

**BASELINE ASSESSMENT OF
MARINE WATER CHEMISTRY
AND MARINE BIOTIC COMMUNITIES
PIILANI PROMENADE
KIHEI, MAUI, HAWAII**

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**STATE OF HAWAII
LAND USE COMMISSION**

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EXHIBIT "K"

I. INTRODUCTION AND PURPOSE

The Piilani Promenade project, located in North Kihei, Maui, is a development of a mix of Light Industrial and Business/Commercial uses with approximately 200 apartment units on a total of 75 acres. The project will include associated onsite and offsite infrastructure improvements including but not limited to water, sewer, roads, drainage, electrical, bicycle and pedestrian pathways and landscaping. A Maui Electric Company (MECO) substation is also proposed on the project site.

The entire project site is located mauka of South Kihei Road with no aspect of the project involving direct alteration of the shoreline or nearshore marine environment (Figure 1). None of the proposed land uses includes any direct alteration of the coastal areas or nearshore waters, and the entire project site is separated from the coastline by other development as well as South Kihei Road. As a result, potential effects to the marine environment from the project are limited only to alteration of basal groundwater flowing beneath the site with subsequent discharge to the ocean.

In the interest of addressing these concerns and assuring maintenance of environmental quality, a baseline marine environmental assessment and potential impact analysis of the nearshore areas off the Piilani Promenade project site was conducted in November 2013. The rationale of this assessment was to collect a set of baseline data to accurately depict both qualitatively and quantitatively the existing physical, chemical and biological setting of the marine areas that could be potentially affected by the project. Because the only reasonable way the project could affect marine waters is by adding subsidies to groundwater, it was determined that the most effective method of determining the potential for such impacts was to determine the existing degree of groundwater input to the ocean off the site. If the existing groundwater input is of a minor extent, it can be assumed that there is not sufficient input for any subsidies from the project site to affect water quality to a detectable degree.

Existing marine community structure, primarily in terms of coral reef assemblages was also described based on rapid ecological assessment (REA) surveys. Evaluation of the existing condition of the water chemistry and marine communities provides an insight into the physical and chemical factors that influence the marine setting, which provide a basis for determining the potential for changes that could be produced by the project. As coral communities are both long-lived and attached to the bottom, they serve as the best indicators of the time-integrated forces that affect offshore reef areas. Understanding the existing physical, chemical and biological conditions of the marine environment that presently occur provides a basis for predicting potential affects that might occur as a result of the proposed Piilani Promenade project.

II. METHODS

A. Water Quality/Chemistry

All fieldwork was conducted on November 20, 2013. As the goal of the assessment was to evaluate the potential for alteration of groundwater discharge, evaluation of water chemistry was

limited to determining variations in salinity and temperature, which are the two physico/chemical components that reflect the mixing of groundwater and marine water in the coastal ocean. Groundwater has a salinity of essentially zero, which open ocean water has a salinity of approximately 35 parts per thousand (‰). Submarine groundwater typically enters the ocean at or near the shoreline resulting in a nearshore zone of mixing characterized by lower salinity, and often lowered temperature (groundwater is typically cooler than ocean water). Weather and sea conditions during the sampling consisted of calm winds and small surf of 1-2 feet breaking on the shoreline. These conditions are somewhat atypical for the Kihei coastline which is generally affected by tradewinds. As a result, conditions during the survey can be considered to have minimum mixing, which should represent the highest detectable groundwater discharge.

Salinity and temperature were assessed along three survey transect that extended perpendicular to the shoreline originated at the beach and extending approximately 100 meters (m) offshore. Data was collected by towing a continuously recording CTD instrument (RBR Model 620) behind a personal watercraft at a dept of approximately 10 centimeters (3 inches) below the surface (Figure 1). These tows were conducted at the upper layer of the water as this is the zone that lower density groundwater will be most evident. Hence, the three surface tansects comprised a sampling scheme is designed to span the greatest range of salinity with respect to potential freshwater efflux at the shoreline. Sampling was limited to the nearshore zone because this area receives the majority of groundwater discharge, and hence is most important with respect to identifying the effects of shoreline modification.

B. Marine Biotic Community Structure

Biotic composition of the survey area was assessed by divers using SCUBA working from a small boat. Dive surveys were conducted by swimming in a zigzag pattern from the shoreline across the reef to a water depth of 30 feet in the same areas as the CTD tows were conducted. During these underwater investigations, notes on species composition were recorded, and numerous digital photographs recorded the existing conditions of the area. All fieldwork was conducted by Dr. Steven Dollar.

III. RESULTS

A. Water Quality/Chemistry - *Distribution of Salinity and Temperature*

Figure 2 shows values of salinity and temperature for continuous horizontal tows along three transects originating downslope from the north (transect 1) central (transect 2) and southern (transect 3) boundaries of the Piilani Promenade project site. With respect to salinity, several trends are apparent. First, on all three transects there is a zone between the shoreline and approximately 30 m (90 ft) offshore where there is a distinct gradient of salinity, with lowest values nearest the shoreline. On all three transects the gradients span a salinity range of about 0.5‰. These gradients reflect the dimension of the zone where groundwater is mixing with ocean water, and is consistently restricted to within approximately 30 m of the shoreline.

The second major trend is that the overall salinity on transect 1 is lower than on transects 2 and 3. In addition the variation within the trace of transect 1 is substantially wider than on transects 2

and 3. These patterns indicate that the location of transect 1 is subjected to somewhat different water masses than transects 2 and 3. The most likely explanation for these patterns is that transect 1 is located on a boundary between water from Maalaea Bay, which may have lower salinity as a result of recent heavy rainfall and runoff, and open ocean waters. Thus, the slightly lower overall values and increased "noise" in the trace for transect 1 relative to the other transects reflects the incomplete mixing of these two water masses. The slightly upward trend of the trace in transect 1 near the ocean terminus of the transect also suggests that there is some mixing of fresh water emanating from the shoreline that diminishes with distance from shore.

Results of the temperature trances in Figure 2 also reveal patterns that indicate a mixing of groundwater and marine waters in the nearshore zone extending from the shoreline to a distance of approximately 30 m from shore. Beyond this distance, temperature is nearly constant on transects 2 and 3. However, the nearshore gradients for each transect are slightly different with temperature slightly elevated on transects 1 and 3 relative to offshore values, and slightly lower values on transect 2 relative to offshore values. These differences indicate that while slightly different factors may be affecting temperature in the nearshore zone, the effect of cooler groundwater is not a dominant feature affecting these overall patterns.

In sum, horizontal gradients of salinity and temperature indicate that there is a detectable zone of mixing of groundwater and ocean water from the shoreline to a distance of approximately 30 m offshore. Beyond this distance, water chemistry, in terms of salinity and temperature reflect open ocean conditions with little effect from inputs from land. Thus, any future input from groundwater subsidies would likewise be limited in effects to water chemistry to a distance of approximately 30 m from shore.

B. Reef Community Structure

1. Physical Structure

Physical composition of the shoreline area fronting the Piilani Promenade site consists of several structures. The approximate northern half of the property is upslope from a narrow sand beach that grades into a rubble zone within the intertidal zone. At the approximate center of the property the shoreline is built up with a boulder wall that extends into the intertidal zone. The shoreline downslope from the southern end of the property consists of a small corridor of white sand that is the ocean terminus of a stream bed. Just to the south of the sand delta is a rock wall of a fishpond (Figure 1).

As clearly evident in Figure 1, the offshore area fronting the project site is composed of a wide shallow reef platform that extends 50-60 meters offshore and extends to a depth of about 3-4 meters. At the beach front bottom composition along the entire property shoreline consists of a rubble bed consisting of broken and eroded limestone chunks interspersed with sand patches (Figure 3). With increasing distance from shore beyond the zone of wave impact, rubble chunks become larger, and are interspersed with patches of coarse white sand (Figure 3). Moving

seaward water depth increases gradually, with bottom composition remaining a mix of sand and rubble with occasional outcroppings of eroded limestone from fossil reef structures (Figures 4-6). At the outer edge of the reef platform, bottom composition turns to a bed of coarse white sand that extends seaward beyond the limits of the present survey (Figure 7).

2. Biotic Community Structure

Overall, biotic community structure throughout the shallow reef flat fronting the Piilani Promenade project site can be considered depauperate, with no well-developed coral reef communities. Such lack of well-developed living coral reef structure is likely a result of the combination of large volumes of sand and loose rubble, which do not provide for an abundance of solid surfaces for settling coral planulae. In addition, the frequent occurrence of breaking waves over the shallow platform result in concussive forces that are too strong for most corals to withstand. Wave action also causes resuspension of sand and movement of rubble fragments which scour the bottom, creating conditions too harsh for settlement and growth of rich reef communities.

However, the area is not completely devoid of macrobenthic (bottom dwelling) organisms. In the sand rubble zone, isolated coral heads colonies occur, primarily of the species *Porites lobata* (Figure 4), and *Pocillopora* spp. (Figure 5). These two genera are the two most common on virtually all Hawaiian reefs. Other species observed were the "soft coral" *Zooanthus* sp. (Figure 6). As can be seen in Figures 5 and 6, most of the coral heads were growing on large rubble fragments that extended somewhat above the level of the sand rubble floor of the shallow platform. Although the elevation above the reef floor is only several inches, the distance is apparently required for reduction in sand and rubble scouring to allow coral colonization.

The other class of benthic organisms that were common on the reef platform was sea urchins. The most common urchins were the small boring species *Echinometra mathaei* that occurred in holes bored into the limestone outcrops and rubble mounds. Other urchin species that were observed included the spiny urchins *Echinothrix diadema*, and *E. calamaris*, and the collector urchin *Tripneustes gratilla* (Figures 5 and 6). Many of these urchins were observed in holes in elevated chunks of coral rubble (Figure 6).

Macroalgae were rare in the inner sand-rubble zone, likely in response to the shifting nature of the substratum. However, at the outer boundaries of the shallow reef platform, where bottom composition consists of beds of coarse sand, the introduced red alga *Acanthophora specifera* occurs in monospecific beds (Figure 7, top). These beds extend to a depth of approximately 15 feet where they disappear, and bottom composition consists entirely of sand flats (Figure 7, bottom).

IV. DISCUSSION and CONCLUSIONS

The purpose of this assessment is to assemble the information to make valid evaluations of the potential for impact to the marine environment from the proposed Piilani Promenade project that

is planned for a parcel of land mauka of South Kihei Road in Kihei, Maui. As the project is not located on the shoreline, and will not structurally alter the shoreline or nearshore marine environment, the only source of potential effect to the ocean is through changes to groundwater as a result of materials leaching from the project site to basal groundwater lens, with subsequent input to the nearshore ocean. As there have been no preliminary estimates of the amount of changes to groundwater hydraulic and chemical fluxes that will result from the project, a most reasonable technique for evaluating potential for impact is to evaluate the magnitude of groundwater flux downslope from the project. If the present magnitude can be considered minor, it can be reasoned that there is even if there are subsidies to groundwater from the project, the overall input over existing conditions will not be sufficient to cause significant negative impacts to the marine environment.

Results of recorded continual traces of salinity and temperature from the shoreline to a distance offshore beyond the influence of input from land revealed that there was indeed a detectable input of groundwater (noted by decreased values of salinity below open ocean values) at the shoreline. However, the groundwater signals consistently extended only to a distance of approximately 30 meters (~90 feet offshore). The width of the mixing zone is a result of both relatively low input, and dilution-mixing by physical forces of wind waves and currents. At the time of the surveys winds were calm and surf breaking on the shoreline was less than one foot. These conditions represent the calmest that can occur, hence the documented width and magnitude of the zone of mixing can be considered maximal; during typical tradewind conditions with higher surf, the zone of mixing will be commensurately smaller.

Results of assessments of the physical and biotic setting of the nearshore area indicates that within a distance of 30 meters from shore, bottom composition consists of a mix of sand and rubble which provides a constantly shifting unstable surface for marine organisms to settle and grow. In addition, continual scour by moving sand in the nearshore zone adds to the harshness of the habitat in terms of suitable habitat. As a result, the reef zone that has any potential for being affected by input from land contains no biotic communities that could be affected. While some isolated corals and other benthic fauna and flora occur on the outer regions of the reef flat, these areas are beyond the influence of inputs from land.

All of these considerations indicate that the proposed Piilani Promenade project will not have any significant negative or likely even measurable, effect on water quality or marine biota in the coastal ocean offshore of the property. Because of groundwater subsidies are likely to be small, based on calculations from similar projects, they are likely to remain within the wide variation in nutrient concentrations of the entirety of Central Maui. As the effects of groundwater input have been shown to be small and restricted in area, and typical ocean conditions have strong mixing characteristics of the nearshore environment, and there is not a biotic community structure in the area of effect, the changes to the marine environment as a result of Piilani Promenade project will likely be undetectable, with no change from the present conditions.



FIGURE 1. Aerial photograph of area of North Kihei, Maui, Hawaii showing location of Piilani Promenade project site. Also shown are locations of three ocean transects extending from the shoreline to approximately 100 m offshore along which salinity and temperature profiles were acquired.

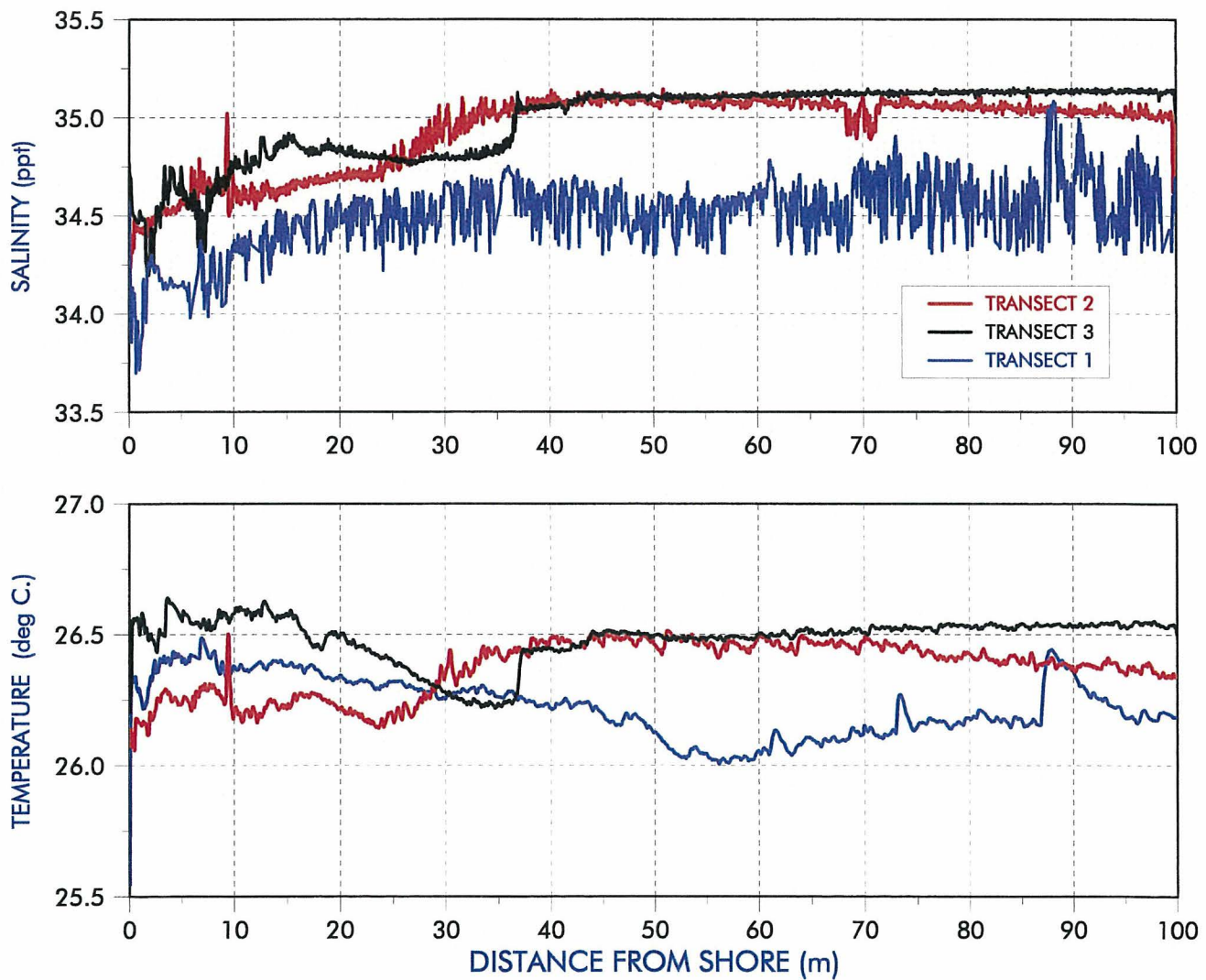


FIGURE 2. Plots of salinity (top) and temperature (bottom) in surface water on three transects that extended from the shoreline to approximately 100 m offshore of the Piilani Promenade property. For locations of transects, see Figure 1.

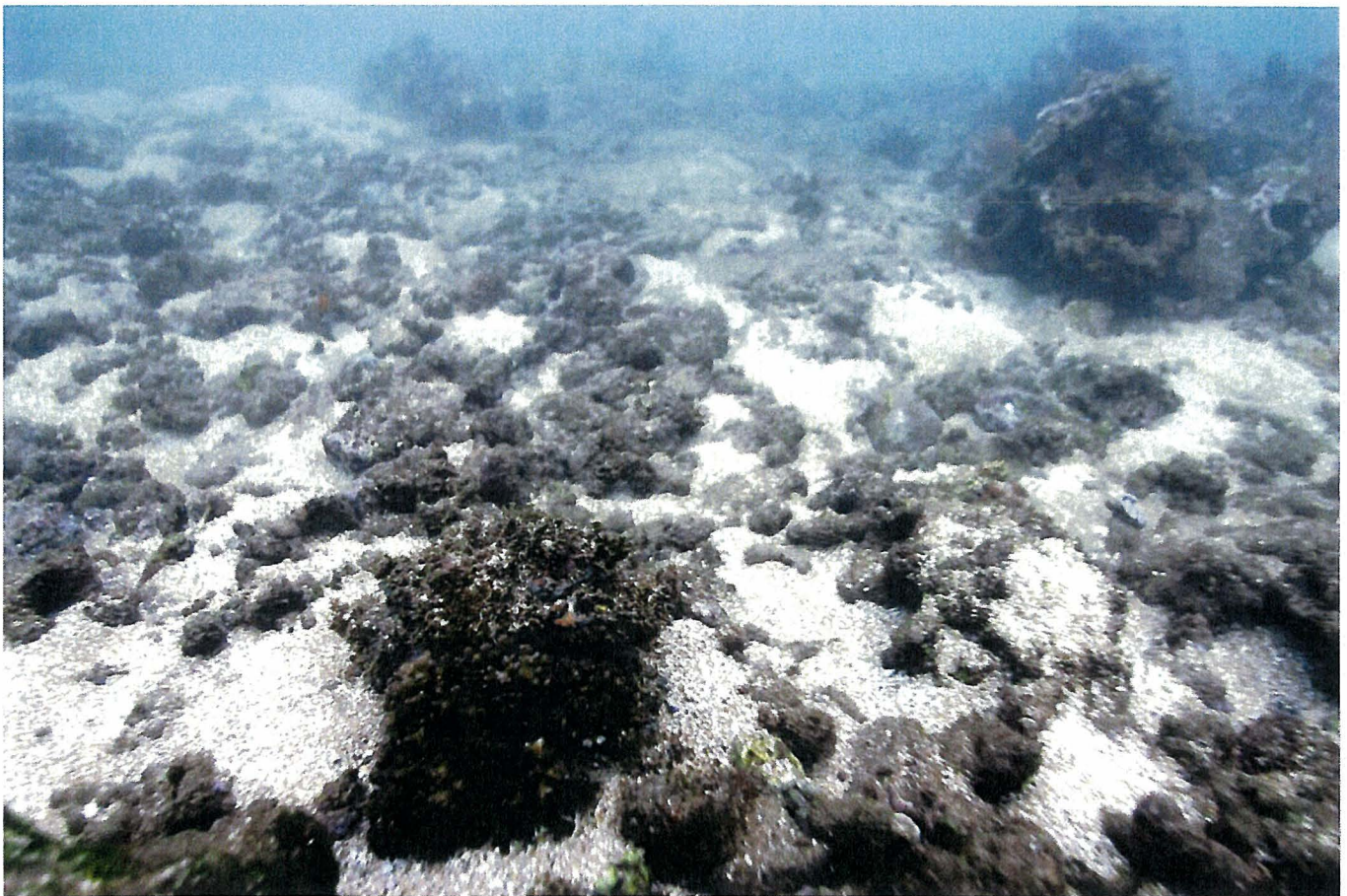
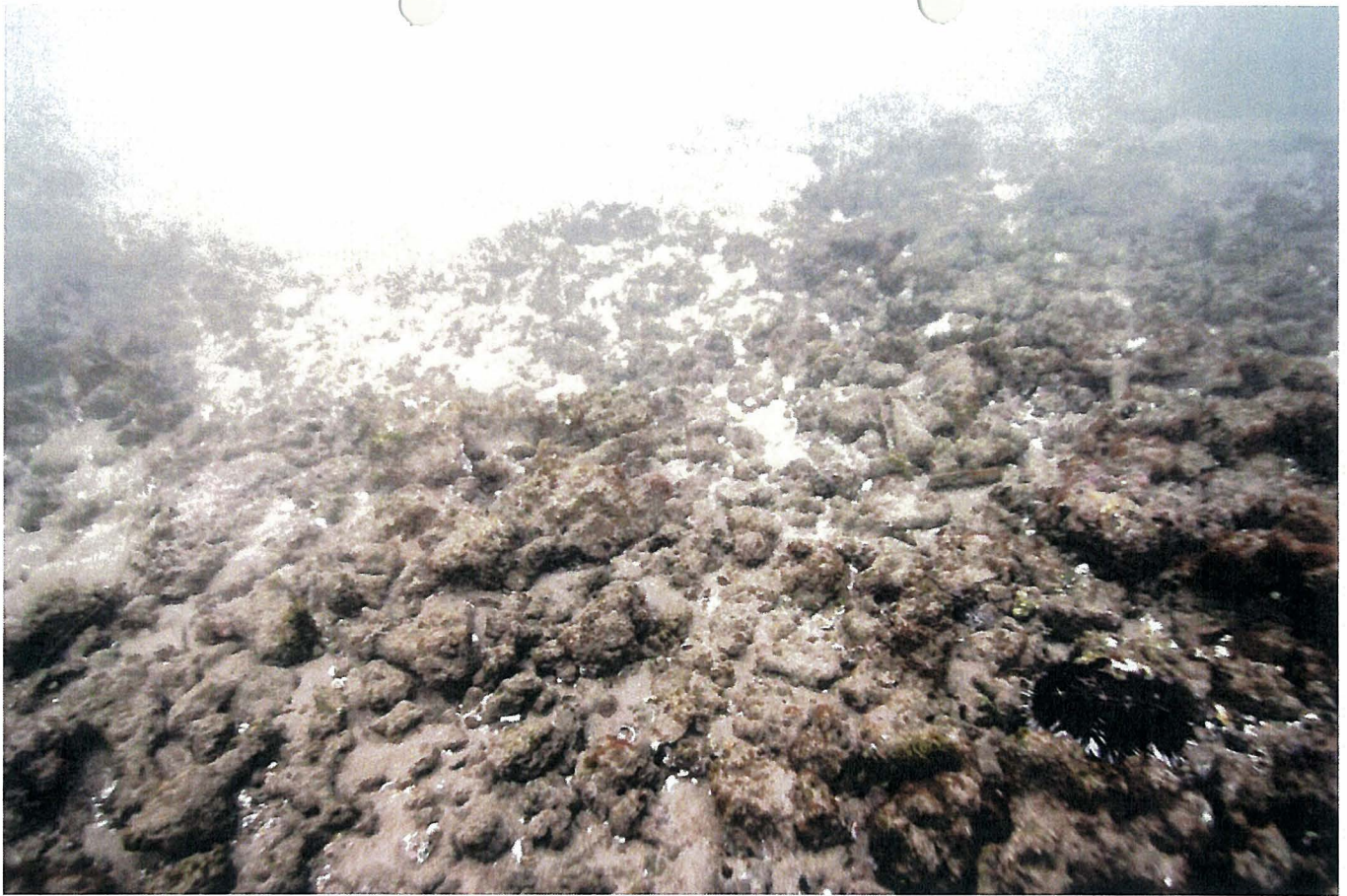


FIGURE 3. Two views of sand and rubble bottom of nearshore zone downslope from the Piilani Promenade Project site in Kihei, Maui, Hawaii. Water depth in both photos is 2-3 feet.

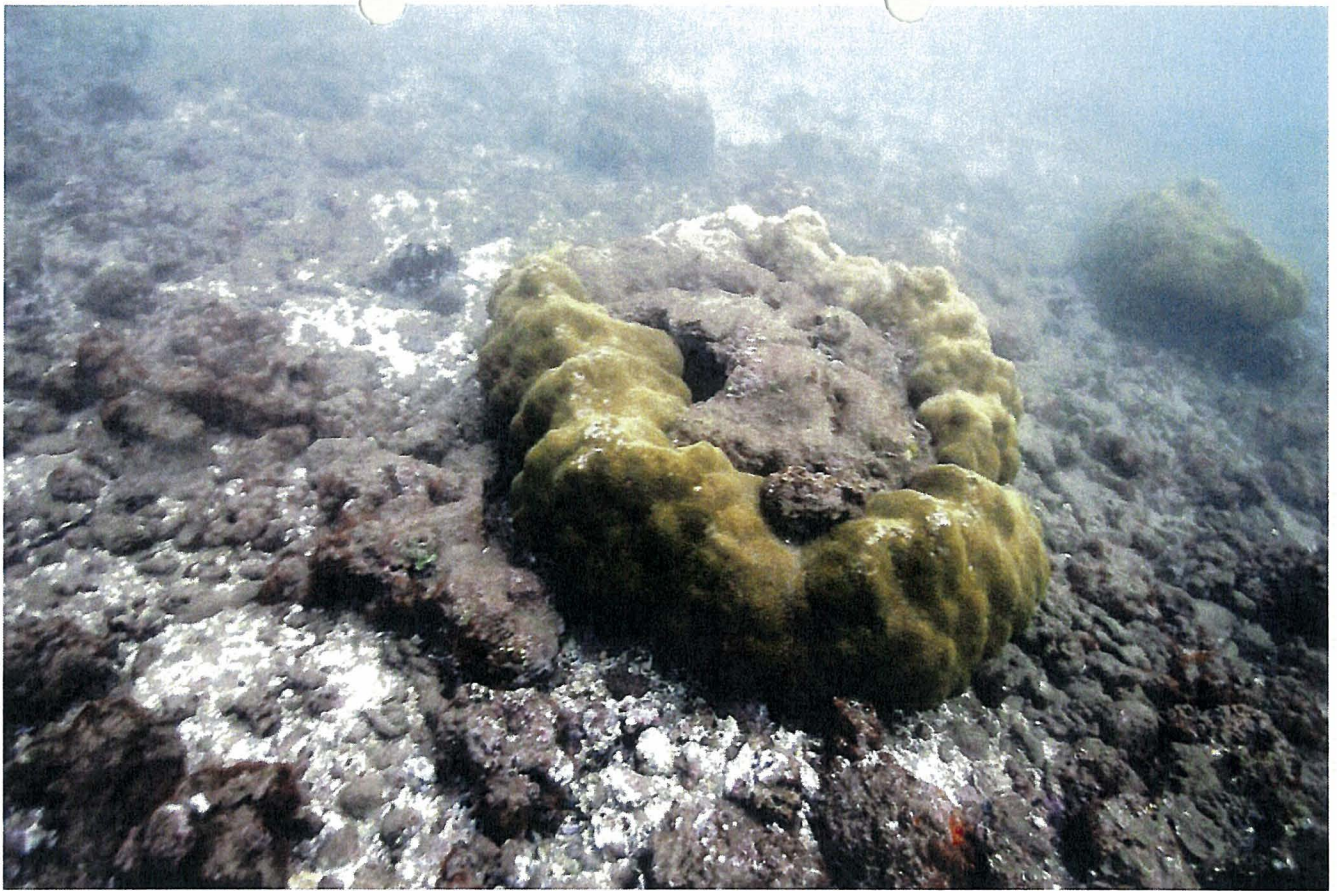


FIGURE 4. Two views of rubble zone with isolated coral colonies. Corals in both photos is *Porites lobata*. Water depth in both photos is 4-5 feet.

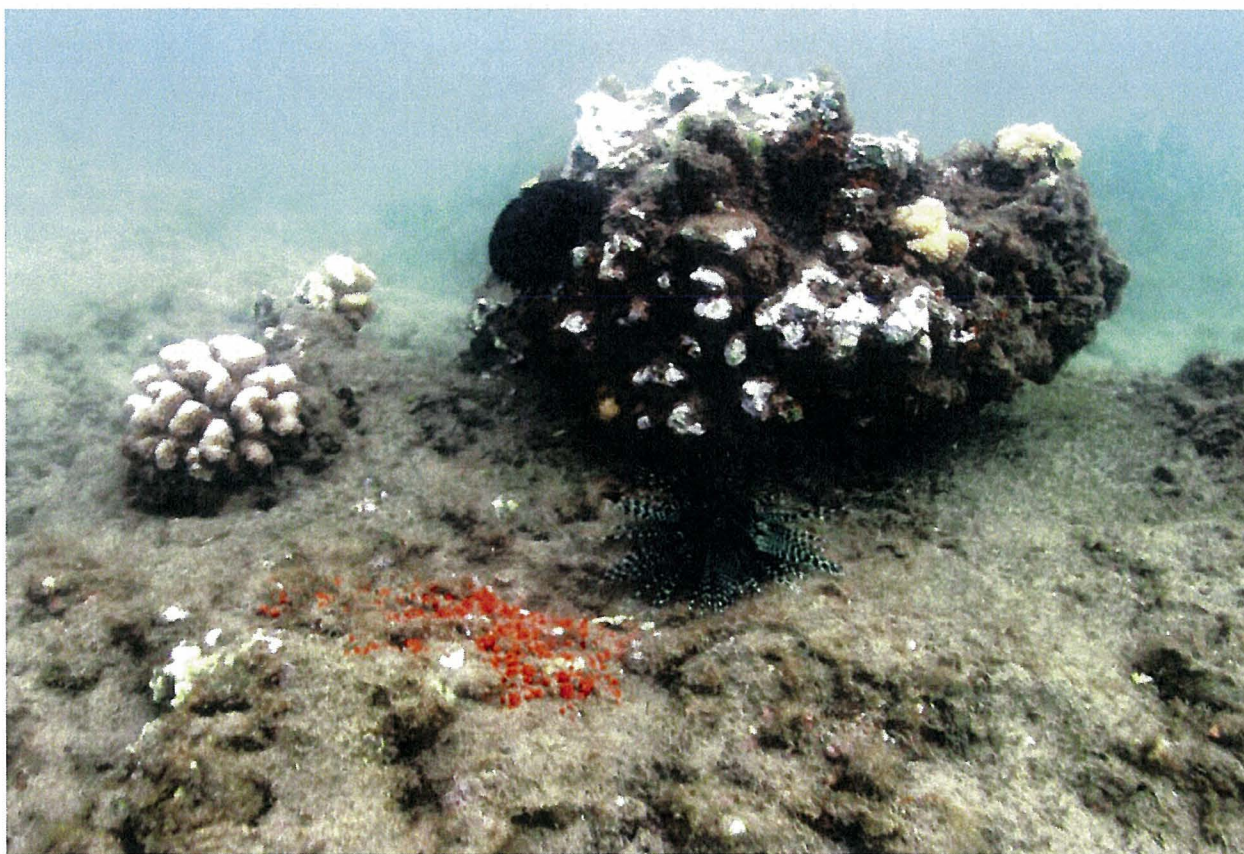
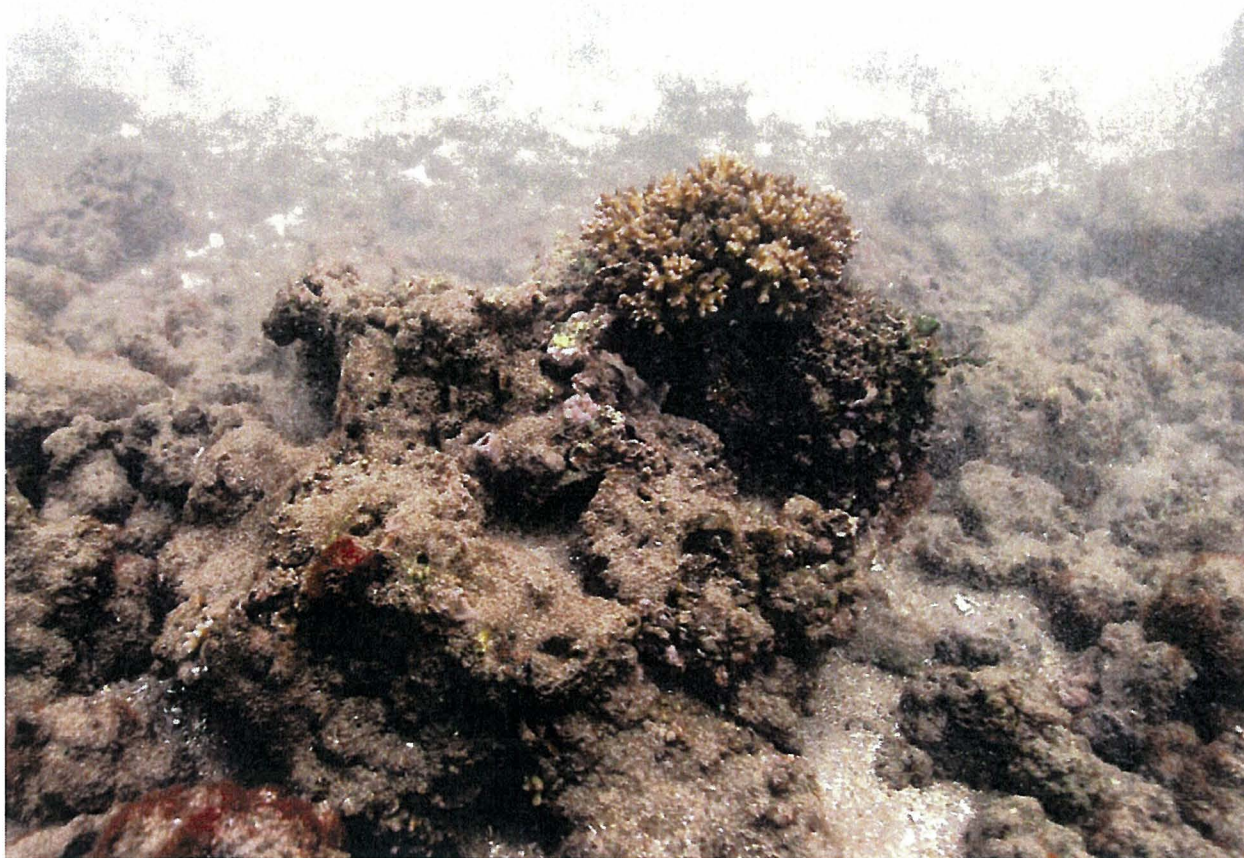


FIGURE 5. Two views of rubble zone with isolated coral colonies. Coral in upper photo is *Pocillopora damicornis*; corals in bottom photo are *Pocillopora meandrina*. Round sea urchin in upper center is *Tripneustes gratilla*; striped long-spined sea urchin in bottom center is *Echinothrix calamaris*. Water depth in both photos is 4-5 feet.



FIGURE 6. Upper photo shows colony of soft coral *Zoanthus* sp. growing on ledge of fossilized reef. Bottom photo shows a cluster of spiny sea urchins (*Echinothrix diadema*) inhabiting holes in mound of dead coral on outer reef off of Kihei. Water depth in both photos is approximately 10 feet.

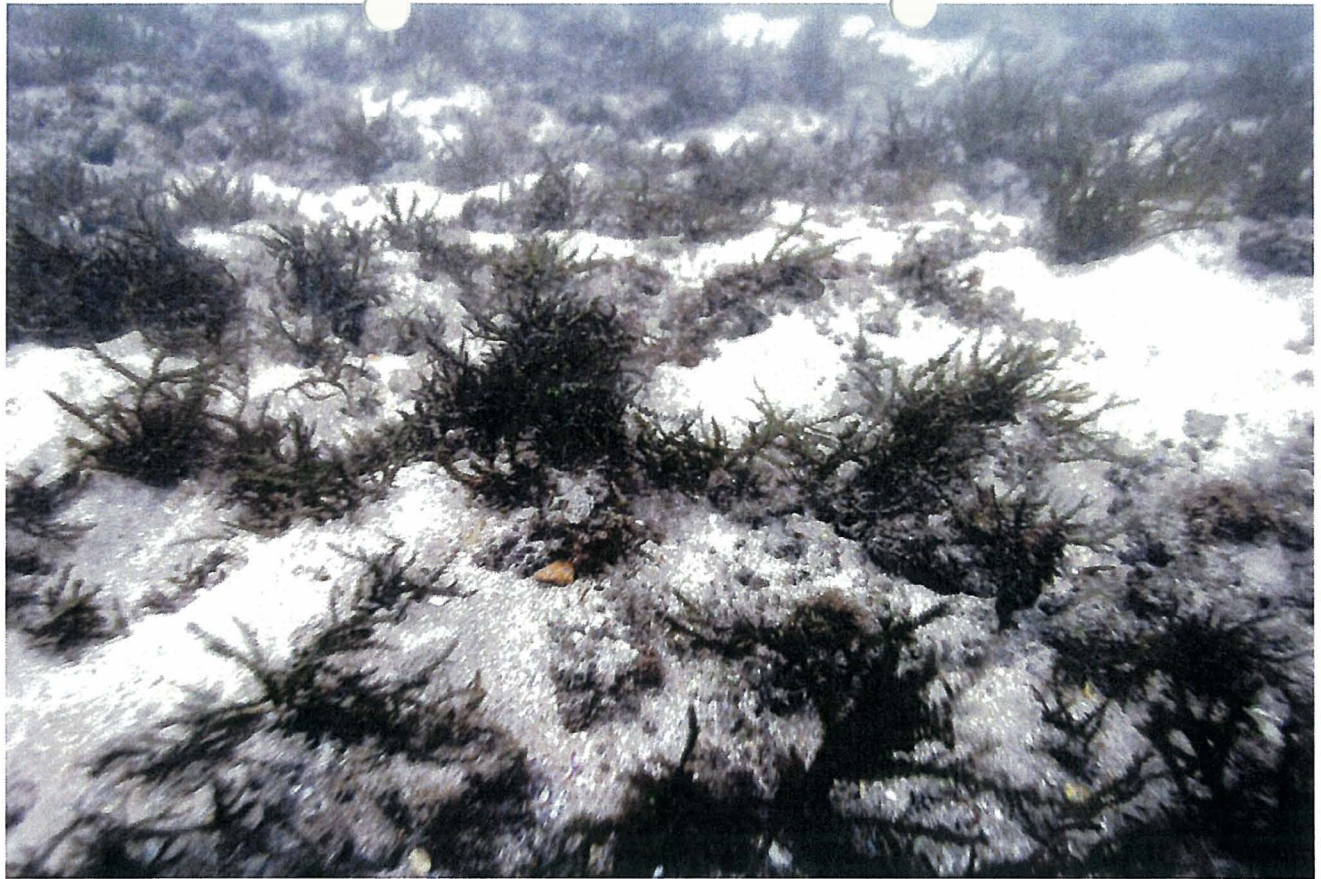


FIGURE 7. Upper photo shows clusters of introduced alga *Acanthophora specifera* in sand flat in outer zone of reef flat off Kihei. Bottom photo shows sand flats that extend offshore into deep water. Water depth top photo is approximately 10 feet, water depth in bottom photo is 15 feet.

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