The Armed Forces sea-disposed excess, obsolete or unserviceable munitions, including CWM, in coastal waters off the United States prior to 1970, at which time it discontinued this practice. Congress subsequently prohibited sea-disposal of waste materials into the ocean in 1972.

The majority of military munitions were sea-disposed at depths in excess of 600 feet. Although records of these operations and disposal sites are incomplete and scattered throughout the National Archives and other information repositories, DoD has undertaken a significant archival research effort to determine or validate the exact locations of sites that contain sea-disposed military munitions, and to identify both the types of munitions sea-disposed and any other DoD-related material disposed at these sites. HUMMA supports the DoD in complying with the requirements of Public Law 109-364, Section 314 (Research on Effects of Ocean Disposal of Munitions).

As a part of this effort, the Army, working with the UH and Environet, a Hawaii based environmental consulting firm, selected a historic sea-disposal site (HI-05) in the vicinity of the entrance of Pearl Harbor off O'ahu. CWM is known to have been disposed at HI-05, which is within close proximity to the UH home port."

- HUMMA Final Investigation Report.

"HAWAI'I UNDERSEA MILITARY MUNITIONS ASSESSMENT, Final Investigation Report, HI-05 SOUTH OF PEARL HARBOR, O'AHU, HAWAI'I," June 2010,
Prepared for: The National Defense Center for Energy and Environment,
Prepared by: The University of Hawai'i at Manoa.
http://www.hummaproject.com/pdfs/HUMMA_Final_Report_June2010.pdf

- HI-05 Estimated Extent Vs. HUMMA Actual Survey Area – Figure.
http://www.hummaproject.com/pdfs/HUMMA_Final_Report_Figures_June2010.pdf

- Currents. The HUMMA Final Report cites:
    - The 1976 USACE Environmental Study regarding the collection of data on currents, bathymetry, geology, sediment chemistry, and ecology at two sites within the HUMMA Study Area.
    - " A baseline study to select environmentally acceptable deep ocean disposal sites for dredge spoil materials from five Hawaiian harbors was conducted in 1977 (Neighbor Island Consultants, 1977)," which included Honolulu.
    - Bottom currents significantly influenced the survey strategy for the semi-submersibles used in the project surveys, since the diurnal currents changed direction in the midst of each dive.
    - Bottom currents "can stir up sediments, noticeably reducing both the visibility of the pilot driving the HOV, the quality of the imagery being collected, and affecting samples being collected."

Section 3.4 PHYSICAL OCEANOGRAPHY INVESTIGATION, describes an oceanographic mooring that was deployed to study bottom currents.

Section 4.6 PHYSICAL OCEANOGRAPHY, describes the bottom current survey results.

In a personal discussion with Jason Rolfe, NOAA Office of Response and Restoration, he mentioned that the U.S. Army/DoD had an in-progress circulation study within Mamala Bay.

There is a separate action involving the temporary deployment of Acoustic Doppler Current Profilers (ADCPs) at 30 stations around the Hawaiian Islands in the spring and summer of 2011. This is by the NOAA Center for Operational Oceanographic Products and Services. Two of the ADCPs will be located on the upper coastal shelf within the Defensive Sea Area, as shown on Figure 1-2, STUDY AREA OF THE HUMMA PROJECT, of the final HUMMA report. One ADCP will be in the approach to (14 meters depth) and the other within the entrance (15 meters depth) to Honolulu Harbor.

David B. Winandy
NEPA Coordinator
Ph: 206-595-8436
E-Mail: David.B.Winandy@noaa.gov

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Seattle, WA 98115-6349

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Pacific Southwest Region
1111 Jackson Street, Suite 520
Oakland, California 94607

IN REPLY REFER TO:
ER#11/277

(Electronically Filed)

2 May 2011

Mr. Peter C. Galloway
Regulatory Project Manager
U.S. Army Corps of Engineers Honolulu District
Building 230, Fort Shafter, Hawaii 96858-5440

Subject: Review of the Draft Environmental Impact Statement (DEIS) for the Proposed Honolulu Seawater Air Conditioning System, City and County of Honolulu, HI

Dear Mr. Galloway:

The Department of the Interior (Department) has reviewed the Draft Environmental Impact Statement (DEIS) for Proposed Honolulu Seawater Air Conditioning Project, City and County of Honolulu, Hawaii. This letter responds to DEIS and has been prepared under authority of and in accordance with provisions of National Environmental Policy Act (NEPA) of 1969 [42 U.S.C. 4321 *et seq*.; 83 Stat. 852], as amended, Fish and Wildlife Coordination Act (FWCA) of 1934 [16 U.S.C. 661 *et seq*.; 48 Stat. 401], as amended, Endangered Species Act (ESA) of 1973 [16 USC 1531 *et seq*.; 87 Stat. 884], as amended, and other authorities mandating Department review for impacts on trust resources.

Based on these authorities, the Department offers comments for your consideration.

GENERAL COMMENTS

In general, the Department recognizes that the proposed project represents an overall beneficial use and we support development of alternative energy. However, the Department is concerned with operation and management of the system. DEIS does not adequately assess effects of proposed action on certain fish and wildlife resources. For example, where are the flow dynamic models to assess whether local fish and benthic community will be affected by either intake flows or return flows?

In addition, DEIS does not propose mitigation measures commensurate with the range of potential adverse impacts anticipated to result from proposed action. Deficiencies in DEIS preclude its use as a basis for a meaningful analysis of anticipated project-related impacts to fish and wildlife resources.

Thus, the Department recommends that DEIS be revised to include more complete information on proposed action, alternatives analysis and impact assessment based on a commitment to avoid and minimize project-related impacts, and proposed mitigation measures that minimize unavoidable impacts and compensate for significant unavoidable impacts.

Proposed Action

Purpose of proposed project is to develop seawater air conditioning technology as a renewable source of energy for buildings in downtown area of Honolulu, Oahu Island, Hawaii. Three alternatives have been presented in DEIS, including a No Action alternative.

Alternative 1, Proposed Honolulu Seawater Air Conditioning Project, is applicant's preferred alternative. This alternative consists of construction of cooling station on Coral Street and construction of a tunnel from station, running underground beneath Keawe Street and Kaka'ako Waterfront Park, in a seaward direction and emerging onto the coral reef at a depth of 31 feet. Two pipelines would be installed in the tunnel for seawater intake (consisting of a 72 inch diameter concrete external pipe and a 54 or 63 inch diameter composite or concrete-polymer pipe) and return of seawater discharge (consisting of a 54 inch diameter concrete pipe).

At 31 foot contour, a 30 foot by 40 foot by 20 foot receiving pit would be excavated in coral reef and an unknown quantity of material would be removed. A receiving pit would be constructed approximately 1,800 feet from shoreline to serve as a junction where landward pipes are connected to seaward pipes. A crane barge using a four point mooring system would be employed to drive sheet piles into receiving pit and conduct dredging operations. A clamshell or open bucket excavator would be used to dredge coral reef materials from receiving pit. Receiving pit would be backfilled and covered with a concrete cap after seawater intake and seawater discharge pipes are connected.

Seawater intake and return pipes would extend beyond receiving pit in a seaward direction. Seawater return pipeline would extend approximately 1,700 feet from receiving pit for a total length of about 3,500 feet from shoreline and terminate at a depth range between 120 to 150 feet. Seawater intake pipeline would extend to approximately 23,000 feet from shoreline to a depth between 1,600 and 1,800 feet.

Combination collars would support both seawater intake and return pipes from receiving pit to termination depths for each pipe. A percussion hammer would be used to drive steel pipe through sleeves into benthic substrate to a depth of about six feet. Approximately 8.7 cubic feet of material would be excavated for each collar and brought to surface and stored on a barge. Tremie cement would be use to cap piles. A total of 112 piles would be driven into benthic substrate to support most combination collars. Some combination collars would be placed on benthic substrate without piles.

Each combination collar comprises a total footprint of about 76 square feet. Therefore, construction and placement of all combination piles for both seawater intake and return pipes would result in filling approximately 18,474 square feet of benthic habitat.

Staging and assembly of offshore pipelines would be conducted at Sand Island and adjacent areas of Ke'ehi Lagoon. On-land pipeline storage area is approximately 18 acres. In-water pipe staging site is approximately 50 acres. Fifty-foot lengths of pipe would be stored on land staging area. Pipes would be fused into lengths of 3,000 feet long and pulled out on Ke'ehi Lagoon staging area. Pipes would be floated and moored in seaplane runway area. Steel pipes would be temporarily driven into benthic substrate and anchors and lines would be attached to serve as mooring points for pipes. DEIS does not describe approximate depth steel pipes would be driven into benthic substrate nor total fill area of pipe and anchors.

Applicant anticipates that seawater operations would result in maximum flow rate of about 44,000 gallons per minute (gpm) drawn up through intake pipeline from depths between 1,600 and 1,800 feet. Average temperature of seawater would be about 44-45 degrees Fahrenheit (F). Since this is an open loop system, an equal amount of seawater would be discharged back into ocean through return seawater pipe at a depth of about 120 to 150 feet and approximate discharge temperature would be about 58 degrees F.

Service life of each pipe is at least 25 years and it is anticipated by applicant that pipes may serve for about 75 years of operational use.

Alternative 2 is similar in design to Alternative 1. DEIS describes diffuser for Alternative 2 to be located approximately 1,500 feet east of Alternative 1 diffuser. Also, receiving pit would be in an area located seaward of eastern portion of Kaka'ako Waterfront Park and construction activities would be close to Kewalo Basin entrance channel. Specific details of length of pipe, combination collars and fill that may result from this alternative are not provided in DEIS as was provided for in Alternative 1.

SPECIFIC COMMENTS

The U.S. Fish and Wildlife Service (the Service) is concerned with possible effects of proposed discharge of cold seawater and its effects on coral reef community. DEIS indicates that large volumes (44,000 gpm) would be discharged at depths between 120 feet and 150 feet after having been drawn from depths of 1,600 feet. The plume of cold seawater may negatively influence scleractinian corals, and potentially induce bleaching by artificially altering temperature regime at discharge depth (Glynn 1996). Therefore, the Service recommends that a revised DEIS analyze potential extension of seawater return pipe to depths that are consistent with anticipated discharge temperature of 58 degrees F.

There is also a concern with potential impacts of warmer seawater on coral reef habitat. On Pages 2-28 & 29, DEIS states that, "[t]he precise location of the anchors or piles would be adjusted to avoid corals [or other protected biota]." U.S. Geological Survey (USGS) notes that DEIS does not include a discussion of how impacts of "warmed waters" on corals and other marine species might be mitigated or avoided. Studies have demonstrated that the emergence of coral reef diseases and increase in bleaching events is partly caused by high water temperatures, among other factors (Weil and Rogers, 2011). USGS recommends DEIS include a discussion of how potential impacts of increased water temperatures might be avoided or minimized.

The Service is also concerned that baseline conditions were not adequately presented in DEIS for several reasons. Biological survey was qualitative with the goal of identifying "major ecological zones." Data presented in Appendix D of DEIS are qualitative, not quantitative data, and do not adequately describe ecological functions that exist within project area. Similarly, data presented in Appendix E of DEIS do not adequately quantify ecological functions and potential impacts and loss of functions that may be associated with planned intake and return seawater pipes. Furthermore, biological studies appear to have been conducted at depths greater (*e.g.*, 40 to 80 foot contour) than what is currently planned (*e.g.*, 31 foot contour) in DEIS for construction of receiving pit to connect shore-side pipes to pipes that would extend seaward of receiving pit. As a result, the Service is concerned that appropriate coral reef communities have not been adequately characterized in DEIS.

The Service recommends that revised DEIS include biological surveys that: 1) are conducted at appropriate project depth contour and 2) measure biomass, densities and size frequency of affected coral reef organisms, with a goal of estimating unavoidable project impacts to coral reef organisms. Similarly, the Service also recommends that quantitative data be collected at Keehi Lagoon staging area to describe biological community and ecological functions that exist within this location of project area.

The Service is concerned that a discussion of mesophotic coral community (Hinderstein 2010, Kahng 2010, and Rooney 2010) is not adequately presented in DEIS. DEIS presents a qualitative description of biological communities between 40 and 80 foot contour and also for 1,500 foot and 1,650 foot contours. However, along most of planned alignment (*e.g.*, depths between about 100 feet and less than 1,500 feet), biological communities are not described. Therefore, the Service recommends that a revised DEIS include a complete discussion of coral communities as they exist within entire project area.

DEIS describes several means by which direct permanent and temporary loss of benthic habitat will occur as a result of several project construction-related activities. DEIS indicates that a total of about 18,474 square feet of benthic habitat may be affected by fill associated with installation combination collars to support return and intake seawater pipes.

However, DEIS does not present a clear description of fish and wildlife resources that may be affected by placement of combination collars on substrate for entire alignment and permanent loss of habitat that will be associated with this activity for either alternative. The Service recommends that marine biological surveys be conducted to quantify species of coral, algae, non-coral macro-invertebrates and reef fish that may be affected by placement of combination collars and seawater pipes on coral reef. In addition to coral cover, estimates of density, size and biomass should be calculated for these species groups.

The Service also recommends that results of these marine biological surveys is presented and discussed in revised DEIS, and that selection of preferred seawater pipe alignment be based on least environmentally damaging practicable alternative.

A receiving pit will be dredged in order to connect landward and seaward intake and return seawater pipes. Approximate area of receiving pit that will be dredged and filled is about 1,200 feet square. The Service considers this a significant permanent loss of benthic habitat. However, DEIS does not discuss in quantitative terms fish and wildlife resources that will be affected by this activity. Therefore the Service recommends that quantitative marine surveys be conducted to evaluate loss of species and habitat from this planned activity and results of these surveys be presented and discussed in revised DEIS. The Department acknowledges the technological and economic challenges to install and clean/repair screens as referenced on pages 3-125, 3-128, 3-129. However, the Department strongly encourages Corps. to re-examine long-term impacts at the project site if no screening is installed and maintained.

The Service is also concerned that vessel anchoring and placement of moorings may result in temporary and permanent loss of benthic habitat. The Service recommends that mooring and anchor sites be identified by divers for purpose of avoiding significant coral reef resources.

Finally, DEIS does not discuss plans to offset anticipated planned project construction-related impacts and lost ecological functions consistent with 2008 Environmental Protection Agency and Department of the Army Final Rule: Compensatory Mitigation for Losses of Aquatic Resources (FR/Vol. 73, No. 70). Pipes or cement structures are not adequate to offset project-related impacts to coral reef communities.

Draft EIS includes several statements of fact, but does not provide references. USGS recommends DEIS include references to support the statements:

- (Page 3-98): "The marine areas in the proposed pipeline corridor are among the most historically degraded coastal habitats in the State…. "and that this area has limited marine biological resources."

- (Page 3-128) "Marine mammals and sea turtles have a much greater tolerance to temperature extremes than do corals."

- (Page 3-129): "…in the unlikely event that a Hawaiian monk seal or sea turtle entered the cone of influence of the HSWAC intake; their swimming capability would be more than adequate to escape entrainment."

SUMMARY

In summary, DEIS does not provide an adequate analysis of potential impacts to coral reef resources. The Department recommends that a revised DEIS discuss proposed actions to offset unavoidable adverse impacts to coral reef resources that may be affected by this planned project. DEIS should be revised to include more complete information regarding marine resources in proposed project area; improved analyses regarding potential project impacts so as to allow unequivocal determination of least environmentally damaging practicable alternative; and a clearer commitment to avoid unnecessary impacts, minimize unavoidable impacts, and adequately compensate or mitigate the latter.

The Pacific Islands Service Office is willing to discuss appropriate methods of quantifying unavoidable impacts to coral reef resources, as well as possible mitigation options to offset unavoidable loss of ecological functions.

Thank you for the opportunity to review and comment on the DEIS.

If you have any questions concerning our comments, please contact Kevin Foster, Pacific Islands Fish and Wildlife Office at (808) 792-9400 or Gary LeCain, USGS Coordinator for Environmental Document Reviews at (303) 236-5050 (x229).

Sincerely,

Patricia Sanderson Port
Regional Environmental Officer

cc:
Director, OEPC
Kevin Foster, FWS/PIFWO
USGS, Reston

REFERENCES:

Weil E. and C Rogers. 2011. "Coral reef diseases in the Atlantic-Caribbean". Part 5. Pages 465-491. In: (editors Zvy Dubinsky, Noga Stambler) *Coral Reefs: An Ecosystem in Transition*. DOI: 10.1007/978-94-007-014-4_27.

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

May 3, 2011

MAY 3 2011

Mr. Peter Galloway
Regulatory Project Manager
U.S. Army Corps of Engineers, Honolulu District
Regulatory Branch (CEPOH-EC-R)
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Galloway:

Subject: POH-2004-01141

Thank you for the opportunity to review and comment on the subject matter. The Department of Land and Natural Resources' (DLNR), Land Division distributed or made available a copy of your report pertaining to the subject matter to DLNR Divisions for their review and comment.

Other than the comments from Division of Boating & Ocean Recreation, Office of Conservation & Coastal Lands, Division of State Parks, Land Division-Oahu District, the Department of Land and Natural Resources has no other comments to offer on the subject matter. Should you have any questions, please feel free to call our office at 587-0414. Thank you.

Sincerely,

[signature]

for Russell Y. Tsuji
Administrator

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
INTERIM CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

GUY H. KAULUKUKUI
FIRST DEPUTY

WILLIAM M. TAM
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
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HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

March 30, 2011

MEMORANDUM

To: Russell Tsuji, Administrator
Land Division

From: Daniel S. Quinn, Administrator
Division of State Parks

Re: Army Permit for a Draft EIS for the Proposed Honolulu Seawater Air Conditioning Project

Our concerns were documented with OCCL when CDUA OA-3579 was circulated for review. Thorne Abbott of TEC Inc. sent a response to our comments confirming continued collaboration, dialogue and coordination with our office. They will be requesting a permit from us for the use of Sand Island State Recreation Area for the assembly and storage of the pipeline prior to its being placed in Ke'ehi Lagoon. Thank you for the opportunity to provide comments.

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

March 21, 2011

MEMORANDUM

FROM: ~~TO~~: **DLNR Agencies:**
x Div. of Aquatic Resources
x Div. of Boating & Ocean Recreation
x Engineering Division
__ Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
~~x Office of Conservation & Coastal Lands~~
x Land Division –Oahu District
~~x Historic Preservation~~

TO: ~~FROM~~: Charlene Unoki, Assistant Administrator *Charlene*
SUBJECT: Army Permit for Draft Environmental Impact Statement for the Proposed Honolulu Seawater Air Conditioning Project
LOCATION: Island of Oahu
APPLICANT: Honolulu Seawater Air Conditioning, LLC

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by May 1, 2011.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
( ) We have no comments.
(X) Comments are attached.

Signed: *Barry Cheung*
Date: 4/18/11

Comments
The construction of the intake and return pipes requires authorization from the Land Board, which normally take the form of an easement. Terms and conditions will be considered at the disposition stage. The contractor staging area during the construction stage also requires similar approval.

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

March 21, 2011

MEMORANDUM

TO: **DLNR Agencies:**

x Div. of Aquatic Resources
x Div. of Boating & Ocean Recreation
x Engineering Division
__ Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division –Oahu District
x Historic Preservation

FROM: Charlene Unoki, Assistant Administrator *Charlene*
SUBJECT: Army Permit for Draft Environmental Impact Statement for the Proposed Honolulu Seawater Air Conditioning Project
LOCATION: Island of Oahu
APPLICANT: Honolulu Seawater Air Conditioning, LLC

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If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
(X) We have no comments.
( ) Comments are attached.

Signed: [signature]
Date: 3/28/11

OA - 11 - 186

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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& COASTAL LANDS
2011 MAR 23 A 10: 44
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NATURAL RESOURCES
STATE OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

March 21, 2011

MEMORANDUM

TO: **DLNR Agencies:**
- x Div. of Aquatic Resources
- x Div. of Boating & Ocean Recreation
- x Engineering Division
- __ Div. of Forestry & Wildlife
- x ~~Div. of State Parks~~
- x Commission on Water Resource Management
- x Office of Conservation & Coastal Lands
- x ~~Land Division—Oahu District~~
- x Historic Preservation

RECEIVED
LAND DIVISION
2011 APR 32 A 8: 21
DEPT. OF LAND &
NATURAL RESOURCES
STATE OF HAWAII

FROM: Charlene Unoki, Assistant Administrator *Charlene*
SUBJECT: Army Permit for Draft Environmental Impact Statement for the Proposed Honolulu Seawater Air Conditioning Project
LOCATION: Island of Oahu
APPLICANT: Honolulu Seawater Air Conditioning, LLC

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by May 1, 2011.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
( ) We have no comments.
(/) Comments are attached.

Signed: [signature]
Date: 4.27.2011

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF:OCCL:TM

Correspondence: OA 11-186

APR 29 2011

MEMORANDUM

TO: Charlene Unoki, Assistant Administrator
Land Division

FROM: Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

SUBJECT: Honolulu Seawater Air Conditioning LLC.'s Department of the Army Permit Application Draft Environmental Impact Statement for Proposed Land Uses Located Offshore of Honolulu, Oahu

The Office of Conservation and Coastal Lands (OCCL) is currently processing a Conservation District Use Application (CDUA) for the proposed seawater air conditioning project within State waters. Attached is a March 21, 2011 correspondence with OCCL's comments that was sent to the applicant.

Should you have any questions regarding this memorandum, contact Tiger Mills of our Office at ~7-0382.

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF:OCCL:TM

CDUA: OA-3579
Acceptance Date: January 10, 2011
180-Day Expiration Date: July 9, 2011

MAR 21 2011

George Krasnick
TEC Inc.
1003 Bishop Street
Pauahi Tower, Suite 1550
Honolulu, HI 96814

SUBJECT: Conservation District Use Application (CDUA) OA-3579 for the Honolulu Seawater Air Conditioning Project Located on Submerged Land Located Makai of Kakaako and Temporary Staging/Assemblage Located Makai of Sand Island, Island of Oahu

Dear Mr. Krasnick:

This letter is regarding the processing of CDUA OA-3579. The public and agency comment period on your application has closed (March 9, 2011). Attached to this letter are your receipts for the application fee and the public hearing fee; and copies of the comments received by the Office of Conservation and Coastal Lands (OCCL) regarding the CDUA. Please send copies of your responses to the questions raised in these letters directly to the authoring agency as well as to the OCCL.

Some of the concerns that the OCCL continues to have include the affects the nutrient rich deep-water return may have on benthos communities in the vicinity of the return pipe, potential coral damage, and lack of mitigation to prevent sea life from entering the intake pipe. However, Staff believes that these matters will be covered under the Department of the Army Permits for construction and water quality.

Early submittal of your response to comments will expedite the review process. Should you have any questions, please contact Tiger Mills of our Office of Conservation and Coastal Lands at 587-0382.

Sincerely,

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

C: Chairperson
DOA

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

KAKUHIHEWA BUILDING
601 KAMOKILA BLVD STE 555
KAPOLEI HI 96706

May 2, 2011

George P. Young, PE
Department of the Army
US Army Corps of Engineers, Honolulu District
Fort Shafter, HI 96858-5440

Log No. 2011.1192
Doc No. 1105PA01
Archaeology

RECEIVED
MAY 6 2011

Dear Mr Young:

**SUBJECT: National Historic Preservation Act (NHPA) Section 106 Review-
Draft Environmental Impact Statement (DEIS) for the
Proposed Honolulu Seawater Air Conditioning Project
Kaka'ako Ahupua'a, Kona District, Island of Oahu
TMK: (1) 2-1**

Thank you for the opportunity to review the above referenced report which we received on March 22, 2011. We apologize for the delayed response. The APE for the undertaking includes the submerged lands offshore of Kakaako where seawater intake and return pipes would be deployed, the area where vessels involved with offshore construction activities would operate, the Keehi Lagoon/Sand Island staging area, the area of the cooling station and all areas to be excavated for pipelines in the downtown Honolulu area.

A review of our records indicates that there are multiple known archaeological and cultural sites, including Native Hawaiian burial sites, in the area of potential effects of the pipeline excavations that are planned for this project. For instance, 6 individuals were encountered during work in the roadway near the intersection of Halekauwila and Punchbowl Streets. This site is recorded on the State Inventory of Historic Places (SIHP) as site number 50-80-14-2964. There are many other examples of Human skeletal remains that were encountered in the roadway in the Kaka'ako area including site -5820 and the Kawaiahao and Honuakaha cemeteries that were encroached on by road development. Consultation with native Hawaiians, as part of a Cultural Impact Assessment that was submitted along with this project, identified native Hawaiian burial sites within the APE that are considered 'sacred' by Native Hawaiians (Collins et. al. 2008 pg. 133).

In Feb 2010 (Log #2010.0326, Doc #1002NM11) we determined actions on Lot D-1 (landing site) would have no effect on historic properties as this is fill land in a former reef area. In December, 2008 we responded to a State Draft Environmental Impact Statement (Log #200.5141, Doc# 0812AL26) pointing out that your report did not include a comprehensive inventory of historic sites within the APE. In November 2008 we approved your archaeological monitoring plan but did not provide an effect determination (Log#2008.4720, Doc#0811WT21).

We note that you provide a list of architectural sites that may be affected by the project. Furthermore, since all connections to historic buildings will use existing connections and will not affect the structure or appearance of the building, we concur with your "no effect" to historic properties for architectural properties along the route.

However, you did not provide a list of archaeological sites along the route that could be affected. Instead, a system of probabilities was provided, with no background as to how probabilities were determined. We are particularly concerned because of the high number of burials found in what are considered areas of "medium probability," especially where your route passes through Kaka'ako and Downtown. We also note that informants in your Cultural Inventory Survey suggested that there could be a high number of burials found during this project. Please identify known archaeological sites and an assessment of how your project will avoid them. If a burial site has been moved, please discuss whether or not it has been moved out of the impact area for this project.

Finally, given that there is a high probability of finding burials during this project, this may constitute an "adverse effect" to cultural resources of importance to Native Hawaiian Organizations. One way to mitigate the adverse effect of discovering a burial is to ensure that you have a plan to address inadvertent burials. We see no discussion of what you will do if burials are discovered during trenching. We suggest you work with Native Hawaiian organizations to address the discovery is iwi during trenching.

Finally, for areas where you will use micro-tunneling, please identify your drop, slurry and surfacing pits.

We look forward to continued consultation on this project.

If you have further question, please contact Pua Aiu or Michael Vitousek at 692-8015.

Sincerely,

Pua Aiu
Administrator

C (by e-mail): William Aila, Jr.
Keola Lindsey, OHA
Peter C. Galloway, USACE

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1601 Kapiolani Blvd., Suite 1110
Honolulu, Hawaii 96814-4700
(808) 944-2200 • Fax: (808) 973-2941

April 26, 2011

RECEIVED
MAY 3 2011

George P. Young, P.E.
Chief, Regulatory Branch
US Army Corp of Engineers Honolulu District
Building 230
Fort Shafter, HI 96858

Dear Mr. Young,

The Habitat Conservation Division (HCD) of the National Oceanic and Atmospheric Administration's (NOAA), National Marine Fisheries Service, Pacific Islands Regional Office has reviewed the draft Environmental Impact Statement (dEIS) for the Honolulu Seawater Air Condition Project (HSWAC), for which your Honolulu District of the U.S. Army Corps of Engineers (USACE) is considering issuance of a Department of Army permit POH-2004-01141. The proposed action involves construction of a seawater air conditioning system on the south shore of Oahu to provide 25,000 tons of centralized air conditioning for downtown Honolulu buildings. The system will involve piping onto land cold seawater from 1600-1800 ft depth four miles offshore of Kakaako, circulating this through an on-shore cooling station, heat exchangers, a network of upland distribution pipes downtown, and returning the warmer seawater into nearshore ocean waters at about 120-150 ft depth about 3500 feet off Kakaako.

NOAA supports the project purpose to provide a renewable energy air conditioning system designed to reduce Hawaii's reliance on the use of fossil fuels. However, HCD has concerns regarding potential impacts to our trust resources including Essential Fish Habitat (EFH). Concerns include: a) in-water construction related impacts to benthos and reduction in water quality from pollutant discharge associated with micro-tunneling, receiving pit excavation, barge operations (including mooring), sheet pile driving, backfill of receiving pit and concrete capping, collar installation on pipe, staging area, pipe installation; and b) operational related impacts associated with impingement/entrainment of organisms during the intake of seawater at depth, and potential water quality reduction and benthic community degradation as the result of the 44,000 gallons per hour of cold and nutrient rich seawater being discharged to the near-shore marine environment. The potential for secondary impingement of organisms also exists as a result of this discharge.

Our general and specific comments addressing these concerns, pursuant to the National Environmental Policy Act (NEPA), are provided in a separate attachment. We request that you respond to these recommendations in the final EIS. Although you have determined that the project "may adversely affect EFH" via a letter dated March 18, 2011, and initiated Essential Fish Habitat (EFH) consultation pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the information that has been provided in section 3.7.5.4 of the dEIS entitled "Essential Fish Habitat", does not satisfy the EFH consultation requirements. The level of detail the section presents is inadequate to be commensurate with the level of threat to EFH from the action: impacts to EFH and measures to eliminate or mitigate such impact have not been adequately described. We request that a more detailed and comprehensive assessment be provided, either submitted within the final EIS in a section of the document clearly labeled as "EFH Assessment", or as a separate document. We will develop EFH Conservation Recommendations within 60 days after receipt of such an EFH Assessment. Under section 305(b)(4)(B) of the MSFCMA, the USACE must provide a written response to NMFS within 30 days after receiving the NMFS EFH Conservation Recommendations.

We look forward to the opportunity to meet with the USACE and the applicant to discuss our concerns regarding the potential impacts to NOAA trust resources resulting from this project. Please contact Danielle Jayewardene at 808-944-2162 or Danielle.Jayewardene@noaa.gov with any questions and/or to coordinate our participation in a meeting.

Sincerely,

Gerry Davis
Assistant Regional Administrator
Habitat Conservation Division

Copies furnished:

- U.S Environmental Protection Agency, Region 9, P.O. Box 50003, Honolulu, HI 96850. Attention: Wendy Wiltse.
- U.S. Fish and Wildlife Service, Environmental Services, P.O. Box 50088, Honolulu, HI 96850. Attention: Kevin Foster.
- State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources, P.O. Box 621, Honolulu, HI 96809. Attention: Alton Miyasaka.

Enclosure

General comments on dEIS

- The alternatives analysis is insufficient providing only one location for the break-out point and return water discharge:
    - Provide alternative locations at greater depths and/or distance from shore for the discharge of return water and identify how the diffusion dynamics, characteristics of return seawater compared to ambient seawater and proximity of discharge to benthic resources such as coral (including mesphotic coral) is different for each option.
    - Identify the probability of being granted authorization to implement a Zone of Mixing (ZOM) at the return water discharge site, and the alternative plan if the authorization is not granted.

- The impact analysis is insufficient with only qualitative surveys of benthic resources in the general nearshore area being presented, and references being made to old studies of entire Mamala Bay:
    - Provide quantitative current water quality and benthic resource data for each area where potential impact may occur including sites of micro-tunneling, receiving pit excavation, barge operations, pipe installation, staging area, intake of seawater, and return water discharge. Importantly, provide coral size frequency-, density of non-coral invertebrates- and biomass of fish- data at and immediately around receiving pit, along pipe up to return water diffuser point and in ZOM. Also identify presence and describe distribution of mesophotic coral along pipe up to 200m depth.
    - Quantify the expected direct and indirect impact to resources described above (it is not appropriate to avoid this characterization by claiming that effect will be temporary and/or minimal in nature, or that impacts will be compensated by the project providing new structure). This would include providing the species, densities and size classes of coral, and densities of non-coral inverts that will be crushed, abraded, smothered etc by construction, as well as descriptions of predicted changes to water quality from operations and further how this might affect algae (phytoplankton and benthic), coral and overall community structure in the nearhshore area influenced by discharge.
    - Identify the expected species and numbers of individuals that may be entrained at the deep seawater intake point and at return water discharge points, and the significance of this.

- Monitoring plans and mitigation plans are not provided:
    - Provide a water quality monitoring plan that will implemented at the return water discharge point.
    - Describe the mitigation measures implemented to avoid and minimize impact to water quality and benthos, and how compensatory mitigation (consistent with the 2008 Environmental Protection Agency and Department of the Army Final Rule:

Compensatory Mitigation for Losses of Aquatic Resources (FR/Vol. 73, No. 70)) will be implemented to address unavoidable impacts to coral.

- Maps:
    - Provide an illustration where the drilling routes break out point for pipes, the point of return water discharge and the proposed ZOM around diffuser, the route of the entire pipe, points anchoring the pipe, and the intake point are as superimposed on a map of biological resources located in the area. Provide GPS coordinates for all construction activity and operational structure locations.

- The EFH section is insufficient to satisfy an EFH consultation as it is weak in content and scope and does not allow evaluation of effect to EFH:
    - Fully characterize impact to all EFH from construction and operational activities (will overlap with information in Water Quality and Marine Biota sections) and describe measures that will be implemented to mitigate these impacts.

Specific comments on dEIS

p. iv Ensure that index page numbering is correct (some pages have been shifted).

<u>Chapter 2</u>

p.2-5 Provide correct coordinates (N and W interchanged) and in common GPS coordinate form.
p.2-7 Provide coordinates of offshore receiving pit, mooring points for barge and all construction related activities.
p.2-9 Correct distance from jacking pit on shore to receiving pit: it seems to only be about 1200 ft from shore, instead of about 1700 ft as stated. Also clarify distance away from shore, and from receiving pit, that the first port of diffuser starts.
p.2-12 Clarify if collars are only sectional, i.e. whether along entire pipe, hence if pipe lays across bottom or hovers above due to collars.
p.2-17 Clarify how much of staging area is in versus out of water.
p.2-50 State how micro-tunneling, the preferred non-trenching option- may affect benthic resources and water quality.
p.2-53 Clarify if the jacking shaft is the same as the receiving pit. If not, clarify if the jacking shaft is on land, or in water.
p.2-54 Clarify if microtunneling activity can extend to 80ft depth to avoid impacts to water quality and benthos from installing pipes from 20-40 ft break-out point.
p.2-55 Clarify the character of pollutants of the HECO condenser cooling discharges of 187MGD into Honolulu Harbor. Clarify if it has equivalent low temp, nutrient level etc as the HSWAC discharge. If not, these two should not be compared, i.e. do not state that HSWAC discharge is 1/3 of HECO amount.
p.2-56 Define shallow coastal waters. Explain the significance of differences in temp 53-58 C vs. 77 C, density 64.09 C vs. 63.88C, and do same for DO and DIN etc.
p.2-57 Explain CORMIX analysis, e.g. assumptions etc.

Chapter 3

Water quality 3.7.4

p.3-75 Describe the exact difference in return water compared to ambient water for temperature, salinity, density, pH, dissolved gases and inorganic nutrients, and characterize environmental consequences from these differences (positive and negative) occurring nearshore off Kakaako.
p.3-92 Characterize and quantify impacts: from (I) construction related activities (Receiving pit excavation, barge operations, sheet pile driving, mooring, backfill of receiving pit and concrete capping, collar installation on pipe), and from (II) operational activities (discharge and impingement). It is stated that (I) will be temporary and mitigated to less than significant, and that (II) will require mixing zone permit thus mitigated to less than significant. Both involve flawed logic and inappropriate conclusions.
p.3-95 Clarify if COMIX program analysis accounts for duration at different current velocities.
p.3-96 Provide water quality monitoring design plan.
p.3-96 Justify how it is appropriate to compare 84MG year sewage versus 23360 MG year (64 MG day) , i.e. 280 times greater amount of water.

Marine Biota 3.7.5

p.3-98 Provide references supporting statement that pipeline corridor is the most degraded coastal habitat in the State and provide that there are in fact limited resources.
p.3-99 Provide analysis whether 44 MGD of return water might cause marine community phase shifts as the Mamala study clearly states that this happened in the past due to effect to water quality from untreated sewage
p.3-100 Provide updated studies beyond Grigg (1995) which are now over 15 years old.
p 3-101 Provide up to date and high resolution benthic maps. The NOAA benthic maps in the Atlas are not always accurate and of low resolution.
p.3-102 Provide quantitative and detailed comprehensive benthic survey data for each of the potential impacts sites (both construction and operation related). This data is qualitative, helpful in focusing quantitative work but not for assessing impacts to resources and/or making final decisions as to where construction should be located to avoid and minimize impact.
p.3-105 Clarify that 75% coral coverage as reported for some areas in the project footprint is very high.
p.3-108 Remove statement that there are no stony corals below 100m as there is evidence that indicates otherwise (see e.g. Rooney et al. 2010).
p.3-110 Remove the statement that alternative 1 will have "long-term less than significant impact" as there is inadequate information provided to support this statement.
p.3-110 Clarify how the proposed break-out point was chosen to avoid coral reef as the data provided in reports is qualitative. Clarify if other data was used.
p.3-112 Describe in greater detail, using scientifically valid up to date research, the potential positive and as well as negative impacts to the biological community in the ZOM from 44 MGD discharge and also outside ZOM, both short-, mid- and long-term. Remove or support with scientifically valid data, statements that consequences will be positive long-term.

Essential Fish Habitat 3.7.5.4

p.3-130 Correct the water column EFH depth designation: is 200m not 100m.
p.3-131 Modify statement and remove the word "possible" from "possible effects to EFH...". Effects will very likely occur.
p.3-131 Include assessment of impacts to EFH nearshore as coral reef EFH is all substrate down to 100m depth.
p.3-131 Describe in far greater detail the impacts to all EFH, including coral reef EFH nearshore. Justify any statements that effects will only be temporary or minimal. Any injury to coral is permanent effect.
p.3-132 Describe how benthic algal communities might be influenced by nutrient influx within return water and if this might lead to phase shifts to algal dominance.
p.3-132 Provide a detailed and comprehensive EFH assessment labeled "EFH assessment" in the final EIS if the wish is to use the NEPA document for EFH consultation with NOAA.

Groundwater 3.8.4.2

p.3-142 State whether and if so how the marine environment might be impacted if the groundwater levels will be affected when dewatering occurs.

Cumulative impacts 3.9

Marine Resources 3.9.6

p.3-147 Revise this section as the analysis is inadequate and flawed in its approach and scope. A NEPA cumulative impacts analysis requires a comprehensive assessment of how this proposed action will, in combination with past, present and future actions in the area (even if unrelated to this action), affect the marine environment. For e.g. it is stated that the nearshore environment has been heavily impacted by action previously, hence identify how this project action might contribute to further degradation of the environment, also in light of other projects in the area. Refer to basic NEPA guidelines to approach this analysis appropriately.

Chapter 4

Unavoidable adverse impacts 4.8

p.4-2 Revise this section by providing far more detail and a comprehensive quantification based analysis of what unavoidable impacts will be.

Potential Mitigation Measures...4.9

p.4.2 Revise this section and provide a comprehensive vetted mitigation plan consistent with the 2008 Environmental Protection Agency and Department of the Army Final Rule: Compensatory Mitigation for Losses of Aquatic Resources (FR/Vol. 73, No. 70).
p.4-3 Clarify whether break-out point is around sand or rubble (described as sand elsewhere).

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1601 Kapiolani Blvd., Suite 1110
Honolulu, Hawaii 96814-4700
(808) 944-2200 • Fax (808) 973-2941

April 29, 2011

Peter C. Galloway, Regulatory Branch
U.S. Army Corps of Engineers Honolulu District
Building 230
Fort Shafter, HI 96858-5440

Dear Mr. Galloway,

The Protected Resources Division of the NOAA Fisheries Pacific Islands Regional Office (PIRO PRD) provides the following comments on the Draft Environmental Impact Statement (DEIS) for the proposed Hawaii Sea Water Air Conditioning (HSWAC) project.

PIRO PRD is the division of NOAA Fisheries that is responsible for the management and conservation of protected marine species throughout the Pacific Islands Region. Our agency manages several species in Hawaiian waters that are protected under the Endangered Species Act (ESA) as well as the Marine Mammal Protection Act (MMPA). These include the Hawaiian monk seal (*Monachus schauinslandi*) and all species of sea turtles, whales, and dolphins that are found within waters surrounding the proposed project area. A list of ESA-listed marine species in Hawaii can be found at http://www.fpir.noaa.gov/PRD/prd_esa_section_7.html, filename "Hawaii Species List".

In addition to ESA-listed marine species in Hawaii, other marine species are proposed or candidates under the ESA: The Hawaiian insular distinct population segment of the false killer whale (*Pseudorca crassidens*) has been proposed for listing under the ESA, and nine species of coral found within Hawaiian waters are currently candidates for listing under the ESA. Please see our ESA Section 4 webpage at http://www.fpir.noaa.gov/PRD/prd_esa_section_4.html for more information on these proposed and candidate species.

Our agency has reviewed the DEIS and found that Section 3.7.5.3 (page 3-118) of the document lacks a description of the occurrence of regular sightings of humpback whales (*Megaptera novaeangliae*) within the proposed project area. These whales are commonly found within the nearshore waters of O'ahu during the months of October through May and are known to breed, give birth, and rear their young during this period.

The project may cause adverse impacts to marine mammals that are found in waters within or near to the project site due to noise generated by construction and laying of the pipelines. In particular, the driving of sheet piles described in Section 2.4.2.2 on page 2-7 and driving of pipe piles described on page 2-9 can create high volumes of noise that may disrupt essential behaviors such as feeding, breeding, resting, and caring for young. This is of particular concern for humpback whales, which are commonly found near to or within the project area during the winter months when construction is planned to take place. We are also concerned that noise from project construction may cause behavioral disturbance to Hawaiian monk seals.

The document acknowledges that construction noise may cause "take" under the MMPA (page 3-127). This may also be considered "take" under the ESA, as the noise may fall under the category of "harassment" of ESA-listed species. We therefore encourage your agency to contact our ESA Section 7 Coordinator, Patrick Opay, at (808) 944-2242 patrick.opay@noaa.gov to discuss early consultation on this project.

Thank you for the opportunity to comment on the DEIS and for working with NOAA Fisheries to conserve and protect Hawaii's living marine resources. If you have any questions about these comments, please contact Jayne LeFors at (858) 546-5653 or at jayne.lefors@noaa.gov.

Sincerely,

Alecia Van Atta
Assistant Regional Administrator
for Protected Resources

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

May 10, 2011

Mr. Peter Galloway
U.S. Army Corps of Engineers
Honolulu District
Regulatory Branch (CEPOH-EC-R)
Building 230
Fort Shafter, HI 96858-5440

Subject: Draft Environmental Impact Statement for the Proposed Honolulu Seawater Air Conditioning Project, Honolulu, Hawaii. (CEQ# 20110078)

Dear Mr. Galloway:

The U.S. Environmental Protection Agency (EPA) has reviewed the Draft Environmental Impact Statement (DEIS) for the Proposed Honolulu Seawater Air Conditioning Project (Project) pursuant to the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508), and Section 309 of the Clean Air Act. Our comments were also prepared under the authority of, and in accordance with, Sections 303, 316, and 402 of the Clean Water Act (CWA), and the provisions of the Federal Guidelines promulgated at 40 CFR 230 under Section 404(b)(1) of the Clean Water Act (CWA).

EPA strongly supports innovative, energy saving technologies, provided that they are suitably located to minimize adverse environmental impacts. Using energy efficient technologies, such as seawater air conditioning (SWAC) for district cooling needs, can help the nation meet its energy requirements while reducing greenhouse gas emissions; however, as proposed, this project would achieve energy-reducing benefits while also causing adverse environmental impacts. EPA would like to work with the Corps to refine the proposed project to avoid the unnecessary environmental tradeoffs further described below and in the attached detailed comments.

We have rated the DEIS EO-2, Environmental Objections – Insufficient Information (see enclosed EPA Rating Definitions), because the Preferred Alternative potentially violates CWA Sections 303(c), 316 (a), and 402 which include requirements for the protection of water quality. Specifically, the project may result in further degradation of already impaired waters, due to the significant load of nutrients and difference in temperature of the discharge at the return pipe outlet. Our rating is also based on the Preferred Alternative's intake velocity and lack of screening, which may violate CWA Section 316(b), which includes requirements to reduce the impingement and entrainment of species at the intake.

The basis for our rating is discussed further in the enclosed detailed comments. The detailed comments also include our concerns about the magnitude of the project impacts involving waters of the United States (WUS), biological resources, habitat, floodplain, hazardous materials from construction, and public health.

EPA appreciates the opportunity to review this DEIS. We also appreciate the Corps' coordination with us prior to and during our review, including meetings, phone calls and a site visit on August 8, 2010. When the FEIS is released, please send one hard copy and three electronic copies to the address above (mail code: CED-2). If you have any questions, please contact me at (415) 972-3521, or have your staff contact James Munson, the lead reviewer for this project. James can be reached at (415) 972-3800 or munson.james@epa.gov.

Sincerely,

Sheryl Bilbrey for:
Enrique Manzanilla, Director
Communities and Ecosystems Division

Enclosures:
Summary of EPA Rating Definitions
Detailed Comments
Cc:

Gary L. Gill
Deputy Director for Environmental Health
Hawaii Department of Health
1250 Punchbowl St., 3rd floor
Honolulu, Hawaii 96813

EPA DETAILED COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS) FOR THE PROPOSED HONOLULU SEAWATER AIR CONDITIONING PROJECT, HONOLULU, HAWAII. (CEQ# 20110078) May 10, 2001

Impacts to Waters of the United States and Water Quality

Clean Water Act Section 303(c)-(d) and 316(a)

Nutrients

The DEIS contains an insufficient analysis of whether and how the Preferred Project Alternative will meet Hawaii's water quality standards for nutrients. Mamala Bay is currently listed under Clean Water Act Section 303(d) as impaired for total nitrogen and chlorophyll-a: http://hawaii.gov/health/environmental/env-planning/wqm/303dpcfinal.pdf and http://hawaii.gov/health/environmental/env-planning/wqm/2006_Integrated_Report/2006_Chapter_IV_Assessment_of_Waters.pdf. The DEIS does not address this listed impairment in the context of potential National Pollutant Discharge Elimination System (NPDES) permitting. Section 3.7.4.3 of the DEIS states the ambient concentrations of nitrate nitrogen at the ~1,700 ft. deep intake are nearly 3 times the water quality standard, and these nutrient-rich waters will be discharged through the return pipe into more shallow (~135 ft deep) waters of Mamala Bay. The FEIS should fully evaluate the ambient concentrations of nutrients at the discharge location as compared to Hawaii's water quality standards and how the proposed discharge will interact with the discharge from the Sand Island wastewater treatment plant. As the Preferred Project Alternative proposes a new discharge to an impaired waterbody and will require an NPDES permit for this discharge, the Final Environmental Impact Statement (FEIS) should consider and analyze the requirements of federal regulations at 40 CFR 122.4(i), which provide, in part, that: "No permit may be issued... to a new source or a new discharger, if the discharge from its construction or operation will cause or contribute to the violation of water quality standards." We recommend that the FEIS also consider the 9th Circuit federal appeals court decision in *Friends of Pinto Creek vs. USEPA*(504 F.3rd 1007, 9th Circuit 2007), as the opinion discusses potential limitations on issuance of NPDES permits for discharges to impaired waters.

A thorough antidegradation analysis will be necessary before a decision can be made to permit this discharge. Mamala Bay would be provided tier 1 protection for nutrients under Hawaii's anti-degradation policy (HAR 11-54-1.1), which requires that existing uses be maintained and protected and prohibits further degradation of already impaired waters. The FEIS should evaluate additional discharge alternatives to address these concerns about the ability of the preferred project alternative to comply with water quality standards and NPDES permitting requirements. For example, the FEIS could evaluate alternative discharge locations that would ensure that the discharge does not contribute to further degradation of Mamala Bay.

As it would appear difficult or impossible to permit a new discharge of nutrient-rich water into a waterbody already impaired by high nutrient levels, the FEIS should provide a more thorough analysis of this issue and analysis of additional discharge alternatives.

Temperature

The DEIS does not address whether nor how the Preferred Project Alternative would meet Hawaii's water quality standards for temperature. Hawaii's water quality standards for open coastal waters, found in Section 11-54 of Hawaii's Administrative Rules, require that temperature not vary more than one degree Celsius from ambient conditions. The difference between the lowest return discharge temperature and ambient temperature is estimated to be 13 degrees Celsius. This large change in temperature would not meet water quality standards and the discharger would need to provide information to comply with CWA Section 316(a) in order to be permitted for this discharge under CWA Section 402 (NPDES). The FEIS should fully evaluate how the Preferred Project Alternative would address the impact of the temperature change on the water quality of Mamala Bay and how the project would meet temperature water quality standards.

Toxic Pollutants

The DEIS fails to consider the potential discharge of toxic pollutants from the return pipe. The FEIS should examine possible sources of toxics from the cooling process, (including the piping, pumps, and use of any antifouling agents), and how the discharge would comply with Hawaii's water quality standards (HAR 11-54).

Recommendations:

The FEIS should include an alternative to the return pipe discharge location and depth that would avoid the discharge of nutrients that would further impair the water quality of Mamala Bay.

The FEIS should describe, in detail, the project's compliance with Clean Water Act Section 303(c) and Hawaii's antidegradation policy.

The FEIS should analyze the specifics of the *Friends of Pinto Creek vs. USEPA* opinion and its potential implications for the proposed project.

The FEIS should evaluate how the proposed discharge will interact with the discharge from the Sand Island wastewater treatment plant.

The FEIS should fully evaluate the impact of the discharge-induced temperature change on Mamala Bay, and how the project would comply with Hawaii's water quality standards or the CWA 316(a) requirements.

The FEIS should include an analysis of potential sources of toxic chemicals from the cooling process.

<u>Clean Water Act Section 316(b)</u>

Although the DEIS considers the requirements of Clean Water Act Section 316(b), (page: 3-128), it fails to adequately address how the Preferred Project Alternative would comply with the requirements for a new facility, described in 40 CFR 125.84 through 40 CFR 125.89.

Specifically, the FEIS should describe how the proposed project would comply with either Track I or Track II. Track I requires reducing the intake flow to a level commensurate with a closed-cycle recirculating water system and designing the intake to a maximum through-screen design intake velocity of 0.5 ft/second. Track II requires the project to demonstrate that the technologies employed will reduce the level of adverse environmental impact from the cooling water intake structure to a comparable level to that achieved by implementing Track I. Based on the DEIS, we assume the proposed project will have to comply with Track II. The proposed project velocity of 5 ft/second, the lack of intake screen, and the limited analysis of ecological impacts of the intake system raise concerns about whether the project would comply with the requirements of CWA Section 316(b) Track II. A complete Track II analysis requires a comprehensive demonstration study, a proposal for information collection, a source water biological study, an evaluation of potential cooling water intake structure effects, and a verification monitoring plan (40 CFR 125.86(c)(2)). These studies are required in addition to the general application information requirements of 40 CFR 122.21(r) for facilities with cooling water intakes, which include source water physical data, cooling water intake structure data, and a source water baseline biological characterization.

Recommendation:

The FEIS should provide additional analysis to demonstrate compliance with either Track I or Track II of the CWA Section 316(b) requirements. If Track II is chosen, the FEIS should fully describe the results of the required Track II studies described above.

For further assistance with issues pertaining to Clean Water Act Sections 303(c) and (d), 316(a) and 316(b), please contact Elizabeth Sablad in, EPA Region 9's NPDES Permits Office. Elizabeth can be reached at (415) 972-3044, or by email at sablad.elizabeth@epa.gov.

Clean Water Act (CWA) Section 404, Rivers and Harbors Act

The DEIS provides limited documentation to support future CWA and Rivers and Harbors Act (RHA) permitting for the seawater intake and outfall pipelines. CWA Section 404 permit coverage may be required for construction of the breakout point/receiving pit and for the piles and concrete collars needed to secure the pipelines (page ES-4, nearly 0.5 acre in total fill area). Assembly and installation of the pipelines may also require authorization under RHA Section 10 for work in navigable waters. Additional information will be needed to support permit applications to the Army Corps of Engineers, including more comprehensive aquatic resource surveys and impact assessment data, and an analysis of alternatives designed to minimize impacts.

The marine biological assessments cited in the DEIS are do not sufficiently describe aquatic resources, particularly the potential occurrence of mesophotic coral reef ecosystems (deep, low light ecosystems composed of coral, semi-precious coral, algae, and invertebrates), given the proposed pipeline depths of > 40 m where mesophotic coral reef ecosystems may occur. Of equal concern is the lack of biological data presented for the staging area at Keehi Lagoon. Divers surveyed the area off Kakaako in 2005, but the DEIS only quotes a study (Grigg 1995) reporting major historical changes in the composition of coral communities and their occurrence in Mamala Bay. Similarly, the deep-water survey by the Hawai'i Undersea Research

Laboratory, referenced on page 3-308, presents only a list of organisms, without sufficient habitat description or quantification. The FEIS should describe the more recent survey data and include current mapping of habitat types, and quantitative data on coral cover, density, size, condition, and species. Similarly, the description of impacts to corals on pages 3-110 and 3-111 is inappropriate because it considers only the area directly covered by living coral heads and, therefore, underestimates the extent of coral reef habitat. It is more biologically relevant to consider the density of coral and the area of coral habitat because complex structures surrounding coral heads are used for feeding, foraging, and reproduction by marine organisms.

With regard to project alternatives, two similar intake/outfall pipeline alignments were analyzed along with a no action alternative. A range of construction methods were also considered, including micro tunneling and trenching. The DEIS considered only one design for the breakout point/receiving pit, involving digging and filling a 1,200 sq ft area within steel sheet piles that extend about 10 feet above the seafloor (page: 2-7). The DEIS also indicates that the breakout point would be sited in 31 ft deep sand channels for both alternatives. Avoidance of coral reef is poorly substantiated, and the DEIS lacks habitat maps and quantitative biological descriptions of the proposed breakout points. A broader range of alternatives that more clearly demonstrate impact avoidance may be necessary for CWA purposes.

Finally, indirect impacts to the marine environment are insufficiently addressed by the DEIS. Although direct fill impacts at the breakout point and the pipeline piles and collars total less than 1 acre, increased turbidity and physical disturbance to soft and hard sea bottoms during installation of pipelines, anchors, moorings, and anchor lines from construction vessels should also be evaluated. Discharge of drilling fluid at the breakout point, and leaks through the seafloor shoreward of the breakout also have the potential to indirectly affect marine life. These impacts should be discussed and mitigated where appropriate.

Recommendations:

The FEIS should consider the need for CWA Section 404 permits for the pipelines and anchor collars and describe how avoidance of corals will be achieved in positioning the pipelines.

The FEIS should analyze alternative sizes and designs for minimizing impacts at the breakout point.

The FEIS should assess the marine resources at the staging area in Keehi Lagoon and discuss the potential for impacts to the marine resources from physical disturbance, anchoring, and chemical discharges during staging.

The FEIS should include quantitative biological assessments of the benthos in the breakout and pipeline sites, including coral density, size, species richness, and condition.

The FEIS should assess the deep benthos to determine if mesophotic coral reef ecosystems occur along the pipeline and if they are likely to be impacted by the cold, high-density water at the diffuser and discharge area.

The FEIS should present benthic photographs or maps to document the avoidance of corals in the evaluations of alternative break out points and pipeline alignments.

The FEIS should include more biologically relevant data (i.e., coral density and habitat area) and delete the calculations for "surface area of live coral cover" (page 3-110). The recommended types of data would provide a more accurate assessment of impacts and represent a more defensible basis for the amount of compensatory mitigation required to replace the lost ecosystem functions.

The FEIS and Corps of Engineers Public Notice should thoroughly describe total direct and indirect impacts to the range of marine habitats and their functions. Compensatory mitigation plans should account for direct and indirect impacts, temporal losses, and the uncertainty of mitigation project success.

The FEIS should describe best management practices to minimize damage from moorings, anchors, and anchor lines during construction. Areas should be designated for moorings and anchors that specifically avoid impacts to corals. Areas of high coral value should be marked with buoys to ensure avoidance of those areas during construction.

The FEIS should describe the potential for leakage or discharge of drilling fluids and their impacts to the marine environment.

The FEIS should discuss how the alternatives analysis complies with Section 404(b)(1) Guidelines that require selection of the least environmentally damaging practicable alternative (LEDPA) for section 404 permitting purposes.

Page ES-7 of the DEIS states that no compensatory mitigation for impacts to aquatic resources is needed because: "*All practicable steps have been taken to avoid and minimize impact to aquatic life*" and "*The pipeline and breakout point structures will provide hard substrate for colonization by corals and other aquatic life.*" Although all practicable means of impact avoidance and minimization must be realized prior to pursuing compensatory mitigation, compensation is often necessary for impacts that are unavoidable, and it is premature to presume otherwise. It is also unlikely that coral colonization of concrete and High Density Polyethylene (HDPE) pipes will occur or be adequate compensatory mitigation for lost aquatic habitat functions. Indeed, although the DEIS cites anecdotal observations of pipeline colonization at Natural Energy Laboratory of Hawai'i Authority (NELHA) on Big Island, (page: 3-111), the DEIS also lauds the "biofouling resistance" of this project's HDPE pipe as a desirable property (Section 2.4.2.8). Marine concretes used in construction also customarily contain an antifouling compound. The extrapolation in the DEIS from colonization of artificial reefs to colonization on construction concretes is, therefore, not appropriate.

Recommendations:

The FEIS should include a description of the use of antifouling compounds to clean the intake and outfall pipelines. The prevention and treatment of biofilms and fouling should be described. If chemicals will be used periodically to keep the pipes clean and open, the impacts of these on the marine environment should be described.

The FEIS should thoroughly explore opportunities to provide compensatory mitigation for all foreseeable direct and indirect adverse impacts from the project.

For further assistance with issues pertaining to waters of the U.S., please coordinate with Wendy Wiltse in EPA Region 9's Wetlands Office. Wendy can be reached at (808) 541-2752, or by email at wiltse.wendy@epa.gov.

Project Purpose and Need

The Draft Environmental Impact Statement (DEIS) should clearly identify the underlying purpose and need to which the United States Army Corps of Engineers (Corps), is responding in proposing the alternatives (40 CFR 1502.13). The purpose of the proposed action is typically the specific objectives of the activity, while the need for the proposed action may be to eliminate a broader underlying problem or take advantage of an opportunity. The Purpose and Need for a project should be stated broadly enough to spur identification of a reasonable range of alternatives, regardless of what the future findings of the alternatives analysis may be.

The Purpose and Need in this DEIS states, "As part of its plan to develop a seawater air conditioning (SWAC) system to serve the downtown area of Honolulu, the applicant proposes to construct seawater intake and return pipelines in coastal waters. The purpose and need for the proposed seawater intake and return pipes is to obtain deep, cold seawater from the ocean to chill fresh water that would circulate through the SWAC system and to return the seawater to the ocean after it has passed through onshore SWAC heat exchangers." While this describes the applicant's purpose, it does not explain the underlying need for such a system.

Recommendation:
The purpose and need should be a clear, objective statement of the rationale for the proposed project. We recommend that the DEIS discuss the proposed project in the context of the larger need for energy efficient strategies to meet the air conditioning needs of downtown Honolulu, and the energy savings that it would achieve.

Alternatives Analysis

The DEIS presents only the Preferred Action Alternative 1, Alternative 2, and a No-Action Alternative. EPA believes that the alternatives analysis needs to be expanded in the FEIS to include a full analysis of a reasonable range of alternatives.

CEQ Regulations for implementing NEPA (40 CFR, Parts 1500 - 1508) state that the alternatives section of an EIS should "rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly describe the reasons for their having been eliminated" (40 CFR, part 1502.14). All reasonable alternatives that fulfill the project's purpose and need should be evaluated in detail, including alternatives outside the legal jurisdiction of the Corps (Council on Environmental Quality's (CEQ) Forty

Questions[1], #2a and #2b). The more alternatives considered, the greater the possibility of avoiding significant impacts. *"In determining a reasonable range of alternatives, the focus is on what is "reasonable" rather than on whether the proponent or applicant likes or is itself capable of carrying out a particular alternative. Reasonable alternatives include those that are practical and feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant."* (CEQ Forty Questions, #2a)

Both action alternatives utilize microtunneled methods to place an open ended intake piping offshore to a depth of approximately 1,800 feet with return pipelines discharging at approximately 150 ft. Differences between the two alternatives are limited to the location of the cooling station and corresponding directional changes to piping placement and access points. Both alternatives would result in negative environmental impacts to wildlife, coral reefs, air quality, water quality, floodplain, and Environmental Justice (EJ) communities.

The DEIS describes Alternative 1 as less costly due to the cooling station location at 210 Coral Street. The reason for this is described as "additional costs that would be incurred for waterproofing" Alternative 2's cooling station location in "Flood Zone A" (page: 2-38), the implication being that such costs would not occur for Alternative 1. Contrary to this apparent assumption, both alternative cooling stations are located in Flood Zone AE.

Recommendations:

EPA encourages the Corps to reconsider a full scope of alternatives, including off-site locations, environmentally preferable onsite alternatives, and other modes of energy saving.

The FEIS should include a comprehensive assessment of an extended return seawater diffuser/screened intake alternative. This alternative should require the return pipe to extend to an ocean depth with ambient temperatures equaling the expected outflow temperature. This alternative should include a screened intake pipe, in compliance with the velocity requirements of CWA 316(b). In addition, the alternative should locate the cooling station in non-flood Zone area. The assessment should fully evaluate compliance with CWA 303(c), 303(d), 316(a), 316(b), and 404(b)(1).

The FEIS should include a comprehensive assessment of a double-closed system that would feature a closed-loop circulating system for both the seaward and terrestrial pipelines. This would eliminate negative impacts at both the open intake and terminal points offshore. Other possible advantages could include lower water requirements, reduced operational kill of species and more consistent predictable water temperatures. The use of high-quality water would also minimize the potential for clogged screens, fouled exchangers, and other mechanical failures. A closed-loop system could also be less susceptible to corrosion and biological fouling than an open pipe intake from the ocean. In addition, the alternative should locate the cooling station in a non-flood zone area.

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[1]Forty Most Asked Questions Concerning CEQ's NEPA Regulations, 40 CFR Parts 1500-1508, Federal Register, Vol. 46, No. 55, March 23, 1981.

The FEIS should be corrected to reflect that the Alternative 1 cooling station location would be in a flood plain and, thus, require waterproofing the structure up to the regulatory flood elevation and complying with structural requirements.

Biological Resources and Habitat

The DEIS implies that impacts from the project to marine biological resources would be less significant because, "the marine areas in the proposed pipeline corridor are among the most historically degraded coastal habitats in the State" (page 3-98); however, the DEIS fails to establish an adequate assessment of baseline conditions for coral reef and species habitat. Page 3-118 states that, "listed marine mammals that could occur in the project area include the humpback whale, the sperm whale, and the Hawaiian monk seal." Other endangered species in the project area include turtles and coral as well as many other non listed species. EPA is concerned with potential impacts of the proposed project to species and benthic aquatic habitats that may already be stressed. We are particularly concerned with potential entrainment of aquatic species at the intake pipe opening, as well as impacts to coral reefs and biota as a result of changes to water quality from the nutrient-rich, low temperature discharge from the return pipe.

The DEIS fails to clearly demonstrate that an adequate biological survey has been completed for the entire project area including all depths and temporary staging areas. It is not clear whether or not a Biological Opinion has been completed for the proposed project. The FEIS should identify all proposed and listed threatened and endangered species and critical habitat that might occur within the project area; identify and quantify any species or critical habitat might be directly, indirectly, or cumulatively affected by each action alternative; and identify measures that could mitigate impacts to those species and habitats. Emphasis should be placed on the protection and recovery of species, such as those listed on page 470 of the DEIS, according to their status or potential status under the Endangered Species Act (ESA).

Recommendation:
The FEIS should include a comprehensive description of existing benthic and aquatic habitats, including locations of coral reefs in relation to the proposed pipelines, common and protected species that rely on these habitats, and the current chemical, physical and biological conditions that these species depend on.

The FEIS should provide a detailed analysis of potential direct, indirect, and cumulative biological resource impacts that would result from the project alternatives, including destruction of coral reefs, increased sedimentation from construction, degraded water quality, and changes to the food web. Special attention should be given to the potential impacts that could occur due to entrainment of aquatic species, changes in temperature from the return pipe discharge, and impacts to water quality that could occur as a result of pipeline construction, operations and maintenance.

The results of consultation with the United States Fish and Wildlife Service and National Oceanic and Atmospheric Administration (NOAA), if appropriate, regarding threatened or endangered species or critical habitat should be included in the FEIS.

Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (February 11, 1994), directs federal agencies to identify and address disproportionately high and adverse human health or environmental effects on minority and low-income populations, allowing those populations a meaningful opportunity to participate in the decision-making process. Guidance[2] by CEQ clarifies the terms "low-income" and "minority population" and describes the factors to consider when evaluating disproportionately high and adverse human health effects. The applicant's preferred Alternative 1 would require "construction between the old landfill and the open drainage culvert" (page: 2-7). The document goes on to say that the "spoil" would be processed at the site. However; DEIS fails to address the fact that the jacking pit location is less than 200 feet away from the Next Steps Homeless Shelter and Reuse Hawaii, which currently reside on the other side of the drainage culvert. Similarly, the jacking pit would be placed in the most west northwest corner of Kaka'ako Waterfront Park, which caters to tourists, families, and amphitheatre events. Furthermore, page 3-42 of the DEIS states: "The region of influence for hazardous and toxic substances is the entire project area and any adjoining area to which spills, leaks or releases could migrate".

Recommendations:
The FEIS should include a commitment to mitigating all adverse impacts to human health. All appropriate environmental, health and safety precautions should be carefully outlined and agreed upon before any construction starts.

The FEIS should assess the potential for disproportionate adverse impacts to minority and low-income populations within the region of influence for hazardous and toxic substances of the project such as the Next Steps Homeless Shelter and the Kaka'ako Waterfront Park. The assessment of the project's impact on minority and low-income populations should reflect coordination with those affected populations.

The FEIS should commit to a notification plan to disclose to the public the health risk of exposure to hazardous or toxics substances inside the region of influence.

Alternative 2 would avoid construction between the old landfill and the open drainage culvert, but presents the same water quality issues as the Preferred Alternative and would call for the "existing warehouse to be partially or completely demolished" (page: 2-38). This is the same structure that is currently occupied by the Next Steps Homeless Shelter and the Reuse Hawaii a non-profit organization mentioned above. Next Step Homeless Shelter is essential to Hawaii's homeless population and the well-being of the population in general. If this homeless shelter is displaced, it is likely that it will not find another location and more homeless individuals will be on the streets with even less resources than they currently have.

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[2]Environmental Justice Guidance under the National Environmental Policy Act, Appendix A (Guidance for Federal Agencies on Key Terms in Executive Order 12898), CEQ, December 10, 1997.

Children's Environmental Health

EPA recommends that an analysis of impacts to children be included in the EIS if there is a possibility of disproportionate impact on children related to the proposed action. (http://www.epa.gov/compliance/resources/policies/nepa/children-health-risks-pg.pdf). Since children are likely to be present in the vicinity of the micro-tunneling operation beneath the Kaka'ako Waterfront Park, we believe that such a possibility exists with the proposed project.

Environmental contaminants can affect children quite differently than adults, both because children may be more highly exposed to contaminants and because they may be more vulnerable to the toxic effects of contaminants. Children generally eat more food, drink more water, and breathe more air relative to their size than adults do, and, consequently, may be exposed to relatively higher amounts of contaminants. Children's normal activities, such as putting their hands in their mouths or playing on the ground, can result in exposures to contaminants that adults do not face. Lastly, environmental contaminants may affect children disproportionately because their immune defenses are not fully developed and their growing organs are more easily harmed.

Recommendation:
Because this project has the potential to cause exposure of children to contaminants of concern (such as organochlorine pesticides, lead, and other heavy metals) from the micro-tunneling operation beneath the Kaka'ako Waterfront Park, the FEIS should analyze and mitigate any potential impacts to children. The DEIS does not contain sufficiently detailed and specific mitigation measures to ensure that exposures to children will not occur (see page 3-44).

Executive Order 11988: Floodplain Management

Executive Order 11988 Floodplain Management requires federal agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy and modification of floodplains. Per the Flood Insurance Rate Map (FIRM), Alternative 1and 2 are in a Zone AE special flood hazard area with an established base flood elevation (BFE) (See FIRM#: 15003C0362G City and County Of Honolulu 1/19/2011). Page 2-38 of the DEIS incorrectly states that Alternative 2 is in a "Flood Zone A (flood fringe district)". Figure 3-9 incorrectly depicts the Alternative 1 pump station area as a Zone X. Similarly, page 3-63 states that "the cooling station and distribution piping would be located within FIRM Zone X", outside the 500 year floodplain. Furthermore, the March 9, 2009 correspondence from the Federal Emergency Management Agency (FEMA) in Appendix J, responding to the Corps' request for comments on the proposed project, presents information that is now outdated in that it reflects a Flood Insurance Rate Map from 2005.

Recommendations:
The FEIS should reflect that the cooling stations of both alternatives are in an AE Flood Zone.

The FEIS should discuss any impacts that the proposed Project may have on the potential for flooding, as well as the impacts of potential flooding on the proposed Project.

The FEIS should provide a detailed description of the current FEMA floodplain.

The results of current consultation with FEMA, if appropriate, should be included in the FEIS.

For more information regarding floodplain requirements, go to: http://www.fema.gov/plan/prevent/floodplain/nfipkeywords/zone_ve.shtm.

Management of Excavated Materials

Installation of the pipeline, either by microtunneling or trenching, will result in the generation of excavated materials. In the case of microtunneling, the DEIS states that slurry would be transported in lined dump trucks to the contractor's own yard for drying and then disposed of properly, likely at the construction waste landfill. The DEIS does not include a sufficient discussion of the management of solids and slurry nor whether the jacking pits are of sufficient size to handle all drilling fluids. Additionally, the DEIS does not address how all excavated materials from the microtunneling operation would be handled nor the specific disposal location(s) of these materials.

Recommendations:

The FEIS should identify projected hazardous waste types and volumes, and describe, in detail, how all materials, including solids and slurry from the microtunneling operations, will be handled, stored, transported, and disposed. The applicability of State and federal hazardous waste management requirements should be discussed and the FEIS should document that no excavated material would be stored or disposed of within waters of the United States. The FEIS should also include the name and location of the landfill authorized to handle the types of waste potentially excavated, such as toxics from the old landfill and old utility lines compromised by construction activity.

The FEIS should address potential direct, indirect, and cumulative impacts of hazardous waste from construction of the proposed project. Appropriate mitigation should be evaluated, including measures to minimize the generation of hazardous waste. Alternate industrial processes using less toxic materials should be evaluated as possible mitigation. This could reduce the volume or toxicity of materials requiring management and disposal as hazardous waste.

Air Quality

Although the DEIS states that the construction activities would have a short term impact on air quality, it does not discuss what the specific potential impacts are reasonably expected to be, nor does it specify measures to mitigate air quality impacts. The DEIS notes that "Specific mitigation measures would be established as conditions of construction permits, but typical mitigation measures include watering the exposed surfaces, covering dirt being transported and keeping offsite roadways clean." (p. 3-139)

The explanation of National Ambient Air Quality Standards in Table 3-25 (p. 3-137) is out of date for various air pollutants. This information changes frequently.

Recommendations:

The FEIS should provide a detailed discussion of the potential direct, indirect, and cumulative air quality impacts of the proposed project during and post-construction.

The FEIS should demonstrate that the proposed project would comply with applicable State and Federal air quality regulations, including any permit requirements for the back-up generators and construction equipment.

The FEIS should include the current NAAQS.

The FEIS should describe specific commitments to minimize and mitigate emissions, including any measures that would be required as permit conditions. EPA recommends that the following construction measures be adopted in the FEIS:

Fugitive Dust Source Controls:

- Stabilize open storage piles and disturbed areas by covering and/or applying water or chemical/organic dust palliative where appropriate. This applies to both inactive and active sites, during workdays, weekends, holidays, and windy conditions.
- Install wind fencing and phase grading operations where appropriate, and operate water trucks for stabilization of surfaces under windy conditions.
- When hauling material and operating non-earthmoving equipment, prevent spillage and limit speeds to 15 miles per hour (mph). Limit speed of earth-moving equipment to 10 mph.

Mobile and Stationary Source Controls:

- Reduce use, trips, and unnecessary idling from heavy equipment.
- Maintain and tune engines per manufacturer's specifications to perform at the EPA certification levels and to perform at verified standards applicable to retrofit technologies. Employ periodic, unscheduled inspections to limit unnecessary idling and to ensure that construction equipment is properly maintained, tuned, and modified consistent with established specifications.
- Prohibit any tampering with engines and require continuing adherence to manufacturers recommendations.
- If practicable, lease newer and cleaner equipment that would meet the most stringent of applicable Federal or State Standards.
- Utilize EPA-registered particulate traps and other appropriate controls where suitable to reduce emissions of diesel particulate matter and other pollutants at the construction site.

Administrative controls:

- Identify where implementation of mitigation measures is rejected based on economic infeasibility.

- Prepare an inventory of all equipment prior to construction and identify the suitability of add-on emission controls for each piece of equipment before groundbreaking. (Suitability of control devices is based on: whether there is reduced normal availability of the construction equipment due to increased downtime and/or power output, whether there may be significant damage caused to the construction equipment engine, or whether there may be a significant risk to nearby workers or the public.)
- Utilize cleanest available fuel engines in construction equipment and identify opportunities for electrification. Use low sulfur fuel (diesel with 15 parts per million or less) in engines where alternative fuels such as biodiesel and natural gas are not possible.

For further assistance with issues pertaining to air quality, please contact Dawn Richmond, EPA Air Division. Dawn can be reached at (415) 972-3097, or by email at Richmond.Dawn@epamail.epa.gov.

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

May 11, 2011

RECEIVED
MAY 16 2011

Mr. Peter Galloway
Regulatory Project Manager
U.S. Army Corps of Engineers, Honolulu District
Regulatory Branch (CEPOH-EC-R)
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Galloway:

Subject: POH-2004-01141

Thank you for the opportunity to review and comment on the subject matter. The Department of Land and Natural Resources' (DLNR), Land Division distributed or made available a copy of your report pertaining to the subject matter to Division of Aquatic Resources for their review and comment.

The Department of Land and Natural Resources has no other comments to offer on the subject matter. Should you have any questions, please feel free to call our office at 587-0414. Thank you.

Sincerely,

Charlene Unoki

Charlene Unoki
Assistant Administrator

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RECEIVED
LAND DIVISION

AM X
PM ✓

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

2011 MAY 10 A K

March 21, 2011

MEMORANDUM

DAR3733

TO: **DLNR Agencies:**
x Div. of Aquatic Resources
x Div. of Boating & Ocean Recreation
x Engineering Division
__Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division –Oahu District
x Historic Preservation

RECEIVED MAR 23 2011

MAY 16 2011

FROM: Charlene Unoki, Assistant Administrator *Charlene*
SUBJECT: Army Permit for Draft Environmental Impact Statement for the Proposed Honolulu Seawater Air Conditioning Project
LOCATION: Island of Oahu
APPLICANT: Honolulu Seawater Air Conditioning, LLC

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by May 1, 2011.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
( ) We have no comments.
(X) Comments are attached.

Signed: [signature]
Date: 5-5-11

State of Hawaii
Department of Land and Natural Resources
DIVISION OF AQUATIC RESOURCES

Date: 4/21/2011

MEMORANDUM

TO: Bob Nishimoto, Program Manager
FROM: Paul Murakawa, Aquatic Biologist
THRU: Alton Miyasaka, Aquatic Biologist

SUBJECT: Comments on Army Permit for Draft Environmental Impact Statement (EIS) for the Proposed Honolulu Seawater Air Conditioning Project

Comment Date	Request	Receipt	Referral
	3/21/11	3/23/2011	4/04/2011

Requested by: Charlene Unoki, Assistant Administrator
Department of Land and Natural Resources, Land Division

Summary of Proposed Project

Title: Honolulu Seawater Air Conditioning Project

Project by: Honolulu Seawater Air Conditioning, LLC

Location: Kakaako, Island of Oahu

Brief Description: The applicant proposes to provide a renewable-energy air conditioning system for downtown Honolulu, by pumping up deep, cold seawater and using it to chill freshwater that would circulate through the seawater air conditioning system and return it to the ocean after it has passed through onshore heat exchangers.

Comments: The Division of Aquatic Resources (DAR) has commented on this project for the State EIS and the Federal EIS. The comments have been addressed, but DAR would like to remind the applicant that a special activity permit is required for the take or damage to coral and/or live rock.

PHONE (808) 594-1888

FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

RECEIVED
MAY 19 2011

HRD11/3186E

May 16, 2011

Peter C. Galloway, Regulatory Project Manager
U.S. Army Corps of Engineers, Honolulu District
Regulatory Branch (CEPOH-EC-R)
Building 230
Fort Shafter, HI 96858-5440

Re: Draft Environmental Impact Statement for the Proposed Honolulu Seawater Air Conditioning Project, Honolulu, Hawai'i (Reg. File no. POH-2004-01141)

Aloha e Mr. Galloway:

The Office of Hawaiian Affairs (OHA) is in receipt of your March 10, 2011 special public notice requesting comments on the above-referenced project. We thank you for the opportunity to provide input into the decision-making process and apologize for our delayed response.

OHA understands that the US Army Corps of Engineers, Honolulu District, has prepared a draft environmental impact statement (EIS) for a permit application to construct a seawater air conditioning system in Kaka'ako, O'ahu. The project proponent, Honolulu Seawater Air Conditioning, LLC (HSAC), plans to construct a system whereby deep, cold ocean water is pumped on to shore, passed through a series of onshore heat exchangers, and returned to coastal waters via a return pipeline. The heat exchangers will be used to cool a separate water pipeline system that will traverse the Kaka'ako and Downtown areas and provide HSAC customers with cold water for air conditioning systems. The HSAC plans also contemplate an ocean-based staging area for connecting deep ocean pipelines together prior to deployment, as well as a receiver pit for the return flow of ocean water.

Based on the documentation provided, OHA has serious concerns over the lack of information pertaining to archeological sites and protections along the proposed routes for distribution pipelines through Kaka'ako and Downtown Honolulu. The Downtown area of potential effect, where trenched, chilled water pipes between eight and forty-two inches would be laid, is bounded by Nu'uanu Avenue, Beretania Street, and Ward Avenue. Although installation is planned below existing roads and right-of-ways, this does not significantly reduce the likelihood of encountering unknown burials and necessitates the need for a plan to address inadvertent burials. We encourage you to address these concerns prior to permit issuance, as well as the concerns found in the May 2, 2011 letter from the Administrator of the State of Hawai'i, Department of Land and Natural Resources, State Historic Preservation Division.

We highly recommend documented, agendized consultation with the O'ahu Island Burial Council, in order to provide a means of addressing the aforementioned concerns. We also recommend continued coordination with the State Historic Preservation Division on the proposed project

Thank you once again for the opportunity to comment. Should you or your staff have any questions, please contact Everett Ohta at 594-0231 or by email at everetto@oha.org.

'O wau iho nō me ka 'oia'i'o,

Clyde W. Nāmu'o
Chief Executive Officer

C: OHA Trustee Todd Apo
William Aila, Jr., State of Hawai'i Historic Preservation Officer
Pua Aiu, State Historic Preservation Division Administrator

APPENDIX Q
DRAFT COMPLIANCE WITH CWA 404 (b)(1) GUIDELINES

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Compliance with the CWA 404(b)(1) Guidelines
Honolulu Seawater Air Conditioning Project
POH-2004-01141

The Honolulu Seawater Air Conditioning (HSWAC) project would involve a discharge of fill material in waters of the U.S. requiring Department of the Army (DA) authorization under Section 404 of the Clean Water Act (CWA). Section 404(b)(1) of the CWA (33 U.S.C. 1344(b)(1)) requires discharges of dredged or fill material into waters of the U.S. authorized by U.S. Army Corps of Engineers (Corps) permits to be in compliance with guidelines specified under 40 CFR Part 230. This document constitutes an evaluation of the proposed HSWAC project in conformance with the Section 404(b)(1) Guidelines (Guidelines).

The HSWAC project would involve several components in navigable waters of the U.S.: the installation of seawater intake and return water pipelines, a pipeline assembly staging area, and the construction of an offshore pipeline receiving pit. The only project component that would involve a discharge of fill material into waters of the U.S. subject to Section 404 of the CWA is the proposed receiving pit. The pipelines would be micro-tunneled from an upland jacking pit to the receiving pit location 1800 ft offshore, where the subsurface pipelines installed in the micro-tunnel would be connected to the seafloor surface mounted pipelines extending seaward. The receiving pit would involve excavating a 40-ft x 40-ft area of seafloor, approximately 20 ft deep, backfilling the pit with clean gravel, and capping the gravel with concrete to restore original seafloor contours. The applicant proposes to dispose of the dredged materials at a state approved upland location or landfill. There would be no discharge of dredged material in waters of the U.S.

Subpart B – Compliance with the Guidelines

§230.10 Restrictions on discharge

Least Environmentally Damaging Practicable Alternative:
Section 230.10(a) "…no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem…" Practicable alternatives are those that are available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

The Corps has defined the basic and overall project purposes of the HSWAC project as follows:

> Basic Project Purpose: Construct facilities to provide seawater air conditioning services. This basic project purpose does not require siting within a special aquatic site. Therefore, practicable alternatives that do not involve special aquatic sites are presumed to be available and to have less adverse impact on the aquatic ecosystem under the Guidelines.

Overall Project Purpose: Construct facilities to provide sea water air conditioning services to downtown Honolulu, HI. This overall project purpose provides the basis for the evaluation of the practicability of potential alternatives.

Activities which do not involve a discharge of dredged or fill material into the waters of the United States:

The only potential alternative that would not involve a discharge of dredged and/or fill material in waters of the U.S. would entail seafloor surface mounted pipes the entire length of the in-water portion of the project, from an upland jacking pit to the offshore intake and return water terminuses. This alternative would result in greater impacts to aquatic resources associated with pipe collar placement within the near shore limestone reef, which contains higher coral abundance. Additionally, according to the applicant, deploying the pipes on the seafloor in the near shore shallow waters would not be logistically practicable considering that the pipes would be exposed to extreme wave forces during storm and high surf events which could result in failures. The construction of seawater air conditioning facilities for the proposed project necessitates a discharge of fill material in waters of the U.S. associated with either trenching and backfilling or micro-tunneling across near shore shallow waters to interface the subterranean pipeline with the seafloor. Therefore, the Corps has determined that alternatives not involving a discharge of dredged and/or fill material in waters of the U.S. are not practicable.

Discharges of dredged or fill material at other locations in waters of the United States or ocean waters:

The proposed project would not involve a discharge of dredged material in waters of the U.S. All dredged material would be disposed of at an approved upland site(s). The applicant completed a comprehensive evaluation of practicable alternatives for siting the facilities and routing the pipelines, considering micro-tunneling and water pumping distances, to the downtown Honolulu service area. All available real estate adjoining Honolulu Harbor and Kaka‘ako was evaluated using a set of feasibility criteria. Once the available and practicable sites for a cooling station, on-shore jacking pit, and pipeline staging areas were identified, all practicable alternative locations for the receiving pit and the pipeline route were investigated. Practicable locations for the receiving pit were limited to locations within proximity (i.e., within technological and logistical micro-tunneling length limitations) of the upland jacking pit and cooling station near/in downtown Honolulu.

Avoidance and minimization of impacts to coral aquatic resources was a fundamental consideration. Alternatives 1, 3, and 4 share a common receiving pit and westerly pipeline route. Alternative 2 would employ a receiving pit location and easterly pipeline route which would result in substantially greater losses of coral aquatic resources. Considering technological and logistical micro-tunneling distance limitations, micro-tunneling greater distances offshore increases risks and uncertainty with potential machine failure and/or loss of directional control, which could result in an undesignated location for receiving pit retrieval. More than minor increases in micro-tunneling distance offshore would necessitate an offshore jacking pit in addition to the offshore receiving pit, which would increase discharges of fill material and direct and secondary impacts to aquatic resources, including corals. Prior to construction, minor adjustments to the receiving pit location may be made to avoid unnecessary direct impacts to corals occurring on spurs adjacent to the receiving pit. No practicable pipeline receiving pit locations were identified that would completely avoid losses or impacts to coral resources. The proposed offshore receiving pit site was selected to minimize impacts to coral aquatic resources to the maximum extent practicable.

Alternative Analysis and LEDPA Determination

In planning for the HSWAC system, the applicant applied numerous practicability criteria in the areas of cooling station location and design, equipment availability, pipe routing and installation methods, materials selection, hazard mitigation, maintenance, and economics based on system cost and customer demand. Four alternatives were determined to be practicable, based on the overall project purpose, which were carried forward for analysis in the Final Environmental Impact Statement (EIS).

The following paragraphs summarize the comparisons of the practicable alternatives leading to the selection of the Preferred Alternative (Alternative 4) as the Least Environmentally Damaging Practicable Alternative (LEDPA). The types of environmental impacts would be the same with all of the action alternatives. However, the scale of anticipated impacts to coral aquatic resources and water quality, the fundamental comparison basis of this LEDPA analysis, would differ. For the purposes of establishing the LEDPA, the Corps must consider environmental impacts of project components other than the actual discharge site. This includes the anticipated environmental damages to aquatic resources (primarily coral) associated with the placement of pipeline collars and the return water effluent zone of mixing (ZOM).

Once practicable locations for the cooling station and on-shore jacking pit were identified, the applicant analyzed potential construction methodologies. Preliminary analysis of alternatives for installation of the pipelines evaluated all potential alternatives. Alternatives evaluated and rejected based on logistical impracticability and/or excessive environmental damages included entirely deploying the pipes on the seafloor, burying the pipes in a backfilled trench from the shore to a water depth of about 80 feet, and burying the pipes from the breakout point to a depth of about 80 feet. Trenching in the soft sediments characteristic of the project area, either from the shore to depth or from the breakout point to depth, would require a very large amount of dredging and filling considering the necessity to create a shallow side slope angle to prevent sediment slumping into the trench. These alternatives would also impact a large area surrounding the trench due to the necessity to side cast and stockpile removed materials. Therefore, to minimize discharges of dredged and/or fill material in waters of the U.S., including coral aquatic resources, all of the action alternatives include a micro tunnel under near shore shallow water limestone reef and surface mounting at depths 30 ft. and greater where wave forces diminish. Micro-tunneling greater distances offshore to greater depths may require an offshore jacking pit in addition to the receiving pit, which would increase discharges of fill material and direct and secondary impacts on aquatic resources, including coral. Additionally, near shore pipeline collars, where coral resources and wave energies are greater, were designed to be pile anchored to provide stability without expanding the footprints. Excavated materials would be disposed of on land and the area of backfilling would be minimized.

Construction and operation of any of the alternatives would have impacts on biota, including unavoidable impacts to coral aquatic resources. Construction impacts would be caused by bottom disturbance and vessel activities, and the degree of impact would depend on the location of activities, the surface area affected and the duration of disturbance. With regard to location, direct construction related impacts on biological resources from Alternative 2 (eastern route) would be greatest, due to the crossing of a relatively vibrant reef, and would be least under Alternative 1 (western route) due to the smaller pipeline collar footprint in shallower, more productive waters. Construction duration would be similar under all alternatives and wouldn't be a discriminator. Construction effects on protected species would be similar under all of the action alternatives.

Coral Resources:
Qualitative biological underwater surveys using towed divers and submersible recording devices were conducted for the proposed pipeline routes and included in the draft EIS. Alternative 2 was identified as having greater impacts to biological communities, including coral aquatic resources, compared to other practicable alternatives with a more westerly route. Therefore, subsequent quantitative coral benthic surveys (including colony size, species, etc.) were conducted for the westerly pipeline routes of Alternatives, 1, 3, and 4 in water depths ranging from 30-150 ft. and a complete coral colony inventory was conducted for the receiving pit discharge site, which would occur at a 30 ft. depth near the seaward edge of biotope scattered corals. Within the 30-150 ft. depth ranges, the pipeline would cross substrates consisting primarily of sand and

rubble with scattered individual coral colonies (0.3 -1.1% coverage) ranging in size from 1-30 cm. Coral colonies indentified in the 150-300 ft. depth range by submersible video were limited to scattered individual plating/encrusting colonies (0.2% coverage) of the mesophotic coral *Leptoseris,* approximately 30-45 cm in size. Coral coverage occurrence within the crossed biotopes, extending seaward from the receiving pit to a 300 ft pipeline depth (where occurrence of *Leptoseris* colonies ceased) for project alternatives are listed below (percentages for deep water zone 1 were estimated from the remote submersible video biological survey).

Coral Coverage by Biotope

Biotope	***Alt. 1***	***Alt. 2***	***Alt. 3***	***Alt. 4***
Biotope: Scattered Corals	0.3%	5.0%	0.3%	0.3%
Shallow Dredged Rubble	1.1%	0.01%	1.1%	1.1%
High Coral Coverage Spur		49.0%		
Sand	0.7%	0.0%	0.7%	0.7%
Deep Dredged Rubble	1.1%	0.001%	1.1%	1.1%
Deep Water Zone 1 (150-300 ft. water depth)	0.2%	0.2%	0.2%	0.2%

Coral Colony Size Frequency Distribution based on quantitative surveys from biotope scattered corals (Receiving Pit and Transects C &D) moving seaward to biotope deep dredged rubble (transects J and K) for Alternatives 1, 3, & 4:

Transects	**Pipeline Route Survey (10–40m), Coral Colony No. in Size Class (cm)**					Total No.
	0<2	**2<5**	**5<10**	**10<20**	**20<40**	
C	1	4	7	1	1	14
D	0	4	1	2	2	9
E	4	19	3	3	1	30
F	0	1	0	0	0	1
G	3	24	3	2	0	32
H	0	0	0	0	0	0
I	0	12	14	6	0	32
J	2	7	8	0	0	17
K	16	5	0	0	0	21
Total No.	**26**	**76**	**36**	**14**	**4**	156
Rec. Pit Count	**0**	**0**	**4**	**15**	**10**	29

Average and Maximum Coral Colony Size by Biotope (Alt. 1, 3, & 4):

Biotope	Avg. Size (cm)	Max. Size (cm)
Scattered Corals	14.3	30
Dredged Rubble (shallow)	7.9	24
Sand	3.2	15
Dredged Rubble (deep)	4.2	15

Discharge Site (Receiving Pit): Alternatives 1, 3, and 4 would occupy the same receiving pit discharge site location and would therefore impact the same quantity and quality of coral resources. Up to 29 coral colonies, averaging in size from 5-30 cm would be lost covering a total area of 4.63 ft^2 (assuming complete failure of coral colony transplantation). Coral colonies larger than 10cm (approximately 15 of the 29 total colonies) would be transplanted to a nearby suitable site and monitored. The receiving pit discharge site location in Alternative 2 presumably contains little to no coral colonies based on cursory qualitative data.

Pipeline Collar Placement: Alternative 2 would result in the greatest amount of coral resource losses, both quantitatively and qualitatively. The pipelines of Alternative 2 would cross a band of comparatively well developed and dense coral reef with an estimated coral coverage of 50%. Compared to the other alternatives, this section of reef is considered to provide substantially greater ecological functions based on its structural complexity and density and accordingly provides valued recreational services known for SCUBA tours. The anticipated coral losses associated with pipeline collar placement within this region greatly surpasses that of the other alternatives. The cumulative anticipated coral losses associated with Alternative 2 would be almost 7 times greater than Alternative 4 (preferred alternative). Alternative 1, which would have the smallest collar footprint, would result in the least amount of anticipated coral mortality from collar placement. Alternatives 1, 3, and 4 differ only in the length of the return water pipes and the location (water depths) of the return water effluent diffuser. The return water pipes of Alternatives 1, 3, and 4 would terminate at depths 150, 300, and 423 feet respectively. The increased return water pipeline lengths of Alternatives 3 and 4 requires additional Type A (double pipe) collars, which are larger than the Type B (single pipe) collars, compared to Alternative 1. Therefore, minor increases in potential coral colony mortality would be anticipated based on the larger collar footprints of Alternatives 3 and 4. Alternatives 3 and 4 would result in identical coral losses from collar placement considering that mesophotic corals were not identified at water depths deeper than 300 ft.

Operations: HSWAC operations would impact biota through seawater intake and return water discharge. The intake would be at the same location for all action alternatives, but the return water discharge locations are different. Under Alternative 1, the return water discharge would be through a 250-ft long diffuser at depths between 120 and 150 ft. Under Alternative 2, due to the flatter bathymetry in the discharge area, the return water discharge would be through a 345-ft long diffuser between the depths of 145 and 150 ft. A much larger area of benthos would be within the Alternative 2 ZOM. Alternative 3 would have a 250-ft long diffuser between the depths of 276 and 300 ft. At this depth, the return water discharge would be within the thermocline for at least a portion of the year. Alternative 4 would have a 250-ft long diffuser between the depths of 326 and 423 ft. At this depth, the diffuser would be at the approximate interface of the mixed layer and the thermocline and limited light penetration would reduce the likelihood of eutrophication.

A primary environmental concern identified during the draft EIS review process was the potential effects of the return water discharge on biological communities considering the difference in both nutrient level concentrations and temperature between the return water discharge and ambient water quality conditions. As water depth increases, nutrient concentrations increase and temperatures decrease. The return effluent water would have higher nutrient levels and lower temperatures compared to ambient water quality conditions, which would inevitably affect biological conditions and community structure, including the survivability of coral communities, the extent to which is not definitively known. By increasing the depth of the return water discharge, the difference in water quality conditions between the effluent discharge and ambient conditions become more similar and would presumably result in fewer impacts on established biological communities. While mobile organisms may relocate, immobile benthic organisms like coral cannot, and some degree of mortality would be anticipated. While coral losses associated with the construction of the receiving pit and pipeline collar placement may be offset by subsequent coral colonization on the created hard substratum, the relatively unknown potential long term effects associated with changes in water quality conditions at the return water ZOM was identified as a priority environmental consideration. Benthic surveys revealed generally that coral colony presence becomes scarcer and coral colony size becomes smaller with increased water depth and that corals did not occur in water depths beyond 300 ft. Therefore, alternatives with deeper return water discharge depths (Alternatives 3 and 4) were added to the National Environmental Policy Act (NEPA) alternatives analysis in the Final EIS to address concerns over long term operational impacts to corals.

With increasing depth, the nutrient assimilation capacity of the receiving waters decreases, resulting in larger ZOM areas needed for assimilation before compliance with state water quality standards can be achieved. However, the water quality characteristics of the return water discharge would be closer to ambient conditions at increasing depths and consequently it is presumed that biota would be less stressed by interactions with the plume. Therefore, the anticipated potential impacts on the physical, chemical, and biological characteristics of the ecosystem are believed to be relatively proportionate to the depth of the return water discharge. The deeper return water discharges of Alternatives 3 and 4 would return the seawater to depths where differences between the discharge and receiving waters are less than at the shallower discharges of Alternatives 1 or 2. The estimated permanent coral mortality that would occur from the return water effluent discharge ZOM would decrease with Alternative 3 and would be absent in Alternative 4, which has a return water discharge depth beyond the depth of coral occurrence. It is anticipated that Alternative 4 (preferred alternative) would result in the least amount of coral loss and would have the least adverse operational impacts on biological resources overall. Alternative 4 (preferred alternative) would result in an estimated cumulative loss of 86 ft^2 (0.002 acre) of coral resources, with coral colony sizes ranging between 1-30cm.

Summary of Estimated Cumulative Coral Area (ft^2) Lost by Biotope:

Impact Type	**Biotopes**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
Receiving Pit and Collars	Scattered Corals	5.7	167.4	5.7	5.7
Collars	Shallow Dredged Rubble	12.2	0.2	12.2	12.2
	Coral Spur (High coral %)		409.6		
	Sand	17.9	0.0	17.9	17.9
	Deep Dredged Rubble	31.9	0.1	31.9	31.9
	Deep Water Zone	7.7	6.2	18.3	18.3
Zone of Mixing	Deep Water Zone	19.0	0.023	4.0	0.0
Total		**94.5 ft^2**	**583.6 ft^2**	**90.0 ft^2**	**86.1 ft^2**

Human Use, Ecological Services: All of the alternatives would restrict human use of the construction area while the system is being installed. Subsequently, there would be no restrictions on recreational activities around the pipes. Construction and operation of Alternative 2, however, would adversely affect the research being done at the Kilo Nalu Observatory of the University of Hawai'i and known SCUBA tours. Scientific measurement devices are mounted on the seafloor off the eastern side of Kaka‘ako Waterfront Park. To the extent that the structures in the water encourage recreational pursuits such as diving and fishing, Alternative 4 (preferred alternative), which would have more of the larger Type A collars and a longer discharge pipe, may have a slightly more beneficial effect than any of the other action alternatives.

Summary: In summary, Alternative 2 would have the greatest adverse impacts to coral aquatic resources, biota, water chemistry and human uses. Alternatives 1, 3 and 4 differ in the depth of the diffuser, with Alternative 4 having the deepest diffuser and consequently more installed physical structure. Direct, construction impacts to biota would be least under Alternative 1. However, after considering both direct and secondary operational impacts of all alternatives, the Corps has determined that both Alternative 1 and Alternative 3 would have greater, potentially significant adverse environmental impacts than Alternative 4. Alternative 4, while having slightly greater potential construction related impacts to coral colonies than Alternative 1, would result in the least environmentally damaging impacts to the aquatic ecosystem overall, including coral aquatic resources, and has therefore been determined to represent the LEDPA.

§ 230.10(b) “No discharge of dredged or fill material shall be permitted if it:”

(1) Causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard: The fill proposed to backfill the receiving pit would consist of clean gravel and tremie concrete which would not violate state water quality standards. Mitigation measures would include complete containment of the receiving pit with sheet pile and silt curtains from seafloor to water surface and water quality monitoring and shut down procedures during excavation and backfilling to minimize turbidity and sedimentation outside of the footprint. Water quality impacts associated with the construction of the receiving pit are expected to be minimal.

(2) Violates an applicable toxic effluent standard or prohibition under Section 307 of the Act: All dredged material would be disposed of in an approved upland disposal site, potentially a landfill. The proposed receiving pit would consist of clean gravel backfill and concrete. The proposed fill materials are not prohibited under the CWA and would not contain any known toxic materials or violate toxic effluent standards.

(3) Jeopardizes the continued existence of species listed as endangered or threatened under the ESA or results in likelihood of the destruction or adverse modification of critical habitat: Pursuant to Section 7 of the ESA, the Corps consulted with the Protected Resources Division of the National Oceanic and Atmospheric Administration’s (NOAA) National Marine Fisheries Service (NMFS) Pacific Islands Regional Office. Formal consultation was completed with NOAA’s

issuance of its Biological Opinion on September 13, 2012. The Corps and NOAA concluded that the proposed project would not jeopardize the continued existence of any ESA listed species. NMFS-recommended mitigation measures would be implemented into the DA permit as special conditions, if issued, to minimize potential adverse effects.

(4) Violates any requirement imposed by the Secretary of Commerce to protect any marine sanctuary: The proposed action would not occur in or affect designated critical habitats or marine sanctuaries.

§ 230.10(c) "…no discharge of dredged or fill material shall be permitted which will cause or contribute to significant degradation of the waters of the United States…". "Under these Guidelines, effects contributing to significant degradation considered individually or collectively, include:

(1) Effects on human health or welfare, including but not limited to effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites: The proposed fill material would consist of clean gravel, precast concrete and tremie concrete at the receiving pit discharge site. The receiving pit would be completely contained to limit impacts to within the contained area of the receiving pit to the maximum extent practicable. The proposed action would reduce municipal water supply demands long term. Immobile benthic organisms, including coral colonies, would be lost within the footprint of the 1600 ft^2 receiving pit. Approximately 4.63 ft^2 of coral colonies (30 cm and smaller) may be lost at the discharge site. The anticipated impacts to aquatic organisms and special aquatic sites would be minimal and not expected to affect human health or welfare.

(2) Effects on life stages of aquatic life and other wildlife dependent on aquatic ecosystems: Immobile benthic biota within or on the sandy rubble substrate of the 40 ft x40 ft receiving pit would be destroyed by excavation and upland disposal. Plankton or demersal fish remaining in the water column within the 1,600 ft^2 pit would be subject to potential physical impact and elevated turbidity during excavation and elevated temperature and pH during placement of tremie concrete. Impacts to water quality would be contained to the receiving pit footprint to the maximum extent practicable and prohibited during coral spawning events. Construction of the receiving pit would not significantly affect life stages of aquatic life within the ecosystem. Following construction of the receiving pit, no adverse affects to aquatic organisms are anticipated.

(3) Effects on aquatic ecosystem diversity, productivity, and stability: The proposed project area has relatively low species and structural habitat diversity and productivity. The area consists primarily of unconsolidated sand and dredged rubble, which is continuously resuspended and redistributed, resulting in

a relatively unstable environment. The benthic biological community is kept in an early successional stage by the scouring effects of sand and rubble mobilized by seasonal high surf. The proposed discharge of fill material would not be expected to have more than a minimal effect on aquatic ecosystem diversity, productivity, and/or stability. Following construction, the concrete cap on the receiving pit would potentially provide a hard, stable substratum for colonization by benthic organisms.

(4) Effects of discharge of pollutants on recreational, aesthetic, and economic values: During construction, recreational use of the project area would be curtailed and aesthetics of the vicinity would be affected by the presence of moored barges. Based on available information, the proposed discharge site would not occur in an area with known recreational, aesthetic, and/or economic values. Following construction the discharge site would not adversely affect recreational, aesthetic, and/or economic values. The proposed discharge site would not be expected to have more than minimal effects on nearby harbors and/or recreational areas.

The Corps has determined that the proposed discharge would not cause or contribute to a significant degradation of waters of the U.S. individually or collectively. The proposed excavation and backfilling of the receiving pit would remove a small amount of benthic habitat and resident infauna as well temporarily decrease water quality in the immediate vicinity affecting nearby adjacent coral reef aquatic resources. The receiving pit location was selected to be in a sand channel to minimize losses of coral colonies and avoid direct impacts to nearby coral resources. An additional preconstruction benthic survey would be required to ensure that the proposed receiving pit is located to minimize direct losses of coral colonies and impacts to nearby adjacent coral reef aquatic resources to the maximum extent practicable. The affected biotope and the associated biota is abundant in the project area. The proposed discharge would alter 0.037 acre of sand and rubble seafloor into a concrete capped gravel pit at preexisting grade. The former sand bottom would be replaced by concrete at the receiving pit providing a hard substratum, which may provide opportunities for settlement of coral and other sessile organisms.

§ 230.11 Factual determinations. Nature and degree of short and long term individual and cumulative effects:

Physical Substrate: The receiving pit would be backfilled with clean gravel and capped with concrete to the level of the existing seabed. Approximately 0.037 acre of sand and rubble bottom would be permanently replaced with concrete. The existing bottom contour would be maintained.

Water circulation, fluctuation, and salinity: Containment of the receiving pit within sheet piles and/or turbidity curtains would have a short-term effect, approximately 7 months, on water circulation within and around the 40' x 40' pit. The alteration of circulation patterns would be temporary and minimal. Following construction, preconstruction elevations would be restored. No effects to water fluctuation and/or salinity levels are anticipated.

Suspended particulate/turbidity: Identified temporary impacts would include potentially elevated levels of suspended sediments and turbidity within the receiving pit footprint and in waters surrounding the pit during construction. The applicant proposes to install sheet piles and floating silt curtains around the pit, which would minimize this effect. The sheet piles and silt curtains would extent from seafloor to water surface to isolate the receiving pit from the surrounding waters. Sediments removed from the pit would be disposed of on uplands. The DA permit, if issued, would require the implementation of water quality BMPs, monitoring, and shut down procedures during all construction operations to minimize adverse impacts to the maximum extent practicable. The proposed discharge would result in temporary adverse effects on turbidity during construction; no long-term or cumulative effects are anticipated.

Contaminants: During construction, the use of heavy equipment would involve the use of petroleum, oil and lubricants (POLs), which include gasoline, diesel, oil, grease, and other related products. The DA permit, if issued, would require the employment of effective measures to prevent, contain, and/or clean up spills and leaks. No excavated material would be stored or disposed in waters of the U.S. With the implementation of BMPs, no more than minimal impacts are anticipated.

Aquatic ecosystem and organisms: Approximately 0.037 acre of sand and rubble bottom at the receiving pit would be replaced with concrete at grade. Benthic organisms in the receiving pit that are not avoided and/or transplanted would be destroyed. Aside from fish and/or plankton potentially trapped within the confines of the sheet pile enclosed receiving pit during construction, 29 coral colonies, ranging in size from 5-30 cm, would be affected by the proposed discharge. Coral colonies larger than 10 cm (approximately half) would be transplanted by the applicant and monitored. The concrete capped receiving pit area is expected to be colonized by coral following construction. No more than minimal long term impacts are anticipated.

Proposed Disposal Site:

(i) Depth of water at the disposal site: The water column averages 31 feet at the receiving pit.

(ii) Current velocity, direction, and variability at the disposal site: Strong tidal velocities measured at Barbers Point and Diamond Head are oriented parallel to the depth contours and directed towards the middle of Mamala Bay. Weak currents result where the flows merge from opposite directions. Converging flows at flood tide cause a downwelling (downward flow) at the center of the bay, which reverses at ebb tide. Consequently, large changes in stratification occur over the tidal cycle, with the water column often becoming homogeneous at different sites. Peak currents of about 20 inches per second were measured at the Sand Island Wastewater Treatment Plant outfall located about two miles west of the HSWAC receiving pit site in approximately 250 feet of water. Net drift from Mamala Bay is toward the southwest, roughly perpendicular to the route of the proposed pipelines. Sediments suspended in construction activities, if not contained within the receiving pit, would therefore tend to move toward deeper waters to the southwest.

(iii) Degree of turbulence: The discharge area is exposed to swells from the south. High surf conditions are experienced seasonally in summer when dredged rubble and sediments are mobilized and resuspended.

(iv) Stratification attributable to causes such as obstructions, salinity or density profiles at the disposal site: There are no obstructions at the disposal site. The water column and seafloor at the discharge site is well mixed by wind and waves and relatively uniform.

(v) Discharge vessel speed and direction, if appropriate: Filling at the discharge site would be accomplished from a stationary vessel and would not require multiple trips.

(vi) Rate of discharge: Tremie concrete would be discharged into the receiving pit through a pipe or hose extending to the bottom at a rate slow enough to avoid washout. Likewise, the inert gravel would be delivered to the bottom through a pipe at a rate slow enough to allow divers to control placement.

(vii) Ambient concentration of constituents of interest: There would be no discharge of dredged material in waters of the U.S. The relatively inert gravel and concrete fill material would not affect ambient constituent concentrations at the discharge site following construction.

(viii) Dredged material characteristics, particularly concentrations of constituents, amount of material, type of material (sand, silt, clay, etc.) and settling velocities: The proposed project would not involve a disposal of dredged material in waters of the U.S. The proposed fill material would consist of clean coralline gravel fragments containing less than five percent fines. The gravel-sized particles would settle rapidly. The volume of fill material would be approximately 1,185 cubic yards.

(ix) Number of discharge actions per unit of time: Approximately 1,185 cubic yards would be discharged into the receiving pit over approximately one week.

(x) Other factors of the disposal site that affect the rates and patterns of mixing. Discharge of fill material into the receiving pit would be contained by the sheet piling and/or turbidity screens to the immediate work area. No more than minimal mixing outside of the receiving pit footprint is anticipated. The sheet piling and/or turbidity screens would be maintained in place and not removed until the receiving pit is stable.

Cumulative Effects on the Aquatic Ecosystem:

The proposed discharge of fill material would minimally contribute to cumulative effects within Mamala Bay. The project area has been subject to repeated historical discharges of dredged materials which has altered the biotic community structure. In addition, Māmala Bay receives discharges from numerous streams, canals and storm drains, which drain industrial, commercial and residential areas. Incinerator waste and other unburned waste were used to fill a section of shoreline. Treated and untreated domestic sewage has been dumped in the area for decades. Anthropogenic debris, including discarded military munitions, litters the seafloor in the area. Waves and currents resuspend sand and mobilize rubble, which scours the bottom keeping the benthic community in an early successional stage. Little solid substratum exists for recruitment by sessile benthic organisms and there is little shelter for fish.

In the area of the receiving pit, the soft bottom would be replaced by a concrete cap covering the connections between pipes in the microtunnel and the surface mounted pipes. The concrete capped discharge site would potentially provide hard substratum which would increase potential for coral and other sessile benthic organism colonization over the existing unconsolidated bottom which is seasonally subject to scouring by rock and coral fragment movements associated with high surf events. Cumulatively, the proposed discharge is not expected to substantially contribute to the adverse anthropogenic ecological stresses within the bay. The proposed discharge following construction may provide limited beneficial effects.

The introduction of invasive species is a primary concern in Hawaii. To minimize the potential for the proposed activities to cause or promote the introduction or spread of aquatic invasive species, the following special conditions would be included in the DA permit, if issued:

- To minimize the potential to cause or promote the introduction or spread of invasive species, prior to the start of in-water work, the applicant must thoroughly clean each vessel and/or equipment used for in-water work. The cleaning of each vessel must include appropriate steps to minimize the introduction or spread of invasive species from ballast water discharge, ballast sediments, and hull fouling.

•The applicant must thoroughly clean the remotely operated vehicle (ROV) used during pipeline deployment prior to each use in Hawaiʻi waters. Following each use, the applicant must store the ROV dry.

Secondary Effects on the Aquatic Ecosystem:

Following construction, the proposed discharge site would be restored to pre project seafloor contours and relatively maintenance free with minimal anticipated secondary impacts on the aquatic ecosystem. The concrete capped discharge pit would be expected to be more conducive to coral recruitment and growth than the preexisting unconsolidated sand and rubble substrate to a limited extent.

Construction activities at the receiving pit would entail driving sheet piles, mounted crane excavation of approximately 1200 yd^3 of substrate, barging excavated material and fill material to/from upland loading sites, removal of the micro-tunneling machine, connecting subsurface pipes with seafloor mounted pipes, backfilling and concrete capping the pit, and piling removal. In order to accomplish a stable platform from which to enable construction activities, the applicant would either need to install a 4-point anchored jack-up barge or a pile supported work platform trestle. Construction activities may take up to 7 months.

Secondary impacts during construction may include physical impact damages or water quality (turbidity) impacts to the immediately adjacent coral spur ridges and potential releases of pollutants (fuel, construction debris, chemicals, lubricants, etc…) in the aquatic environment. The DA permit, if issued, would include special conditions to require locating the receiving pit and construction related structures and equipment to prevent physical impacts to the adjacent coral spurs, prevention of construction related pollutants from entering the water, and water quality monitoring and shut down procedures. The sheet pile and silt curtain perimeter containment structure, which would span the entire water column from sea floor to water surface, would be expected to alter water circulation to a limited extent. Recreational activities would be displaced to other shoreline or offshore areas, but these effects would be short-term and less than significant due to the limited number of people affected and the large amount of other park area or offshore water available. Aesthetics, both visual and noise would be affected in the immediate vicinity for up to 7 months.

Subpart C – Potential Impacts on Physical and Chemical

Characteristics of the Aquatic Ecosystem

§ 230.20 Substrate: The receiving pit would be backfilled with clean gravel and capped with concrete to the level of the existing seabed, which would permanently physically replace approximately 0.037 acre of sand and rubble bottom with gravel and concrete. The capped receiving pit would match the existing seafloor grade and elevation and it is anticipated that wave-driven resuspension of sand and rubble would cover the capped receiving pit. No more than minimal impacts to the physical and chemical characteristics of the aquatic ecosystem would be anticipated.

§ 230.21 Suspended Particulates/turbidity: Turbidity in the project area is often high due to resuspension of unconsolidated sediments by wind and waves. Elevated levels of suspended sediments in waters within and surrounding the discharge site are anticipated during excavation and backfilling activities. The applicant proposes to install sheet piles and floating silt curtains around the perimeter of the pit from seafloor to water surface, which would minimize turbidity in adjacent waters. The sheet piles either would extend to the sea surface or would be augmented by silt curtains at shallower depths to completely isolate the receiving pit from the surrounding waters to the maximum extent practicable. Other sources of turbidity would include pile driving, if required to secure working platforms or vessels offshore during construction. Following construction, the capped discharge site would not be expected to affect suspended particulates/turbidity characteristics of the aquatic ecosystem. No more than minimal impacts are anticipated.

§230.22 Water: Water quality in the project area is affected by waste discharges, terrestrial runoff and sediment resuspension. Turbidity from backfilling the receiving pit would be minimized by isolation and containment. In addition, only clean, pre-washed 3/8-inch to 2-inch crushed basalt gravel and concrete would be used. Temporary adverse impacts to the physical and chemical characteristics of the water column within and immediately adjacent to the discharge site would be anticipated. Following construction, the proposed discharge would not be expected to affect water quality conditions. The material proposed for discharge would not introduce, relocate, or increase contaminants.

§230.23 Current Patterns and Water Circulation: Containment of the receiving pit within sheet piles and/or turbidity curtains would have a short-term physical impact on water circulation around the pit during construction. Following construction, the proposed discharge site would match existing seafloor elevations and would not be expected to affect current patterns and/or water circulation.

§230.24 Normal Water Fluctuations: The proposed discharge site would match existing seafloor elevations following construction and would not be expected to affect tide levels or wave patterns.

§230.25 Salinity Gradients: The waters within the discharge area are well mixed by winds, waves and currents above the thermocline. No measureable effects to salinity gradients are anticipated.

Subpart D – Potential Impacts on Biological Characteristics of the Aquatic Ecosystem

§230.30 Threatened and Endangered Species: Pursuant to Section 7 of the ESA, the Corps consulted with the Protected Resources Division of the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) Pacific Islands Regional Office. Formal consultation was completed with NOAA's issuance of its Biological Opinion on September 13, 2012. The proposed project would not jeopardize the continued existence of any ESA listed or proposed species, and NMFS-recommended measures would be implemented to minimize potential adverse effects. One species of coral proposed for listing as threatened under the ESA (*Montipora patula*) is common in the project area. One colony of *M. patula* is within the footprint of the receiving pit. That colony would be transplanted prior to excavation of the pit. A pre-construction survey of the area of potential effect of the discharge site would be conducted, which may result in potential adjustments to the location of the receiving pit to minimize construction related impacts to coral colonies, including potentially avoiding direct effects to *M. patula*.

§230.31 Fish, Crustaceans, Mollusks, and other Aquatic Organisms in the Food Web: At the receiving pit, the epibenthic and infaunal organisms would be destroyed and/or relocated during excavation of the 0.037 acre receiving pit. 29 coral colonies, ranging in size from 5-30 cm would be destroyed or relocated, resulting in a total potential loss of 4.6 ft^2 of coral. The applicant proposes to transplant and monitor coral colonies larger than 10 cm in size to suitable sites nearby. The concrete capped discharge site would provide a hard substratum for potential coral colonization following construction. Nekton and plankton trapped within the water column of the sheet pile contained receiving pit during construction may be subject to injury or death during construction activities. Additionally, in the vicinity of construction operations, temporary adverse impacts on aquatic organisms, including nekton, plankton and benthos may result from physical impacts from vessel anchoring and turbidity generation. Nekton would be expected to be temporarily displaced during construction activities. In turbid areas, light available to phytoplankton and corals would be temporarily reduced; filter feeding zooplankton may ingest particulate matter. Following construction, the proposed discharge would not be expected to have more than minimal impacts to aquatic organisms within the food web.

§230.32 Other Wildlife: No terrestrial wildlife would be impacted by the proposed discharge.

Subpart E – Potential Impacts on Special Aquatic Sites

§230.40 Sanctuaries and refuges: The proposed project would not involve a discharge of dredge or fill material in a sanctuary or refuge.

§230.41 Wetlands: The proposed project would not involve a discharge of dredge or fill material in wetlands.

§230.42 Mudflats: The proposed project would not involve a discharge of dredge or fill material in mudflats.

§230.43 Vegetated Shallows: The proposed project would not involve a discharge of dredge or fill material in vegetated shallows.

§230.44 Coral Reefs: The proposed discharge area occurs within a spur and groove coral reef area that is relatively degraded with minimal vertical relief. The actual discharge site would occur within the groove area composed primarily of unconsolidated sand and dredge rubble, with scattered small coral colonies. The discharge site is 0.037 acre (1,600 ft^2), within which 29 coral colonies ranging in size from 5 to 30 cm occupy a total area of 4.6 ft^2. Coral reef communities occur on the spurs adjacent to the discharge site. The adjacent coral reef communities have larger (older) colonies, which are more abundant and structurally complex. These adjacent communities could be indirectly impacted during the construction activities by turbidity generation and potential physical damage from the presence and operation of a jack up barge and excavation activities. The receiving pit would be contained within sheet piling and silt curtains, which would minimize sediment deposition outside of the receiving pit footprint. Additionally, the applicant proposes to transplant coral colonies within the discharge site that are larger than 10 cm (approximately half of the total colonies) to suitable areas nearby to minimize losses. Therefore, the unavoidable coral losses would be approximately 15 total coral colonies smaller than 10cm (largest measurement) in size. However, it cannot be reasonably assumed that all of the transplanted coral colonies would survive. Conservatively assuming that half of the transplanted colonies survive, approximately 7 additional colonies, ranging in size from 14-30 cm would also be lost. Following construction, the receiving pit footprint would be returned to preconstruction contours and the hard substrate (concrete cap) that would remain would likely be colonized by coral.

The DA permit, if issued, would require the applicant to conduct a pre construction survey to ensure that direct and indirect impacts to coral colonies are minimized to the maximum extent practicable. Based on this survey, the receiving pit location may be adjusted to further minimize unavoidable coral losses within the receiving pit as well as allow adequate spacing between the receiving pit construction and the adjacent coral spurs to prevent physical damages and/or sedimentation. Provided that physical damages and/or turbidity exposure to higher value coral spur communities are avoided and minimized to the maximum extent practicable, no more than minimal unavoidable impacts to coral reef special aquatic sites are anticipated.

§230.45 Riffle and Pool Complexes: The proposed project would not involve a discharge of dredge or fill material in riffle and pool complexes.

Subpart F - Potential Effects on Human Use Characteristics

§230.50 Municipal and Private Water Supplies: No more than minimal impacts to water supplies is anticipated.

§230.51 Recreational and Commercial Fisheries: The proposed discharge site is infrequently used for recreational and/or commercial fishing. During construction activities, fishing within the vicinity of the discharge site would be curtailed. Following construction, the proposed discharge would not be expected to have more than minimal effects to fisheries.

§230.52 Water Related Recreation: The proposed discharge site is not a known or established water recreation area. During construction, water related recreation would be temporarily displaced to other shoreline or offshore areas for safety purposes. These effects would be short-term and less than significant due to the limited number of people affected and the large amount of other park areas or offshore water recreational sites available. Following construction, the proposed discharge would potentially provide beneficial scuba diving recreational use.

§230.53 Aesthetics: During construction, visual and sound related aesthetics would be temporarily altered from the physical presence and operation of the barge, excavator, etc. Following construction, the discharge would not be visible above the surface. No more than minimal temporary effects anticipated.

§230.54 Parks, National, and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves: The proposed discharge site would not be located within or near these areas and would accordingly not produce an impact. Inshore of the proposed location of the discharge, Kakaʻako Waterfront Park fronts Mamala Bay. A portion of the sparsely used western edge of the park would be used for construction of a jacking pit and staging of the microtunneling equipment. The University of Hawaii's Kilo Nalu Observatory, an oceanographic research site with bottom-mounted sensors for data collection, is located more than a half mile to the east. The applicant's preferred alternative was selected to avoid affecting the research site. No more than minimal impacts anticipated.

Subpart G – Evaluation and Testing:

The evaluation and testing procedures of Section 230.60 of the CWA 404(b)(1) Guidelines are intended to characterize potentially contaminated materials to be dredged from one aquatic location and discharged into another. The proposed action would not involve a discharge of dredged material in waters of the U.S. The 1,185 yd^3 of material excavated from the receiving pit would be disposed at an approved upland location. The excavated materials, after settling and dewatering onsite, would be tested for long-term disposal options according to the Hawaii Department of Health Technical Guidance Manual, which may include beneficial reuse as construction fill. If a beneficial reuse cannot be identified, the applicant proposes to dispose of the material at the PVT Land Company, LTD construction and demolition materials landfill on Oahu where they could be used for interim cover. The PVT landfill operates in accordance with Chapter 342H, Hawaii Revised Statutes and Title 11 Hawaii Administrative Rules Chapter 58.1 Solid Waste Management Control, which preclude disposal of hazardous or toxic materials at the landfill. The pit would be backfilled with clean prewashed gravel, a naturally occurring inert material, and then capped with tremie concrete, which would also become inert after setting up. When the concrete is first placed there likely would be some suspended solids and turbidity generated within the contained pit area. The alkaline nature of the cement would tend to elevate the pH of the immediately surrounding water. This would be a short-term adverse effect on water quality. Containment of the work site within sheet piles and/or silt curtains would limit the extent of the effect. The concrete would contain no additives that would inhibit settling or growth of marine organisms. Settling of particulates and mixing, advection, and diffusion of dissolved substances would restore the ambient water quality. Water quality surrounding the sheet pile/silt curtain-contained pit would be monitored during construction.

Subpart H – Actions to Minimize Adverse Effects:

§230.70 Location of the Discharge: Section 230.70 describes actions concerning the location of the discharge to minimize the effects of an unconstrained discharge of dredged materials. The proposed action would not involve a discharge of dredged material in waters of the U.S. The action is limited to the discharge of backfill at the confined receiving pit.

(a) Locating and confining the discharge to minimize smothering of organisms: There would be no discharge of material outside of the receiving pit. The receiving pit would be contained within sheet piling and silt curtains from seafloor to water surface to prevent sediment deposition outside of the receiving pit footprint. To avoid impacting shallow limestone reef in near shore waters, the proposed pipelines would be micro-tunneled to a breakout point approximately 1,800 ft. offshore in a water depth of 31 ft. The offshore receiving pit location would occur in a groove consisting primarily of sand and rubble and would avoid coral reef resources closer to shore and on adjacent coral spurs. Excavation of the pit would destroy organisms on and within the substrate. Organisms outside of the pit would not be smothered as there would be no side casting or stockpiling of materials in the marine environment. Following construction, the receiving pit footprint would be returned to preexisting contours. A preconstruction survey would be required by the DA permit, if issued, to ensure that the receiving pit is located to minimize coral losses to the maximum extent practicable, including adjacent coral spurs.

(b) Designing the discharge to avoid a disruption of periodic water inundation patterns: The receiving pit would be backfilled to its original grade, at a water depth of approximately 30 ft. The discharge would not affect inundation patterns.

(c) Selecting a disposal site that has been used previously for dredged material discharge: There would be no discharge of dredged material in waters of the U.S.

(d) Selecting a disposal site at which the substratum is composed of material similar to that being discharged: There would be no discharge of dredged material in waters of the U.S. The excavated pit would be back filled with clean gravel and capped with concrete to properly secure the transition of the micro-tunneled pipeline to the seafloor mounted pipeline.

(e) Selecting the disposal site, the discharge point, and the method of discharge to minimize the extent of any plume: The receiving pit would be contained with a sheet pile and silt curtain perimeter from seafloor to water surface to minimize any plume outside of the footprint during excavation and backfilling operations.

(f) Designing the discharge to minimize or prevent creation of standing bodies of water in areas of normally fluctuating water levels: The excavated pit would be backfilled to preexisting grade. The proposed discharge would not prevent or create standing bodies of water or affect fluctuating water levels.

§230.71 Material to be Discharged

(a) Disposal of dredged material in such a manner that physicochemical conditions are maintained and the potency and availability of pollutants are reduced: There would be no disposal of dredged material in waters of the U.S. The receiving pit would be backfilled with clean gravel and concrete. The concrete mix would be introduced into the pit within the area contained by sheet piles/silt curtains and would contain additives designed to enhance setup underwater. This would minimize potential temporary disturbances of physicochemical conditions outside the immediate area of discharge.

(b) Limiting the solid, liquid, and gaseous components of material to be discharged at a particular site: The discharge would consist entirely of gravel and concrete.

(c) Adding treatment substances to the dredged material: There would be no discharge of dredged material in waters of the U.S. The fill material would be prewashed gravel and concrete. Treatment substances would not be necessary.

(d) Utilizing chemical flocculants to enhance the deposition of suspended particulates in diked disposal areas: There would be no diked disposal areas and the proposed fill material would rapidly settle.

§230.72 Controlling the Material after Discharge

Section 230.72 describes actions to control the material after discharge and applies to materials that could migrate after emplacement. The proposed gavel backfill in the receiving pit would be confined within sheet piles and capped with concrete to preexisting grade. Migration of discharged material outside of the disposal site would not be expected to occur.

§230.73 Method of dispersion

Section 230.73 describes actions affecting the method of dispersion. Potential actions applicable to the proposed discharge are as follows:

(e) Minimizing water column turbidity by using a submerged diffuser system: The gravel and concrete would be delivered from a moored barge to the bottom in a controlled manner through submerged pipes or hoses at rates slow enough that divers can control placement. The tremie concrete delivery hose would be submerged in the concrete as soon as possible to further minimize washout.

(f) Selecting sites or managing discharges to confine and minimize the release of suspended particulates to give decreased turbidity levels and to maintain light penetration for organisms: The proposed work area would be enclosed within sheet piles and silt curtains from seafloor to water surface to minimize suspended particulates and turbidity outside of the receiving pit footprint. After connecting the tunneled pipes to the respective surface-mounted pipes, the pit would be backfilled and covered with a concrete cap. These operations would take about one week. The backfill would be crushed basalt gravel graded between 3/8-inch and 2-inch size and pre-washed to remove any fines. After backfilling and capping of the receiving pit, the sheet piles would be removed or cut off below the existing seafloor grade.

§230.74 Technology

Section 230.74 describes actions related to technology. Potential actions applicable to the proposed discharge are as follows:

(a) Using appropriate equipment or machinery, including protective devices, and the use of such equipment or machinery in activities related to the discharge of dredged or fill material: The proposed micro tunneling of the pipes 1,800 ft. offshore beneath the biotope of scattered corals on the near shore limestone reef would minimize impacts to aquatic resources compared to trenching and backfilling or seafloor mounting the near shore pipes. Vibratory hammer driven sheet piles and silt curtains around the perimeter of the receiving pit would contain the pit from surrounding waters. To minimize physical damages to adjacent coral aquatic resources during construction (e.g., sheetpile driving, pit excavation and seafloor mounted pipe assembly) heavy equipment would occur off of either a four point mounted jack-up crane barge or off of a pile supported platform, as opposed to working from anchored barges.

(b) Employing appropriate maintenance and operation on equipment or machinery, including adequate training, staffing, and working procedures: According to the applicant, contract specification would include requirements for maintenance and operation of equipment and machinery, staff qualifications and training, and operating procedures to avoid and minimize potential impacts to aquatic resources.

(e) Employing appropriate machinery and methods of transport of the material for discharge: According to the applicant, contract specifications for the marine contractor would include use of appropriate equipment and machinery for transport and emplacement of the fill material.

§230.75 Plant and Animal Populations

Section 230.75 describes actions affecting plant and animal populations. Potential actions applicable to the proposed discharge are as follows:

(a) Avoiding changes in water current and circulation patterns which would interfere with the movement of animals: The final elevation of the top of the backfilled discharge site would be approximately even with the surrounding bottom contours. Following construction, no changes to water currents or circulation patterns associated with the discharge site are anticipated.

(b) Selecting sites or managing discharges to prevent or avoid creating habitat conducive to the development of undesirable predators or species which have a competitive edge ecologically over indigenous plants or animals: Considering that the backfilled pit would match surrounding bottom contours and would be covered with adjacent sand and rubble, the proposed discharge would not be expected to result in the creation of differing habitat. The concrete capped receiving pit would provide hard substratum for potential coral recruitment, however, no competitive advantage for undesirable species is anticipated. With the exception of the blue-lined snapper, which is now common throughout the Hawaiian Islands, invasive species are rare in the receiving pit area and would not be anticipated to preferentially relocate or recruit to this area. To minimize the potential for the proposed activities to cause or promote the introduction or spread of aquatic invasive species, the following special condition would be added to the DA permit, if issued:

> To minimize the potential to cause or promote the introduction of spread of invasive species, prior to the start of in-water work, the applicant must thoroughly clean each vessel and equipment used for in-water work. The cleaning of each vessel must include appropriate steps to minimize the introduction or spread of invasive species from ballast water discharge, ballast sediments, hull fouling, etc.

(c) Avoiding sites having unique habitat or other value, including habitat of threatened or endangered species: No information has been identified that would indicate that the proposed discharge site has unique values for habitat or threatened or endangered species.

§230.76 Actions affecting Human Use

Section 230.76 of the 404(b)(1) Guidelines describes actions affecting human use. Potential actions applicable to the proposed action include:

(a) Selecting discharge sites and following discharge procedures to prevent and minimize any potential damage to the aesthetically pleasing features of the aquatic site…particularly with respect to water quality: No information has been identified to suggest that the proposed discharge site is a popular recreational site or that provides unique aesthetically pleasing features. The discharge site occurs in a groove consisting of sand, rubble and sparsely scattered small coral colonies. The work area in general is on an open coast exposed to high summer surf and storm surge. Much of the seafloor is covered with sediments deposited from previous dredging of Honolulu Harbor. These sediments are remobilized and resuspended during high wave energy events so the biological community is periodically exposed to high suspended sediment concentrations and turbidity. Immediately adjacent to the proposed discharge site are higher value coral spur ridges. A preconstruction survey may modify the exact location of the discharge site to minimize potential physical damages to these resources. The proposed discharge site and methods would minimize damages, including water quality impacts, to adjacent coral ridge resources to the maximum extent practicable.

(b) Selecting disposal sites which are not valuable as natural aquatic areas: Based on available information, the proposed discharge site is not considered to be a valuable natural aquatic resource area.

(d) Following discharge procedures which avoid or minimize the disturbance of aesthetic features of an aquatic site or ecosystem. The applicant's proposed physical containment of the receiving pit footprint, water quality monitoring, and methods for discharge would avoid and minimize disturbance of aesthetic features of the aquatic ecosystem. The capped receiving pit would match pre-project seafloor grade and would have no more than minimal affects on aesthetic features. Additionally, the receiving pit would be situated to avoid damages to higher value aquatic resources on adjacent coral spur ridges.

§230.77 Other Actions:

The applicant is proposing to use a form of trenchless technology to route pipes beneath the nearshore area where the majority of the corals are located and has selected a preferred breakout point to avoid coral reefs and coral-dominated communities. Additionally, the receiving pit was designed to be completely isolated from surrounding waters and dredged material would not be discharged into waters of the U.S. The size of the receiving pit would be the minimum size required to accommodate retrieval of the micro-tunneling machine and connect the subsurface pipeline with the seafloor mounted pipeline.

Subpart J – Compensatory Mitigation for Losses of Aquatic Resources

The LEDPA would cumulatively result in a direct loss of approximately 86 ft^2 (0.002 acre) of scattered individual small coral colonies ranging in size from 1-30 cm. The cumulative loss of coral colonies would occur from the excavation and backfilling of the receiver pit and over a linear distance of approximately 3,500 ft. of pipeline (distance from the receiver pit to the 300 ft. water depth contour), where placement of support collars may potentially crush scattered colonies. The 86 ft^2 (0.002 acre) potential coral loss would occur over an area of 94,670 ft^2 (2.2 acres). To minimize unnecessary losses to corals directly in the footprint of the receiving pit, the applicant would be required to implement a transplantation plan to relocate and monitor corals larger than 10 cm in size from the receiving pit footprint to nearby suitable locations. Additionally, pre construction surveys would be required to potentially further minimize coral losses associated with the receiving pit and collar placement. The proposed collar and pipeline structures would create vertical relief, which would provide nekton habitat opportunities, and would create approximately 160,000 ft^2 (3.67 acres) of hard substratum, which would be conducive to coral recruitment and sustainable growth, compared to the existing relatively flat unconsolidated sand and dredge rubble substrate. The Corps has determined that the proposed project would result in relatively minimal losses of aquatic resources from construction related activities, which would be expected to be offset and/or exceeded, albeit artificial and out-of-kind, by project related resource gains. Therefore, the Corps has determined that compensatory mitigation is not required for the proposed action.