Appendix B:
Transportation Impact Assessment Report

WAIKĪKĪ WAR MEMORIAL COMPLEX

Transportation Impact Assessment Report

September 2018

City & County of Honolulu
Department of Design and Construction
650 South King Street, 11th Floor
Honolulu, Hawai‘i 96813

AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, Hawai‘i 96813
Ph. (808) 521-5031

Project Reference: 60542733

Transportation Impact Assessment Report

Waikīkī War Memorial Complex
Waikīkī, Hawai‘i

September 2018

Prepared for:

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Prepared by:

AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, Hawai‘i 96813
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1. INTRODUCTION

The Waikīkī War Memorial Complex (WWMC) includes the Waikīkī Natatorium War Memorial (Natatorium) that was constructed in 1927 to serve as a memorial to honor the more than 10,000 men and women from the territory of Hawaiʻi who served in World War I, including the 101 individuals who lost their lives during the war. In the site, there is a 100 meter by 40 meter salt water swimming pool where several swim-meets involving world-famous swimmers were held. After the attack on Pearl Harbor in 1941, the United States of America (USA) army took over the facility to use it for training its troops. In 1949, the facility was refurbished and turned over to the City and County of Honolulu. Over time, its condition deteriorated, and it was officially closed in 1979.

The WWMC is located along the makai-side of Kalākaua Avenue in the vicinity of Queen Kapiʻolani Regional Park in Waikīkī. The surrounding area includes the Waikīkī Aquarium on the ʻEwa side of the site and Sans Souci Beach, which is commonly referred to as Kaimana Beach, on the Koko Head side. The site is bounded by Queen Kapiʻolani Regional Park and Kalākaua Avenue on its mauka-side and the Pacific Ocean on its makai side. Figure 1 illustrates the location of the WWMC.

The City and County of Honolulu is currently exploring alternatives to remedy the deteriorated state of the Natatorium. As part of this process, a Draft Environmental Impact Statement (DEIS) is being prepared that identifies and evaluates potential impacts associated with implementing each of the alternatives.

The purpose of this Transportation Impact Assessment Report (TIAR) is to support the Draft EIS by assessing the traffic impacts that could result from implementing different WWMC alternatives. This TIAR also updates a previous transportation study performed in 2011 for the WWMC. The current TIAR documents the existing transportation conditions, peak period transportation counts, and traffic operations analyses conducted at the WWMC driveway access intersection with Kalākaua Avenue. The TIAR also identifies potential transportation enhancements.

Figure 1: Project Site Location

2. EXISTING CONDITIONS

2.1 Site Description

The WWMC site includes a memorial that honors the 101 men and women who died in service during World War I. In the surrounding park area, there are outdoor showers, picnic tables, and vehicular parking. The site also includes the Natatorium which contains a saltwater swimming pool, bleachers, restrooms, and a small administrative office. Figure 2 illustrates the WWMC site.

Figure 2: WWMC Site

2.2 Roadway Facilities

2.2.1 WWMC Driveway

Vehicular access to the WWMC is provided by a single driveway that intersects Kalākaua Avenue. The WWMC driveway is an undivided two lane roadway, with one lane in each direction. Free parallel parking is provided along both sides of the driveway. Two parking stalls along the makai-side of the road are reserved for active lifeguards from 7:00 AM to 6:00 PM. At its intersection with Kalākaua Avenue, egress from the site is controlled by a STOP sign.

2.2.2 Kalākaua Avenue

Kalākaua Avenue is an ‘Ewa-Koko Head arterial roadway that runs from the Makiki area through Waikīkī to Diamond Head. In the vicinity of the site, Kalākaua Avenue serves more as a collector roadway providing traffic circulation and access to properties. In this area, Kalākaua Avenue has one lane in each direction, separated by a raised median.

At the WWMC driveway, there is a break in the median that allows traffic access into and out of the WWMC driveway. The median break is also used by vehicles on Kalākaua Avenue to execute U-turns to access other properties whose driveways are blocked by the raised median. There are bicycle lanes serving both directions of Kalākaua Avenue.

Koko Head-bound Kalākaua Avenue adjacent to the site is under the jurisdiction of the City and County of Honolulu Department of Transportation Services. There is free on-street parallel parking on the makai-side of Kalākaua Avenue. From 7:00 AM to 6:00 PM, these parking stalls have a 2-hour duration limit except on Sundays and state holidays. The posted speed limit is 25 miles per hour (mph).

‘Ewa-bound Kalākaua Avenue adjacent to Queen Kapi‘olani Regional Park is under the jurisdiction of the City and County of Honolulu Department of Parks and Recreation. There are metered, angled parking stalls adjacent to the park. The metered stalls allow 4-hour parking from 10:00 AM to 6:00 PM during the week. At other times, the parking is free and there is no limit on parking duration. The posted speed limit is 15 mph on this segment of the road.

2.3 Pedestrian & Bicycle Facilities

2.3.1 Pedestrian Facilities

There are sidewalks on both sides of Kalākaua Avenue. At the intersection of Kalākaua Avenue and the WWMC driveway, there is a crosswalk across the WWMC driveway and across Kalākaua Avenue on the Koko Head-side of the intersection. There is no crosswalk across Kalākaua Avenue on the ‘Ewa-side of the intersection. There are no existing pedestrian facilities that provide access to WWMC from Kalākaua Avenue. Pedestrians entering the WWMC site walk through the lawn areas away from the WWMC driveway.

2.3.2 Bicycle Facilities

There are bicycle lanes along both sides of Kalākaua Avenue in the vicinity of WWMC. On the makai-side of Kalākaua Avenue, the bicycle lane is located between the on-street parallel parking stalls and the driving lane. On the mauka-side of Kalākaua Avenue, the bicycle lane is located on the makai-side of the driving lane, adjacent to the median.

2.4 Public Transit Conditions

There are no City bus stops located immediately adjacent to the site. The closest City bus stops are located near the Waikīkī Aquarium (Stop #159) and near the Outrigger Canoe Club (Stop #161). Bus service is only provided in the Koko Head-bound direction in this segment of Kalākaua Avenue.

City bus routes that travel along Kalākaua Avenue that pass the site are Routes 14, 19, 20, and 22.

Route 14 (Maunalani Heights via Kapahulu) runs from around 5 AM to 10 PM (span of 17 hours), Route 19 (Waikīkī Beach and Hotels) runs from around 4 AM to 2 AM (span of 22 hours), Route 20 (Waikīkī Beach) runs from about 5 AM to 8 PM (span of 15 hours), and Route 22 (The Beach Bus Hawai'i Kai-Hanauma Bay-Sea Life Park) runs from about 6 AM to 5 PM (span of 11 hours).

2.5 Transportation Volumes

A previous Traffic Impact Assessment Report – Waikiki War Memorial was completed by Phillip Rowell and Associates and dated December 8, 2011. As part of that TIAR, traffic turning movement and pedestrian counts were conducted for the AM and PM peak periods on Thursday, October 27, 2011 and for the midday peak period on Saturday, November 5, 2011.

Although the study area is not viewed as a high traffic growth area, the 2011 traffic counts are almost 7 years old. For this reason, traffic and pedestrian counts were updated as part of this study effort.

Figure 3 illustrates peak period transportation turning movement counts collected at the intersection of Kalākaua Avenue and the WWMC driveway. Vehicular turning movements, pedestrian, and bicycle counts are included. Counts were conducted on Thursday, August 9, 2018, during the AM (6:15 AM to 8:45 AM) and PM (3:30 PM to 5:30 PM) peak periods, and on Saturday, August 11, 2018 during the weekend midday (11:30 PM to 1:30 PM) peak period. Based on these counts, the weekday AM peak hour was determined to occur from 7:45 AM to 8:45 AM, the weekday PM peak hour was found to occur from 4:15 PM to 5:15 PM, and the weekend midday peak hour was found to occur from 12:15 PM to 1:15 PM.

2.5.1 Vehicular Volumes

Peak hour vehicular volumes on Kalākaua Avenue are more than twice as large in the Koko Head-bound direction than in the ‘Ewa-bound direction. This is attributable to the street network in this area which tends to direct ‘Ewa-bound through traffic onto Paki Avenue, a street that is roughly parallel to and mauka of Kalākaua Avenue. The ‘Ewa-bound traffic on Kalākaua Avenue in this area tends to be traffic accessing properties with access on Kalākaua Avenue or traffic directly associated with Kapi‘olani Park.

FIGURE 3: YEAR 2018 TRANSPORTATION MOVEMENT COUNTS
Waikīkī War Memorial Complex
Source: AECOM, 2018

Figure 3: Year 2018 Transportation Movement Counts

The through traffic volumes on Kalākaua Avenue collected in 2018 are approximately 50 percent larger than those collected in 2011. However, this difference is attributed to fluctuation in visitor and resident activity rather than growth in through traffic. Data documented in Hawaii Tourism Authority, 2011 Monthly Final and Hawaii Tourism Authority, Aug17 Table 1. Total Visitors by Air, distributed by the State of Hawaii Department of Business, Economic Development & Tourism (DBEDT-http://dbedt.hawaii.gov/visitor/tourism/) shows that visitor activity is between 44 and 51 percent greater during the month of August (when the 2018 counts were conducted) and the months of October/November (when the 2011 counts were conducted. Additionally, summer months such as August usually see more resident recreational activity as all schools are not in session yet. The area served by this segment of Kalākaua Avenue contains mature development that has not significantly changed since 2011. Therefore, it is judged that the difference in traffic volumes counted Kalākaua Avenue in the vicinity of the WWMC between the 2011 study and the current 2018 study is due mainly to normal variations in traffic volumes by month. The conclusion is that there is almost negligible growth in traffic volumes along this segment of Kalākaua Avenue and this trend is likely to remain in the foreseeable future.

2.5.2 Bicycle Volumes

During the data collection periods, bicycle volumes were found to be low to moderate. Bicycle volumes on Kalākaua Avenue ranged from 26 bikes/hour during the weekday AM peak hour to 30 bikes/hour during the weekend midday peak hour. The bicycle facilities appeared to be sufficient and operating well during the observed peak hour conditions.

2.5.3 Pedestrian Volumes

During the data collection periods, large volumes of pedestrian activity were observed. The pedestrian activity included park and beach users, joggers, and dog walkers.

The two existing crosswalks at the intersection are very active during the peak hours. Pedestrians crossing Kalākaua Avenue ranged from 69 pedestrians/hour during the weekday AM peak hour to 170 pedestrians/hour during the weekend midday peak hour. Pedestrians crossing the WWMC driveway ranged from 215 pedestrians/hour during the weekday AM peak hour to 153 pedestrians/hour during the weekend midday peak hour.

The large number of pedestrians that cross at the Kalākaua Avenue/WWMC driveway intersection were observed to create numerous pedestrian/vehicle conflicts. The low-speed of the vehicles traveling on Kalākaua Avenue help to manage these conflicts, but there appears to be opportunities to enhance pedestrian safety at this location.

2.6 Traffic Operations

Table 1 summarizes the weekday AM and PM commuter peak hour operations at the intersection of Kalākaua Avenue and the WWMC driveway on Thursday, August 9, 2018.

The intersections were analyzed using the unsignalized methods described in Chapter 16 of the 2010 Highway Capacity Manual (HCM) through the Highway Capacity Software (HCS) 2010. For this method, individual delays and levels of service (LOS) are calculated for selected traffic movements which for this intersection are the Koko Head-bound Kalākaua U-turn, the ‘Ewa-bound Kalākaua U-turn and left-turn into WWMC driveway, and the shared left and right turns out of the WWMC driveway. The HCS 2010 analysis worksheets are included in Appendix C.

Table 1: Existing Weekday Peak Hour Intersection Operations

Intersection	AM Peak Hour		PM Peak Hour	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Kalākaua Avenue/WWMC Driveway*	7.0/8.6/14.9	A/A/B	7.1/8.6/19.9	A/A/C

Notes: Based on counts conducted on Thursday, 8/9/18
AM Peak Hour: 7:45 AM - 8:45 AM, PM Peak Hour: 4:15 PM - 5:15 PM
Kalākaua Avenue/WWMC Driveway is unsignalized:
KKHD-bound U-turn/‘Ewa-bound U-turn and left into WWMC driveway/shared right and left out of WWMC driveway
sec/veh = seconds per vehicle
LOS = level of service

As shown in Table 1, the intersection operates well with LOS C or better for the key turning movements during the peak hours. LOS for unsignalized intersections is a qualitative index that references a performance measure such as intersection delay to express the quality of traffic services.

The intersection operations for the key turning movements are acceptable for peak hour conditions. The delays for each of the key movements that were calculated using HCS appear to be similar to the delays observed during the data collection process.

Table 2 summarizes the weekend midday peak hour operations of the intersection of Kalākaua Avenue and the access driveway on Saturday, August 11, 2018.

Table 2 Existing Weekend Midday Peak Hour Intersection Operations

Intersection	Weekend Midday Peak Hour	
	Delay (sec/veh)	LOS
Kalākaua Avenue/WWMC Driveway	7.1/8.5/21.8	A/A/C

Notes: Based on counts conducted on Saturday, 8/11/18
Weekend Midday Peak Hour: 12:15 PM - 1:15 PM
Kalākaua Avenue/WWMC Driveway is unsignalized:
KKHD-bound U-turn/‘Ewa-bound U-turn and left into WWMC driveway/shared right and left out of WWMC driveway
sec/veh = seconds per vehicle
LOS = level of service

As shown in Table 2, the key movements of the intersection operate well during the weekend midday peak with an LOS C or better, which is similar to what was observed during the data collection process.

3. ACTION ALTERNATIVES

Four alternatives were evaluated in the Draft EIS for the WWMC. Along with the No Action alternative, the three action alternatives evaluated include:

- Perimeter Deck Alternative;
- War Memorial Beach Alternative; and
- Closed System Pool Alternative.

3.1 Perimeter Deck Alternative

The perimeter deck alternative involves retaining and rehabilitating much of the physical structures that historically define the Natatorium, while reconfiguring the saltwater pool so that it no longer is classified as an enclosed public pool. Transportation-wise, as shown in Figure 4, the WWMC driveway will remain similar to its existing configuration. The location of its intersection with Kalākaua Avenue does not change. The number of parking stalls within the WWMC site remains the same at 77 parking stalls.

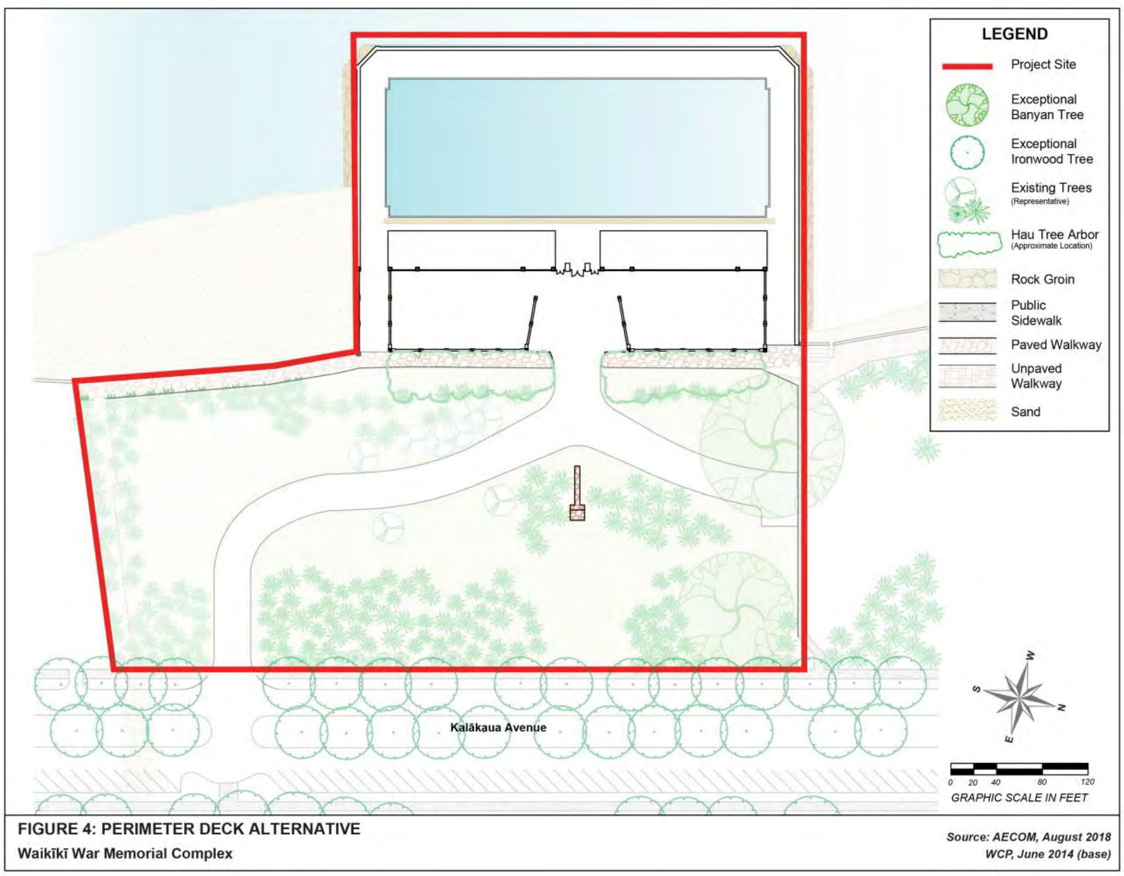


Figure 4: Perimeter Deck Alternative

3.1.1 Construction Transportation Impacts

During construction, there will be periods when significant large truck activity is anticipated. There may be periods when the sidewalks, bike lanes, or roadway need to be partially or completely closed. Best construction practices such as avoiding major truck activity during the peak traffic hours and preparing required traffic control plans for appropriate and safe management of vehicular, bike, pedestrian, and public transit modes in the area will be implemented.

3.1.2 Traffic Operations

The location and configuration of the WWMC driveway at its intersection with Kalākaua Avenue and the parking counts within the WWMC site are similar to the existing condition. As discussed in the section 2.5.1 in this TIAR, traffic volumes on this segment of Kalākaua Avenue have been and are projected to remain stable with negligible growth in the future.

For these reasons, future transportation conditions with the Perimeter Deck alternative would be similar to the transportation conditions observed in 2018.

3.1.3 Alternative-Specific Recommendations

The Perimeter Deck alternative is not expected to significantly change transportation conditions; therefore, transportation mitigation is not needed.

3.2 War Memorial Beach Alternative

The War Memorial Beach alternative replaces the Natatorium with a beach. A replica memorial arch, aligned with the Roll of Honor Plaque, would be constructed to replace the Natatorium entry arch. As shown in Figure 5, the road within the project site changes from the existing condition. The existing WWMC driveway within the site would be replaced with a paved walkway and parkland area and parking would be consolidated into a new parking lot located on the Koko Head side of the site, which will contain the same amount of parking stalls that existed on the road. The access to this new parking lot would access Kalākaua Avenue at the same location as the existing WWMC driveway and the number of parking stall provided in this new parking lot, would be the same as the existing parking count of 77 stalls.

3.2.1 Construction Transportation Impacts

During construction, there will be periods when significant large truck activity is anticipated. There may be periods when the sidewalks, bike lanes, or roadway need to be partially or completely closed. Best construction practices such as avoiding major truck activity during the peak traffic hours and preparing required traffic control plans for appropriate and safe management of vehicular, bike, pedestrian, and public transit modes in the area will be implemented.

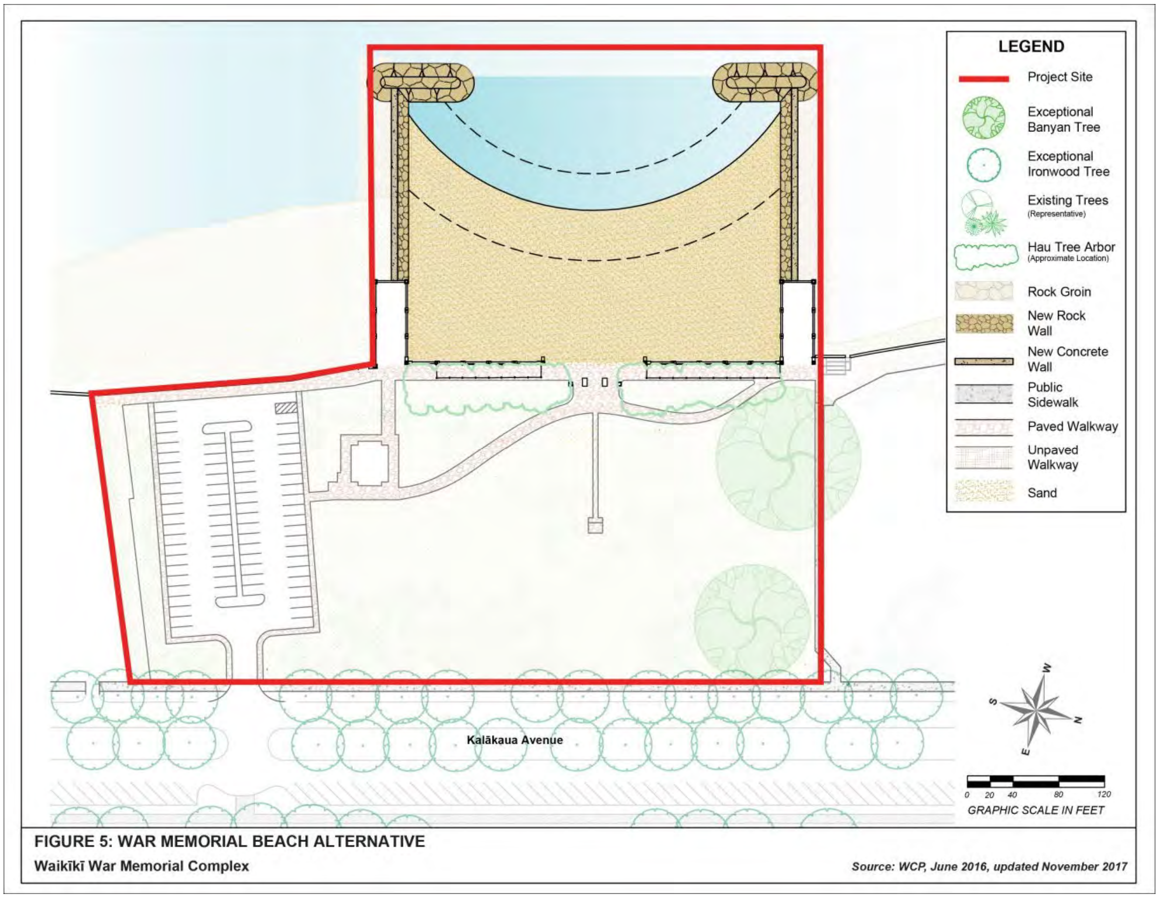


Figure 5: War Memorial Beach Alternative

3.2.2 Traffic Operations

The access to the new parking lot proposed for this alternative would access Kalākaua Avenue at the same location as the existing WWMC driveway and the number of parking stall provided in this new parking lot, would be the same as the existing parking count of 77 stalls. As discussed in the section 2.5.1 in this TIAR, traffic volumes on this segment of Kalākaua Avenue have been and are projected to remain stable with negligible growth in the future.

For these reasons, future transportation conditions with the War Memorial Beach alternative would be similar to the transportation conditions observed in 2018.

3.2.3 Alternative-Specific Recommendations

The War Memorial Beach alternative is not expected to significantly change transportation conditions; therefore, transportation mitigation is not needed.

3.3 Closed System Pool Alternative

The closed system pool alterative would restore Natatorium structures but completely replace the existing ocean-fed pool with a new fresh water swimming pool. As shown in Figure 6, the WWMC driveway will remain similar to its existing configuration. The location of its intersection with Kalākaua Avenue does not change. The number of parking stalls within the WWMC site remains the same at 77 parking stalls.

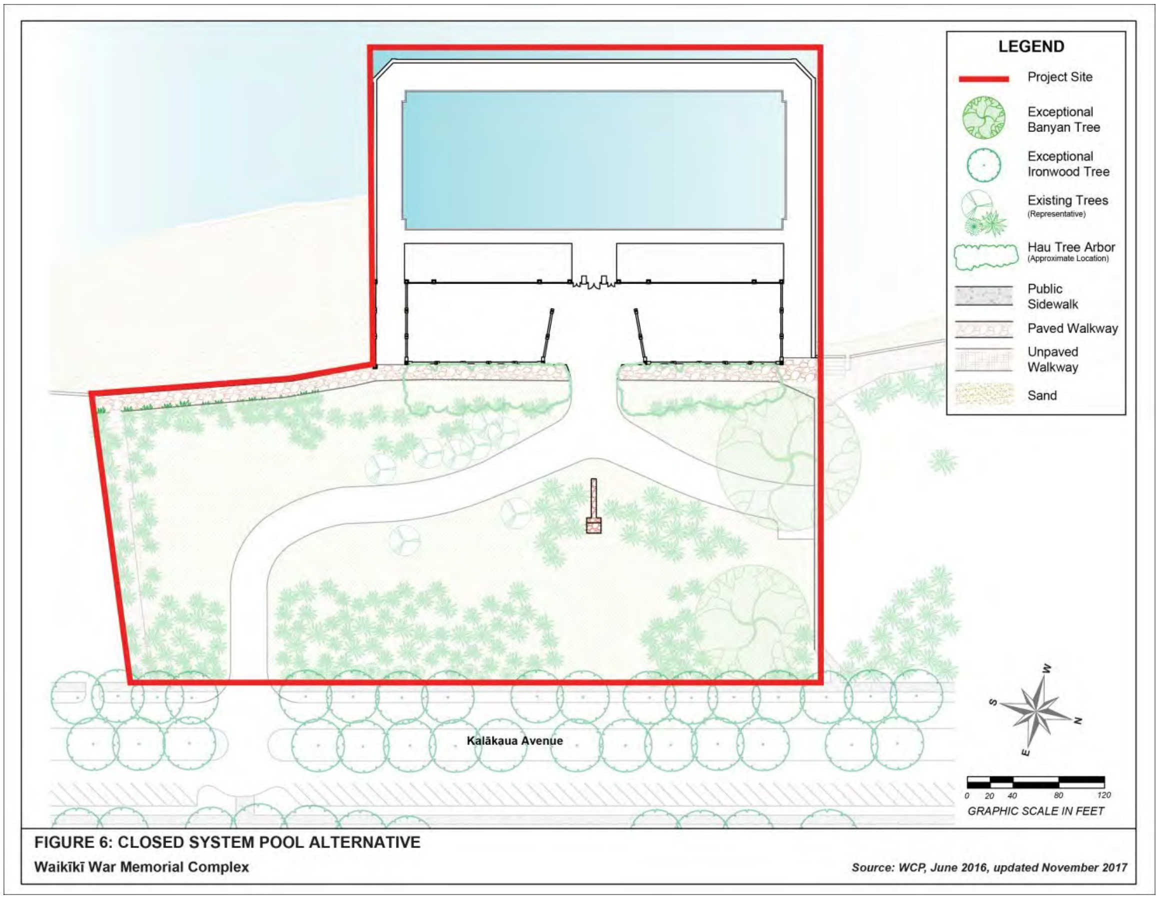


Figure 6: Closed System Pool Alternative

3.3.1 Construction Transportation Impacts

During construction, there will be periods when significant large truck activity is anticipated. There may be periods when the sidewalks, bike lanes, or roadway need to be partially or completely closed. Best construction practices such as avoiding major truck activity during the peak traffic hours and preparing required traffic control plans for appropriate and safe management of vehicular, bike, pedestrian, and public transit modes in the area will be implemented.

3.3.2 Traffic Operations

The location and configuration of the WWMC driveway at its intersection with Kalākaua Avenue and the parking counts within the WWMC site are similar to the existing condition. As discussed in the section 2.5.1 in this TIAR, traffic volumes on this segment of Kalākaua Avenue have been and are projected to remain stable with negligible growth in the future.

For these reasons, future transportation conditions with the Closed System Pool alternative would be similar to the transportation conditions observed in 2018.

3.3.3 Alternative-Specific Recommendations

The Closed System Pool alternative is not expected to significantly change transportation conditions; therefore, mitigation is not needed.

4. SUMMARY AND RECOMMENDATIONS

4.1 Summary

A transportation analysis of existing and projected conditions around the Waikīkī War Memorial Complex (WWMC) was conducted as part of the Draft EIS for the WWMC. The analysis focused on conditions at the intersection of Kalākaua Avenue and the WWMC driveway for existing and proposed future alternatives for the WWMC.

Existing Conditions

Updated transportation counts for the weekday AM and PM peak periods and the weekend midday peak period indicate that volumes are stable on Kalākaua Avenue and are not anticipated to change significantly in the foreseeable future. During the peak hours, there was a large amount of pedestrian activity observed and both the crosswalks at the intersection were very active. The bicycle facilities were only moderately utilized.

Future Conditions

All action alternatives evaluated propose to maintain the existing configuration and location of the WWMC driveway at its intersection with Kalākaua Avenue. Parking on the WWMC site will remain at the existing 77 parking stall level. These features coupled with the stable traffic volumes on Kalākaua Avenue indicate that projected future conditions will be similar to the existing conditions.

Traffic Operations

Under the existing conditions and projected conditions for all action alternatives, the intersection of Kalākaua Avenue and the WWMC driveway are projected to operate well during weekday AM and PM peak and weekend midday peak hours. All alternatives have similar access and parking configurations to the existing situation and consequently are projected to experience similar traffic operating conditions.

4.2 Recommendations

Transportation conditions would be similar for the No Action and any of the three action alternatives for the weekday AM and PM peak hours and for the weekend midday peak hour. All would have similar transportation conditions to the existing situation. Therefore, no transportation mitigation is needed for any of the alternatives.

4.3 Improvements not Connected to WWMC Project

Based on observations of the vehicular operations and interactions between pedestrians and vehicles at the existing Kalākaua Avenue/WWMC driveway intersection, enhancements would be desirable independent of any redevelopment action at the WWMC.

The Honolulu Complete Streets Design Manual describes various techniques that could be applied to enhance mobility and walkability. Examples of these techniques include:

- adjustments in intersection configuration for turning vehicles;
- pedestrian crossing enhancements.

Adjustments in Intersection Configuration for Turning Vehicles

The median break in Kalākaua Avenue at the WWMC driveway is configured to facilitate U-turns on Kalākaua Avenue. This creates a condition that has vehicles within the median area driving on the opposite side than is standard for roadways in the U.S. This configuration is permissible and makes sense given the significant U-turn traffic volumes during the weekday PM peak hour and the weekend midday peak hour. However, this alignment can also create confusion for vehicles turning into and out of the WWMC driveway. Vehicles turning left out of the WWMC driveway and vehicles turning left into the WWMC driveway must understand to keep to the left when traveling through the median break to avoid direct conflict with vehicles executing U-turns. It was observed that drivers turning into and out of the WWMC driveway were often confused and did not properly utilize the median break area.

To help drivers better understand the proper utilization of the median break area, lane-use pavement arrows could be placed on the roadway within the median break area. Figure 77 illustrates the location and appearance of the lane-use arrows at this intersection.

Figure 7: Kalākaua Avenue/Access Driveway Intersection Improvements

Pedestrian Crossing Enhancements

The transportation count data indicate that there is substantial pedestrian activity crossing both Kalākaua Avenue and the WWMC driveway. The pedestrian mix is recreational in nature and includes young children and parents pushing baby strollers.

To enhance driver awareness of the pedestrian activity at this intersection, the feasibility of installing a raised intersection at this location could be pursued. A raised intersection involves bringing a large area of the intersection to the same level as the surrounding sidewalk and median. Traffic approaching the intersection would ramp up from and departing traffic would ramp down to the existing roadway grade at the transition zones. This type of treatment has been found to lower vehicle speeds at an intersection while increasing driver awareness of the pedestrian crossings. Figure 7 illustrates the potential enhancements that would be associated with a raised intersection.

To maintain a clear delineation of the vehicle drive areas within the raised intersection, bollards could be implemented around the tip of the medians. The existing Kalākaua Avenue crosswalk would become continuous between the mauka and makai sides of Kalākaua Avenue.

One of the impacts of a raised intersection at this location would be the need to relocate the existing handicapped parking stalls and the loss of 4 to 5 standard metered parking stalls on several typical parking stalls on Kalākaua Avenue fronting Queen Kapiʻolani Regional Park.

There is existing street lighting at the Kalākaua Avenue/WWMC driveway. As an enhancement for pedestrians, the feasibility of increasing lighting at this intersection to increase the visibility of pedestrians crossing Kalākaua Avenue and vehicular movements at night could be explored. The feasibility study would need to consider the impacts of the increased lighting on shore birds.

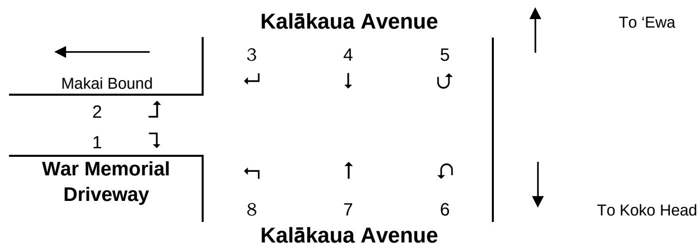
5. REFERENCES

Transportation Research Board of the National Academies. 2010. “Urban Street Facilities.” In *Highway Capacity Manual 2010*, 3:16-1-16–47. Washington, DC: Transportation Research Board.

Appendix A: Transportation Count Worksheets

WAIKIKI WAR MEMORIAL TRANSPORTATION ANALYSIS VEHICLE TURNING MOVEMENT FORM

LOCATION: Waikiki War Memorial Driveway and Kalakaua Avenue
DATE: 8/9/2018 (Thursday)
TIME: 6:15a-8:45a
WEATHER: Wet but not raining
RECORDER: JY

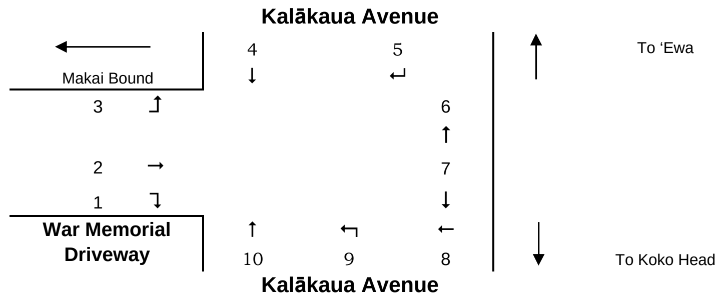


TIME PERIOD	MOVEMENT NUMBER							
	1	2	3	4	5	6	7	8
6:15-6:30a	1	1	4	15	1	1	13	5
6:30-6:45a	0	2	7	28	2	1	5	2
6:45-7:00a	1	1	4	27	0	0	11	2
7:00-7:15a	6	3	10	40	0	1	11	1
7:15-7:30a	1	4	4	37	1	2	17	3
7:30-7:45a	1	1	3	43	1	3	22	0
7:45-8:00a	4	3	6	58	2	4	22	1
8:00-8:15a	4	2	5	51	0	0	19	7
8:15-8:30a	1	3	3	43	3	2	15	1
8:30-8:45a	4	5	10	54	1	2	18	4
Peak Hour 7:45-8:45a	13	13	24	206	6	8	74	13

Notes:

WAIKIKI WAR MEMORIAL TRANSPORTATION ANALYSIS PEDESTRIAN TURNING MOVEMENT FORM

LOCATION: Waikiki War Memorial Driveway and Kalakaua Avenue
DATE: 8/9/2018 (Thursday)
TIME: 6:30a-8:45a
WEATHER: Wet but not raining
RECORDER: WYY

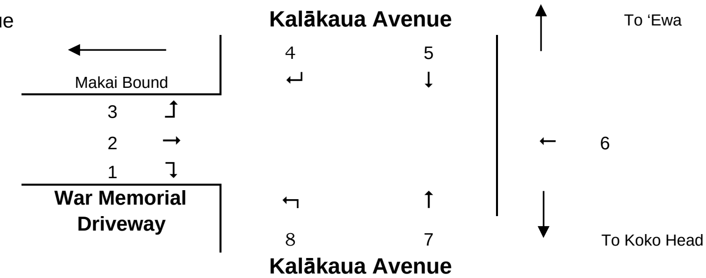


TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	7	8	9	10
6:15-6:30a	4	8	0	32	0	13	8	7	0	20
6:30-6:45a	3	1	0	24	0	15	17	8	0	16
6:45-7:00a	1	1	0	33	1	16	7	12	3	28
7:00-7:15a	3	4	1	34	0	14	1	5	0	26
7:15-7:30a	3	4	0	32	0	8	7	4	2	21
7:30-7:45a	3	10	0	24	0	7	4	5	4	19
7:45-8:00a	2	5	1	33	0	12	7	5	0	23
8:00-8:15a	4	13	0	24	0	19	6	13	7	20
8:15-8:30a	7	8	2	27	3	19	4	7	4	30
8:30-8:45a	4	7	1	47	1	17	11	11	0	11
Peak Hour 7:45-8:45a	17	33	4	131	4	67	28	36	11	84

Notes:

WAIKIKI WAR MEMORIAL TRANSPORTATION ANALYSIS BICYCLE TURNING MOVEMENT FORM

LOCATION: Waikiki War Memorial Driveway and Kalakaua Avenue
DATE: 8/9/2018 (Thursday)
TIME: 6:30a-8:30a
WEATHER: Wet but not raining
RECORDER: WYY

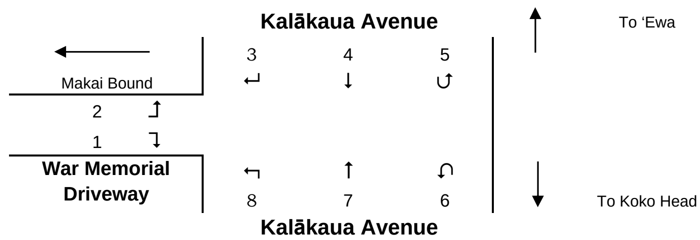


TIME PERIOD	MOVEMENT NUMBER							
	1	2	3	4	5	6	7	8
6:15-6:30a	0	0	0	0	4	0	2	0
6:30-6:45a	1	0	0	1	4	2	7	0
6:45-7:00a	0	0	0	0	2	0	3	0
7:00-7:15a	0	0	0	0	1	0	0	1
7:15-7:30a	0	0	0	1	4	0	0	0
7:30-7:45a	3	0	0	1	6	0	3	3
7:45-8:00a	0	2	0	0	2	0	1	0
8:00-8:15a	0	0	0	0	3	0	2	1
8:15-8:30a	0	0	2	0	4	0	1	2
8:30-8:45a	1	0	0	0	7	0	3	0
Peak Hour 7:45-8:45a	1	2	2	0	16	0	7	3

Notes:

WAIKIKI WAR MEMORIAL TRANSPORTATION ANALYSIS VEHICLE TURNING MOVEMENT FORM

LOCATION: Waikiki War Memorial Driveway and Kalakaua Avenue
DATE: 8/9/2018 (Thursday)
TIME: 3:30p-5:30p
WEATHER: Clear
RECORDER: JY

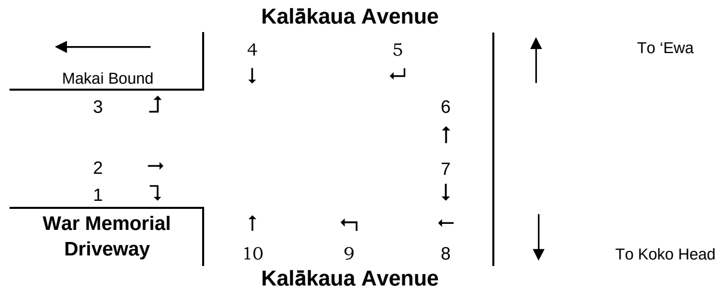


TIME PERIOD	MOVEMENT NUMBER							
	1	2	3	4	5	6	7	8
3:30-3:45p	12	6	17	98	7	5	38	7
3:45-4:00p	6	9	6	94	10	8	30	2
4:00-4:15p	5	2	12	81	10	5	36	3
4:15-4:30p	12	2	10	113	12	4	61	6
4:30-4:45p	12	6	14	101	20	5	55	2
4:45-5:00p	9	7	15	100	15	8	45	12
5:00-5:15p	16	8	18	104	12	10	41	3
5:15-5:30p	9	6	13	114	7	5	45	5
Peak Hour 4:15-5:15p	49	23	57	418	59	27	202	23

Notes:

WAIKIKI WAR MEMORIAL TRANSPORTATION ANALYSIS PEDESTRIAN TURNING MOVEMENT FORM

LOCATION: Waikiki War Memorial Driveway and Kalakaua Avenue
DATE: 8/9/2018 (Thursday)
TIME: 3:30p-5:30p
WEATHER: Clear
RECORDER: WYY

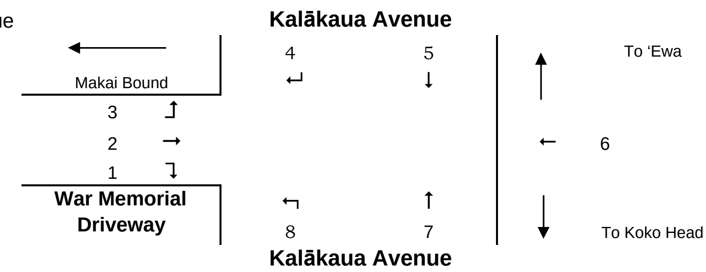


TIME PERIOD	MOVEMENT NUMBER									
	1	2	3	4	5	6	7	8	9	10
3:30-3:45p	7	17	2	7	0	5	3	17	4	11
3:45-4:00p	5	2	0	10	3	3	5	2	3	10
4:00-4:15p	1	16	0	14	1	7	5	16	3	17
4:15-4:30p	5	18	0	9	0	2	8	18	15	18
4:30-4:45p	10	15	0	11	2	12	10	15	12	17
4:45-5:00p	10	6	0	16	3	34	13	6	14	20
5:00-5:15p	38	12	0	20	0	11	11	12	14	22
5:15-5:30p	7	8	0	26	0	18	2	8	9	19
Peak Hour 4:15-4:30p	63	51	0	56	5	59	42	51	55	77

Notes:

WAIKIKI WAR MEMORIAL TRANSPORTATION ANALYSIS BICYCLE TURNING MOVEMENT FORM

LOCATION: Waikiki War Memorial Driveway and Kalakaua Avenue
DATE: 8/9/2018 (Thursday)
TIME: 3:30p-5:30p
WEATHER: Clear
RECORDER: WYY

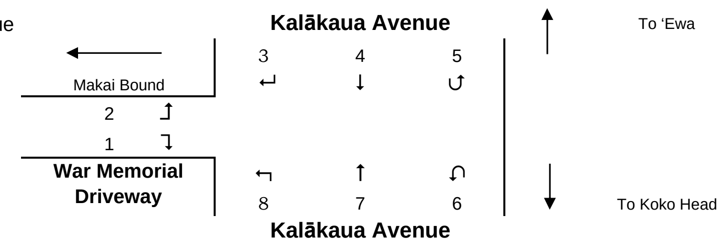


TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	7	8
3:30-3:45p	0	0	0	0	2	0	3	1
3:45-4:00p	1	0	0	0	1	0	2	0
4:00-4:15p	0	0	0	1	7	0	1	0
4:15-4:30p	1	0	0	1	6	0	1	0
4:30-4:45p	0	0	0	0	2	0	3	1
4:45-5:00p	2	0	0	1	8	0	4	1
5:00-5:15p	0	0	0	0	6	0	10	1
5:15-5:30p	0	0	1	0	10	0	5	0
Peak Hour 4:15-5:15	3	0	0	2	22	0	18	3

Notes:

WAIKIKI WAR MEMORIAL TRANSPORTATION ANALYSIS VEHICLE TURNING MOVEMENT FORM

LOCATION: Waikiki War Memorial Driveway and Kalakaua Avenue
DATE: 8/11/2018 (Saturday)
TIME: 11:30a-1:30p
WEATHER:
RECORDER:

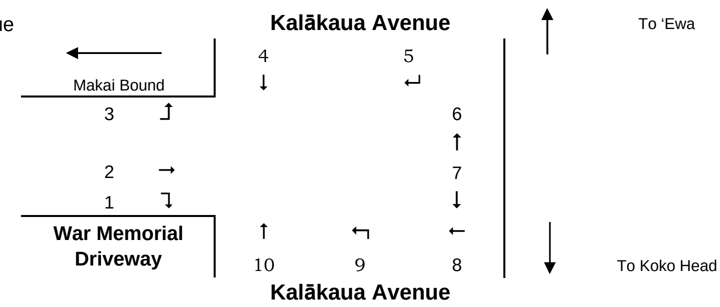


TIME PERIOD	MOVEMENT NUMBER							
	1	2	3	4	5	6	7	8
11:30-11:45a	8	8	8	84	7	7	25	3
11:45a-12:00p	13	8	9	89	6	9	39	8
12:00-12:15p	8	12	12	79	14	6	38	7
12:15-12:30p	12	10	15	108	10	3	35	5
12:30-12:45p	15	6	17	105	15	4	30	2
12:45-1:00p	15	9	15	96	13	7	31	4
1:00-1:15p	15	6	14	84	16	8	38	4
1:15-1:30p	11	5	11	97	14	5	38	8
Peak Hour 12:15-1:15p	57	31	61	393	54	22	134	15

Notes:

WAIKIKI WAR MEMORIAL TRANSPORTATION ANALYSIS PEDESTRIAN TURNING MOVEMENT FORM

LOCATION: Waikiki War Memorial Driveway and Kalakaua Avenue
DATE: 8/11/2018 (Saturday)
TIME: 11:30a-1:30p
WEATHER: Clear
RECORDER: WYY

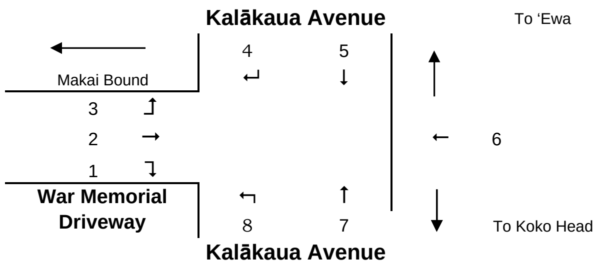


TIME PERIOD	MOVEMENT NUMBER									
	1	2	3	4	5	6	7	8	9	10
11:30-11:45a	6	14	0	35	0	10	3	19	5	24
11:45a-12:00p	2	23	0	17	0	7	2	19	1	12
12:00-12:15p	6	17	0	18	0	1	2	20	8	18
12:15-12:30p	0	15	0	25	0	16	1	13	2	27
12:30-12:45p	3	16	0	10	0	15	2	25	6	29
12:45-1:00p	0	37	0	16	0	5	2	35	5	19
1:00-1:15p	3	8	0	8	0	4	7	30	2	19
1:15-1:30p	2	12	0	27	0	11	0	9	6	16
Peak Hour 12:15-1:15p	6	76	0	59	0	40	12	103	15	94

Notes:

WAIKIKI WAR MEMORIAL TRANSPORTATION ANALYSIS BICYCLE TURNING MOVEMENT FORM

LOCATION: Waikiki War Memorial Driveway and Kalakaua Avenue
DATE: 8/11/2018 (Saturday)
TIME: 11:30a-1:30p
WEATHER: Clear
RECORDER: WYY



TIME PERIOD	MOVEMENT NUMBER							
	1	2	3	4	5	6	7	8
11:30-11:45a	0	0	0	0	4	0	2	0
11:45a-12:00p	0	0	0	0	8	0	6	0
12:00-12:15p	1	0	0	0	2	0	0	0
12:15-12:30p	1	0	0	2	2	0	3	1
12:30-12:45p	3	0	1	0	3	0	0	0
12:45-1:00p	0	0	0	0	4	0	3	0
1:00-1:15p	0	0	0	1	8	0	3	0
1:15-1:30p	1	0	0	0	0	0	3	0
Peak Hour 12:15-1:15p	4	0	1	3	17	0	9	1

Notes:

Appendix B: Intersection Level of Service Definition

Highway Capacity Manual 2010

Signalized intersection level of service (LOS) is defined in terms of a weighted average control delay for the entire intersection. Control delay quantifies the increase in travel time that a vehicle experiences due to the traffic signal control as well as provides a surrogate measure for driver discomfort and fuel consumption. Signalized intersection LOS is stated in terms of average control delay per vehicle (in seconds) during a specified time period (e.g., weekday PM peak hour). Control delay is a complex measure based on many variables, including signal phasing and coordination (i.e., progression of movements through the intersection and along the corridor), signal cycle length, and traffic volumes with respect to intersection capacity and resulting queues. Table 1 summarizes the LOS criteria for signalized intersections, as described in the *Highway Capacity Manual 2010* (Transportation Research Board, 2010).

Table 1. Level of Service Criteria for Signalized Intersections

Level of Service	Average Control Delay (seconds/vehicle)	General Description
A	≤10	Free Flow
B	>10 – 20	Stable Flow (slight delays)
C	>20 – 35	Stable flow (acceptable delays)
D	>35 – 55	Approaching unstable flow (tolerable delay, occasionally wait through more than one signal cycle before proceeding)
E	>55 – 80	Unstable flow (intolerable delay)
F[1]	>80	Forced flow (congested and queues fail to clear)

Source: *Highway Capacity Manual 2010*, Transportation Research Board, 2010.
1. If the volume-to-capacity (v/c) ratio for a lane group exceeds 1.0 LOS F is assigned to the individual lane group. LOS for overall approach or intersection is determined solely by the control delay.

Unsignalized intersection LOS criteria can be further reduced into three intersection types: all-way stop, two-way stop, and roundabout control. All-way stop and roundabout control intersection LOS is expressed in terms of the weighted average control delay of the overall intersection or by approach. Two-way stop-controlled intersection LOS is defined in terms of the average control delay for each minor-street movement (or shared movement) as well as major-street left-turns. This approach is because major-street through vehicles are assumed to experience zero delay, a weighted average of all movements results in very low overall average delay, and this calculated low delay could mask deficiencies of minor movements. Table 2 shows LOS criteria for unsignalized intersections.

Table 2. Level of Service Criteria for Unsignalized Intersections

Level of Service	Average Control Delay (seconds/vehicle)
A	0 – 10
B	>10 – 15
C	>15 – 25
D	>25 – 35
E	>35 – 50
F[1]	>50

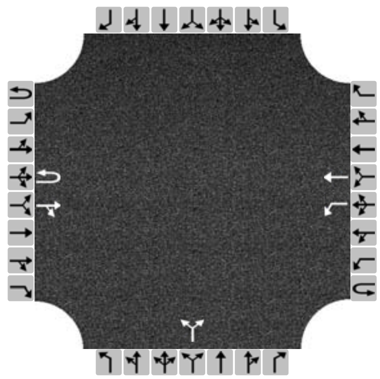
Source: *Highway Capacity Manual 2010*, Transportation Research Board, 2010.
1. If the volume-to-capacity (v/c) ratio exceeds 1.0, LOS F is assigned an individual lane group for all unsignalized intersections, or minor street approach at two-way stop-controlled intersections. Overall intersection LOS is determined solely by control delay.

Appendix C: Highway Capacity Software 2010 Worksheets

HCS 2010 Two-Way Stop Control Summary Report

General Information		Site Information	
Analyst		Intersection	Kalakaua and WWM Driveway
Agency/Co.		Jurisdiction	
Date Performed	8/14/2018	East/West Street	Kalakaua Avenue
Analysis Year	2018	North/South Street	WWM Driveway
Time Analyzed		Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	Year 2018 AM Peak Hour		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	1	0	1	0	0	1	1	0		0	0	0		0	0	0
Configuration	U			TR		L	T				LR					
Volume (veh/h)	6		206	24	8	13	74			13		13				
Percent Heavy Vehicles	3				3	3				3		3				
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Left Only															
Median Storage	1															

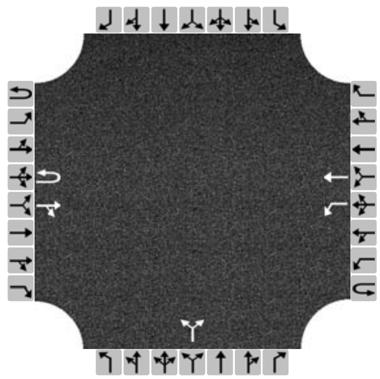
Delay, Queue Length, and Level of Service

Flow Rate (veh/h)	7					23					28					
Capacity	1773					1021					390					
v/c Ratio	0.00					0.02					0.07					
95% Queue Length	0.0					0.1					0.2					
Control Delay (s/veh)	7.0					8.6					14.9					
Level of Service (LOS)	A					A					B					
Approach Delay (s/veh)	0.2				1.9				14.9							
Approach LOS									B							

HCS 2010 Two-Way Stop Control Summary Report

General Information		Site Information	
Analyst		Intersection	Kalakaua and WWM Driveway
Agency/Co.		Jurisdiction	
Date Performed	8/14/2018	East/West Street	Kalakaua Avenue
Analysis Year	2018	North/South Street	WWM Driveway
Time Analyzed		Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	Year 2018 PM Peak Period		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	1	0	1	0	0	1	1	0		0	0	0		0	0	0
Configuration	U			TR		L	T				LR					
Volume (veh/h)	59		418	57	27	23	202			23		49				
Percent Heavy Vehicles	3				3	3				3		3				
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Left Only															
Median Storage	1															

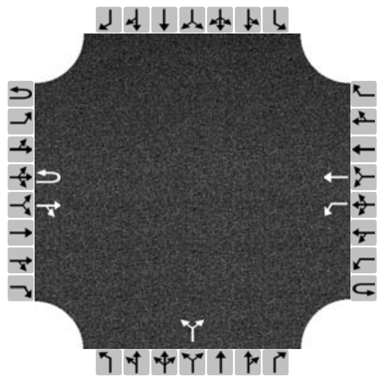
Delay, Queue Length, and Level of Service

Flow Rate (veh/h)	64					54					78					
Capacity	1773					1047					319					
v/c Ratio	0.04					0.05					0.24					
95% Queue Length	0.1					0.2					0.9					
Control Delay (s/veh)	7.1					8.6					19.9					
Level of Service (LOS)	A					A					C					
Approach Delay (s/veh)	0.8				1.7				19.9							
Approach LOS									C							

HCS 2010 Two-Way Stop Control Summary Report

General Information		Site Information	
Analyst		Intersection	Kalakaua and WWM Driveway
Agency/Co.		Jurisdiction	
Date Performed	8/14/2018	East/West Street	Kalakaua Avenue
Analysis Year	2018	North/South Street	WWM Driveway
Time Analyzed		Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	Year 2018 Weekend Midday Peak		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	1	0	1	0	0	1	1	0		0	0	0		0	0	0
Configuration	U			TR		L	T				LR					
Volume (veh/h)	54		393	61	22	15	134			31		57				
Percent Heavy Vehicles	3				3	3				3		3				
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Left Only															
Median Storage	1															

Delay, Queue Length, and Level of Service

Flow Rate (veh/h)	59					40					96					
Capacity	1773					1063					309					
v/c Ratio	0.03					0.04					0.31					
95% Queue Length	0.1					0.1					1.3					
Control Delay (s/veh)	7.1					8.5					21.8					
Level of Service (LOS)	A					A					C					
Approach Delay (s/veh)	0.8				1.8				21.8							
Approach LOS									C							

Appendix C:
Acoustic Study

ACOUSTIC STUDY FOR THE WAIKIKI WAR MEMORIAL PROJECT HONOLULU, HAWAII

Prepared for:

WIL CHEE - PLANNING AND ENVIRONMENTAL

Prepared by:

Y. EBISU & ASSOCIATES
1126 12th Avenue, Room 305
Honolulu, Hawaii 96816

FEBRUARY 2012

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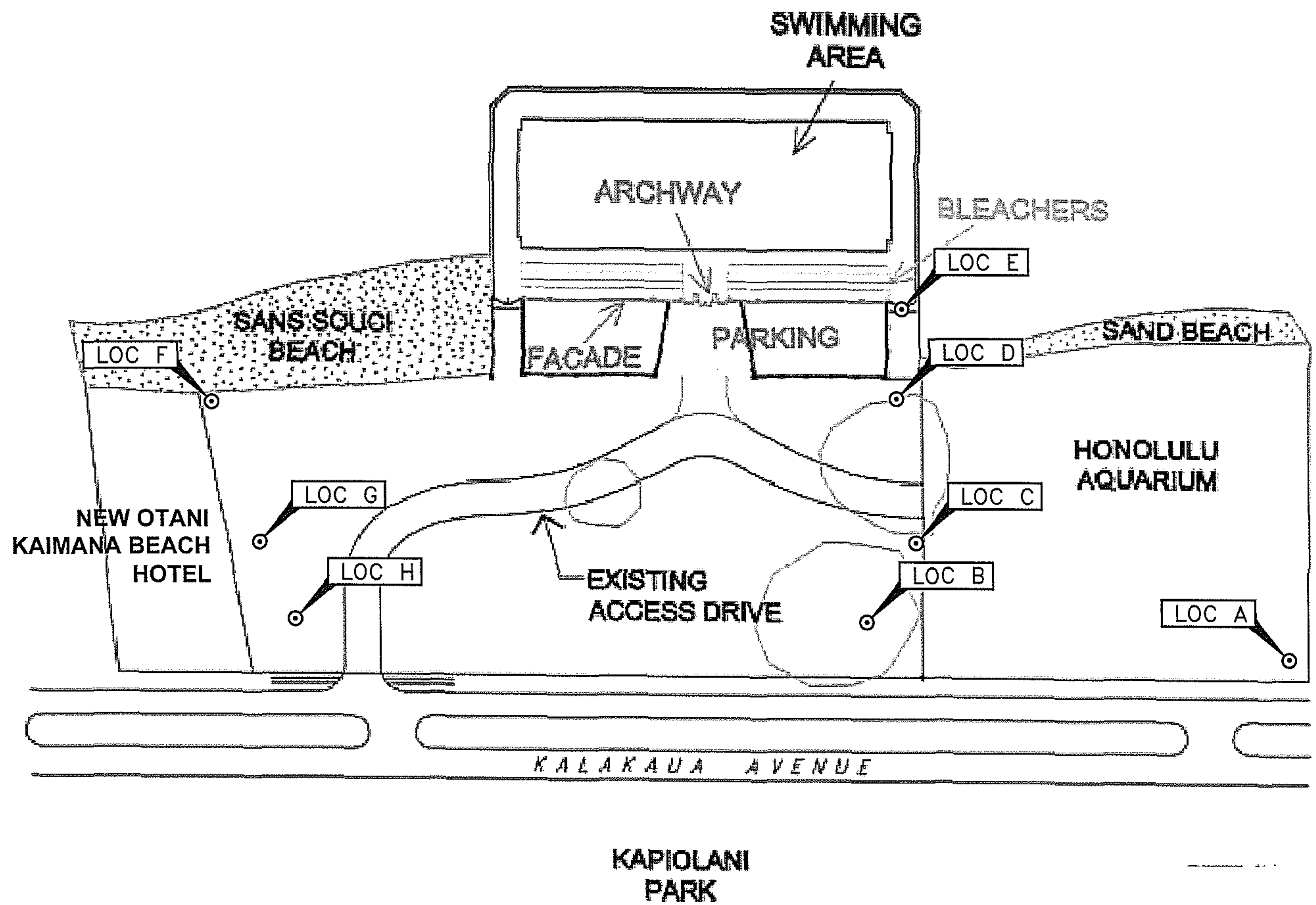
CHAPTER I. SUMMARY

The existing and future traffic noise levels in the vicinity of the proposed Waikiki War Memorial Project in Waikiki were evaluated for their potential impacts and their relationship to current FHA/HUD noise standards in the project environs (see Figure 1). Because future traffic volumes in the project environs are not expected to change as a result of the proposed project, future noise level changes along the roadways in the project environs are not expected to be linked to the project. No significant changes in traffic noise levels are predicted to occur as a result of the project following project completion.

Potential changes in intermittent background noise levels are possible due to the planned location of a new parking lot at the south end of the project site. The potential changes could occur due to the concentration of intermittent noise sources (talking, car door slamming, vehicle alarms, etc.) closer to the adjacent residences and resort units along the south property boundary. Estimates of the increased risk of noise impacts from intrusive noise events from the new parking lot were made, and it was concluded that risks of potential noise impacts from the new parking lot could be increased by approximately 10 dB or by a factor of 10 to 1. However, the likelihood of adverse noise impacts from the new parking lot was still considered to be low due to the very high and continuous noise levels required at each parked vehicle in order to exceed the noise impact threshold.

Unavoidable, but temporary, noise impacts may occur during demolition and construction activities on the proposed project site, particularly during the demolition and earthwork activities on the project site. Because construction activities are predicted to be audible within the project site and at adjoining properties, the quality of the acoustic environment may be degraded to unacceptable levels during periods of construction. Mitigation measures to reduce construction noise to inaudible levels will not be practical in all cases, but the use of quiet equipment and compliance with existing State Department of Health noise regulations are recommended.

Waikiki War Memorial
Existing Conditions



Base Map Prepared by Sea Engineering, Inc.

PROJECT LOCATION MAP AND NOISE MEASUREMENT LOCATIONS

FIGURE 1

CHAPTER II. PURPOSE

The primary objective of this study was to describe the existing and future traffic noise environment in the environs of the proposed Waikiki War Memorial Project on the island of Oahu. Results and conclusions from the project's traffic study were used to develop conclusions regarding potential traffic noise impacts associated with the project. Traffic noise level increases and impacts associated with the proposed development were to be determined along the public roadways which are expected to service the project traffic. A specific objective was to determine future traffic noise level increases associated with both project and non-project traffic, and the potential noise impacts associated with these increases.

Noise impacts from the new parking lot and from short term construction noise at the project site were also included as noise study objectives. Recommendations for minimizing potential construction noise impacts were also to be provided as required.

CHAPTER III. NOISE DESCRIPTORS AND THEIR RELATIONSHIP TO LAND USE COMPATIBILITY

The noise descriptor currently used by federal agencies (such as FHA/HUD) to assess environmental noise is the Day-Night Average Sound Level (Ldn or DNL). This descriptor incorporates a 24-hour average of instantaneous A-Weighted Sound Levels as read on a standard Sound Level Meter. By definition, the minimum averaging period for the DNL descriptor is 24 hours. Additionally, sound levels which occur during the nighttime hours of 10:00 PM to 7:00 AM are increased by 10 decibels (dB) prior to computing the 24-hour average by the DNL descriptor. A more complete list of noise descriptors is provided in APPENDIX B to this report.

Table 1, derived from Reference 1, presents current federal noise standards and acceptability criteria for residential land uses. Land use compatibility guidelines for various levels of environmental noise as measured by the DNL descriptor system are shown in Figure 2. As a general rule, noise levels of 55 DNL or less occur in rural areas, or in areas which are removed from high volume roadways. In urbanized areas which are shielded from high volume streets, DNL levels generally range from 55 to 65 DNL, and are usually controlled by motor vehicle traffic noise. Residences which front major roadways are generally exposed to levels of 65 DNL, and as high as 75 DNL when the roadway is a high speed freeway. In the project area, traffic noise levels associated with Kalakaua Avenue are typically greater than 65 DNL along the makai Right-of-Way due to the number of city buses and trolleys which use the southbound lane.

For purposes of determining noise acceptability for funding assistance from federal agencies (FHA/HUD and VA), an exterior noise level of 65 DNL or less is considered acceptable for residences. This standard is applied nationally (Reference 2), including Hawaii. Because of our open-living conditions, the predominant use of naturally ventilated dwellings, and the relatively low exterior-to-interior sound attenuation afforded by these naturally ventilated structures, an exterior noise level of 65 DNL does not eliminate all risks of noise impacts. Because of these factors, and as recommended in Reference 3, a lower level of 55 DNL is considered as the "Unconditionally Acceptable" (or "Near-Zero Risk") level of exterior noise. However, after considering the cost and feasibility of applying the lower level of 55 DNL, government agencies such as FHA/HUD and VA have selected 65 DNL as a more appropriate regulatory standard.

For commercial, industrial, and other non-noise sensitive land uses, exterior noise levels as high as 75 DNL are generally considered acceptable. Exceptions to this occur when naturally ventilated office and other commercial establishments are exposed to exterior levels which exceed 65 DNL.

On the island of Oahu, the State Department of Health (DOH) regulates noise from construction activities, through the issuance of permits for allowing excessive

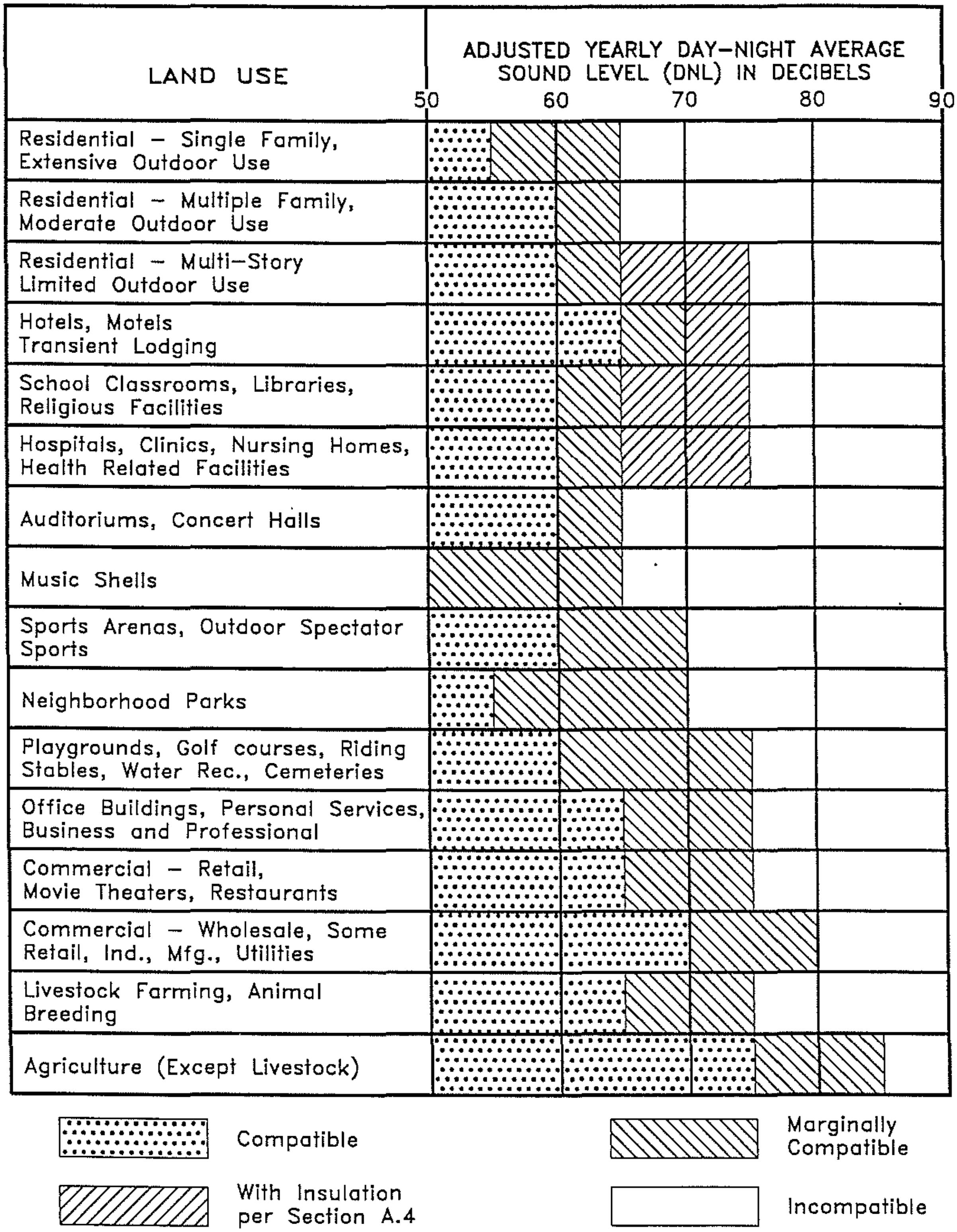
TABLE 1

EXTERIOR NOISE EXPOSURE CLASSIFICATION (RESIDENTIAL LAND USE)

NOISE EXPOSURE CLASS	DAY-NIGHT SOUND LEVEL	EQUIVALENT SOUND LEVEL	FEDERAL (1) STANDARD
Minimal Exposure	Not Exceeding 55 DNL	Not Exceeding 55 Leq	Unconditionally Acceptable
Moderate Exposure	Above 55 DNL But Not Above 65 DNL	Above 55 Leq But Not Above 65 Leq	Acceptable(2)
Significant Exposure	Above 65 DNL But Not Above 75 DNL	Above 65 Leq But Not Above 75 Leq	Normally Unacceptable
Severe Exposure	Above 75 DNL	Above 75 Leq	Unacceptable

Notes: (1) Federal Housing Administration, Veterans Administration, Department of Defense, and Department of Transportation.

(2) FHWA uses the Leq instead of the Ldn descriptor. For planning purposes, both are equivalent if: (a) heavy trucks do not exceed 10 percent of total traffic flow in vehicles per 24 hours, and (b) traffic between 10:00 PM and 7:00 AM does not exceed 15 percent of average daily traffic flow in vehicles per 24 hours. The noise mitigation threshold used by FHWA for residences is 67 Leq.



LAND USE COMPATIBILITY WITH YEARLY AVERAGE DAY-NIGHT AVERAGE SOUND LEVEL (DNL) AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED.
(Source: American National Standards Institute S12.9-1998/Part 5)

FIGURE 2

noise during limited time periods. State DOH noise regulations are expressed in maximum allowable property line noise limits rather than DNL (see Reference 4). Although they are not directly comparable to noise criteria expressed in DNL, State DOH noise limits for residential, commercial, and industrial lands equate to approximately 55, 60, and 76 DNL, respectively.

It should be noted that the noise compatibility guidelines and relationships to the DNL noise descriptor may not be applicable to impulsive noise sources such as hoe rams. The use of penalty factors (such as adding 10 dB to measured sound levels or the use of C-Weighting filters) have been proposed. However, the relationships between levels of impulsive noise sources and land use compatibility have not been as firmly established as have the relationships for non-impulsive sources. The State DOH limits for impulsive sounds which exceed 120 impulses in any 20 minute period are 10 dB above the limits for non-impulsive sounds. If impulsive sounds do not exceed 120 impulses in any 20 minute time period, there are no regulatory limits on their sound levels under the State DOH regulations.

CHAPTER IV. GENERAL STUDY METHODOLOGY

Existing traffic noise levels were measured at Location A (Public Baths Wastewater Pump Station) in the project environs to provide a basis for developing the existing traffic noise levels along Kalakaua Avenue. The location of the traffic noise measurement site is shown in Figure 1. Traffic noise measurements were performed during the month of January 2012. The results of the traffic noise measurements were compared with calculations of existing traffic noise levels to validate the computer model used. The traffic noise measurement results, and their comparisons with computer model predictions of existing traffic noise levels are summarized in Table 2.

Traffic noise calculations for the existing and future conditions were performed using the Federal Highway Administration (FHWA) Traffic Noise Model, Version 2.5 (Reference 5). Traffic data entered into the noise prediction model were: roadway and receiver locations; hourly traffic volumes, average vehicle speeds; estimates of traffic mix; "Pavement" propagation loss factor for elevated receptors, and "Loose Soil" propagation loss factor for ground level receptors. The traffic data for the project (Reference 6), hourly traffic counts along Kalakaua Avenue obtained by the Hawaii State Department of Transportation, Highways Division (References 7 and 8), plus the spot traffic counts obtained during the noise measurement periods were the primary sources of data inputs to the model. APPENDIX C summarizes the AM and PM peak hour traffic volumes for a weekday during CY 2011, and the midday peak hour volumes for a Saturday during 2011, which were obtained from Reference 6. These traffic volumes were used to model both existing and future traffic noise along Kalakaua Avenue in the project environs and along the project's entrance driveway. Hawaii State Department of Transportation counts on Kalakaua Avenue (Reference 7) were also used to develop the relationship between the 24-hour DNL and PM peak hour Leq traffic noise levels. For existing and future traffic, it was assumed that the average noise levels, or Leq(h), during the PM peak hour were approximately 0.5 dB greater than the 24-hour DNL along Kalakaua Avenue in the project environs. This assumption was based on computations of both the hourly Leq and the 24-hour DNL of traffic noise along Kalakaua Avenue (see Figures 3 and 4).

Based on the conclusion of the project's traffic study that future traffic volumes along Kalakaua Avenue would not differ from existing volumes following completion of the project, existing traffic noise levels were used to describe both the existing and future conditions in the project environs. Traffic noise levels were developed for ground level receptors within the project site, as well as for both ground level and elevated receptors at the neighboring residences to the south.

In order to estimate and quantify the potential changes in intermittent noise from the proposed new parking lot on the south side of the project site, the cumulative noise level from 77 vehicles parked in the new parking lot was calculated and the result compared with the cumulative noise level of the same number of vehicles located along the existing driveway and parking area of the Waikiki Natatorium facility. Along the

TABLE 2

TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	Hourly Traffic Volume AUTO	Hourly Traffic Volume M.TRUCK	Hourly Traffic Volume H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
A. 64.5 FT from the center-line of Kalakaua Ave. (1/5/12)	1500 TO 1600	35	551	8	9	68.2*	65.9
A. 64.5 FT from the center-line of Kalakaua Ave. (1/5/12)	1601 TO 1701	35	662	5	6	67.1**	66.3

Notes:
* 62.0 Leq associated with residual background noise, and 67.0 Leq associated with Kalakaua Avenue traffic noise sources.
** 62.6 Leq associated with residual noise, and 65.2 Leq associated with Kalakaua Avenue traffic noise sources.

FIGURE 3

HOURLY VARIATIONS OF TRAFFIC NOISE AT 65 FT SETBACK DISTANCE FROM THE CENTERLINE OF KALAKAUA AVENUE AT WAIKIKI AQUARIUM (MAY 26, 2010)

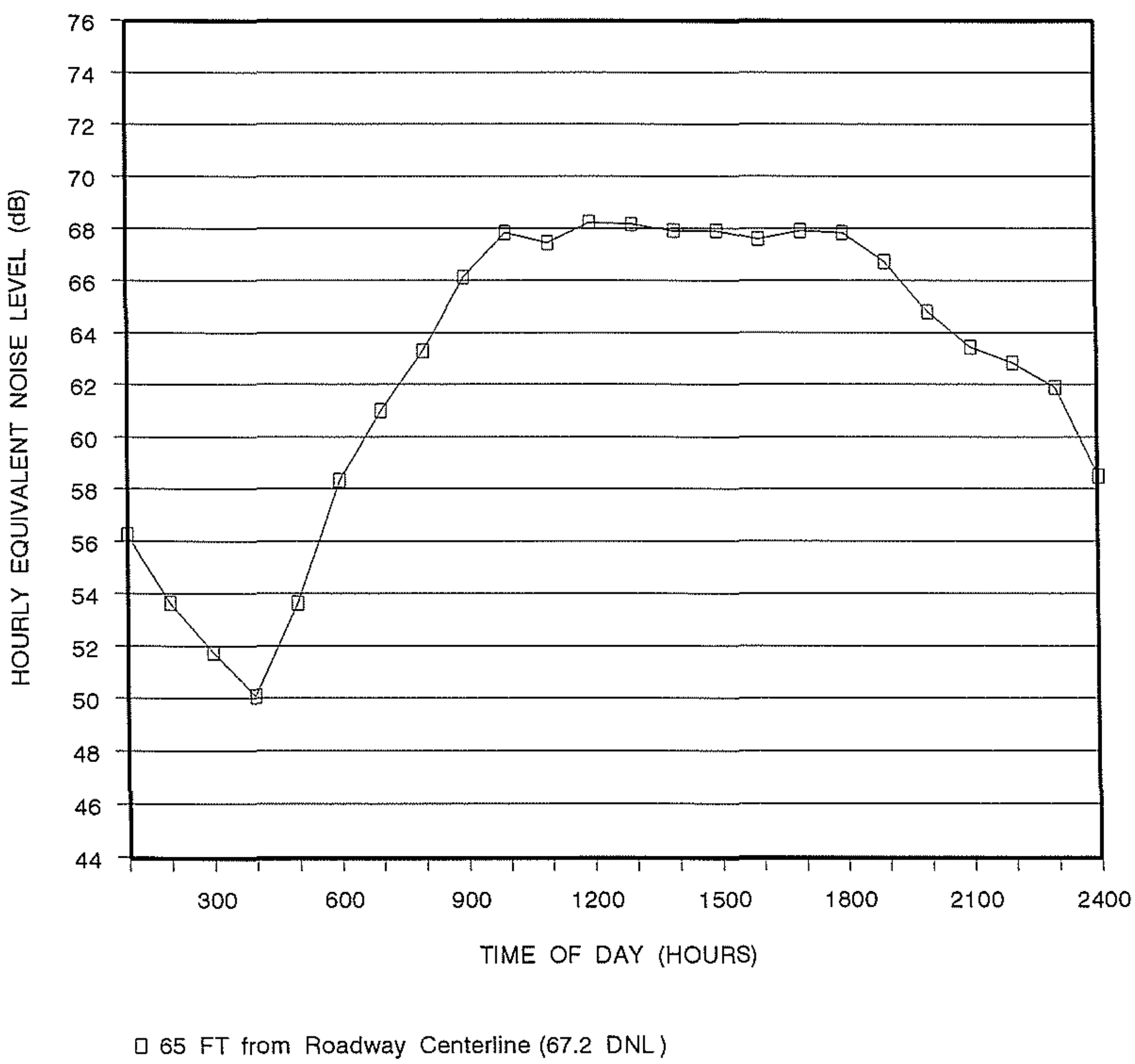
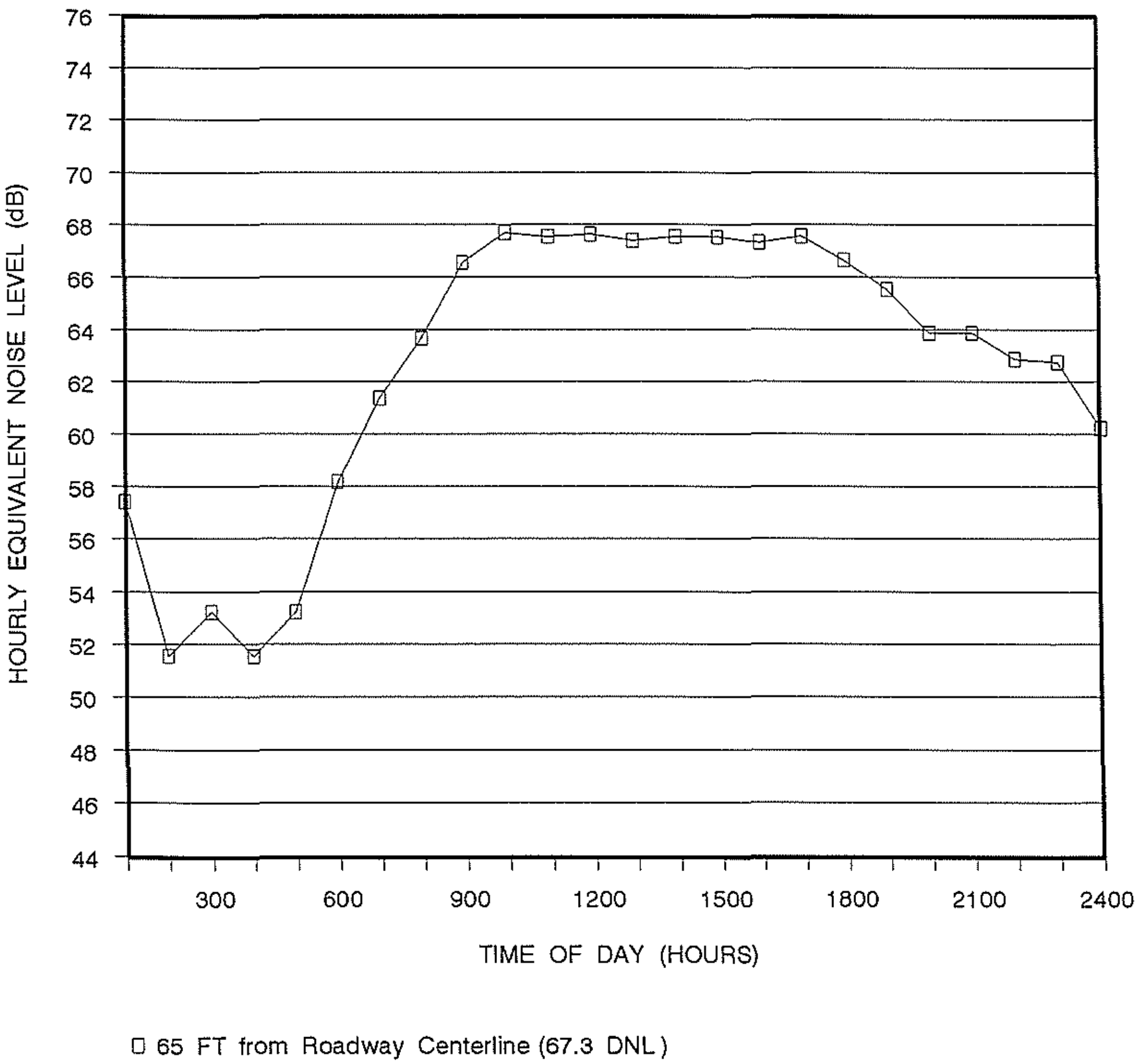


FIGURE 4

HOURLY VARIATIONS OF TRAFFIC NOISE AT 65 FT SETBACK DISTANCE FROM THE CENTERLINE OF KALAKAUA AVENUE AT WAIKIKI AQUARIUM (MAY 27, 2010)



south boundary line near the Kaimana Beach Hotel and Apartments, the cumulative noise level from the proposed parking lot was compared to the cumulative noise level from the 77 existing parking spaces distributed within the existing facility grounds. For the purposes of this evaluation, each parking space was assumed to have a sound source emitting a sound level of 72 dBA at 3 feet, which is approximately equal to a male's raised voice level. The difference between the existing and the proposed parking configurations was expressed in decibels (or dB), which was used to quantify the potential cumulative noise impacts associated with the proposed new parking lot at receptors located near the south boundary of the project site.

Calculations of average exterior and interior noise levels from demolition and construction activities were performed for typical naturally ventilated and air conditioned buildings. Predicted noise levels at the closest neighboring receptor locations were compared with existing background ambient noise levels, and the potential for noise impacts was assessed. Recommendations for minimizing potential noise impacts from demolition and construction activities on the project site were provided.

V. EXISTING ACOUSTICAL ENVIRONMENT

The existing background ambient noise levels within the project area are controlled by traffic along Kalakaua Avenue. City and trolley buses, motorcycles, and mopeds are some of the louder noise events which are intermittently audible.

Existing traffic noise level measurements were obtained at Location A along Kalakaua Avenue. In addition, short term background ambient noise measurements were obtained on a Saturday at Locations B through H where shown in Figure 1. The results of the traffic and background ambient noise measurements are summarized in Tables 2 and 3. All measurement sites were located at street level. As shown in Table 2, correlation between measured and predicted traffic noise levels was poor to fair at Location A. The traffic noise model's "Pavement" propagation loss factor was used at Location A. The fair to poor agreement between measured and predicted traffic noise levels at Location A was caused by the additional noise contributions from the residual background noise level contribution of approximately 62 to 63 dBA (from distant traffic and people activity).

Figures 5 and 6 depict the sound level vs. time strip charts during measurements at Location A. The louder noise events were typically the louder buses, motorcycles, and mopeds on Kalakaua Avenue. These louder events were typically greater than 80 dBA at Location A. At Location A, minimum background noise levels were greater than 55 dBA, with median values (levels exceeded 50 percent of the time) being approximately 62 to 63 dBA.

APPENDIX C contains the existing peak hour traffic volumes on Kalakaua Avenue in the project environs during 2011. Calculations of existing traffic noise levels during the PM peak traffic hour using the traffic volumes contained in APPENDIX C are presented in Figure 7. The hourly Leq (or Equivalent Sound Level) traffic noise contributions from the Kalakaua Avenue sections north and south of the project's entrance driveway were calculated on the makai side of Kalakaua Avenue for ground level and elevated receptors and depicted as traffic noise level vs. distance curves in Figure 7. The two sound level vs. distance curves shown in Figure 7 do not take into account the beneficial noise shielding effects from existing buildings on the north, south, and west sides of the project site. The existing setback distance to the 65 DNL contour from the centerline of Kalakaua Avenue is approximately 60 feet, and is in the vicinity of the existing makai Right-of-Way.

The short term background noise measurement results at Locations B through H as shown in Table 3 were plotted in Figure 7 at the applicable setback distances of the measurement locations from the centerline of Kalakaua Avenue. The measured existing average background noise levels at Locations B through H ranged from approximately 59.6 dBA to 63.4 dBA, and were typically controlled by people who use the project site and adjacent beaches.

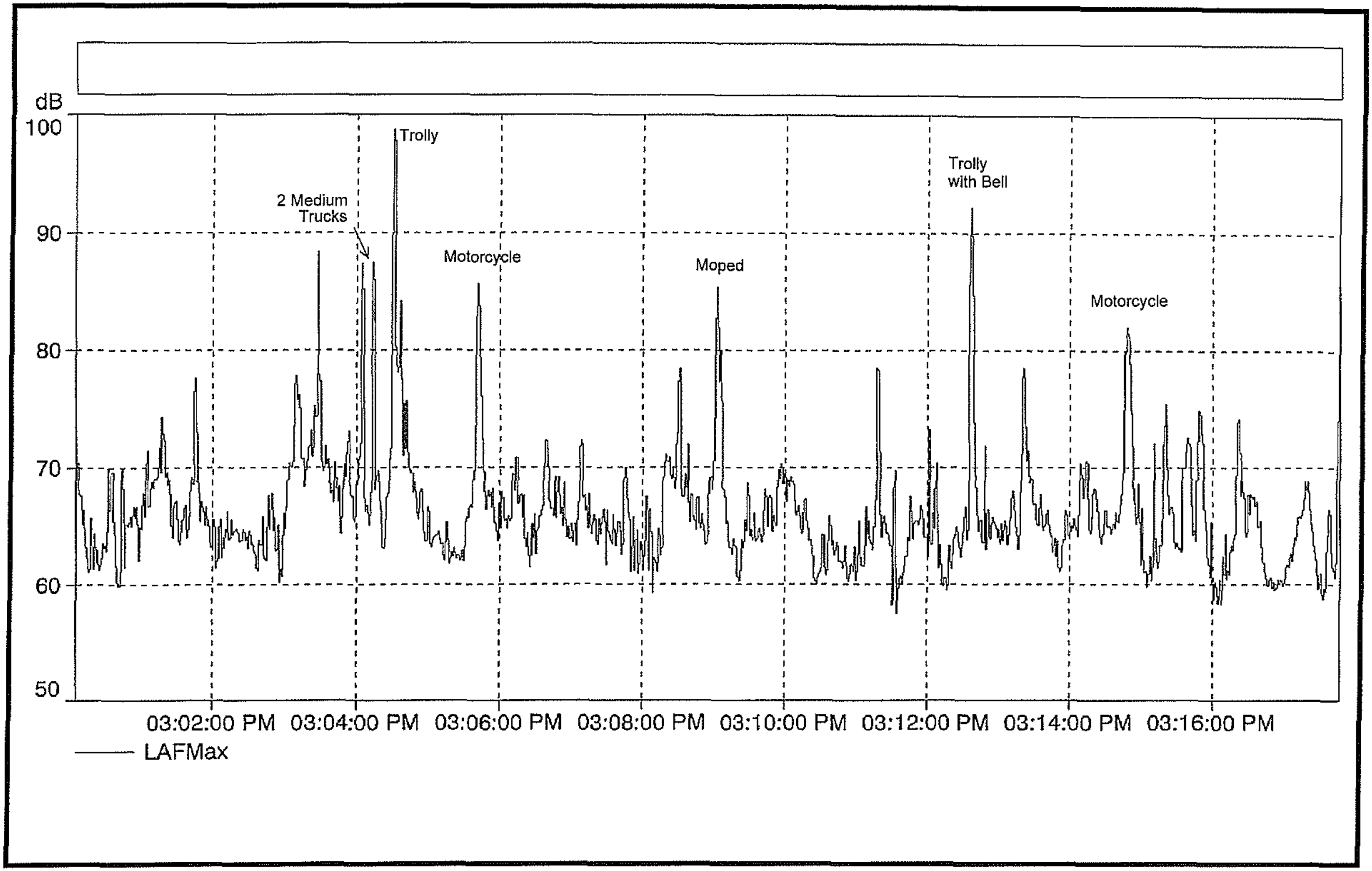
TABLE 3 - AMBIENT NOISE MEASUREMENTS

LOCATION "B" THROUGH "H"
PROJECT: WAIKIKI WAR MEMORIAL
DATE: JANUARY 7, 2012

Location	Start Time	End Time	Leq	Lmax	Lmin	L10	Event Description
B	13:30	13:45	62.0	78.1	51.8	64.1	
C	13:47	14:02	61.0	79.6	53.8	63.3	
D	14:04	14:19	62.4	77.0	52.7	65.5	
E	14:20	14:35	61.0	77.2	52.0	64.0	
F	14:42	14:57	63.4	81.4	53.5	66.3	
G	15:00	15:15	59.6	77.5	53.5	61.4	
H	15:17	15:32	62.5	80.2	52.9	65.5	

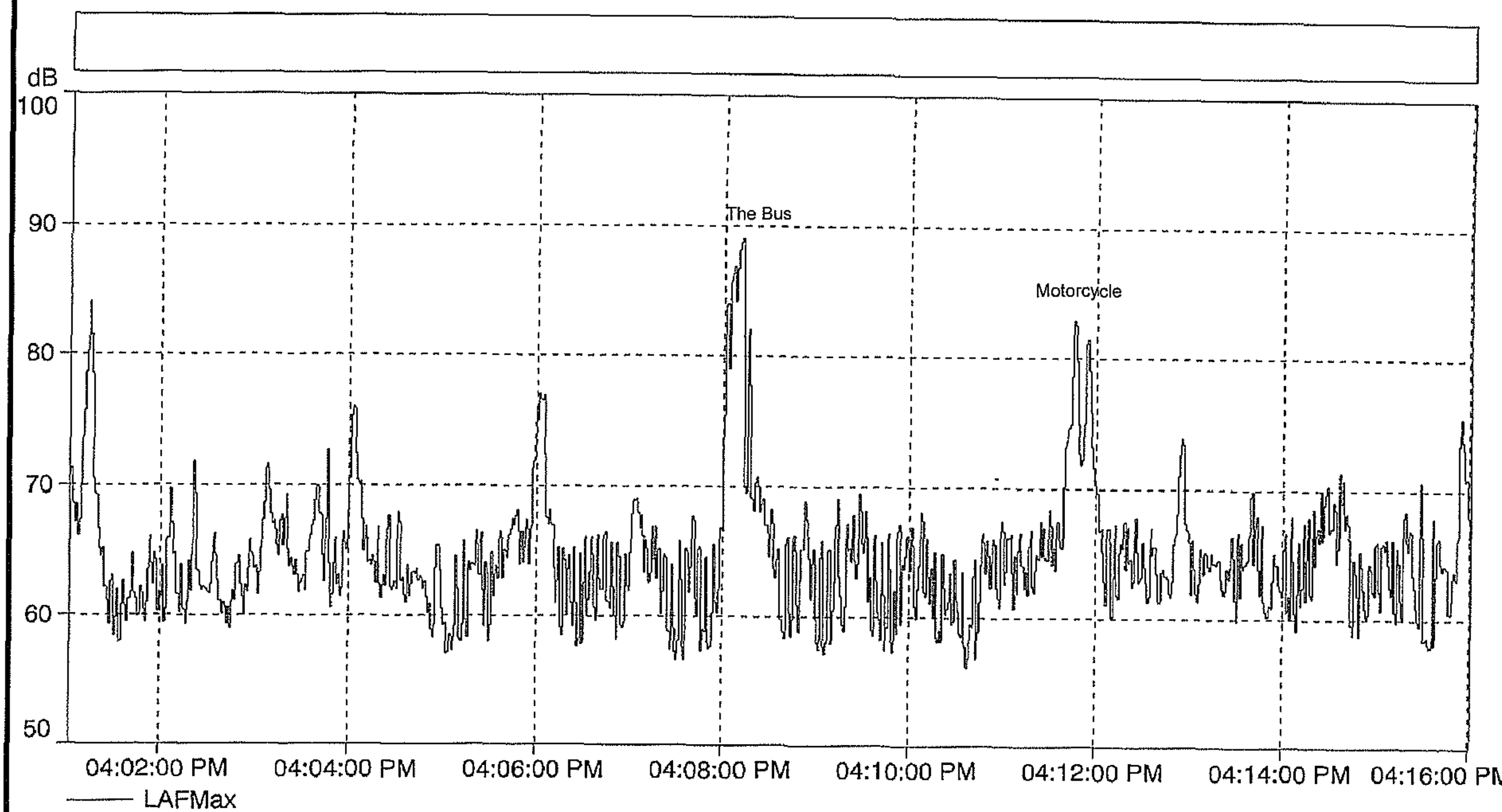
Notes:

a. Leq = Average A-Weighted Sound Level (in dBA)
b. Lmax = Maximum A-Weighted Sound Level (in dBA)
c. Lmin = Minimum A-Weighted Sound Level (in dBA)
d. L10 = A-Weighted Sound Level (in dBA) which was exceeded 10 percent of the time.



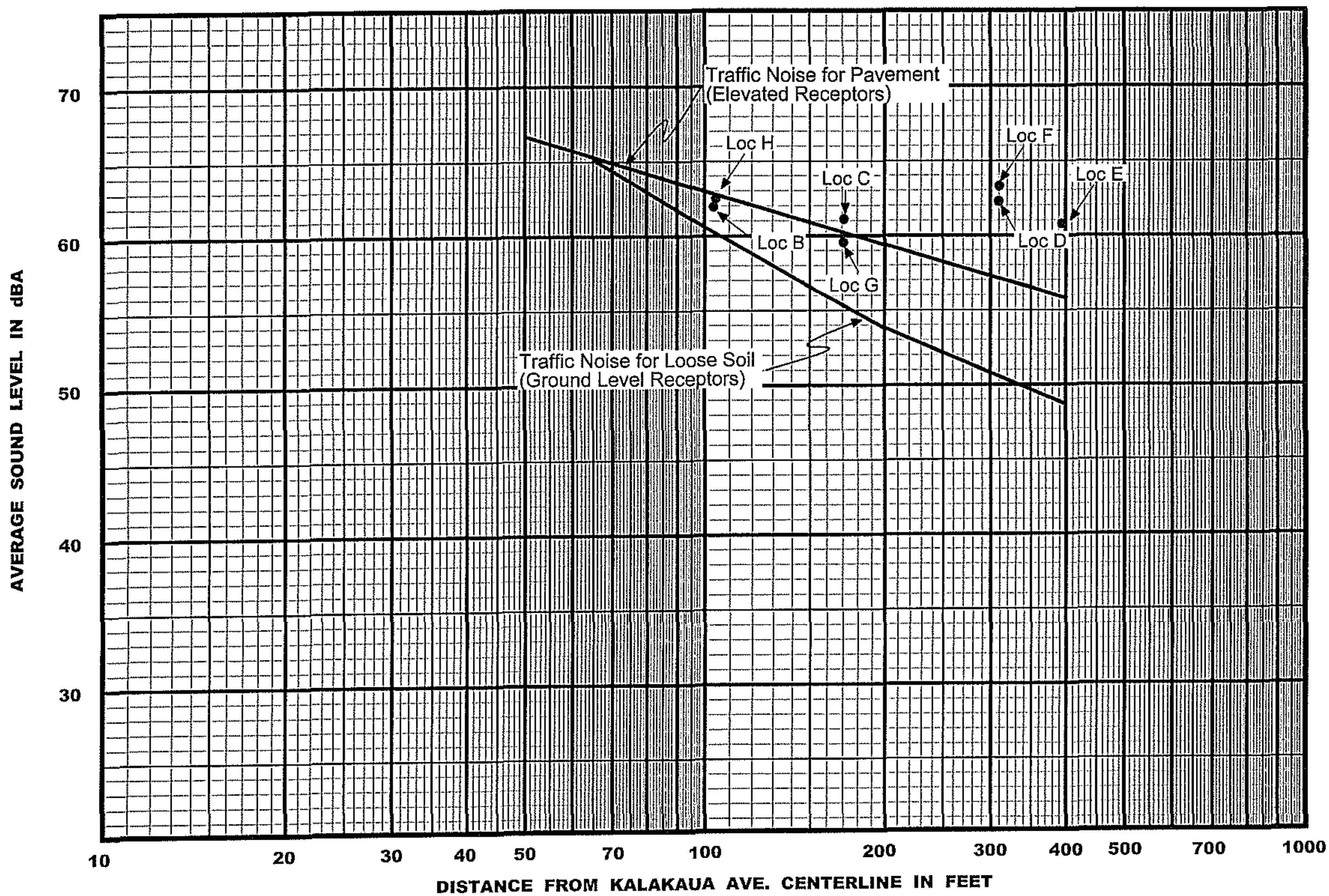
A- WEIGHTED, MAXIMUM SOUND LEVEL VS. TIME AT LOCATION "A" (1500 TO 1517 HOURS, JANUARY 5, 2012)

FIGURE 5



A- WEIGHTED, MAXIMUM SOUND LEVEL VS. TIME AT LOCATION "A" (1602 TO 1616 HOURS, JANUARY 5, 2012)

FIGURE 6



TRAFFIC NOISE LEVEL VS. DISTANCE CURVES FOR KALAKAUA AVENUE AT PROJECT SITE

FIGURE 7

The existing traffic noise levels in the project environs beyond 60 feet from the centerline of Kalakaua Avenue are in the "Moderate Exposure, Acceptable" category. However, when the contributions from other residual background noise sources are added to the existing traffic noise levels from Kalakaua Avenue, total background noise levels increase to approximately 67 DNL at 60 feet from the centerline of Kalakaua Avenue. At approximately 80 feet from the centerline of Kalakaua Avenue, total (traffic plus residual background) noise levels diminish to less than 65 DNL, and are in the "Moderate Exposure, Acceptable" category. At greater setback distances of 200 feet from the centerline of Kalakaua Avenue, other sources (birds, people, local traffic, and surf) become the more dominant noise sources which control the total background noise levels.

CHAPTER VI. FUTURE NOISE ENVIRONMENT

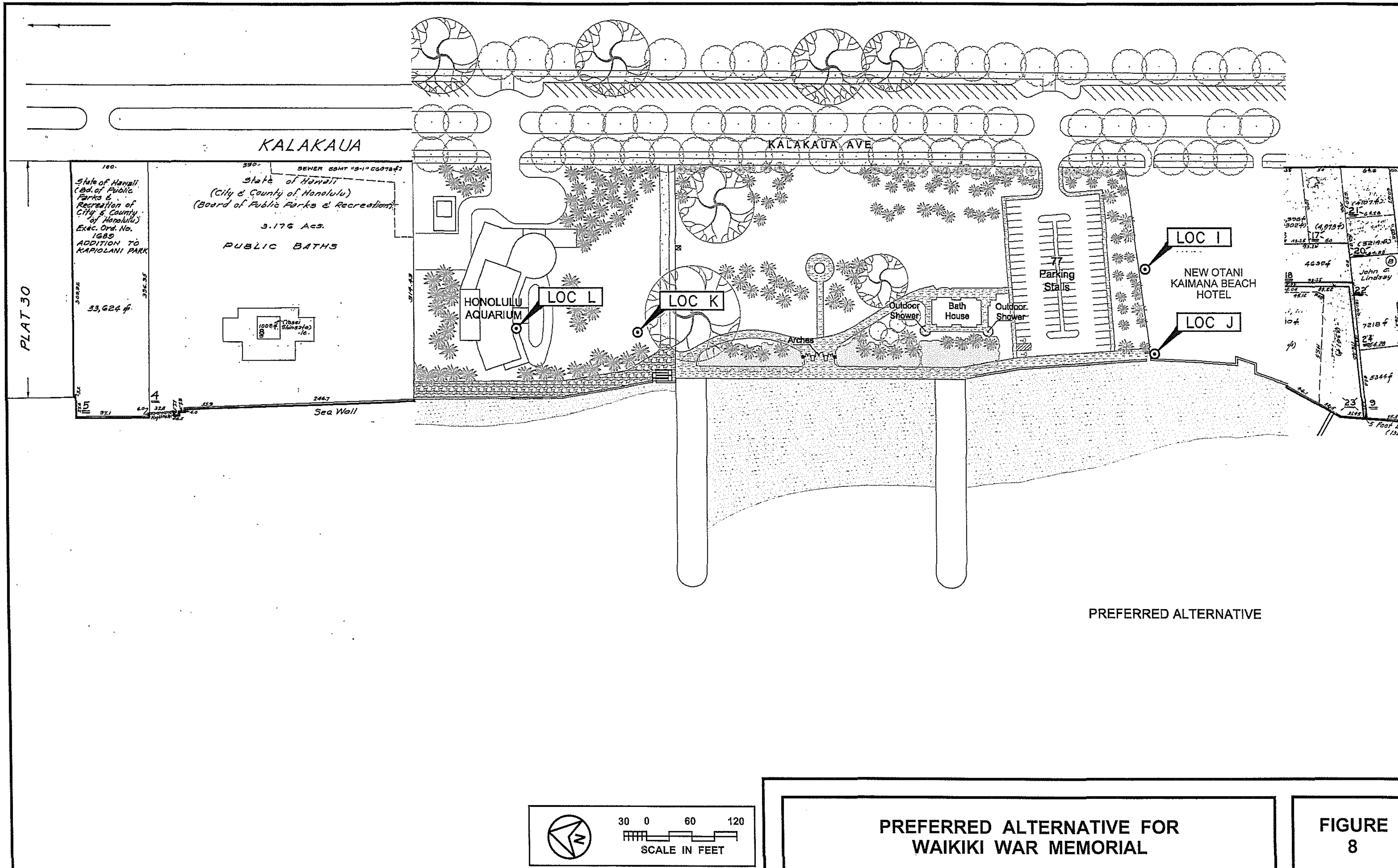
Because additional parking stalls will not be provided on the project site, the project's traffic study (Reference 6) concluded that there should not be any increase in project related traffic along Kalakaua Avenue. Therefore, any future changes in traffic noise levels along Kalakaua Avenue were assumed to be caused by non-project traffic. For the purposes of this noise study, it was assumed that future traffic noise levels would be essentially the same as existing traffic noise levels in the project environs.

Evaluations of potential noise impacts associated with the location of the proposed 77 stall parking lot were performed at the south boundary of the project site next to the New Otani Kaimana Beach Hotel. Figure 8 depicts the preferred project development alternative, with the 77 stall parking lot located at the south end of the project site. Calculations of the potential increase in the cumulative noise levels from parked vehicles under the proposed conditions were performed by assuming a sound level of 72 dBA at 3 feet from center of each parked vehicle, by first distributing these 77 noise sources among the existing parking stalls, and then by distributing these same 77 noise sources among the 77 stalls of the proposed parking lot shown in Figure 8. Calculations of the cumulative noise levels from the existing parking stalls as well as from the proposed parking stalls were performed. The results of these calculations were then compared for ground level receptors at Locations I and J, which are shown in Figure 8.

Based on the calculations of the potential increases in noise levels associated with parked vehicles located in the proposed parking lot under the preferred alternative, it was concluded that noise levels associated with parked vehicles at the proposed facility could be approximately 10 dBA higher at Location I and 11 dBA higher at Location J when compared to the parked vehicles located at the existing parking stalls. An increase by 10 dBA of average noise level implies an increase by a factor of 10 when using equivalent energy metrics (such as Leq or DNL) for quantifying noise exposure. By existing Hawaii State Department of Transportation, Highways Division, noise policy, an increase of 15 dBA in traffic noise levels is considered to be significant (see Reference 9).

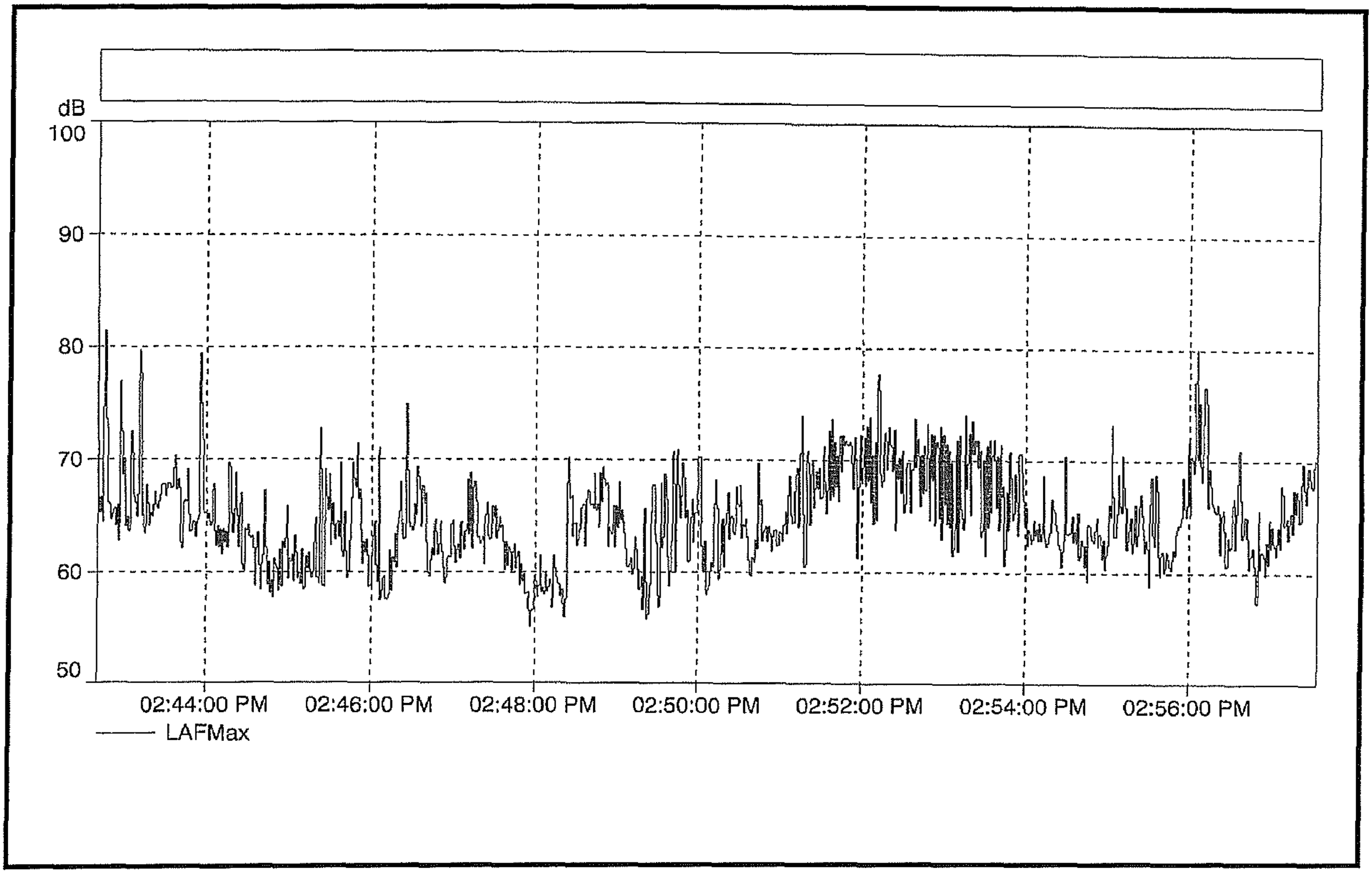
If all 77 parked vehicles in the proposed parking lot were to continuously emit 72 dBA of sound level at 3 feet distance, the total sound level at Locations I and J were predicted to be 59 dBA and 57 dBA, respectively. These levels are below the short term background noise levels of 61 to 66 dBA average noise levels measured along the south property line on January 7, 2012 (see Table 3). If the common noise emission level from all 77 vehicles is 78 dBA (equal to a loud voice at 3 feet distance), their combined noise levels at Locations I and J would be equal to the existing background noise levels measured along the south boundary line. Figures 9 and 10 depict the measured background noise levels at Locations F and G, which were closest to Locations I and J.

It was concluded that noise impacts from the proposed 77 stall parking lot are



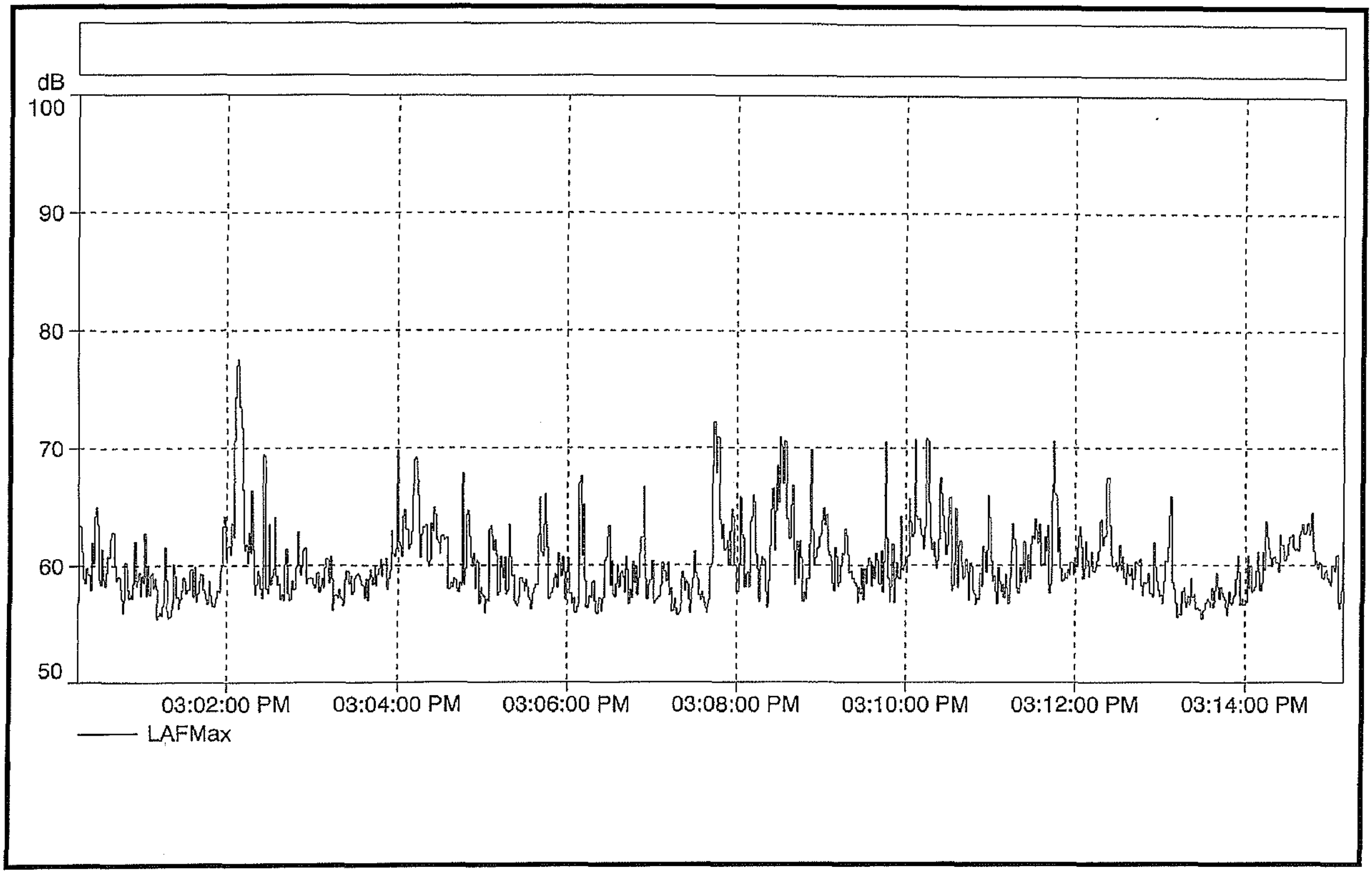
PREFERRED ALTERNATIVE FOR WAIKIKI WAR MEMORIAL

FIGURE 8



EXISTING BACKGROUND NOISE LEVELS MEASURED AT LOCATION "F"

FIGURE 9



EXISTING BACKGROUND NOISE LEVELS MEASURED AT LOCATION "G"

FIGURE 10

possible, but are more likely to occur if there are very loud noise events (shouting, vehicle alarms, horns, etc.) in the order of 80+ dBA which occur at frequent intervals (or continuously) within the new parking lot. Frequent occurrences of these very loud noise events are not characteristic of existing parked vehicles located on or off the project site.

CHAPTER VII. DISCUSSION OF PROJECT RELATED NOISE IMPACTS AND POSSIBLE MITIGATION MEASURES

Traffic Noise. Traffic noise mitigation measures should not be required since project related traffic noise increases are not expected to occur.

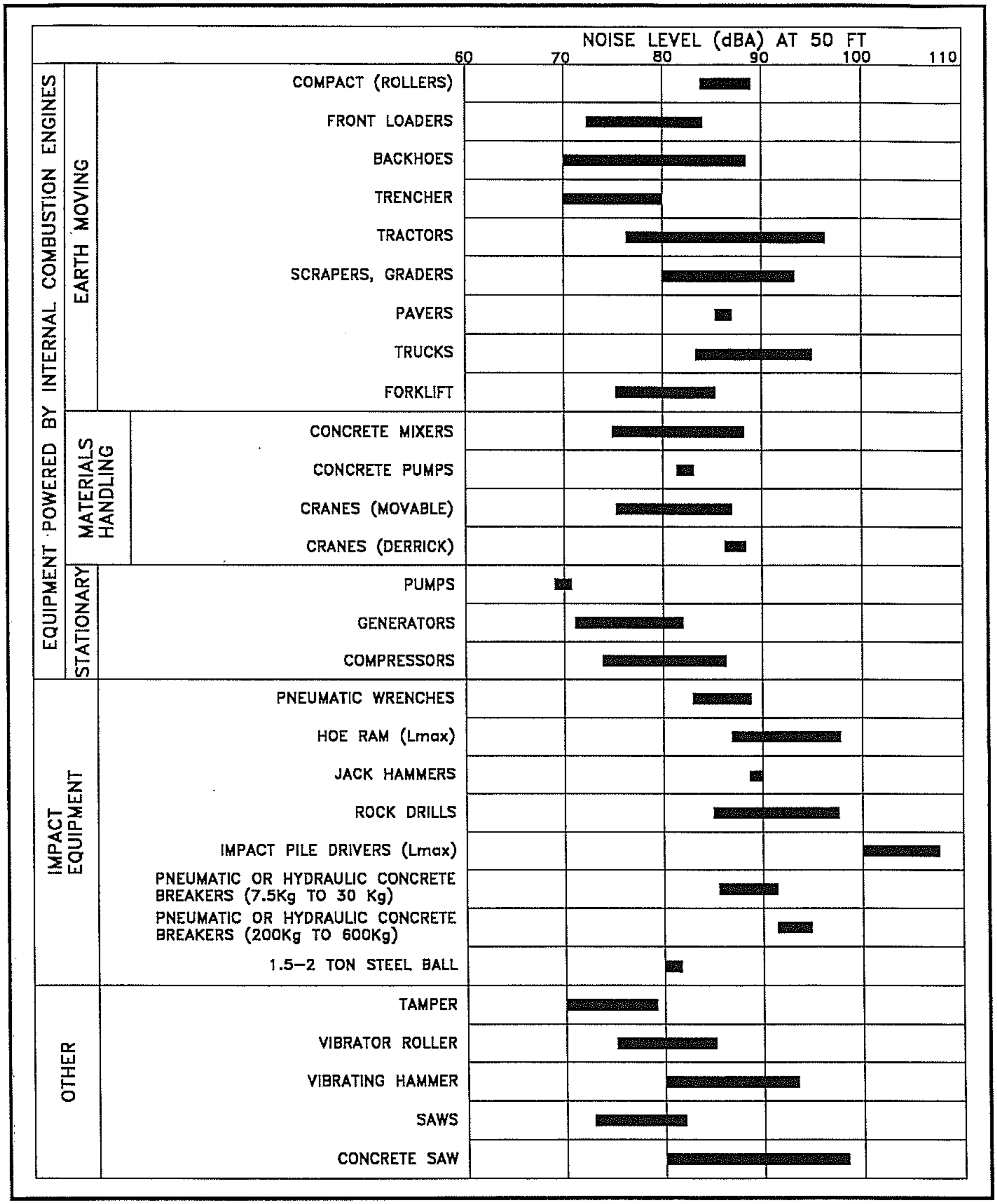
General Construction Noise. Audible construction noise will probably be unavoidable during the entire project construction period. The total time period for construction is unknown, but it is anticipated that the actual work will be moving from one location on the project site to another during that period. Actual length of exposure to construction noise at any receptor location will probably be less than the total construction period for the entire project. Typical levels of exterior noise from construction equipment at 50 feet distance from the equipment are shown in Figure 11.

The existing Honolulu Aquarium and the New Otani Kaimana Beach Hotel are predicted to experience the highest noise levels during construction activities due to their close proximity to the construction site. The highest noise levels are expected to occur during the demolition, earthwork and site preparation phase of construction. Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work, the availability of closure and air conditioning for noise mitigation at the majority of the resort and commercial units in the project area, and due to the administrative controls available for regulation of construction noise. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the project site.

Demolition of the existing Waikiki Natatorium entrance, seating, and pool structures will occur during the initial phase of work. The demolition work could occur using hoe rams, saws, jack hammers, excavators, wrecking ball, bulldozers, and/or front end loaders. Noise during preparation for the actual demolition of the structures, during the actual demolition by hoe ram, jack hammer, wrecking ball, excavator, and/or front end loaders, and during site cleanup and removal of the debris can be expected.

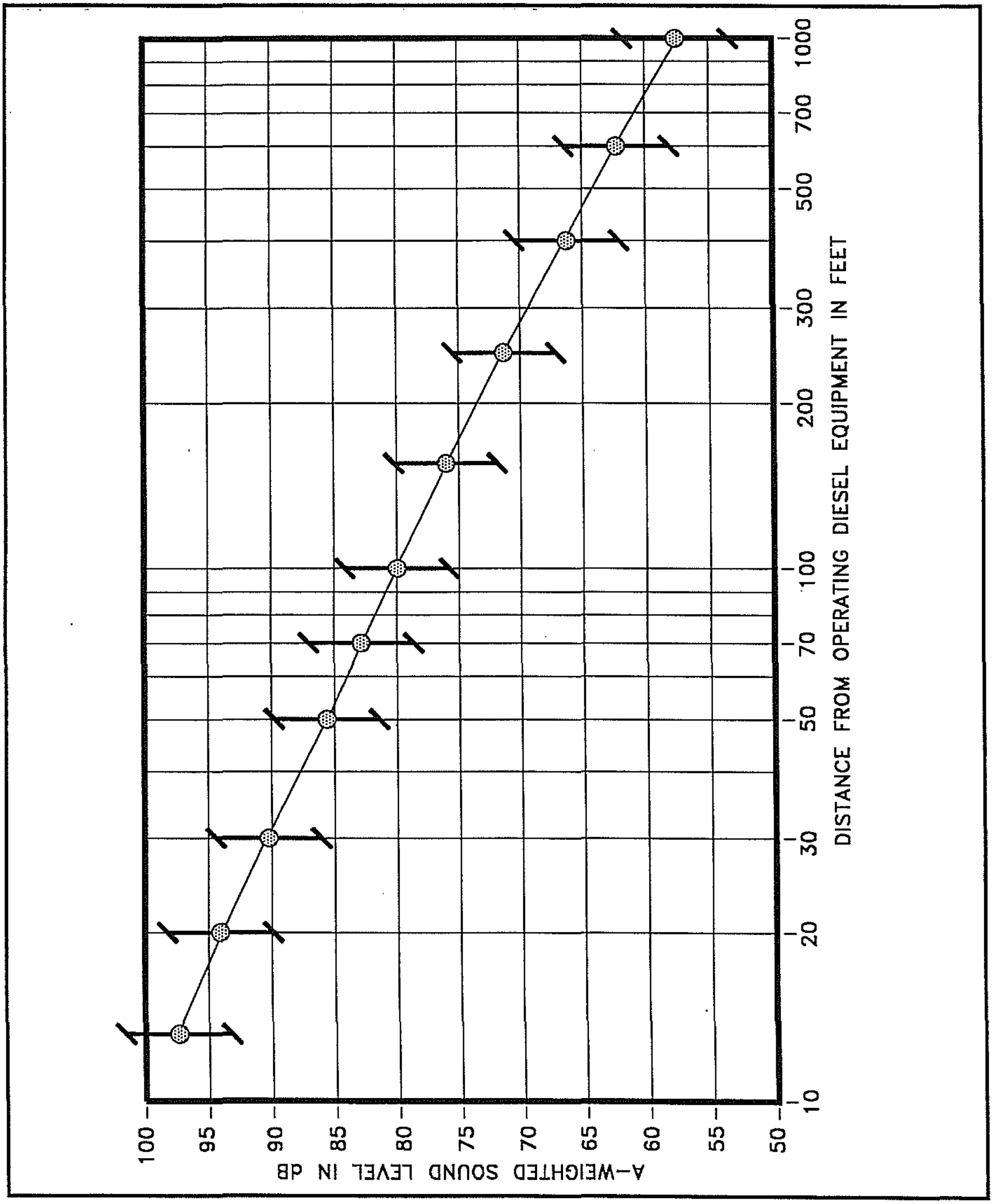
Following demolition and cleanup, the noise from site excavation, grading, and preparation activities will be present. Typical levels of exterior noise from construction activity (excluding pile driving activity) at various distances from the job sites are shown in Figure 12. The impulsive noise levels of impact pile drivers are approximately 15 dB higher than the levels shown in Figure 12, while the intermittent noise levels of vibratory pile drivers are at the upper end of the noise level ranges depicted in the figure.

Figure 12 is useful for predicting exterior noise levels at short distances (within 500 FT) from the work when visual line of sight exists between the construction equipment and the receptor. Direct line-of-sight distances from the construction equipment to buildings will range from 50 FT to 800 FT, with corresponding average noise levels of 86 to 59 dBA (plus or minus 5 dBA). Typical levels of construction



RANGES OF CONSTRUCTION EQUIPMENT NOISE LEVELS

FIGURE 11



ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE

FIGURE 12

noise inside naturally ventilated and air conditioned structures are approximately 10 and 20 dB less, respectively, then the levels shown in Figures 11 and 12.

Table 4 presents the predicted ranges of construction noise during three phases of work (demolition, earthwork/site preparation, and building erection) at receptor locations in the immediate vicinity of the project site. The predicted construction noise levels and corresponding risks of adverse noise impacts would be greatest during the demolition and site preparation phase, and the risks would be least during the building erection phase. During the building erection phase, the noise levels at the various receptor locations should be more similar to existing background noise.

The units in the Kaimana Beach Hotel and Apartment buildings which are adjacent to and which face the project site are predicted to experience the highest noise levels during construction activities due to their close proximity to the planned location of the new parking lot.

Mitigation of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 to 90+ dB at 50 FT distance), and due to the exterior nature of the work (breaking concrete with hoe rams, jack hammers, or saws, grading and earth moving, trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required on the job site.

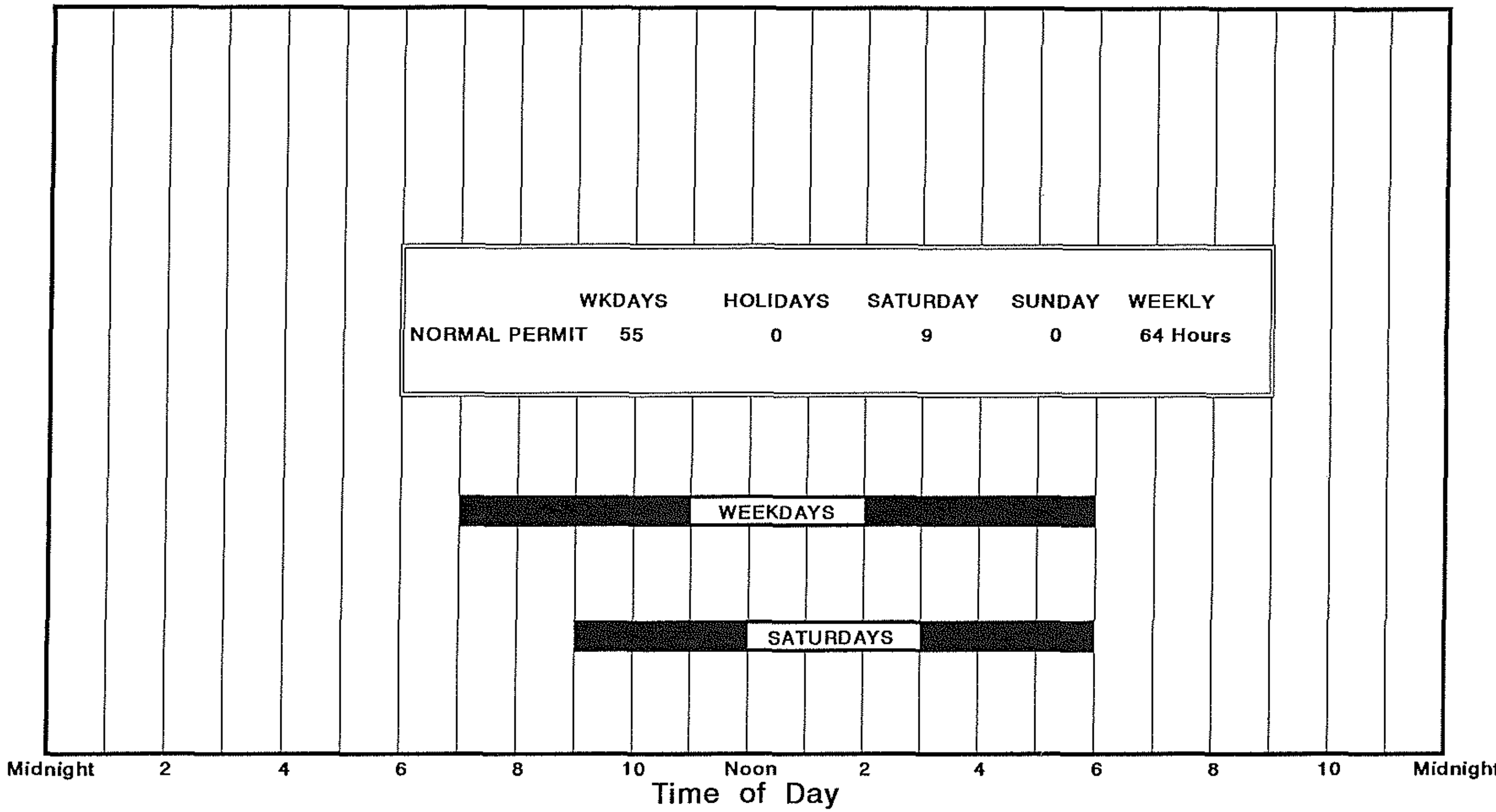
Severe noise impacts are not expected to occur inside air conditioned structures which are within 70 to 200 FT of the project construction site. Inside naturally ventilated structures, interior noise levels (with windows or doors opened) are estimated to range between 64 to 73 dBA at 70 FT to 200 FT distances from the construction site. Closure of all doors and windows facing the construction site would generally reduce interior noise levels by an additional 5 to 10 dBA.

The incorporation of State Department of Health construction noise permit procedures is another noise mitigation measure which is normally applied to construction activities. Figure 13 depicts the normally permitted hours of construction. Noisy construction activities are not allowed on Sundays and holidays, during the early morning, and during the late evening and nighttime periods under the DOH permit procedures.

TABLE 4
SUMMARY OF PREDICTED NOISE LEVELS DURING CONSTRUCTION

Receptor Location	Memorial	New Parking	New Bathhouse
	-------- Location of Construction Work --------		
Demolition, Earthwork, & Site Prep. Phase (Range of Ave. Levels, dBA):			
Kaimana Beach Hotel	64 to 79	73 to 87	72 to 75
Kaimana Beach Apartments	64 to 77	75 to 89	72 to 75
Honolulu Aquarium Grounds	68 to 88	64 to 67	68 to 70
Honolulu Aquarium Building	65 to 80	62 to 64	64 to 67
Building Erection Phase (Range of Ave. Levels, dBA):			
Kaimana Beach Hotel	51 to 58	N/A	59 to 62
Kaimana Beach Apartments	51 to 57	N/A	59 to 62
Honolulu Aquarium Grounds	55 to 68	N/A	55 to 57
Honolulu Aquarium Building	52 to 60	N/A	51 to 54

Notes:
1. All receptors located a ground level.
2. Kaimana Beach Hotel receptor at Location J in Figure 8.
3. Kaimana Beach Apartment receptor at Location I in Figure 8.
4. Honolulu Aquarium Grounds receptor at Location K in Figure 8.
5. Honolulu Aquarium Building receptor at Location L in Figure 8.



AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 13

APPENDIX A. REFERENCES

(1) "Guidelines for Considering Noise in Land Use Planning and Control;" Federal Interagency Committee on Urban Noise; June 1980.

(2) "Environmental Criteria and Standards, Noise Abatement and Control, 24 FR, Part 51, Subpart B;" U.S. Department of Housing and Urban Development; As Amended March 29, 1984.

(3) "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety;" Environmental Protection Agency (EPA 550/9-74-004); March 1974.

(4) "Title 11, Administrative Rules, Chapter 46, Community Noise Control;" Hawaii State Department of Health; September 23, 1996.

(5) "FHWA Traffic Noise Model User's Guide;" FHWA-PD-96-009, Federal Highway Administration; Washington, D.C.; January 1998 and Version 2.5 Upgrade (April 14, 2004).

(6) Traffic Impact Assessment Report; Waikiki War Memorial; Phillip Rowell and Associates; December 8, 2011.

(7) 24-Hour Traffic Counts, Station B72761200221, Kalakaua Avenue Between Monsaratt and Kiele Avenues; State Department of Transportation; May 26, 2010.

(8) 24-Hour Traffic Counts, Station B72761200221, Kalakaua Avenue Between Monsaratt and Kiele Avenues; State Department of Transportation; May 27, 2010.

(9) "Highway Noise Policy and Abatement Guidelines;" State of Hawaii, Department of Transportation, HIghways Division and U.S. Department of Transportation, Federal Highway Administration; April 25, 2011.

APPENDIX B

EXCERPTS FROM EPA'S ACOUSTIC TERMINOLOGY GUIDE

Descriptor Symbol Usage

The recommended symbols for the commonly used acoustic descriptors based on A-weighting are contained in Table I. As most acoustic criteria and standards used by EPA are derived from the A-weighted sound level, almost all descriptor symbol usage guidance is contained in Table I.

Since acoustic nomenclature includes weighting networks other than "A" and measurements other than pressure, an expansion of Table I was developed (Table II). The group adopted the ANSI descriptor-symbol scheme which is structured into three stages. The first stage indicates that the descriptor is a level (i.e., based upon the logarithm of a ratio), the second stage indicates the type of quantity (power, pressure, or sound exposure), and the third stage indicates the weighting network (A, B, C, D, E.....). If no weighting network is specified, "A" weighting is understood. Exceptions are the A-weighted sound level and the A-weighted peak sound level which require that the "A" be specified. For convenience in those situations in which an A-weighted descriptor is being compared to that of another weighting, the alternative column in Table II permits the inclusion of the "A". For example, a report on blast noise might wish to contrast the LCdn with the LAdn.

Although not included in the tables, it is also recommended that "Lpn" and "LepN" be used as symbols for perceived noise levels and effective perceived noise levels, respectively.

It is recommended that in their initial use within a report, such terms be written in full, rather than abbreviated. An example of preferred usage is as follows:

The A-weighted sound level (LA) was measured before and after the installation of acoustical treatment. The measured LA values were 85 and 75 dB respectively.

Descriptor Nomenclature

With regard to energy averaging over time, the term "average" should be discouraged in favor of the term "equivalent". Hence, Leq, is designated the "equivalent sound level". For Ld, Ln, and Ldn, "equivalent" need not be stated since the concept of day, night, or day-night averaging is by definition understood. Therefore, the designations are "day sound level", "night sound level", and "day-night sound level", respectively.

The peak sound level is the logarithmic ratio of peak sound pressure to a reference pressure and not the maximum root mean square pressure. While the latter is the maximum sound pressure level, it is often incorrectly labelled peak. In that sound level meters have "peak" settings, this distinction is most important.

"Background ambient" should be used in lieu of "background", "ambient", "residual", or "indigenous" to describe the level characteristics of the general background noise due to the contribution of many unidentifiable noise sources near and far.

With regard to units, it is recommended that the unit decibel (abbreviated dB) be used without modification. Hence, DBA, PNdB, and EPNdB are not to be used. Examples of this preferred usage are: the Perceived Noise Level (Lpn was found to be 75 dB. Lpn = 75 dB). This decision was based upon the recommendation of the National Bureau of Standards, and the policies of ANSI and the Acoustical Society of America, all of which disallow any modification of bel except for prefixes indicating its multiples or submultiples (e.g., deci).

Noise Impact

In discussing noise impact, it is recommended that "Level Weighted Population" (LWP) replace "Equivalent Noise Impact" (ENI). The term "Relative Change of Impact" (RCI) shall be used for comparing the relative differences in LWP between two alternatives.

Further, when appropriate, "Noise Impact Index" (NII) and "Population Weighed Loss of Hearing" (PHL) shall be used consistent with CHABA Working Group 69 Report Guidelines for Preparing Environmental Impact Statements (1977).

APPENDIX B (CONTINUED)

TABLE I

A-WEIGHTED RECOMMENDED DESCRIPTOR LIST

TERM	SYMBOL
1. A-Weighted Sound Level	L_A
2. A-Weighted Sound Power Level	L_{WA}
3. Maximum A-Weighted Sound Level	L_{max}
4. Peak A-Weighted Sound Level	L_{Apk}
5. Level Exceeded x% of the Time	L_x
6. Equivalent Sound Level	L_{eq}
7. Equivalent Sound Level over Time (T) (1)	$L_{eq(T)}$
8. Day Sound Level	L_d
9. Night Sound Level	L_n
10. Day-Night Sound Level	L_{dn}
11. Yearly Day-Night Sound Level	$L_{dn(Y)}$
12. Sound Exposure Level	L_{SE}

(1) Unless otherwise specified, time is in hours (e.g. the hourly equivalent level is $L_{eq(1)}$). Time may be specified in non-quantitative terms (e.g., could be specified a $L_{eq(WASH)}$ to mean the washing cycle noise for a washing machine).

SOURCE: EPA ACOUSTIC TERMINOLOGY GUIDE, BNA 8-14-78,

APPENDIX B (CONTINUED)

TABLE II

RECOMMENDED DESCRIPTOR LIST

	TERM	A-WEIGHTING	ALTERNATIVE[1] A-WEIGHTING	OTHER[2] WEIGHTING	UNWEIGHTED
1.	Sound (Pressure)[3] Level	L_A	L_{pA}	L_B, L_{pB}	L_p
2.	Sound Power Level	L_{WA}		L_{WB}	L_W
3.	Max. Sound Level	L_{max}	L_{Amax}	L_{Bmax}	L_{pmax}
4.	Peak Sound (Pressure) Level	L_{Apk}		L_{Bpk}	L_{pk}
5.	Level Exceeded x% of the Time	L_x	L_{Ax}	L_{Bx}	L_{px}
6.	Equivalent Sound Level	L_{eq}	L_{Aeq}	L_{Beq}	L_{peq}
7.	Equivalent Sound Level Over Time(T) [4]	$L_{eq(T)}$	$L_{Aeq(T)}$	$L_{Beq(T)}$	$L_{peq(T)}$
8.	Day Sound Level	L_d	L_{Ad}	L_{Bd}	L_{pd}
9.	Night Sound Level	L_n	L_{An}	L_{Bn}	L_{pn}
10.	Day-Night Sound Level	L_{dn}	L_{Adn}	L_{Bdn}	L_{pdn}
11.	Yearly Day-Night Sound Level	$L_{dn(Y)}$	$L_{Adn(Y)}$	$L_{Bdn(Y)}$	$L_{pdn(Y)}$
12.	Sound Exposure Level	L_S	L_{SA}	L_{SB}	L_{Sp}
13.	Energy Average Value Over (Non-Time Domain) Set of Observations	$L_{eq(e)}$	$L_{Aeq(e)}$	$L_{Beq(e)}$	$L_{peq(e)}$
14.	Level Exceeded x% of the Total Set of (Non-Time Domain) Observations	$L_{x(e)}$	$L_{Ax(e)}$	$L_{Bx(e)}$	$L_{px(e)}$
15.	Average L_x Value	L_x	L_{Ax}	L_{Bx}	L_{px}

(1) "Alternative" symbols may be used to assure clarity or consistency.

(2) Only B-weighting shown. Applies also to C,D,E,.....weighting.

(3) The term "pressure" is used only for the unweighted level.

(4) Unless otherwise specified, time is in hours (e.g., the hourly equivalent level is Leq(1). Time may be specified in non-quantitative terms (e.g., could be specified as Leq(WASH) to mean the washing cycle noise for a washing machine.

APPENDIX C

SUMMARY OF BASE YEAR TRAFFIC VOLUMES

ROADWAY LANES	**** CY 2011 ***** AM VPH	PM VPH	CY 2011 (SATURDAY) MIDDAY PEAK VPH
Kalakaua Ave. N. of War Memorial Driveway (NB)	87	156	146
Kalakaua Ave. N. of War Memorial Driveway (SB)	277	378	331
	---------------	---------------	---------------
Two-Way	364	534	477
Kalakaua Ave. S. of War Memorial Driveway (NB)	112	145	134
Kalakaua Ave. S. of War Memorial Driveway (SB)	269	364	325
	---------------	---------------	---------------
Two-Way	381	509	459
War Memorial Driveway (EB)	13	31	34
War Memorial Driveway (WB)	46	34	28
	---------------	---------------	---------------
Two-Way	59	65	62

Appendix D:
Geotechnical Exploration and Foundation Evaluation Report (Yogi Kwong Engineers, LLC 2011)

For *Geotechnical Consultation Letter Report in Support of Beach Stabilization Concept Development* (Yogi Kwong Engineers, LLC 2015), see Appendix D of the *Natatorium Coastal Assessment and Basis of Design Waikiki, Oahu, Hawaii* ~~(Sea Engineering, Inc. 2018)~~(Sea Engineering, Inc. 2019) in Appendix E of this EIS.

For Geotechnical Investigation (Harding Lawson Associates 1991), see Appendix E in the *Natatorium Coastal Assessment and Basis of Design Waikiki, Oahu, Hawaii* ~~(Sea Engineering, Inc. 2018)~~(Sea Engineering, Inc. 2019) in Appendix E of this EIS.

FINAL SUBMITTAL

Geotechnical

Exploration and Foundation Evaluation Report

Waikiki War Memorial Complex at Waikiki Beach

Honolulu, Oahu, Hawaii

Prepared for:

Wil Chee – Planning & Environmental
1018 Palm Drive
Honolulu, Hawaii 96814

December 2011

Prepared by:

Yogi Kwong Engineers, LLC
1357 Kapiolani Blvd., Suite 1450
Honolulu, Hawaii 96814

YKE Project No. 10022

December 23, 2011

Ms. Barrie Morgan
Wil Chee – Planning & Environmental
1018 Palm Drive
Honolulu, Hawaii 96814

Subject: **Final Submittal**
Geotechnical Exploration and Foundation Evaluation Report
Waikiki War Memorial Complex at Waikiki Beach
Waikiki, Oahu, Hawaii

Dear Ms. Morgan:

Yogi Kwong Engineers, LLC (YKE) is pleased to submit this Geotechnical Exploration and Foundation Evaluation Report for the proposed Waikiki War Memorial Complex at Waikiki Beach on the island of Oahu, Hawaii, for your use. Our geotechnical engineering services were performed in general accordance with our fee proposal dated November 4, 2009.

A Draft Geotechnical Report was submitted to Wil Chee – Planning & Environmental for review and comment on August 31, 2011, and the review comments are addressed in this report. We appreciate the opportunity to provide these services to Wil Chee – Planning & Environmental. If you have any questions regarding this letter and the attached draft Geotechnical Exploration and Foundation Evaluation Report, please do not hesitate to contact us.

Yours truly,

Yogi Kwong Engineers, LLC

Reyn Hashiro, P.E.
Project Geotechnical Engineer

James Kwong, Ph.D., P.E.
Principal

Yogi Kwong Engineers, LLC
1357 Kapiolani Blvd., Suite 1450
Honolulu, Hawaii 96814
Tel: 808.942.0001
Fax: 808.942.0004

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APPENDIX

1.0 INTRODUCTION

This report presents the results of a geotechnical exploration and foundation evaluation performed by Yogi Kwong Engineers, LLC (YKE) for the proposed Waikiki War Memorial Complex at Sans Souci Beach Park in Waikiki on the island of Oahu, Hawaii. The approximate project location and its general vicinity are shown on the Project Location Map, Figure 1, and the Aerial Photograph of Project Location, Figure 2, respectively.

1.1 PROJECT DESCRIPTION

Based on a preferred alternative plan dated July 7, 2011 provided by Wil Chee Planning & Environmental, the proposed Waikiki War Memorial Complex at Sans Souci Beach Park will consist of a replica of the existing World War I (WWI) triple-arch entry arcade, a medium sized Bathhouse, and a new parking area.

According to the proposed action, the replica WWI entry arcade will be constructed approximately 95 feet east from the original entry arcade in the beach park. Based on the City and County of Honolulu's typical building sections, the proposed Bathhouse will be a single story on-grade structure approximately 65 feet long by 39 feet wide providing two (2) outdoor shower stations with one each on the opposite sides of the structure. The project will also include the construction of a proposed parking lot with 77 parking stalls including handicap stalls on the south side of the Bathhouse.

Based on our recent communications with the project's design team, it is our understanding that there are two scenarios for the replica monument's loading. A 'heavy loading' scenario, provided by the project design team in an earlier email dated July 19, 2011, would consist of interior column loads of 300 kips, and exterior columns loads of 50 kips for the replica triple-arch structure. On the other hand, a 'light loading' scenario would involve a hollow triple-arch structure with a total load of 200 kips, as provided in an email dated October 24, 2011.

A photograph of the existing original WWI war memorial is shown in Figure 3.

1.2 PURPOSE AND SCOPE OF WORK

The purpose of this geotechnical exploration was to explore and evaluate the subsurface conditions at or near the project site for developing preliminary geotechnical recommendations pertaining to foundation subgrade improvements, if appropriate, and feasible foundation support for the planning and preliminary design of the proposed Waikiki War Memorial Complex.

The following scope of services was initially performed in general accordance with our fee proposal dated November 4, 2009:

- Reviewed available geotechnical information pertaining to the project site, including as-built drawings, published geologic maps, and soil survey maps.
- Performed a geotechnical site reconnaissance, selected proposed boring locations, contacted Hawaii One Call Center to identify subsurface utilities, and obtained clearance for drilling the borings.
- Verified probable underground utility locations and work areas with utility agency personnel based on available topographic plans prior to drilling.
- Drilled a total of three (3) borings to 17, 30, and 43.5 feet respectively below the existing ground surface at the replica entry arcade's currently proposed location.
- Excavated one (1) test pit to the approximate depth of 2.3 feet below ground surface at the proposed parking lot area.
- Performed soil sampling and classification during the field exploration, and preserved soil samples for subsequent laboratory testing.
- Performed geotechnical laboratory tests on selected soil samples to determine pertinent geotechnical properties.
- Analyzed field exploration and laboratory test data for the development of our geotechnical engineering evaluation findings and recommendations.
- Prepared a draft Geotechnical Report dated August 31, 2011 summarizing our preliminary findings of the geotechnical field exploration, laboratory testing, engineering analyses and evaluations conducted, and presenting our preliminary geotechnical recommendations for the planning and foundation design support of the replica WWI triple-arch entry arcade at its currently proposed location and the design of the new parking lot pavement.
- Conducted an in-house quality assurance review of the geotechnical recommendations and evaluation findings by a principal engineer of our firm.

Subsequently on October 19, 2011, an additional subsurface exploration consisting of two (2) dynamic cone penetrometer tests was performed at the request of the project design team to obtain an approximate subsurface characterization at the proposed Bathhouse and parking area locations. The additional exploration findings and the project design team's review comments of the draft geotechnical report were evaluated and addressed in this Final Geotechnical Exploration and Foundation Evaluation Report.

The scope of our services presented herein was limited to a geotechnical exploration and foundation evaluation and did not include any civil, structural, hydrological, environmental, and hazardous waste assessments or evaluations; detail design; permit applications; and/or topographic survey of the project site.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 FIELD EXPLORATION

The initial field exploration was performed on July 18, 2011 under the supervision of our engineering personnel in general accordance with the scope of work in our fee proposal dated November 24, 2009. The field exploration included drilling and sampling a total of three (3) borings to the approximate depths of 17, 30, and 43 feet below the ground surface located in the vicinity of the proposed replica WWI Entry Arcade location, and one (1) test pit to the approximate depth of 2.3 feet below ground surface at the proposed parking lot area.

A subsequent field exploration was performed at the proposed Bathhouse and parking area locations on October 24, 2011 including two (2) dynamic cone penetrometer (DCP) tests to the approximate depths of 9 and 10.5 feet below the existing ground surface.

The approximate locations of the exploratory borings, the test pit and the DCP tests are shown on the Approximate Boring Location Plan, Figure 4. A detailed description of the procedures used to perform the exploratory borings and DCP tests, along with the logs of these borings and the DCP tests, is presented in Appendix A.

2.2 LABORATORY TESTING

Laboratory testing was performed to verify our visual field classifications and to determine pertinent geotechnical engineering properties of selected soil samples retrieved from the exploratory borings and the test pit. The geotechnical laboratory testing was performed at YKE's laboratory in Honolulu, Hawaii, and by Construction Engineering Labs, Inc. in Pearl City, Hawaii.

The completed geotechnical laboratory tests include various moisture content and density determination tests, two (2) Atterberg limit tests, three (3) gradation or sieve analysis tests, one (1) California bearing ratio test, one (1) modified proctor test, and two (2) one-dimensional consolidation tests.

A description of the laboratory test procedures and the testing results are presented in Appendix B.

3.0 SITE CONDITIONS

3.1 SURFACE CONDITIONS

The project site is located to the east of the existing original WWI War Memorial in Sans Souci Beach Park on the island of Oahu, as shown in Figure 1. The beach park is bounded on the south by the New Otani Kaimana Beach Hotel and on the north by the Waikiki Aquarium.

The beach park is currently provided with several shower stations, several bathrooms within the existing War Memorial complex, and shoulder parking areas along an existing narrow access road. The surface topography of the project area is generally flat at an average ground surface elevation of seven (7) feet above Mean Sea Level (MSL).

The existing ground cover at the currently proposed location for the replica WWI War Memorial includes grass, topsoil and asphalt concrete pavement. Utility poles and overhead electrical and telephone lines were observed within the project site routing along Kalakaua Avenue. Water, sewer, and irrigation lines traverse underground across Sans Souci Beach Park including the currently proposed location for the replica WWI triple-arch entry arcade structure based on the available record drawings.

3.2 REGIONAL GEOLOGY

The island of Oahu was built by two (2) shield volcanoes, the Waianae volcano and the Koolau volcano. The older Waianae volcano is built in the west, and the younger Koolau volcano is built in the east. Each volcano has been truncated by massive submarine landslides, the Waianae Slump to the southwest and the Nuuanu Slide to the northeast. The Waianae volcano and Koolau volcano have ages dated from about 4.0 million year (Ma, Mega annum) to as young as about 2.9 Ma and 3.0 Ma to 1.78 Ma respectively (Sherrod et al, 2007).

A vast amount of the Waianae and Koolau volcanoes was removed by fluvial and marine erosion during the Pleistocene that created deep valleys. After these erosion cycles, the island was submerged more than 1,200 feet, and the valleys were drowned and alluviated. Scattered sporadically above the Koolau basalt are lava flows and vent deposits of the rejuvenated stage of Hawaiian volcanism, the Honolulu Volcanics. About 40 Honolulu Volcanic vents have been identified and are concentrated within the southeastern portion of the elongated Koolau edifice. Some of the best known vents include Diamond Head, Punchbowl Crater, Salt Lake Crater, and Koko Head. During the last several hundred thousand years, regressions and transgressions of sea level occurred, which resulted in renewed erosion of the higher deposits and growth of coral farther offshore.

The project area is located in lower Waikiki on the island of Oahu. The fluctuations of the sea level that took place at the same time that the Honolulu Volcanic Series were deposited (about 50,000 years ago to present) resulted in migrating shorelines, and the formation of deep erosion channels. These erosion channels dissected upland or deeper basaltic lava flows and earlier coral and alluvial deposits. During periods of low sea level, these alluvial channels (valleys) and erosion surfaces developed well below the current mean sea level. Sea level fluctuations also contributed to the consolidation or over-consolidation of some alluvial silts and clays, resulting in very stiff to hard consistency. Basaltic cobbles and boulders are anticipated in these alluvial sediments, due to the proximity of the sewer alignment to lava flows and erosion channels and gullies. Most of these erosion channels in the project area were later filled in by the alluvial and tuffaceous deposits.

Ancient back-reef sedimentation basins in the area were infilled by lagoonal and estuarine deposits and swamps while the sea level rose and fell during glacial and interglacial periods. Substantial man-made fills were placed to raise the ground surface of much of the lower Waikiki when the area was originally developed. Due to the past complex depositional environment in the area, variations in stratigraphy, complex interbedding and intercalations of the above deposits within short distances, in both vertical and horizontal directions, should be expected.

Coralline deposits were formed primarily as a result of wave actions on coralline reefs during different stands of the sea level. Wave actions caused breakage of reef formation to form rubblestone to coralline detritus. Subsequent re-cementation of coralline debris and beach sand deposits formed cemented calcareous sandstone to “beach rock” limestone ledges. Rises in sea level introduced an influx of fine sediments in a matrix with coarse coralline detritus. Due to the wave actions dominating the depositional environment, coralline deposits and coral reef limestone are often highly variable in all directions.

The regional geology map of the project area and its vicinity is presented in Figure 5. The geology of the project site consists of beach deposits (Qbd) that were formed by the erosion of paleo coral reefs which have been re-worked by waves and deposited as beach deposits. To the east of the project area lies alluvium (Qa) and Honolulu Volcanics tuff cone deposits (Qot).

3.3 SUBSURFACE CONDITIONS

The subsurface conditions presented in this report are based on our interpretation of the subsoil data obtained from both field explorations and the field and laboratory testing performed for this project, which are supplemented by available geologic and soil survey maps and YKE’s general experience in this area. More detailed descriptions of the subsurface conditions encountered in the YKE borings, the test pit and the DCP test probes are presented on the boring and DCP logs respectively in Appendix A. Photographs of the soil samples are shown in Appendix C.

The available boring and laboratory testing data show that the subsoil profile varies substantially below the upper fills and beach deposits within the currently proposed location for the replica entry arcade structure. Hard coral reef limestone was encountered at a relatively shallow depth in Boring B-1 drilled on the north side below the very loose beach deposits. The remaining two-third area of the proposed replica entry arcade location was underlain by a thick compressible layer of coralline or lagoonal deposits encountered in Borings B-2 and B-3 apparently overlying above the limestone, which however was not encountered in the borings.

Based on the nearest Boring B-3, the DCP tests provided an estimate of the relative densities of the anticipated loose to medium dense beach sand deposits below a thin fill crust at the proposed Bathhouse location to the maximum probed depths of 9 to 10.5 feet below the existing ground surface. The relatively shallow DCP probe test data appear to be generally consistent with the upper subsoil conditions encountered in the boring.

We believe that the subsoil conditions can therefore be generalized into four (4) predominant soil or geologic units which, however, were not all encountered within the same boring as discussed below.

- <u>FILL</u> – Variable fill materials were encountered in Borings B-1 and B-3 to approximately 1.5 to 2.5 feet below ground surface (bgs) respectively. The fill unit was absent in Boring No. 2 and primarily consisted of medium stiff to stiff brown elastic silt with sand and roots.
- <u>BEACH DEPOSITS</u> – Beach deposits were encountered in Boring B-1 approximately from 2.5 to 7 feet bgs, in Boring B-2 approximately from 0.5 to 7 feet bgs, and in B-3 approximately from 1.5 to 10 feet bgs. The beach deposits primarily consisted of very loose to medium dense, tan to off-white coralline sand and silty coralline sand.
- <u>LAGOONAL DEPOSITS</u> – Lagoonal deposits were encountered only in Boring B-3 from approximately 10 feet to the maximum boring depth of the boring at 43.5 feet bgs where refusal blow counts were recorded. The upper lagoonal deposits (between the approximate depths of 10 and 17 feet) primarily consisted of very loose, off-white to gray silty coralline gravel and sand with abundant shell fragments. The lower lagoonal deposits graded to very soft gray sandy silt with shells.

- CORAL REEF LIMESTONE / CORALLINE DEPOSITS – Off-white to tan, moderately to strongly cemented hard coral reef limestone was encountered in Boring B-1 approximately from 7 feet to the end of the boring at approximately 17 feet bgs. Coralline deposits were encountered in Boring B-2 approximately from 7 feet to the end of the boring at approximately 30 feet bgs. The coralline deposits primarily consisted of loose to dense, off-white to tan silty well graded coralline gravel with sand. Neither coral reef limestone nor coralline deposits were encountered in Boring B-3 to its maximum boring depth of approximately 43.5 feet bgs.

The project site is located inland of the Kapua Entrance, a possible ancient alluvial channel cutting through the coral reef limestone during the Malama Low Stand of sea level. Based on the boring data from Borings B-1, B-2, and B-3, it appears that the southern portion of the project area including the southern two-third of the proposed replica entry arcade site is located over the eroded channel (in filled by lagoonal deposits) and the northern portion of the project area including the northern one-third of the currently proposed replica structure site is located over relatively shallow coral reef limestone.

Groundwater was encountered at approximately seven (7) feet below the existing ground surface at the time of drilling of our exploratory borings. Due to the proximity of the project site to the shoreline, we recommend that the effect of ocean tides should be taken into account during design and construction of the subject project. Groundwater levels will also fluctuate due to rainfall, storm surfaces and tsunami inundations.

4.0 DISCUSSION AND PRELIMINARY GEOTECHNICAL RECOMMENDATIONS

Based on our preliminary geotechnical evaluation of the available boring data, we believe that the currently proposed location east of the existing original WWI Entry Arcade is generally feasible for supporting the replica WWI Triple-Arch Entry Arcade under both loading scenarios, however, the subsoil profile at this location was found to vary substantially in foundation support characteristics across the current replica entry arcade footprint and it warrants special design considerations.

The foundation bearing stratum of hard coral reef limestone was encountered or anticipated at widely varying depths and apparently submerged below a thick deposit of highly compressible subsoils under two thirds of the currently proposed location of the replica entry arcade. Based on our geotechnical engineering analysis, the use of shallow foundation support appeared inadequate even by preloading the highly variable subsoils at the proposed location with a substantial amount of imported surcharge materials. Conceptually, we believe that the proposed replica WWI Entry Arcade structure could be more suitably supported by deep foundation elements such as micropiles, precast concrete piles, and/or jet grout columns. Additionally, two (2) Dynamic Cone Penetrometer (DCP) tests were performed at the proposed Comfort Station location. Based on the DCP test data and the subsurface conditions encountered in the nearest Boring B-3, we believe that the proposed Bathhouse may be adequately supported by shallow footing foundations bearing on the underlying beach deposits provided an adequate embedment depth and a moderate allowable bearing capacity are used.

More detailed discussions and our geotechnical recommendations for earthwork, subgrade preparation, foundation support options, and parking lot pavement thickness are presented in the following subsections of this report.

4.1 SITE GRADING & DRAINAGE REQUIREMENTS

Based on our site reconnaissance, the project site was covered by light vegetation and asphalt concrete pavements at the time of the site visit. In general, construction areas which are lightly vegetated or paved should be thoroughly grubbed by a minimum depth of six (6) inches. The grubbed areas should be cleared of asphalt concrete, vegetation, roots, rubbish, debris, and any other deleterious materials, and then re-compacted by proof rolling. The grubbed materials should be properly disposed of offsite prior to any fill placement. Any unsuitable materials encountered at or below the cleared subgrade surface should be removed and if necessary, replaced with a suitable backfill material, such as imported non-expansive (with expansion index less than 20) granular select borrow material, compacted to no less than 95% of its maximum dry density per the latest procedure of ASTM D-1557 Test Method.

If required, imported non-expansive granular select borrow material for use as backfill should consist of well-graded granular materials, free of organic matter, debris, and particles greater than three (3) inches in maximum dimension. The imported granular material can also be used as a fill material and should have less than 15% fines passing the No. 200 sieve, a CBR value of at least 25, a liquid limit of 25% or less, and a plasticity index of 10% or less. All imported soils should be inspected and approved at the borrow site, and tested prior to import by YKE as the Geotechnical Engineer-of-Record.

Fill and backfill materials should be placed in maximum 8-inch thick loose lifts, and compacted to a minimum of 95% maximum dry density per the latest procedure of ASTM D-1557 Test Method. The contractor should be required to perform proper quality control density testing during fill and subgrade compaction in accordance with the project specification requirements. The testing should be performed in the presence of YKE as the Geotechnical Engineer-of-Record. Fill or backfill below water level should consist of free-draining granular materials, such as open-graded gravel (ASTM C 33, No. 67 gradation) or locally available #3B Fine gravel, and should be wrapped in a non-woven filter fabric.

Any standing water that collects in open excavations should be pumped out immediately to avoid softening of foundations soils. It is recommended that the final ground surface around the replica WWI Entry Arcade and the Bathhouse be graded to provide positive drainage away from the proposed structures. It is also recommended that the final ground surface around the proposed parking lot should be similarly positively graded. Where this is not feasible, other suitable measures should be provided to avoid ponding and quickly drain away storm water that may collect around the new structures and parking lot.

4.2 REPLICA WWI TRIPLE-ARCH ENTRY ARCADE FOUNDATION

If a shallow foundation was to be used, it is our opinion that the replica structure should be supported on a continuous system such as a mat foundation to minimize differential settlement concerns because of the highly variable subsoil conditions below the replica entry arcade structure at its currently proposed location.

Based on our preliminary geotechnical analysis and the available subsurface information, however, it appeared that a shallow mat foundation under the heavy loading scenario (300 kips for interior columns and 50 kips for exterior columns) could be subject to as much as nine (9) inches of total settlement at the center of the replica entry arcade and correspondingly excessive differential settlements between the edges and the center. Likewise, settlement analysis performed for the light loading scenario (total load of 200 kips) showed that the potential differential settlements of the mat foundation could still be as high as 2.5 inches. A surcharge analysis was therefore performed to evaluate if shallow foundation support can still be used after preloading the proposed location.

4.2.1 Surcharging of Proposed Location

Based on our preliminary surcharge analysis and the available geotechnical information, we estimated that the use of 25 feet or more of surcharge could take close to 1-1/2 years to induce the required settlement under the heavy loading scenario due to relatively low permeability of the lagoonal subsoils. In addition, a much higher surcharge would be required to reduce the preloading duration to a more practical time frame of three (3) to six (6) months.

Under the light loading scenario, it was estimated that the use of a minimum 20-foot high surcharge could reduce the surcharge period to a more practical duration of two (2) to three (3) months. Because of the limitations of settlement and surcharge analysis methods, however, there is no assurance that significant differential settlements will not occur at the currently proposed location unless a prolonged surcharge program is implemented due to the highly variable subsoil conditions especially under the heavy loading scenario.

Therefore, it appears impractical to implement a surcharge program at the currently proposed location of the replica entry arcade within the existing beach park. It should also be noted that the major existing utilities traversing below the proposed replica entry arcade location and its vicinity areas may be ruptured by the resulting ground settlements induced by surcharge loading. The surcharge program may also disrupt service to the park patrons, in addition to the high costs to import and dispose of a large quantity of surcharge materials that cannot be obtained nearby or within the project site based on the current grading concept.

4.2.2 Foundation Design Concepts

Based on the exploratory borings and the available testing data, the subsurface conditions at the proposed WWI Entry Arcade location were found to be highly variable. Under both the heavy and light loading scenarios, the proposed replica WWI Triple-Arch structure supported on shallow foundations will likely experience excessive differential settlements. A preliminary surcharge analysis also indicated that preloading the site is not practical and will likely adversely impact existing underground utilities as discussed above.

Therefore, we believe that deep foundation support should be considered for the replica WWI Entry Arcade at the currently proposed location under both loading scenarios. The proposed deep foundations should extend into the underlying coral reef limestone present at greatly varying depths from approximately 7 feet to potentially more than 43.5 feet below the existing ground surface at the proposed location.

Three (3) preliminary foundation design concepts, including micropiles, driven piles, and ground improvement by jet grouting, have been developed for consideration by the project team. The foundation subgrade for the replica Entry Arcade structure should be proof rolled prior to construction of the structural slab and/or pile caps depending on the foundation concept to be selected. Any loose material encountered at or below the cleared subgrade surface should be removed and replaced with a suitable backfill material as recommended in section 4.1. More details of these viable foundation design concepts are discussed below.

4.2.2.1 Concept No. 1 – 5.5-inch Diameter Micropile with Steel Casing

Based on our discussions with local micropile contractors and our experience with micropile installation, it appears that locally available small drill rigs can access the currently proposed location of the replica WWI Entry Arcade to allow installation of small diameter micropiles with steel casing down to the hard coral reef limestone for foundation support.

It is our understanding that the largest steel casing (hot-dip galvanized) that can be installed with a locally available small drill rig could have an outside diameter (O.D.) of 5.5 inches, which will allow a grout extension of 4.5 inches in diameter to approximately 5 feet in depth below the casing. For this concept, we estimate an allowable vertical capacity of 16 kips per micropile can be achieved, assuming that the micropiles will penetrate a minimum of 6 to 10 feet into the underlying coral reef limestone at variable depths to allow for the installation of a minimum of 5 feet of concrete grout extension.

For planning and preliminary design purposes, the 5.5-inch diameter micropiles could be assumed to have an average total pile length of 17 feet per pile near Boring B-1 and 50 feet per pile near Boring B-2 and B-3 and should be installed at a minimum spacing of not less than 3 feet center to center to minimize overlapping of bearing stresses in the highly compressible coralline and/or lagoonal deposits.

4.2.2.2 Concept No. 2 – 12-inch Square Driven Piles

Based on the subsurface conditions encountered, we believe that driven concrete piles bearing onto the underlying coral reef limestone could be used as another deep foundation option for the proposed replica WWI Entry Arcade structure.

Based on our past project experience and a preliminary pile foundation analysis, we believe that 12-inch square, precast prestressed concrete piles can be driven onto the underlying coral formation to provide an allowable vertical compression capacity of up to 50 tons per pile for design. However, a lower allowable vertical pile capacity of 30 tons per pile may be considered for use by the project's design team in order to eliminate the need for a costly pile load test program that will otherwise be required. A one third (1/3) increase in the allowable vertical capacity may be used for design when transient loads such as wind and/or seismic forces are considered.

For planning and preliminary design purposes, the 12-inch square concrete piles could be assumed to have an average total pile length of 15 feet per pile near Boring B-1 to 50 feet per pile near Borings B-2 and B-3 and should be installed at a minimum spacing of not less than three (3) feet center to center. More accurate pile lengths would have to be determined with the implementation of a pile load test program or additional field exploration to delineate the approximate depths of the coral reef limestone formation underlying the proposed replica WWI Entry Arcade location. During our field exploration, the coral reef limestone formation was not encountered in Borings B-2 and B-3 drilled within the southern two-thirds of the replica WWI Entry Arcade location.

To achieve the relatively low allowable pile capacity, however, we believe that a simple steam pile hammer capable of delivering a rated energy of 15,000 to 20,000 foot-pounds could be used to drive the end-bearing piles. As a preliminary recommendation, assuming a steam hammer delivering energy of approximate 20,000 foot-pounds per blow is used, the piles should be driven to a minimum depth of 10 feet below the existing grade and a minimum driving resistance of 3 blows per inch for the last 6 inches of final pile penetration into the coral reef limestone.

In general, driven piles derive their vertical compression capacity primarily from end-bearing. Therefore, pile group effect should not be significant and the expected settlement may be assumed as the settlement of a single pile. A maximum total settlement, including elastic deformation of the pile, of less than one (1) inch is anticipated for the 12-inch square precast prestressed concrete piles properly driven to the preliminary pile driving criteria discussed above.

During pile installation, we recommend that YKE as the Geotechnical Engineer-of-Record or a licensed civil engineer in the State of Hawaii practicing geotechnical engineering, with a minimum of five (5) years of proven pile driving monitoring and testing experience, should be retained to monitor the pile driving activities. The retained Geotechnical Engineer should be responsible for verifying that the piles are driven continuously without interruption to the required depth and penetration resistance.

Should the driving process be interrupted for more than four (4) hours or the required depth is not achieved, the Geotechnical Engineer may reject or reduce the design capacity of the pile. During driving through the very loose / very soft Lagoonal Deposits, the energy of the hammer stroke should be carefully controlled in order to avoid the development of excessive tensile stress in the pile.

4.2.2.3 Concept No. 3 – Ground Improvement Using Jet Grouting

To reduce potential differential foundation settlements, we believe that over-lapping jet grout columns can be installed below the proposed replica WWI Entry Arcade foundation level at the proposed location in an overlapping fashion along gridlines, to improve and stabilize the subsurface conditions below the entire proposed structure footprint.

The improved foundation subgrade will allow the use of a shallow mat foundation with an adequate foundation bearing capacity without causing significant differential settlement concerns. The jet grouted zone should extend at least 3 feet beyond the edges of the mat footing and should penetrate a minimum of 1 foot into the coral reef limestone. Based on our experience with jet grouting in dense / hard coral reef limestone, the bottom jet grout column extensions will have a much smaller diameter.

Assuming the jet grout columns will bear directly onto the coral reef limestone anticipated at approximately 45 feet bgs, we estimate that an allowable vertical capacity of 4,000 pounds per square foot (psf) may be used for planning and preliminary design purposes, for footing founded directly on jet grouted soils with a minimum unconfined compressive strength of 400 pounds per square inch (psi) at 28 day strength.

4.2.3 Load Testing and Jet Grouting Test Program Considerations

If micropiles or driven piles with an allowable vertical pile capacity greater than 30 tons are selected as the foundation support system, we recommend that a minimum of one (1) pile load test be performed per ASTM D1143 on a test micropile or driven pile installed within the currently proposed location of the replica WWI Entry Arcade structure, to an ultimate vertical downward load of at least two (2) times the design capacity of the micropile or driven pile as discussed above. The Contractor should retain an experienced Civil Engineer licensed in the State of Hawaii (with at least 5 years of geotechnical engineering experience) in conducting the pile load test to set up the instrumentation, perform the static load test, obtain necessary measurements, and submit a report in accordance with ASTM D1143 to the City. The Contractor is responsible to design, fabricate, and set up the load test frame to meet ASTM D1143 requirements.

If jet grouting methods are used, the Contractor is required to conduct a thorough and representative grout test program to develop and verify the grouting parameters to be used in production grouting. Because of the very loose ground conditions, jet grouting through the upper lagoonal deposits may cause local ground subsidence and ground movement. The sequencing and jetting parameters must be carefully considered and implemented by a qualified jet grouting specialist to avoid adverse impact to the surrounding area. The spoils generated as a waste product from the jet grouting operation should be contained within the allowable construction work areas prior to disposal. Ponding or any stockpiling of jet grout return or spoils on site should be prohibited.

During jet grouting, we recommend that YKE as the Geotechnical Engineer-of-Record or a licensed civil engineer in the State of Hawaii practicing geotechnical engineering, with a minimum of five (5) year proven jet grouting monitoring experience, should be retained to monitor the jet grouting operations.

4.2.4 Settlement Monitoring

A monitoring program for potential ground movements is recommended to evaluate the construction impacts on the existing adjacent structures and utilities, in particular the existing sewer, water and irrigation lines. The settlement or movement information would be useful during construction to alert the Contractor of potential ground movements, and the possible need for mitigation actions by the Contractor. Such a monitoring program could be developed in conjunction with a detailed pre-construction survey of the conditions of the existing adjacent structures and other improvements within the anticipated zone of influence of the construction activities.

Survey monuments should be established on the ground surface prior to construction. Periodic surveys of the monuments should be made before, during, and after construction to measure potential vertical and horizontal movements.

4.3 BATHHOUSE FOUNDATION

In anticipation of generally low roof loading, we believe that shallow footings adequately embedded below the existing grade can be used to support the proposed Bathhouse by bearing directly on properly prepared fill or beach sand subgrade based on the subsoil conditions encountered in the nearby Boring B-3 and the DCP test probe (DCP-1) conducted directly at the new structure site.

It is our opinion that an allowable bearing pressure of 2,000 psf and a minimum footing embedment of twenty four (24) inches may be used for design of the shallow spread and/or continuous wall footing foundations for the proposed Bathhouse. The excavated footing foundation subgrade in the on-site fill material should be scarified to a minimum depth of eight (8) inches, moisture conditioned to within 2% wet of optimum moisture content, and re-compacted to at least 95% maximum dry density. The excavated footing foundation subgrade in the on-site beach sand deposit should be moisture conditioned and proof-rolled a minimum of four (4) passes to achieve a smooth and well compacted subgrade surface.

Any unsuitable materials encountered at or below the foundation subgrade surface should be removed and replaced with a suitable backfill material, such as imported non-expansive (with expansion index less than 20) granular select borrow material, compacted to no less than 95% of its maximum dry density per the latest procedure of ASTM D-1557 Test Method. Imported non-expansive granular select borrow material described in Section 4.1, can be used as backfill for the footing excavations. Backfill materials should be placed in maximum 8-inch thick loose lifts, and compacted to a minimum of 95% maximum dry density per the latest procedure of ASTM D-1557 Test Method.

A one third (1/3) increase in the allowable bearing capacity may be used for design when transient loads such as wind and/or seismic forces are considered. A base friction factor of 0.35 and a passive lateral earth resistance of 250 psf per foot of depth (psf/ft) can also be used for the footing design. The lateral earth resistance should be discounted in the upper two (2) feet if the finish grade above will not be paved or adequately protected to prevent ground erosion. We estimate that the settlements of the shallow footing foundations should be less than one (1) inch total and one half (1/2) of an inch differential based on the recommended allowable bearing pressure and the anticipated subsoil conditions.

4.3.1 Slab-On-Grade

Based on the anticipated near surface subsoil conditions, we believe that concrete slabs bearing on the surface fill material or beach sand deposits at grade with a minimum 4-inch thick subbase course (of the imported select borrow materials compacted to 95% maximum dry density) may be used at the proposed Bathhouse. If a capillary water break layer and/or a basaltic termite barrier are required, it is our opinion that the subbase course may be substituted by four (4) inches of basaltic termite barrier and/or six (6) inches of #3B Fine gravel or ASTM C 33 No. 67 aggregates below the concrete slabs.

After scarification, the slab subgrade in fill materials should be re-compacted to at least 95% maximum dry density per ASTM D-1557 Test Method. For slab subgrade in the beach sand deposits, it should be moisture conditioned and proof rolled a minimum of four (4) passes to form a smooth subgrade surface and covered with a layer of geotextile such as Mirafi 180 N prior to placement of the subbase course, the water break layer and/or the termite barrier.

Any unsuitable materials encountered at or below the slab subgrade level should be removed and replaced with a suitable backfill material, such as the imported non-expansive granular select borrow material, compacted to no less than 95% of its maximum dry density per the latest procedure of ASTM D-1557 Test Method.

4.4 Liquefaction Potential And Seismic Design Considerations

Liquefaction is a phenomenon in which a soil loses a substantial amount of shear strength due to the build-up of excess pore-water pressure, which is most commonly generated by strong earthquake ground shaking. Liquefaction can also occur as a result of cyclic loading conditions generated by vibratory construction equipment. In general, soils most susceptible to liquefaction are saturated, loose, uniformly graded, fine-grained sands containing little or no fines.

Because the Waikiki War Memorial Complex site is underlain by very loose to loose silty sands and gravels (mainly beach and lagoonal deposits) under a high groundwater table, we believe that the onsite deposits may have a high liquefaction potential under ground shaking conditions during a major earthquake, or induced by construction equipment such as vibratory hammers and vibratory compaction rollers.

A detailed analysis of the liquefaction potential of the project site would have required a more elaborate field exploration program including the drilling and sampling of deep borings to about 100 feet below the existing grade. Such an analysis is beyond the scope of work for this geotechnical exploration and foundation evaluation. A simplistic determination based on the available boring data and the published geological information of the vicinity areas was made to develop the preliminary geotechnical recommendation in this planning phase.

Based on Section 1613.5.2 and Table 1613.5.2 of the International Building Code (IBC 2006), and the subsoil conditions encountered, we therefore recommend that the site class be assumed to be "F". We believe the use of driven piles or ground improvement using jet grouting methods can mitigate against potential adverse impacts due to potential soil liquefaction should a significant earthquake impact the subject site.

4.5 PARKING LOT PAVEMENT

We understand that the new parking pavement will only be used by passenger cars, two axle trucks, occasional trash vehicles, and on rare occasions by large emergency vehicles. Due to the lack of specific traffic data for the parking lot area, however, design assumptions were made for traffic loading and composition in our conceptual design evaluation of the proposed parking lot pavement as discussed below.

All areas within the pavement limits should be thoroughly cleared and grubbed of vegetation, rubbish, debris, and any other deleterious materials and the removed materials should be properly disposed off-site. The anticipated pavement subgrade in the surface fill materials should be scarified to a minimum depth of six (6) inches below the sub-grade surface, moisture conditioned to within 2% wet of the optimum moisture content, then re-compacted to 95% maximum dry density per ASTM D-1557 Test Method and kept moist but not wet prior to placement of the pavement structure.

Based on our laboratory test results performed on a bulk sample obtained from test pit TP-1, a design CBR value of 7.5 was used as the subgrade soil strength in the conceptual pavement evaluation. Based on the above considerations and the design CBR value, we recommend that the following minimum flexible pavement thickness design be used for a conceptual design evaluation of the proposed parking lot (Figure 6):

2.5-inch Asphalt Concrete
<u>8-inch Base Course (CBR=80, 95% Compaction per ASTM D-1557)</u>
10.5-inch Minimum Total Pavement Thickness

The recommended pavement section considers that good surface and/or subsurface drainage will be provided to divert surface and underground seepage water away from the parking lot areas. The final pavement section may be different depending on knowledge of more accurate traffic mix data, and the results of additional CBR tests performed on the actual subgrade soils throughout the pavement areas during construction.

It should be noted that the preliminary pavement thickness recommended herein is not developed for support of heavy construction traffic. Heavy construction equipment and traffic should be anticipated, but detailed construction traffic loads are not available for our consideration in this report. We recommend that the contractor be required to designate/design, as necessary, construction access roads for use by their heavy construction equipment such as dump trucks and tracked vehicles to avoid damage to the finished surface of the new pavement.

5.0 REFERENCES

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Sowers, G. F., Hedges, C. S., 1966. "*Dynamic Cone for Shallow In-Situ Penetration Testing", Vane Shear and Cone Penetration Resistance Testing of In-Situ Soils.* ASTM Special Technical Publication #399.

Stern, H.T. and Vaksvik, K.N., 1935. *Geology and Groundwater Resources of the Island of Oahu, Hawaii*. Division of Hydrography Bulletin 1.

U.S. Geologic Survey Topographic Map, 1998. *Honolulu Quadrangle*. U.S. Department of Defense.

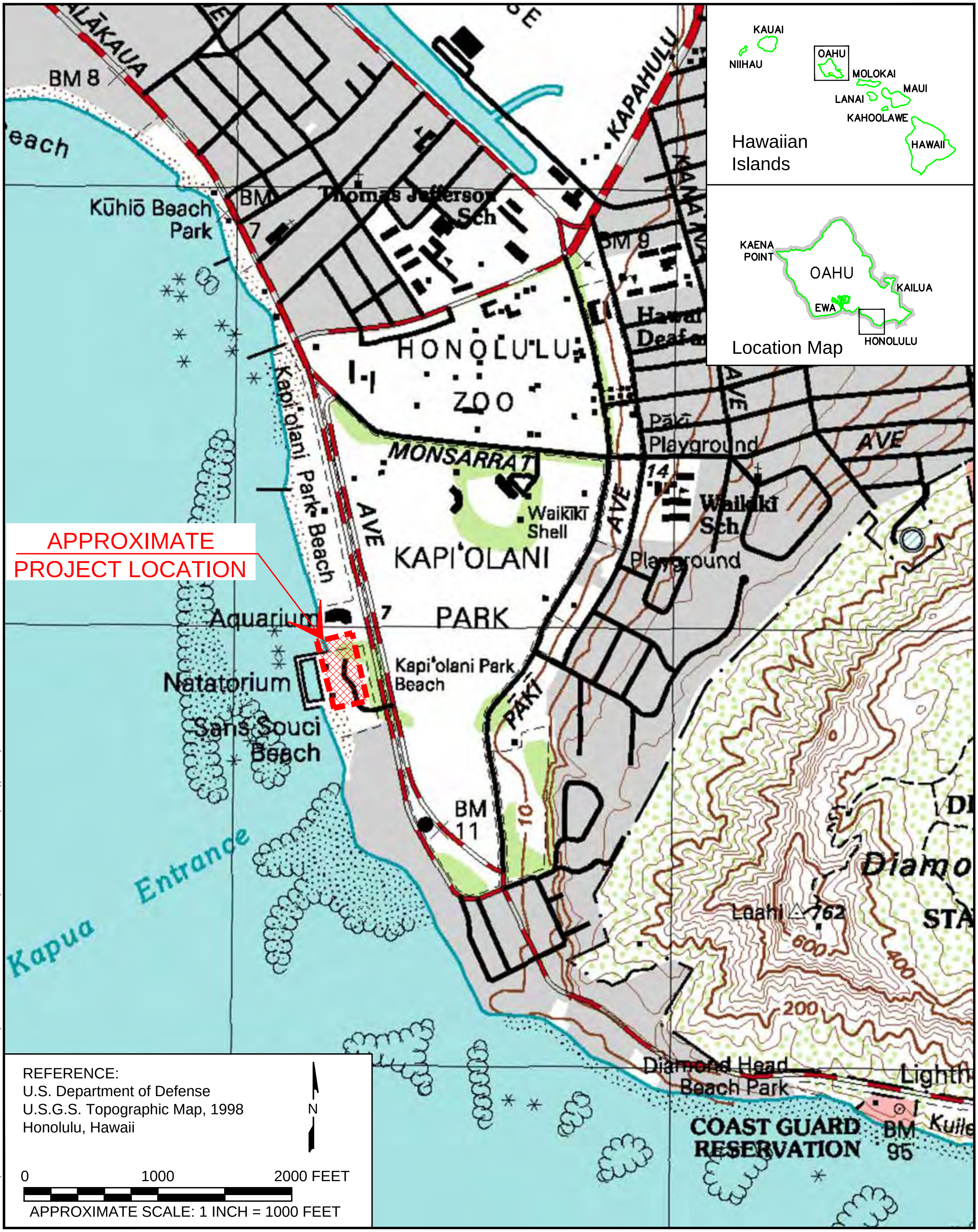
6.0 LIMITATIONS

The geotechnical recommendations and conclusions presented in this report are based on the assumption that the scope of the construction project, as described, does not change appreciably and that significant variations in soil properties from those encountered by our field exploration do not occur. The borings are widely spaced; therefore, some variation in soil properties between the borings is likely. If any conditions notably different from those described herein are encountered during construction, we should be immediately notified. The geotechnical recommendations presented in this report were developed assuming the Geotechnical Engineer-of-Record will be retained to observe actual field conditions encountered during construction to verify the applicability of the recommendation presented in this report, and to recommend appropriate changes in design or construction procedures, if conditions differ from those described herein.

This report was prepared for use by Wil Chee Planning & Environmental in accordance with generally accepted geotechnical engineering principles and practices. The geotechnical opinions and recommendations given in this report are based on our analysis of the data collected for this project. Additional conclusions and/or recommendations made from the data by others are solely their own responsibility.

Our analysis is based on the data obtained from the borings at the locations indicated on the Boring Location Map. If project plans or requirements change, the conclusions and recommendations provided herein by YKE may need to be revised. The nature and extent of variations between the borings may become evident during construction and will likely differ from those discussed in this report. No warranty is included, either expressed or implied, that the actual conditions encountered will conform exactly to the conditions described herein.

Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended or implied.



P:\10022 WAIKIKI NATATORIUM EIS\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\(10022) FIGURES 1 TO 3 & 5 – PROJECT LOCATION, AERIAL PHOTO, REGIONAL GEOLOGY.DWG

PROJECT LOCATION MAP
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC

FIGURE 1

AERIAL PHOTOGRAPH OF PROJECT LOCATION

Waikiki War Memorial Complex at Waikiki Beach

Honolulu, Oahu, Hawaii

Project No. 10022

YKE
YOGI KWONG ENGINEERS, LLC

FIGURE 2

P:\10022 WAIKIKI NATATORIUM EIS\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\(10022) FIGURES 1 TO 3 & 5 - PROJECT LOCATION, AERIAL PHOTO, REGIONAL GEOLOGY.DWG

REFERENCE:
Provided by Wil Chee-Planning & Environmental in Email, Dated October 24, 2011

Not to Scale

PHOTO PROPOSED WWI TRIPLE - ARCH ENTRY ARCADE

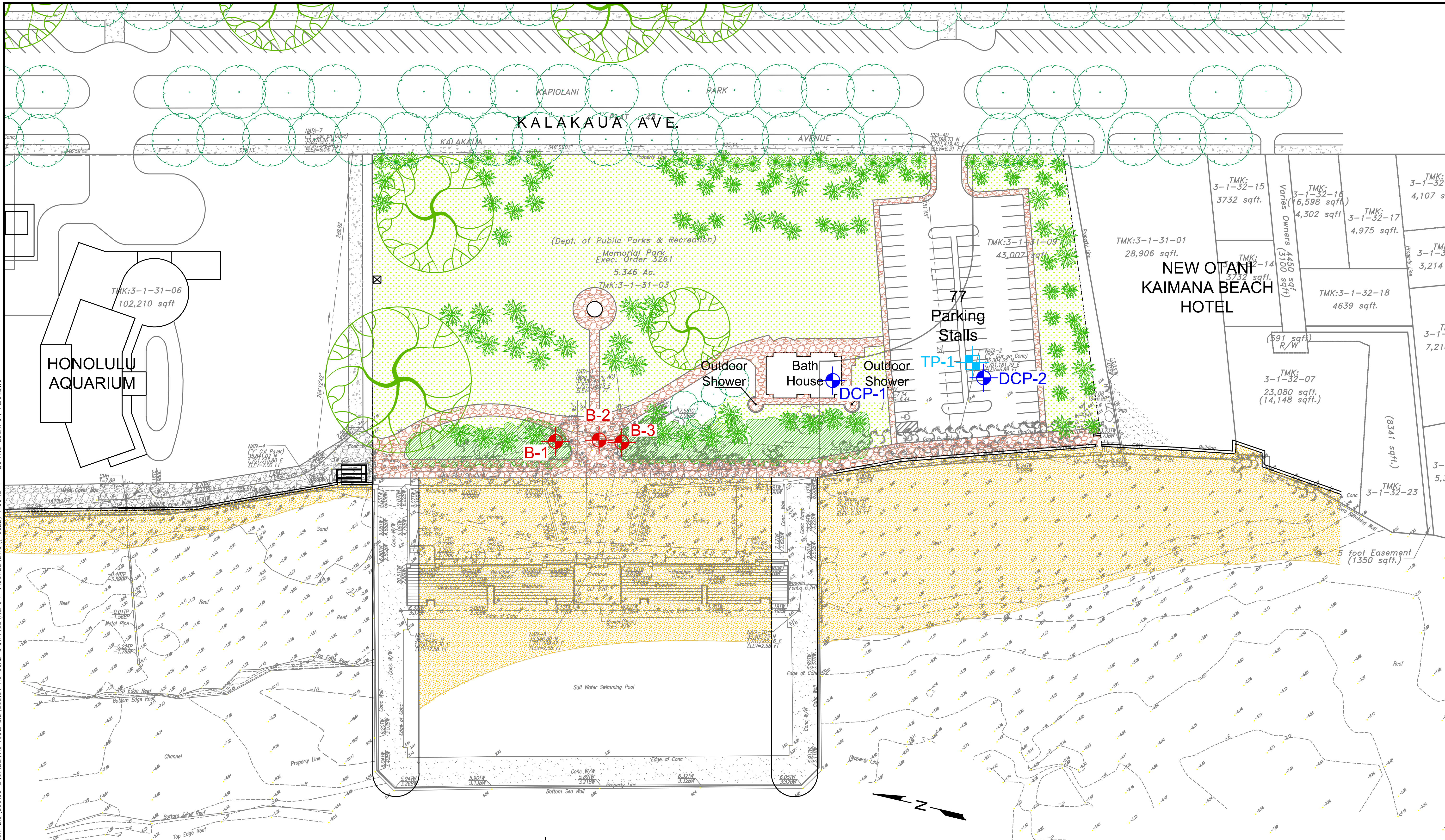
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC

FIGURE 3

P:\10022 WAIKIKI NATATORIUM EIS\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\(10022) FIGURES 1 TO 3 & 5 - PROJECT LOCATION, AERIAL PHOTO, REGIONAL GEOLOGY.DWG



P:\10022_WAIKIKI NATATORIUM_EIS\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\10022 FIGURE 4 - BORING LOCATION PLAN.DWG

APPROXIMATE BORING LOCATION PLAN

Waikiki War Memorial Complex at Waikiki Beach

Honolulu, Oahu, Hawaii

Project No. 10022

REFERENCE:

- Topographic Survey by Sam O. Hirota, Inc., Dated October 20, 2010
- Wil Chee-Planning & Environmental, Preferred Alternative, Dated August 2010

NOTES:

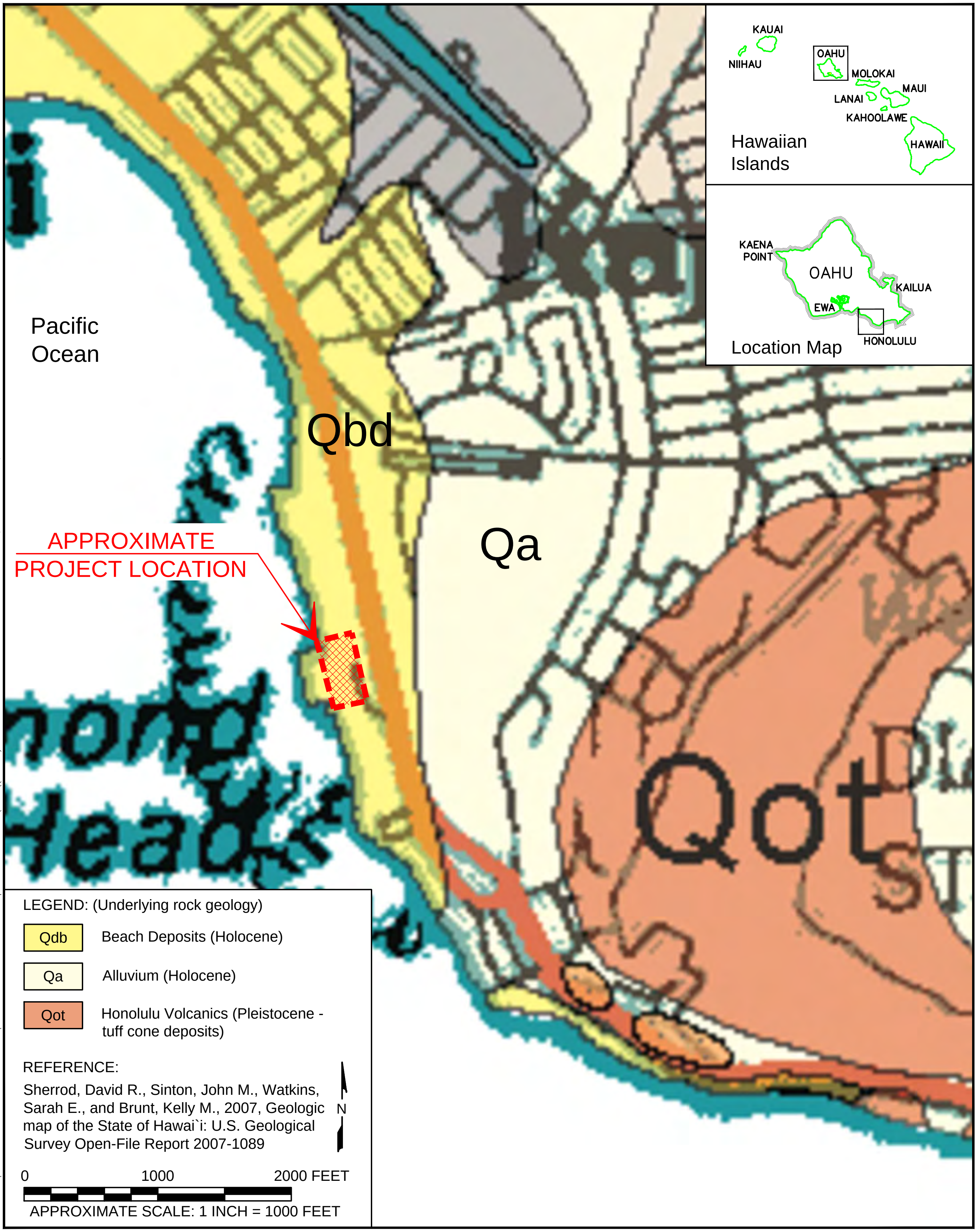
- Exploratory Boring Location
- Exploratory Test Pit Location
- DCP Test Location

0 80 160 FEET

APPROXIMATE SCALE: 1 INCH = 80 FEET

YOGI KWONG ENGINEERS, LLC

FIGURE 4



REGIONAL GEOLOGY MAP

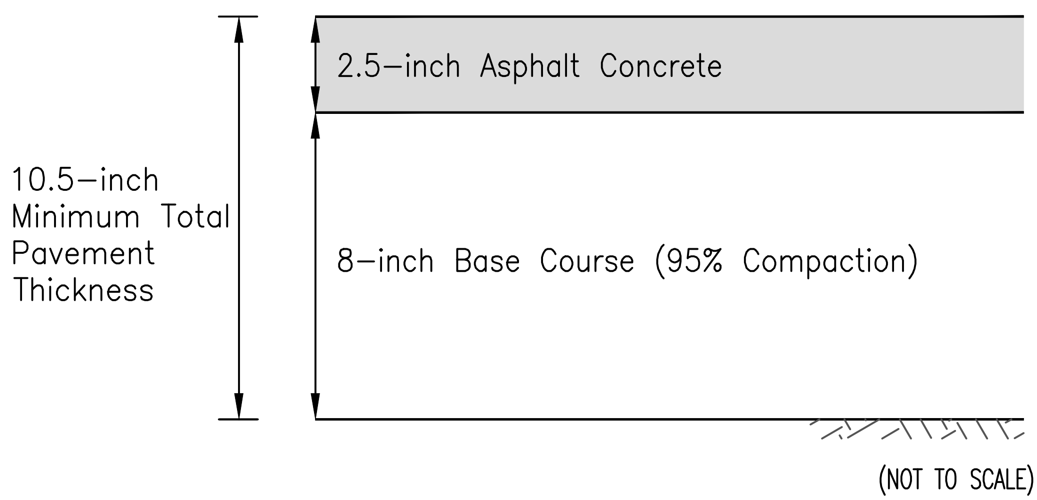
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022

YKE
YOGI KWONG ENGINEERS, LLC

FIGURE 5

P:\10022 WAIKIKI NATATORIUM EIS\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\(10022) FIGURES 1 TO 3 & 5 - PROJECT LOCATION, AERIAL PHOTO, REGIONAL GEOLOGY.DWG



DESIGN ASSUMPTIONS:

1. Traffic = Passenger cars, two axle trucks, occasional trash vehicles and large emergency vehicles
2. Subgrade Compaction CBR = 7.5
3. Base Course CBR = 80

PAVEMENT THICKNESS RECOMMENDATION FOR PRKING LOT

Waikiki War Memorial Complex at Waikiki Beach

Honolulu, Oahu, Hawaii

Project No. 10022

Yogi Kwong Engineers, LLC

FIGURE 6

P:\10022 Waikiki Natatorium EIS\500.00 Engineering Analysis\505.01 AutoCad Drawings\Report Figures\dwg\10022 - Figure 6 - Pavement and Concrete Thickness Drawings.dwg

Plotted on November 11, 2011

LIST OF APPENDIX FIGURES

APENDIX A FIELD EXPLORATION

This appendix summarizes the results of our field exploration and soil sampling performed in support of the proposed Waikiki War Memorial Complex at Waikiki Beach. Refer to Section 3.3 of report for anticipated subsurface conditions for this project. The location of the study corridor is presented in Figure 1, and the approximate boring locations are presented in Figure 4.

A.1 EXPLORATORY BORINGS

The borings were drilled by YK Drilling LLC (YKD) using a Simco SK2400 drill rig with 4-inch solid-stem, continuous flight augers, and PQ-size steel casing with wireline coring using recirculated water. Drilling methods used are noted on the Logs of Borings, which are presented on Figures A-4 through A-6.

After drilling, the borings were backfilled with drill cuttings and imported gravel as necessary, and then sealed with bentonite and cement grout in the top 5 feet.

A.2 SOIL SAMPLING

Soil sampling was conducted under the observation of YKE personnel, who logged the materials encountered in the boring and obtained samples for further examination and laboratory tests.

Both relatively undisturbed and disturbed soil samples were obtained using a Standard Penetration Test (SPT) sampler or a Dames & Moore type “U” sampler. The SPT or Dames & Moore samplers were driven into the ground by successive blows of a 140-pound hammer falling 30 inches. The sampler was driven for a total distance of 18 inches, and blow counts for each 6 inches of penetration were recorded. Where the SPT sampler was used, this procedure followed the American Society of Testing and Materials (ASTM) D1586 standard for determining the standard penetration resistance of soil. Blow counts for the last 12 inches of penetration are noted on the Logs of Borings.

Soil samples were initially classified in the field according to ASTM D2488 and the Unified Soil Classification System shown on Figure A-1. The field classifications were later refined according to ASTM D2487 based on the results of laboratory tests performed on selected samples.

Rock cores were obtained using PQ coring in maximum 5-foot lengths. Percentages of recovery and Rock Quality Designation (RQD) were recorded for each core run. The RQD was determined by measuring the percentage of rock pieces greater than 4-inches in length over the entire length of the core run, in accordance with the ASTM D6032 standard test method. Rock cores were classified according to Figure A-2, Description of Rock Materials.

Figure A-2, references material from both the International Society of Rock Mechanics and ASTM D4879 Standard Guide for Geotechnical Mapping of Large Underground Openings in Rock.

Samples recovered during the field exploration program were transported to our office in Honolulu for further examination and laboratory testing.

A.3 DYNAMIC CONE PENETROMETER (DCP) TEST

Two (2) Dynamic Cone Penetrometer (DCP) tests were completed by YKE personnel to approximate depths of 10.5 and 9 feet below the existing ground surface. The tests were performed in accordance with ASTM Special Technical Publication #399. The DCP test consists of driving a cone tip 1.75 inches into the ground by successive blows of a 15 pound hammer falling 20 inches. The number of blows and penetration were recorded, and the resulting penetration rate can be related to the N-values derived from Standard Penetration Tests. Hand auger probes were conducted along the DCP tests after four (4) consecutive 1.75-inch increments, in order to minimize the effect of side friction of the shaft and record descriptions of the encountered soils. Approximate locations of the DCP tests are shown on Figure 4. The DCP and hand auger probe logs are presented on Figures A-8 and A-9.

SOIL CLASSIFICATION CHART

	Major Divisions		Symbol	Typical Names	Other Criteria
COARSE GRAINED SOILS More than 50% of material larger than No. 200 sieve size	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravel** Little or no fines (<5%)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Cu>4 and 1<=Cc=3
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting Cu and Cc criteria for GW
		Gravels with Fines Appreciable amount of fines (>12%)	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limit below A-line or PI<4
			GC	Clayey gravels, gravel-sand-silt mixtures	Atterberg limit above A-line with PI>7
	Sands More than 50% of coarse fraction passing No. 4 sieve	**Clean Sands** Little or no fines (<5%)	SW	Well-graded sands, gravelly sands, little or no fines	Cu>6 and 1<=Cc=3
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting Cu and Cc criteria for SW
		Sands with Fines Appreciable amount of fines (>12%)	SM	Silty sands, sand-silt mixture	Atterberg limit below A-line or PI<4
			SC	Clayey sands, sand-clay mixture	Atterberg limit above A-line with PI>7
FINE GRAINED SOILS More than 50% of material smaller than No. 200 sieve size	**Silts and Clays** Liquid limit less than 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Atterberg limit below A-line
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clay	Atterberg limit above A-line
			OL	Organic silts and organic silty clays flow plasticity	Atterberg limit below A-line
	Silts and Clays Liquid limit larger than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Atterberg limit below A-line
			CH	Inorganic clays of high plasticity, fat clays	Atterberg limit above A-line
			OH	Organic clays of high plasticity, organic silts	Atterberg limit below A-line
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils	

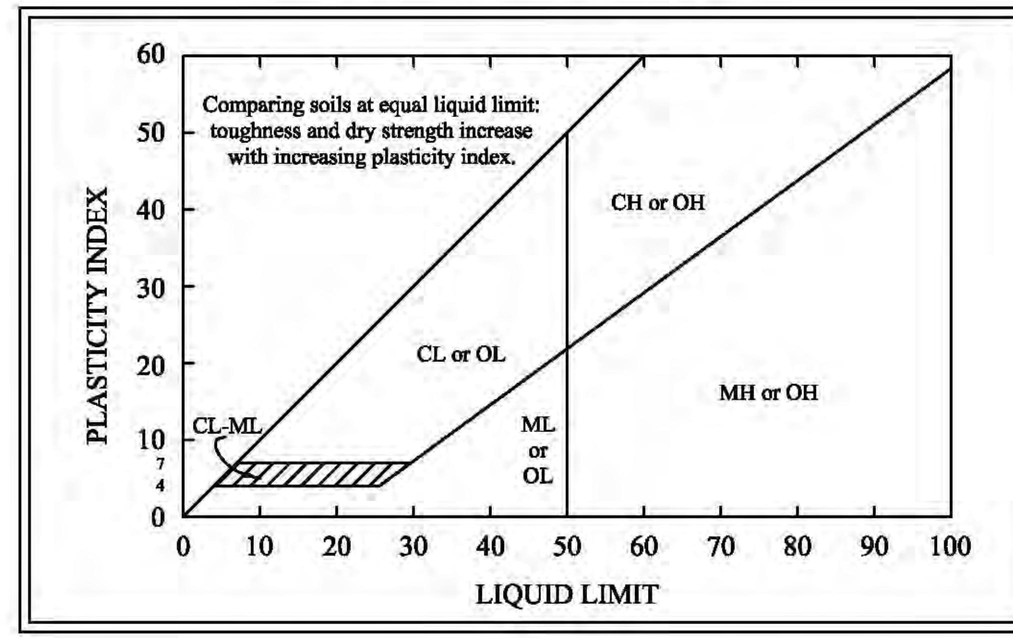
Notes: 1. Cu = D60/D10, Cc = (D30)^2/(D60 x D10) where D60, D30 and D10 are diameters associated with 60%, 30% and 10% smaller in gradation curves.
2. Dual symbols are used to indicate borderline classifications such as GP/SP.

GRADATION CHART

Soil Fraction		Size Range			
		Lower Limit		Upper Limit	
		Millimeters	Sieve	Millimeters	Sieve
Boulders		304.8	12*	914.4	36*
Cobbles		76.2	3*	304.8	12*
Gravel		4.76	4**	76.2	3*
Sand	Coarse	2	10**	4.76	4**
	Medium	0.42	40**	2	10**
	Fine	0.074	200**	0.42	40**
Fines				0.074	200**

* U.S. standard sieve opening in inches
** U.S. standard sieve number

PLASTICITY CHART



UNIFIED SOIL CLASSIFICATION
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii
Project No. 10022

YOGI KWONG ENGINEERS, LLC
PROJECT NO. 10022

FIGURE A-1

DESCRIPTION OF ROCK MATERIALS

A. DEGREE OF WEATHERING

The following terms were used to describe the chemical weathering of rock:

Extremely Weathered: The original minerals of the rock have been almost entirely altered to secondary minerals, even though the original fabric may be intact.

Highly Weathered: The rock is weakened to such an extent that a 2-inch diameter core can be broken readily by hand across the rock fabric.

Moderately Weathered: Rock is discolored and noticeably weakened, but a 2-inch diameter core cannot usually be broken by hand, across the rock fabric.

Slightly Weathered: Rock is slightly discolored, but not noticeably lower in strength than fresh rock.

Unweathered: Rock shows no discoloration, loss of strength, or any other effect of weathering.

B. HARDNESS

The following terms were used to describe the hardness of rock and soil (per ASTM D4879-08 Standard Guide for Geotechnical Mapping of Large Underground Opening in Rock):

Very Soft or Hard, Soil-like Material (Friable): Scratched with fingernail. Slight indention produced by light blow of point of geologic pick. Requires power tools for excavation. Peels with pocket knife.

Soft Rock: Hand-held specimen crumbles under firm blows with point of geologic pick.

Moderately Soft Rock: Shallow indention (1-3mm) produced by light blows with point of geologic pick. Peels with pocket knife with difficulty.

Moderately Hard Rock: Cannot be scraped or peeled with pocket knife. Intact hand held specimen breaks with single blow of geologic hammer. Can be distinctly scratched with 20d common steel nail.

Hard Rock: Intact held specimen requires more than one hammer blow to break it. Can be faintly scratched with 20d common steel nail.

Very Hard Rock: Intact specimen breaks only by repeated, heavy blows with geologic hammer. Cannot be scratched with 20d common steel nail.

C. ROCK FRACTURE CHARACTERISTICS

The general fracture spacing is described in the boring log according to the following criteria:

Crushed: Less than 5 microns (mechanical clay) to 0.1 foot.

Intensely Fractured: 0.05 to 0.1 foot (contain no clay).

Closely Fractured: 0.1 to 0.5 feet.

Moderately Fractured: 1.0 to 3.0 feet.

Very Widely Fractured: Over 3 feet.

WAIKIKI WAR MEMORIAL COMPLEX AT WAIKIKI BEACH

LOG OF BORING KEY

LOCATION: HONOLULU, OAHU, HAWAII
DATE(S) DRILLED:
GROUND SURFACE ELEVATION:
LOGGED BY:
CHECKED BY:
GROUNDWATER LEVEL / DATE:
HAMMER TYPE:
HAMMER WEIGHT/DROP:
CONTRACTOR:
DRILLING METHOD:
DRILL EQUIP:
BOREHOLE BACKFILL:

ELE. (FT, MSL)	DEPTH (FT)	SAMPLE TYPE	SAMPLE NO.	SAMPLING RESISTENCE	RECOVERY, %	RQD, %	GRAPHIC LOG	DESCRIPTION	WATER CONTENT, %	DRY UNIT WEIGHT, pcf	UCS, psf	LIQUID LIMIT	PLASTICITY INDEX	OTHER TESTS AND REMARKS
0	0							STRATA SYMBOLS						
								Asphalt concrete pavement						
								Well-graded gravel (GW)						
								Silty gravel (GM)						
								Elastic silt (MH)						
-5	5							Silt (ML)						
								Well-graded sand (SW)						
								Poorly graded sand (SP)						
								Silty sand (SM)						
								Sand with silt (SW-SM)						
-10	10							Coral reef limestone						
								SAMPLER SYMBOLS						
								Standard Penetration Test (SPT) sampler						
								Dames and Moore (D&M) sampler						
				10				Number of blows to advance sampler 12 inches, or distance indicated						
-15	15							Core sample						
								Bulk Sample						
						40		Rock Quality Designation, % of sample that is > 4 inches						
-20	20							ABBREVIATIONS FOR TESTS						
								Gravel = % of sampler passing through 76.2 mm sieve and retained on #4 sieve						
								Sand = % of sample passing through #4 sieve and retained on #200 sieve						
								Fines = % of sample passing through #200 sieve						
								Consol = One-Dimensional Consolidation Test						
-25	25							CBR = California Bearing Ration Test						
								Mod. Proctor = Modified Proctor Compaction Test						
								ABBREVIATIONS						
								WOH = Weight of Hammer						
-30	30													

WAIKIKI WAR MEMORIAL COMPLEX AT WAIKIKI BEACH

LOG OF BORING B-1

LOCATION: HONOLULU, OAHU, HAWAII
DATE(S) DRILLED: 7-18-11
GROUND SURFACE ELEVATION: 7.7 FT MSL
LOGGED BY: D. GANDY
CHECKED BY: R. HASHIRO
GROUNDWATER LEVEL / DATE: 7 FT BGS / 7-18-11
HAMMER TYPE: SAFETY
HAMMER WEIGHT/DROP: 140 LB / 30 IN
CONTRACTOR: YK DRILLING, LLC
DRILLING METHOD: 4-INCH SSA, WASH BORE, PQ WIRELINE
DRILL EQUIP: SIMCO 2400 SK-1
BOREHOLE BACKFILL: CUTTINGS, GROUT

SAMPLE NO.	SAMPLING RESISTENCE	RECOVERY, %	RQD, %	DESCRIPTION	WATER CONTENT, %	DRY UNIT WEIGHT, pcf	UCS, psf	LIQUID LIMIT	PLASTICITY INDEX	OTHER TESTS AND REMARKS
				FILL Brown with specks of tan sandy elastic silt with roots (MH), medium stiff, moist to dry						
1	8	89								
				BEACH DEPOSIT Off-white to tan poorly graded coralline sand with basalt and coralline gravel (SP), very loose, moist to dry						
2	3	50								
3	6	33								
4	4	72		grades with roots, moist						Install casing @ 7' bgs
5	30/0"	0								Sampler bouncing @ 7' bgs
				CORAL REEF LIMESTONE Off-white to tan moderately to strongly cemented coral reef limestone, hard, closely to intensely fractured, contains voids						Off-white water return
PQ-1		100	72							Driller reports core barrel dropping 2-4" in several zones during PQ-1 and PQ-2
PQ-2		77	40	contains local uncemented gravel zones, fissures with shell fragments, porous and sand in voids						No water return
				Boring completed at 17.0 feet below existing ground surface on 7/18/2011.						

Depth scale (FT): 0, 5, 10, 15, 20, 25, 30. Elevation scale (FT, MSL): 5, 0, -5, -10, -15, -20.

WAIKIKI WAR MEMORIAL COMPLEX AT WAIKIKI BEACH

LOG OF BORING B-2

Sheet 1 of 1

LOCATION: HONOLULU, OAHU, HAWAII
DATE(S) DRILLED: 7-18-11
GROUND SURFACE ELEVATION: 7.5 FT MSL
LOGGED BY: D. GANDY
CHECKED BY: R. HASHIRO
GROUNDWATER LEVEL / DATE: 7 FT BGS / 7-18-11
HAMMER TYPE: SAFETY
HAMMER WEIGHT/DROP: 140 LB / 30 IN
CONTRACTOR: YK DRILLING, LLC
DRILLING METHOD: 4-INCH SSA, WASH BORE, PQ WIRELINE
DRILL EQUIP: SIMCO 2400 SK-1
BOREHOLE BACKFILL: CUTTINGS, GROUT

ELE. (FT. MSL)	DEPTH (FT)	SAMPLE TYPE	SAMPLE NO.	SAMPLING RESISTANCE	RECOVERY, %	RQD, %	GRAPHIC LOG	DESCRIPTION	WATER CONTENT, %	DRY UNIT WEIGHT, pcf	UCS, psf	LIQUID LIMIT	PLASTICITY INDEX	OTHER TESTS AND REMARKS
	0							6" Asphalt Concrete Pavement						
			1	7	100			BEACH DEPOSIT Off-white to tan poorly graded coralline sand with roots and shells (SP), very loose, moist to dry						Elastic silt in top 2" of sample
5			2	5	78			becomes loose, moist	6.4					
	5		3	8	100			becomes very loose						
			4	5	78			becomes loose	12.4					Gravel = 1% Sand = 98% Fines = 1%
0			5	83	100			CORALLINE DEPOSIT Off-white to tan well-graded coralline sand with silt and gravel (SW), dense, wet						
			6	53	94			grades with more gravel, very dense						Install casing @ 9' bgs
	10		PQ-1		71			Off-white to tan silty well-graded coralline gravel with sand (GM), loose, wet						Partial brown water return
-5			7	25	39									
			8	30	89			becomes medium dense to dense						
	15		PQ-2		71			contains coralline cobble, gravel and shells						Partial brown water return
-10			9	66	100			becomes gray and medium dense						
	20		PQ-3		38			contains coralline cobbles and gravel						Partial brown water return
-15			10	17	78			becomes loose						
	25		PQ-4		26			contains coralline gravel						Partial brown water return
-20			11	32	67			becomes medium dense						
			12	12	50			Boring completed at 30.0 feet below existing ground surface on 7/18/2011.						
	30													

WAIKIKI WAR MEMORIAL COMPLEX AT WAIKIKI BEACH

LOG OF BORING B-3

LOCATION: HONOLULU, OAHU, HAWAII
DATE(S) DRILLED: 7-18-11
GROUND SURFACE ELEVATION: 7.5 FT MSL
LOGGED BY: D. GANDY
CHECKED BY: R. HASHIRO
GROUNDWATER LEVEL / DATE: 7 FT BGS / 7-18-11
HAMMER TYPE: SAFETY
HAMMER WEIGHT/DROP: 140 LB / 30 IN
CONTRACTOR: YK DRILLING, LLC
DRILLING METHOD: 4-INCH SSA, WASH BORE, PQ WIRELINE
DRILL EQUIP: SIMCO 2400 SK-1
BOREHOLE BACKFILL: CUTTINGS, GROUT

ELE. (FT, MSL)	DEPTH (FT)	SAMPLE NO.	SAMPLING RESISTENCE	RECOVERY, %	RQD, %	DESCRIPTION	WATER CONTENT, %	DRY UNIT WEIGHT, pcf	UCS, psf	LIQUID LIMIT	PLASTICITY INDEX	OTHER TESTS AND REMARKS
	0	1	22	100		FILL Brown with tan specks elastic silt with sand and roots (MH), stiff, moist						
5		2	15	72		BEACH DEPOSIT Off-white to tan poorly graded sand with roots (SP), medium dense, moist	8.3					
		3	15	100		becomes loose						
	5	4	6	78			10.3					
		5	11	100		becomes very loose to loose						
0		6	26	78		Dark gray to off-white well-graded coralline/basalt sand with silt (SW-SM), medium dense, wet	26.7					Gravel = 10% Sand = 84% Fines = 6% Install casing @ 9' bgs
	10					LAGOONAL DEPOSIT Off-white to greenish gray well-graded coralline gravel with sand (GW), very loose, wet						
-5		7	4	11								
	15	8	2	83		Gray silty sand with shells (SM), very loose, wet	60.5	65.7				Gravel = 5% Sand = 55% Fines = 40% Consol
-10		9	WOH	100		Gray sandy silt with shells (ML), very soft, wet	58.4	67.7		35.5	3.8	Consol
	20											
-15		10	WOH	100								
	25											
-20		11	1	100								SPT probe started @ 28.5' bgs where very soft/very loose conditions were encountered
	30											

WAIKIKI WAR MEMORIAL COMPLEX AT WAIKIKI BEACH

LOG OF BORING B-3

LOCATION: HONOLULU, OAHU, HAWAII
DATE(S) DRILLED: 7-18-11
GROUND SURFACE ELEVATION: 7.5 FT MSL
LOGGED BY: D. GANDY
CHECKED BY: R. HASHIRO
GROUNDWATER LEVEL / DATE: 7 FT BGS / 7-18-11
HAMMER TYPE: SAFETY
HAMMER WEIGHT/DROP: 140 LB / 30 IN
CONTRACTOR: YK DRILLING, LLC
DRILLING METHOD: 4-INCH SSA, WASH BORE, PQ WIRELINE
DRILL EQUIP: SIMCO 2400 SK-1
BOREHOLE BACKFILL: CUTTINGS, GROUT

ELE. (FT, MSL)	DEPTH (FT)	SAMPLE TYPE	SAMPLE NO.	SAMPLING RESISTENCE	RECOVERY, %	RQD, %	GRAPHIC LOG	DESCRIPTION	WATER CONTENT, %	DRY UNIT WEIGHT, pcf	UCS, psf	LIQUID LIMIT	PLASTICITY INDEX	OTHER TESTS AND REMARKS
	30													
-25														
	35													
-30														
	40													
-35														SPT probe refusal @ 43.5' bgs
								Boring completed at 43.5 feet below existing ground surface on 7/18/2011.						
	45													
-40														
	50													
-45														
	55													
-50														
	60													

WAIKIKI WAR MEMORIAL COMPLEX AT WAIKIKI BEACH

LOG OF BORING TP-1

LOCATION: HONOLULU, OAHU, HAWAII
DATE(S) DRILLED: 7-13-11
GROUND SURFACE ELEVATION: 7.5 FT MSL
LOGGED BY: B. FUKUDA
CHECKED BY: R. HASHIRO
GROUNDWATER LEVEL / DATE: N/A
HAMMER TYPE: N/A
HAMMER WEIGHT/DROP: N/A
CONTRACTOR: YOGI KWONG ENGINEERS, LLC
DRILLING METHOD: MANUAL
DRILL EQUIP: HAND SHOVEL
BOREHOLE BACKFILL: CUTTINGS

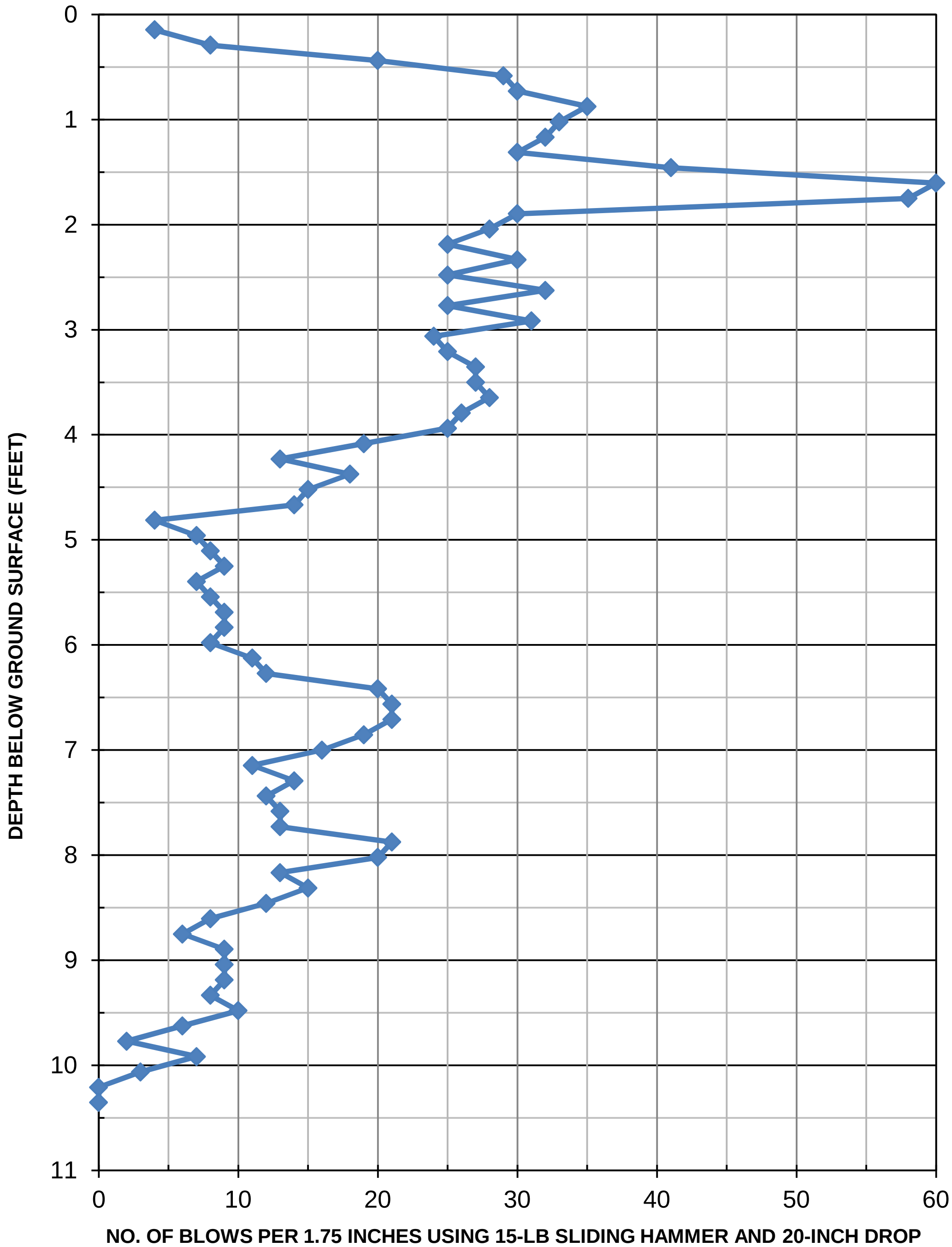
ELE. (FT, MSL)	DEPTH (FT)	SAMPLE TYPE	SAMPLE NO.	SAMPLING RESISTENCE	RECOVERY, %	RQD, %	GRAPHIC LOG	DESCRIPTION	WATER CONTENT, %	DRY UNIT WEIGHT, pcf	UCS, psf	LIQUID LIMIT	PLASTICITY INDEX	OTHER TESTS AND REMARKS
	0							FILL Dark brown sandy fat clay with roots (CH), moist to dry	28.1			61.8	32.0	CBR Mod. Proctor
5								Grades to brown to tan poorly graded sandy elastic silt (MH)						
								Excavation complete at 2.25 feet below ground surface on 7-13-2011						
	5													
0														
	10													
-5														
	15													
-10														
	20													
-15														
	25													
-20														
	30													

v3

YOGI KWONG ENGINEERS, LLC

Date Printed:11/28/2011

FIGURE A-7



Exploration Log

0' - 2.5'
Dark brown with tan specks elastic silt with sand and roots, dry to moist

2.5' - 4.2'
Light brown and tan silty sand with gravel, moist

4.2' - 8.0'
grades to tan coralline sand with less silt

8.0' - 9.6'
becomes dark gray to off - white, wet

9.6' - 10.4'
Off-white to greenish gray coralline gravel and sand (Lagoonal Deposits)
DCP-1 completed at 10.4' bgs on 10/24/11

Location	Date	Test Elevation (feet bgs)	Notes
DCP-1	10/24/11	N/A	DCP Test performed at proposed bath house

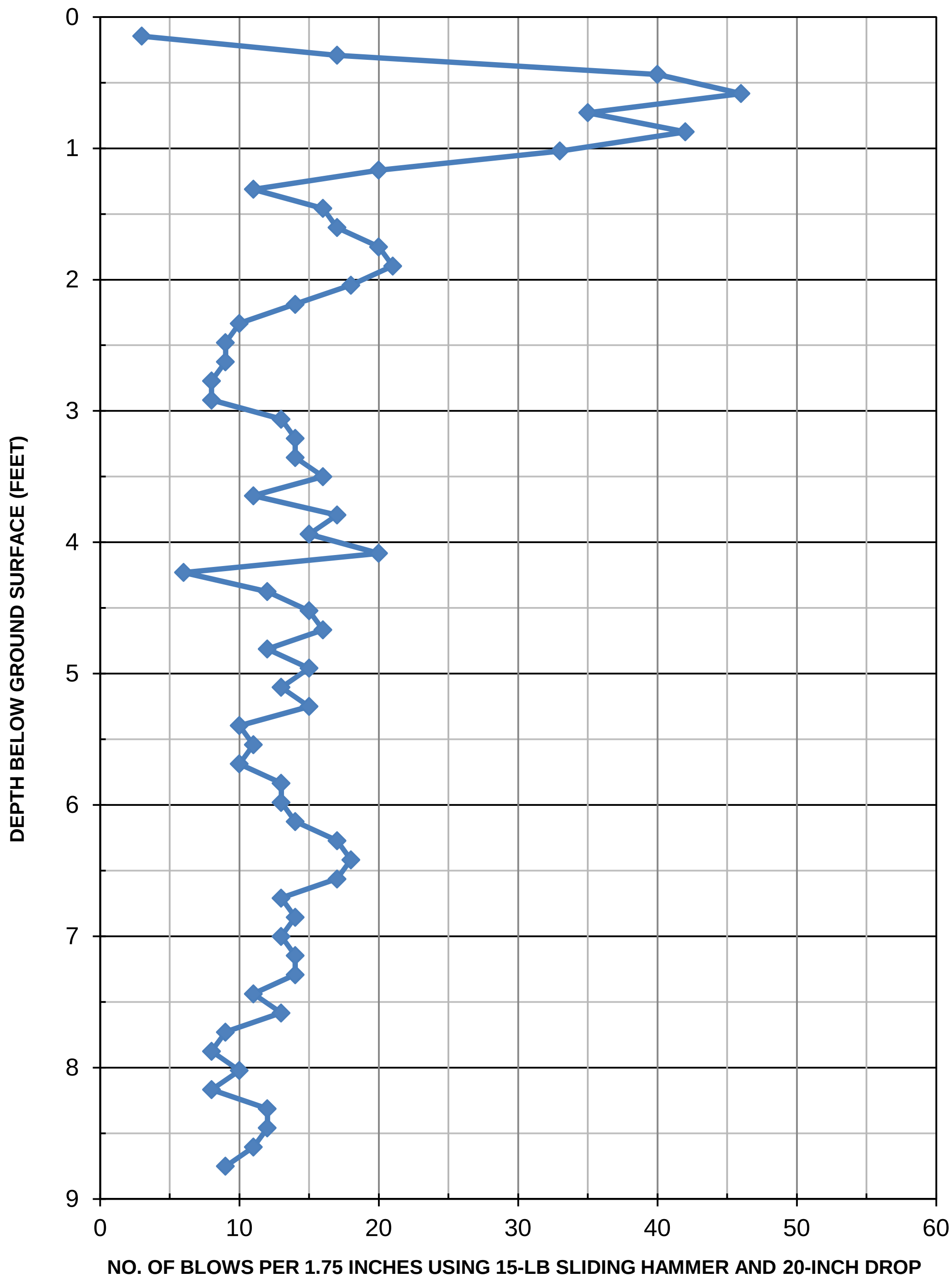
Project: Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project Number: 10022

DCP TEST & HAND AUGER PROBE

FIGURE A-8

Yogi Kwong Engineers, LLC



Exploration Log

0' - 2.3'
Dark brown with tan specks elastic silt with sand and roots, dry to moist

2.3' - 4.1'
Light brown and tan silty sand with gravel, moist

4.1' - 7.6'
grades to tan coralline sand with less silt

7.6' - 8.8'
becomes tan to white, wet
DCP-2 completed at 8.8' bgs on 10/24/11

Location	Date	Test Elevation (feet bgs)	Notes
DCP-2	10/24/11	N/A	DCP Test performed at proposed parking lot

Project: Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project Number: 10022

DCP TEST & HAND AUGER PROBE

Yogi Kwong Engineers, LLC

FIGURE A-9

APPENDIX B LABORATORY TESTING

To verify field classifications, selected soil samples obtained during the field exploration were laboratory tested for moisture contents, dry densities, Atterberg limits (plasticity index), unconfined compressive strength, modified proctor compaction, California Bearing Ratio, and one-dimensional consolidation tests. The tests and results are described in the following paragraphs.

B.1 MOISTURE CONTENT AND DRY DENSITY

Selected soil samples were tested to measure their moisture contents and dry densities. The tests were performed in accordance with American Society for Testing and Materials (ASTM) Test Method D2216 and D2937. When measuring the moisture content, each sample had a minimum mass of 20 grams and was dried in a draft oven at 110°C for at least 12 hours. The densities were found by testing relatively undisturbed ring samples from a Dames and Moore sampler. Moisture contents and dry densities are presented on the Log of Borings at the appropriate sample depths.

B.2 ATTERBERG LIMITS (PLASTICITY INDEX)

To assist in soil classification, the liquid limit and plastic limit tests were performed on select samples. The tests were performed in accordance with ASTM D4318. This test is useful for determining the plasticity of a soil and whether the fines behave more like a clay or silt. After passing the sample through a No. 40 sieve and mixing it thoroughly with water, the soil was put into a liquid limit device where blows were counted to close a 2 mm groove. The procedure was repeated with varying moisture contents. After plotting the data, the liquid limit was taken as the moisture content needed to close the 2 mm groove at 25 blows. The plastic limit was the moisture content of the soil when it was able to be rolled into 3.2 mm diameter threads. The plasticity index is the difference between the liquid limit and plastic limit. The results are presented in Figure B-1, and also in the Logs of Borings at the appropriate sample depths.

B.3 ONE-DIMENSIONAL CONSOLIDATION TEST

The compressibility of a relatively undisturbed soil samples are determined by the performance of one-dimensional consolidation test in accordance with ASTM D2435. The consolidation test is used to estimate the magnitude and rate of differential and total settlement. This method restrained the sample laterally and drained it axially. Typically, the ring samples, approximately 61 mm (2.4-inches) in diameter, are cut to 19 mm (0.75-inches) in height, maintaining a minimum 2.5 diameter-to-height ratio. The samples are placed into a consolidometer and loaded incrementally every 24 hours. Once the sample reached the end of the consolidation, it is then unloaded incrementally every 24 hours until all the loads are removed. The results are presented in Figure B-2 and Figure B-3.

B.4 CALIFORNIA BEARING RATIO (CBR)

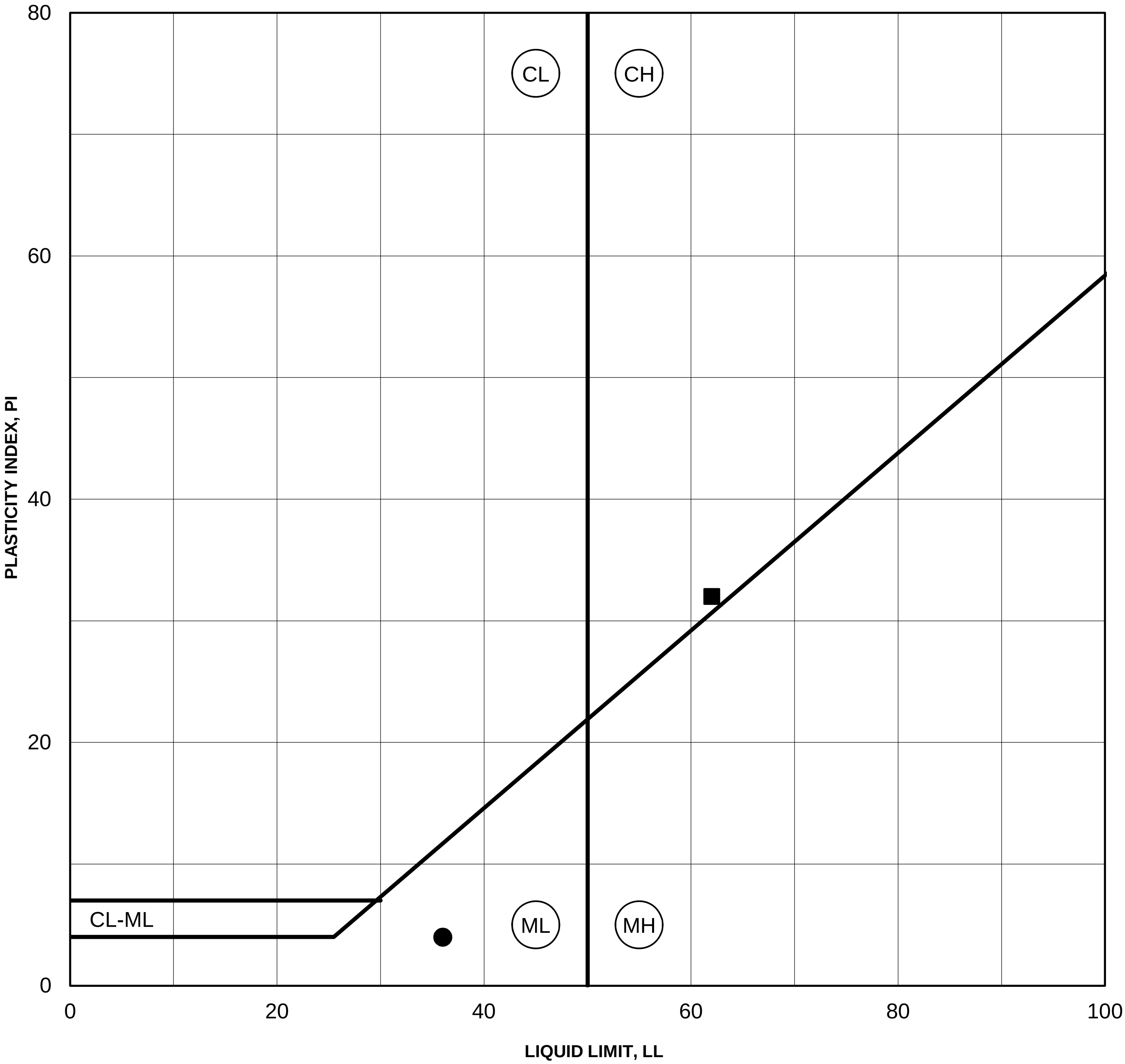
Laboratory CBR tests were performed on near surface bulk samples obtained at select boring locations in accordance with ASTM D1883-05 test procedures. The CBR tests were performed at the optimum moisture contents of the bulk samples as determined by the Modified Proctor Compaction test performed in accordance with ASTM D1557. After compaction, the samples were soaked in water for four (4) days and then penetrated by a cylindrical rod. The penetration resistance, in load per unit area, was taken at specific penetration values and the results were plotted to find the CBR values in accordance with the prescribed methods in ASTM D1883-05. The test results are presented in Figure B-4.

B.5 MODIFIED PROCTOR COMPACTION TEST

Modified Proctor Compaction Tests were performed on near surface bulk samples obtained within the project site. The tests were performed in accordance with ASTM D1557-07 test procedures. The soil is first passed through a No. 4 sieve (4.75 mm) and is separated into five pound specimens. The soil is then placed into a 4 inch diameter mold and compacted in 5 layers with 25 blows of a 10 pound hammer applied to each layer. The moisture content and the density was taken at the end of the test. The test is repeated with varying moisture contents. A minimum of four sets of moisture contents and densities were plotted on a graph to find the optimum moisture content and density. The test results are presented in Figure B-5.

B.7 GRADATION ANALYSIS

Gradation analyses (ASTM D422) were performed on selected samples using the wash sieve method to evaluate grain size distribution. The soil was passed through various sieves with decreasing opening sizes. The dry weights retained on each sieve were used to calculate the percent passing for each grain size. Results of gradation analyses are presented on Figure B-6 and included on the Log of Borings at the appropriate sample depths.



Boring		Depth (ft)	LL %	PL %	PI %	Classification
●	B-3	17-18.5	36	32	4	Silt (ML)
■	TP-5	1.0-2.0	62	30	32	Fat clay (CH)

Project: Waikiki War Memorial Complex at Waikiki Beach

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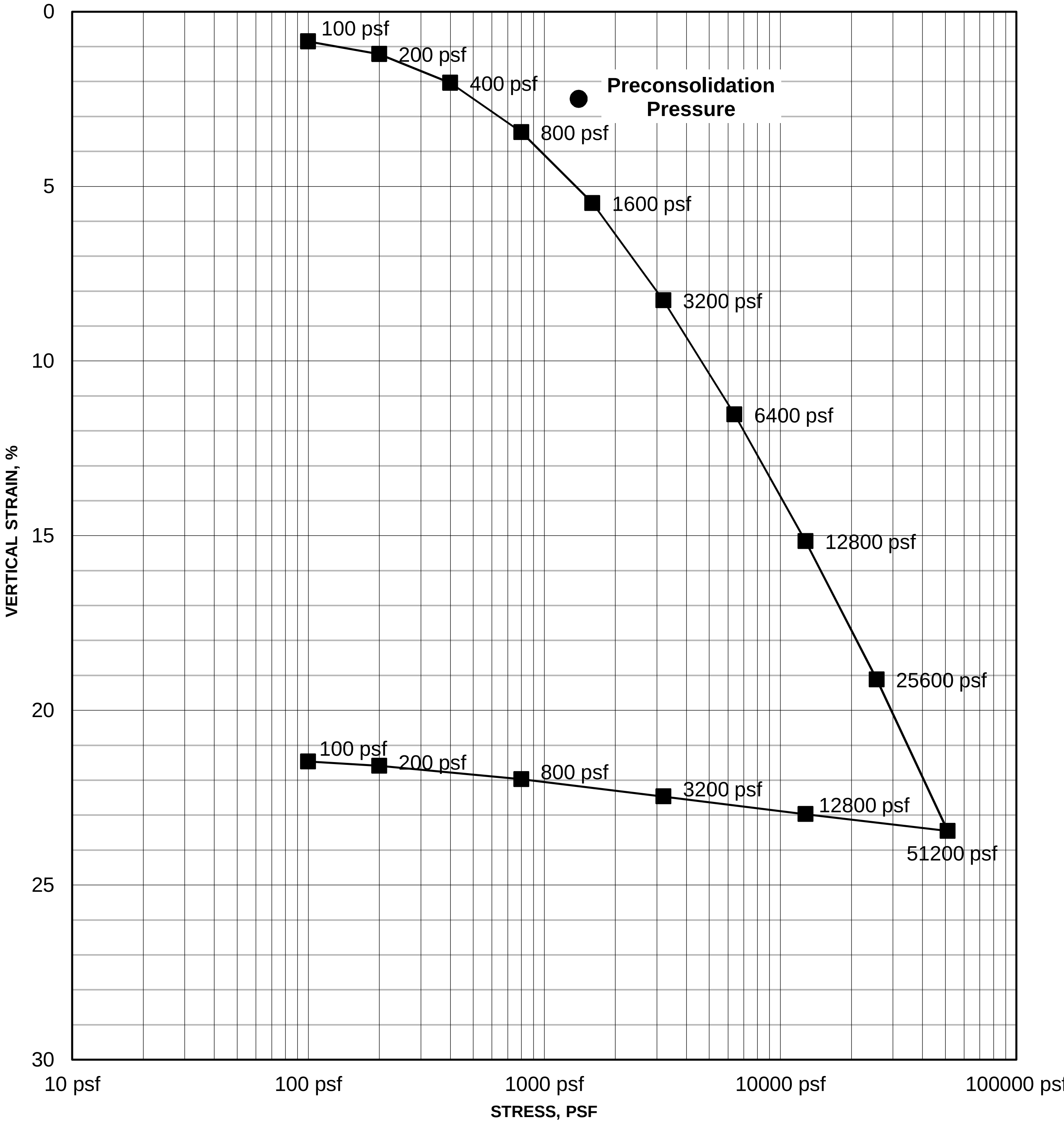
PLASTICITY CHART

FIGURE B-1

Yogi Kwong Engineers, LLC



Boring	Depth (ft)	Description	LL	PI	Initial		Final		p_o (psf)	$C\varepsilon_c$ (*)	$C\varepsilon_r$ (*)
					w_o (%)	γ_d (pcf)	w_o (%)	γ_d (pcf)			
B-3	14.0	Gray Silty Sand with Shells	-	-	60.5	65.7	35.7	83.7	1400	12.6	0.77

* % Vertical Strain / Log Stress

Project: Waikiki War Memorial Complex at Waikiki Beach

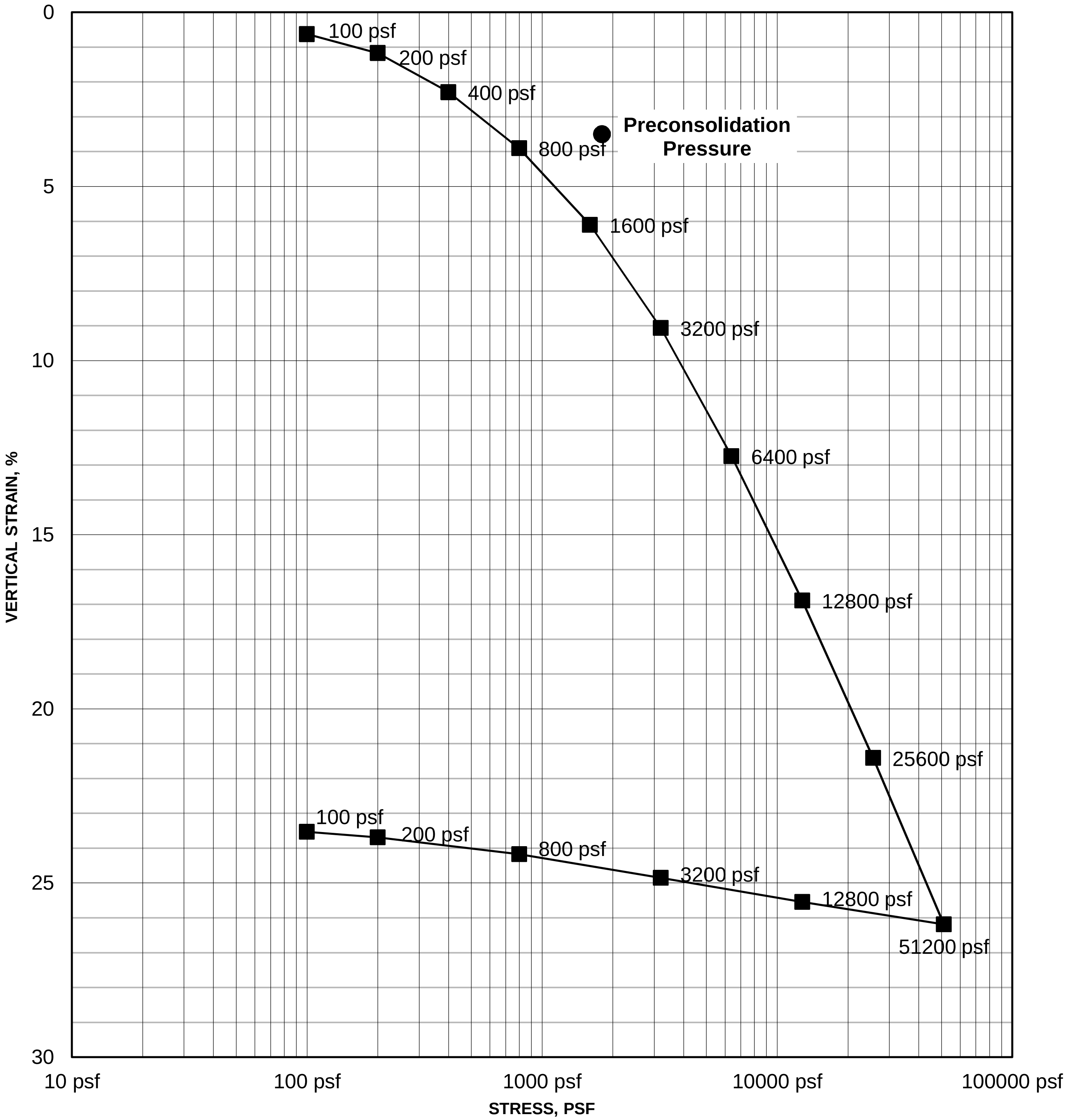
Honolulu, Oahu, Hawaii

CONSOLIDATION TEST

Project Number: 10022

Yogi Kwong Engineers, LLC

FIGURE B-2



Boring	Depth (ft)	Description	LL	PI	Initial w_o (%)	Initial γ_d (pcf)	Final w_o (%)	Final γ_d (pcf)	p_o (psf)	$C\varepsilon_c$ (*)	$C\varepsilon_r$ (*)
B-3	17.0	Gray Sandy Silt with Shells	36	4	58.4	67.7	34.2	72.9	1800	14.9	1.06

* % Vertical Strain / Log Stress

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Honolulu, Oahu, Hawaii

Project Number: 10022

CONSOLIDATION TEST

FIGURE B-3

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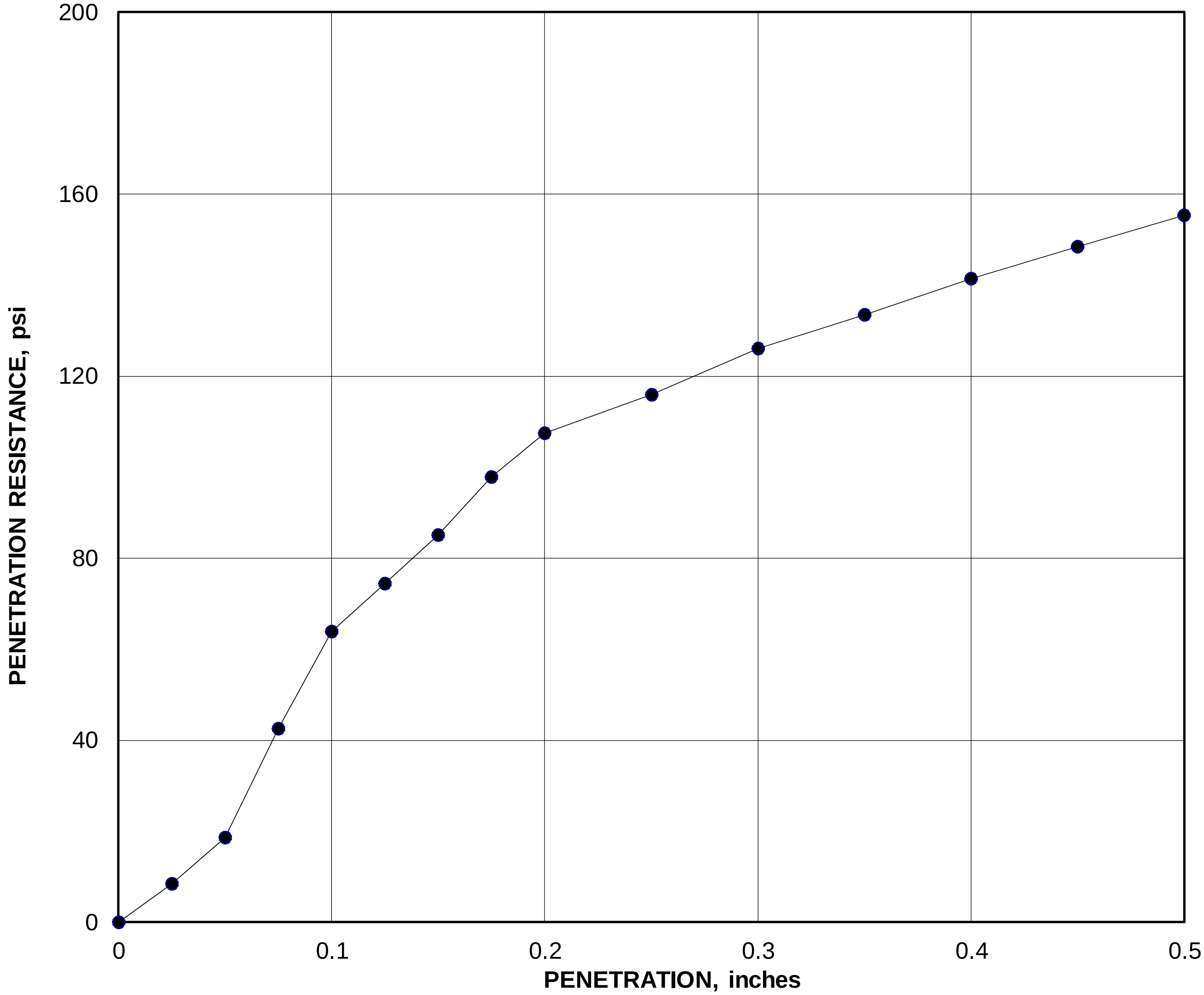

ASTM TEST SPECIFICATION: D 1883-05 Standard Test Method for CBR of Laboratory-Compacted Soil

Boring	Test Pit 1	**Depth**	1' - 2'
Description	Dark brown sandy fat clay		

Modified Proctor Maximum Dry Density (γ_{dmax}, pcf)	Optimum Moisture Content (w_{opt}, %)
108.6	9.4

Test No.		1	2	3
Initial	Moisture Content, %	9.9		
	Dry Density, pcf	104.3		
Final	Moisture Content, %	10.3		
	Dry Density, pcf	104.3		
Linearity Correction (in.)		0.026		
Surcharge Weight, lbs		10		
Total Swell, %		0.0		
CBR Value @ 0.1"		7.5		
CBR Value @ 0.2"		7.4		

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Honolulu, Oahu, Hawaii

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LABORATORY CBR TEST

FIGURE B-4

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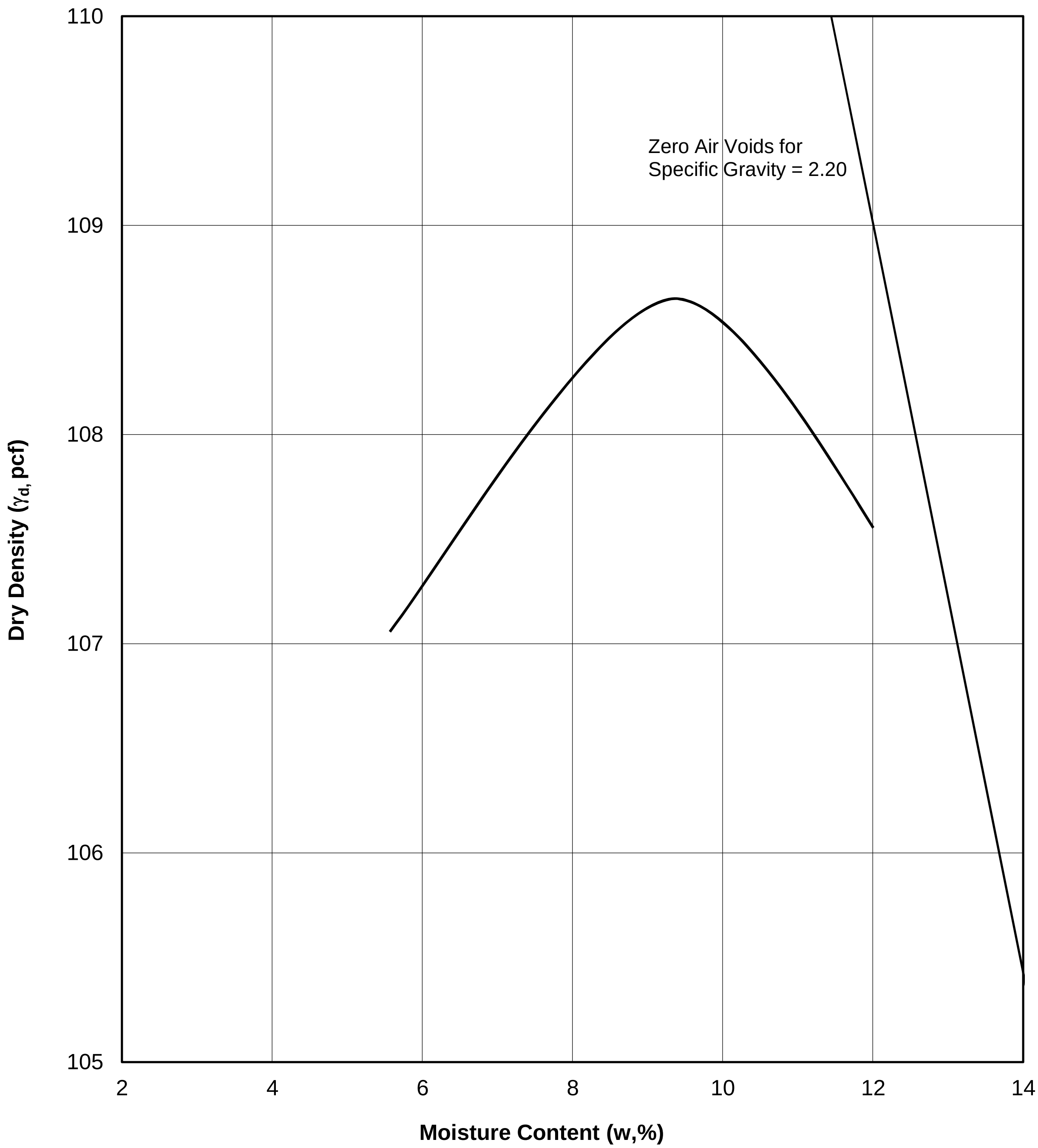


ASTM TEST SPECIFICATION: D 1557-00 Method C MODIFIED

	CLASSIFICATION		PLASTICITY		Specific Gravity	TEST RESULTS	
Boring Location / Depth	USCS	AASHTO	LL (%)	PI (%)		Maximum Dry Density (γ_{dmax}, pcf)	Optimum Moisture Content (w_{opt}, %)
Test Pit 1 / 1' - 2'	-	-	62	32	2.20	108.6	9.4

Project: Waikiki War Memorial Complex at Waikiki Beach

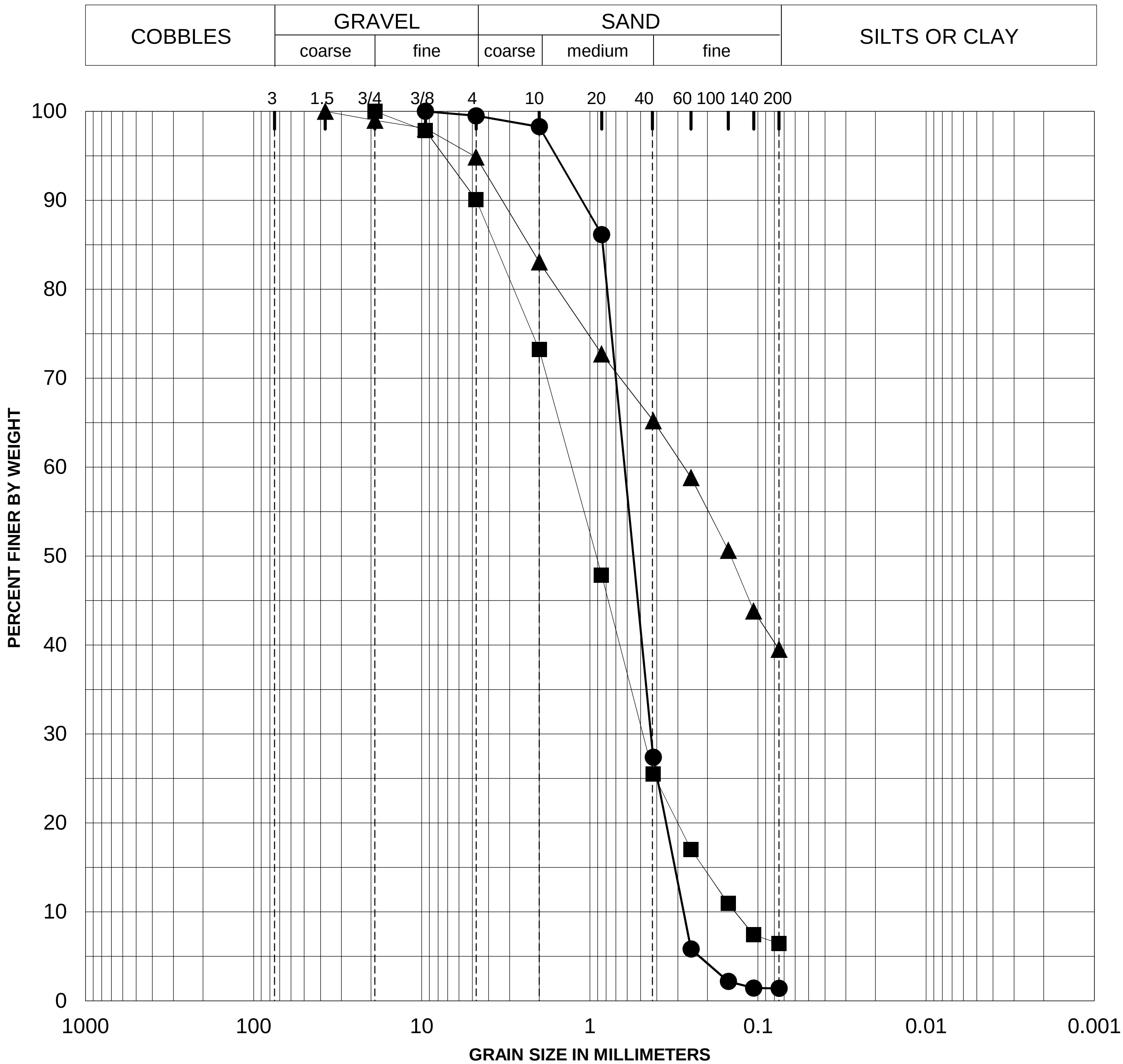
Honolulu, Oahu, Hawaii

MODIFIED PROCTOR COMPACTION TEST

Project Number: 10022

Yogi Kwong Engineers, LLC

FIGURE B-5



Boring		Depth (ft)	Description	Gravel %	Sand %	Fines %
●	B-2	5.5-7	Tan Poorly Graded Coralline Sand	1	98	1
■	B-3	7.5-9	Dark Gray to Off-white Well Graded Sand with Silt	10	84	6
▲	B-3	14-15.5	Gray Silty Sand	5	55	40

Project: Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

GRAIN SIZE DISTRIBUTION CURVES

Project Number: 10022

Yogi Kwong Engineers, LLC

FIGURE B-6

APPENDIX C

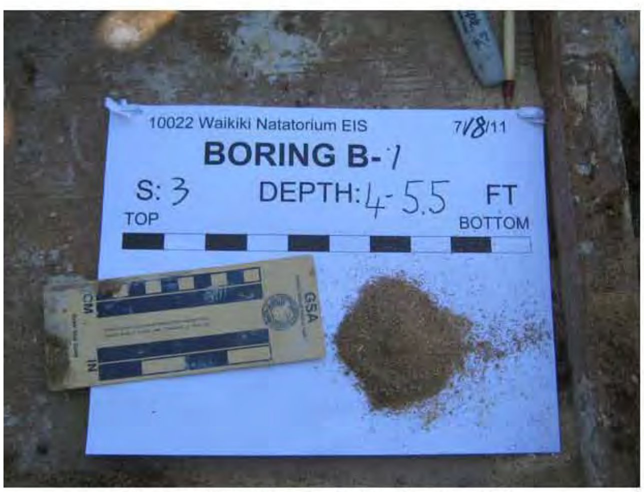
Photographs of Soil Samples

Boring B-1, Sample 1, Depth 1' to 2.5'

Boring B-1, Sample 1, Depth 1' to 2.5'

Boring B-1, Sample 2, Depth 2.5' to 4'

Boring B-1, Sample 2, Depth 2.5' to 4'



Boring B-1, Sample 3, Depth 4' to 5.5'

Boring B-1, Sample 3, Depth 4' to 5.5'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-1

Boring B-1, Sample 4, Depth 5.5' to 7'


Boring B-1, Sample 4, Depth 5.5' to 7'


Boring B-1, Sample 4, Depth 5.5' to 7'

Boring B-1, PQ-1, Depth 7' to 12'

Boring B-1, PQ-1, Depth 7' to 12'


Boring B-1, PQ-1, Depth 7' to 12'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-2

Boring B-1, PQ-1, Depth 7' to 12'

Boring B-1, PQ-2, Depth 12' to 17'

Boring B-1, PQ-2, Depth 12' to 17'

Boring B-1, PQ-2, Depth 12' to 17'

Boring B-1, PQ-2, Depth 12' to 17'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-3

Boring B-2, Sample 1, Depth 1' to 2.5'

Boring B-2, Sample 1, Depth 1' to 2.5'

Boring B-2, Sample 2, Depth 2.5' to 4'

Boring B-2, Sample 2, Depth 2.5' to 4'

Boring B-2, Sample 2, Depth 2.5' to 4'

Boring B-2, Sample 3, Depth 4' to 5.5'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii **Project No.** 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-4

Boring B-2, Sample 3, Depth 4' to 5.5'

Boring B-2, Sample 4, Depth 5.5' to 7'

Boring B-2, Sample 4, Depth 5.5' to 7'

Boring B-2, Sample 4, Depth 5.5' to 7'

Boring B-2, Sample 5, Depth 7' to 8.5'

Boring B-2, Sample 5, Depth 7' to 8.5'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

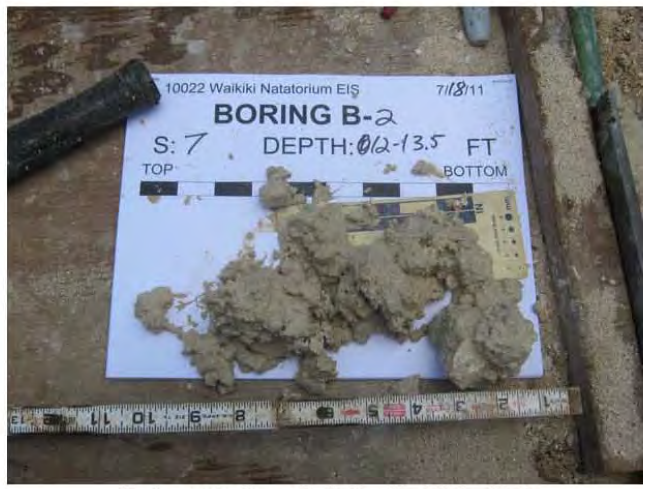
YOGI KWONG ENGINEERS, LLC.

FIGURE C-5

Boring B-2, Sample 6, Depth 8.5' to 10'

Boring B-2, Sample 6, Depth 8.5' to 10'

Boring B-2, Sample 6, Depth 8.5' to 10'



Boring B-2, Sample 7, Depth 12' to 13.5'

Boring B-2, Sample 7, Depth 12' to 13.5'

Boring B-2, Sample 8, Depth 13.5' to 15'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-6

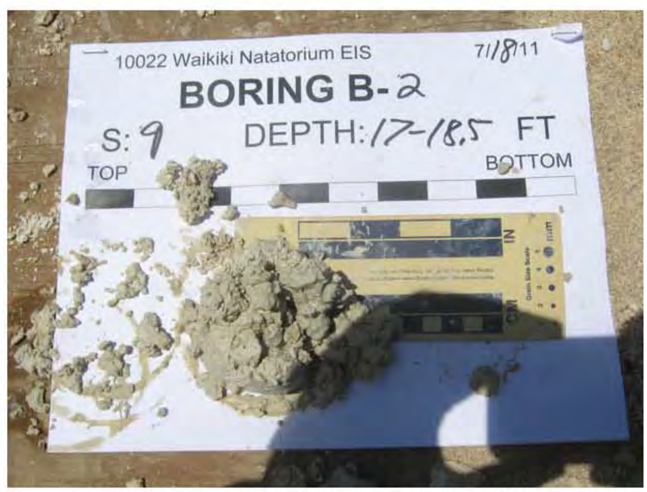
Boring B-2, Sample 8, Depth 13.5' to 15'

Boring B-2, Sample 8, Depth 13.5' to 15'

Boring B-2, PQ-1 and PQ-2, Depth 10' to 12' and 15' to 17'

Boring B-2, PQ-1 and PQ-2, Depth 10' to 12' and 15' to 17'

Boring B-2, PQ-1 and PQ-2, Depth 10' to 12' and 15' to 17'



Boring B-2, Sample 9, Depth 17' to 18.5'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-7

Boring B-2, Sample 9, Depth 17' to 18.5'

Boring B-2, PQ-3 and PQ-4, Depth 18.5' to 22' and 23.5' to 27'

Boring B-2, PQ-3 and PQ-4, Depth 18.5' to 22' and 23.5' to 27'

Boring B-2, PQ-3 and PQ-4, Depth 18.5' to 22' and 23.5' to 27'

Boring B-2, PQ-3 and PQ-4, Depth 18.5' to 22' and 23.5' to 27'

Boring B-2, Sample 10, Depth 22' to 23.5'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-8

Boring B-2, Sample 10, Depth 22' to 23.5'

Boring B-2, PQ-3 and PQ-4, Depth 18.5' to 22' and 23.5' to 27'

Boring B-2, PQ-3 and PQ-4, Depth 18.5' to 22' and 23.5' to 27'

Boring B-2, PQ-3 and PQ-4, Depth 18.5' to 22' and 23.5' to 27'

Boring B-2, PQ-3 and PQ-4, Depth 18.5' to 22' and 23.5' to 27'

Boring B-2, Sample 11, Depth 27' to 28.5'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-9

Boring B-2, Sample 11, Depth 27' to 28.5'

Boring B-2, Sample 12, Depth 28.5' to 30'

Boring B-2, Sample 12, Depth 28.5' to 30'

Boring B-2, Sample 12, Depth 28.5' to 30'

PHOTOGRAPHS OF SOIL SAMPLES
Project Name: Waikiki War Memorial Complex at Waikiki Beach
Location: Honolulu, Oahu, Hawaii **Project No.** 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-10

Boring B-3, Sample 1, Depth 0' to 1.5'

Boring B-3, Sample 1, Depth 0' to 1.5'

Boring B-3, Sample 2, Depth 1.5' to 3'

Boring B-3, Sample 2, Depth 1.5' to 3'

Boring B-3, Sample 2, Depth 1.5' to 3'

Boring B-3, Sample 3, Depth 3' to 4.5'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-11

Boring B-3, Sample 3, Depth 3' to 4.5'

Boring B-3, Sample 4, Depth 4.5' to 6'

Boring B-3, Sample 4, Depth 4.5' to 6'

Boring B-3, Sample 4, Depth 4.5' to 6'

Boring B-3, Sample 5, Depth 6' to 7.5'

Boring B-3, Sample 5, Depth 6' to 7.5'

PHOTOGRAPHS OF SOIL SAMPLES
Project Name: Waikiki War Memorial Complex at Waikiki Beach
Location: Honolulu, Oahu, Hawaii **Project No.** 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-12

Boring B-3, Sample 6, Depth 7.5' to 9'


Boring B-3, Sample 6, Depth 7.5' to 9'


Boring B-3, Sample 6, Depth 7.5' to 9'

Boring B-3, Sample 7, 12' to 13.5'

Boring B-3, Sample 7, 12' to 13.5'

Boring B-3, Sample 8, Depth 14' to 15.5'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-13

Boring B-3, Sample 8, Depth 14' to 15.5'

Boring B-3, Sample 9, Depth 17' to 18.5'

Boring B-3, Sample 9, Depth 17' to 18.5'

Boring B-3, Sample 10, Depth 22' to 23.5'

Boring B-3, Sample 10, Depth 22' to 23.5'

Boring B-3, Sample 11, Depth 27' to 28.5'

PHOTOGRAPHS OF SOIL SAMPLES

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-14

Boring B-3, Sample 11, Depth 27' to 28.5'

PHOTOGRAPHS OF SOIL SAMPLES
Project Name: Waikiki War Memorial Complex at Waikiki Beach
Location: Honolulu, Oahu, Hawaii **Project No.** 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE C-15

APPENDIX D
Selected Site Condition Photographs

General view of site

General view of site

General view of site

View of site around Boring B-1

View of site around Boring B-1

View of site around Boring B-1

SELECTED SITE PHOTOGRAPHS

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE D-1

View of site around Boring B-2

View of site around Boring B-2

View of site around Boring B-2

View of site around Boring B-3

View of site around Boring B-3

View of site around Boring B-3

SELECTED SITE PHOTOGRAPHS

Project Name: Waikiki War Memorial Complex at Waikiki Beach

Location: Honolulu, Oahu, Hawaii

Project No. 10022

YKE

YOGI KWONG ENGINEERS, LLC.

FIGURE D-2


General view of proposed parking lot location


General view of proposed parking lot location


General view of proposed parking lot location


General view of proposed parking lot location


General view of proposed parking lot location


General view of proposed bath house location

SELECTED SITE PHOTOGRAPHS
Project Name: Waikiki War Memorial Complex at Waikiki Beach
Location: Honolulu, Oahu, Hawaii **Project No.** 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE D-3


General view of proposed bath house location


General view of proposed bath house location


General view of proposed bath house location

SELECTED SITE PHOTOGRAPHS
Project Name: Waikiki War Memorial Complex at Waikiki Beach
Location: Honolulu, Oahu, Hawaii **Project No.** 10022

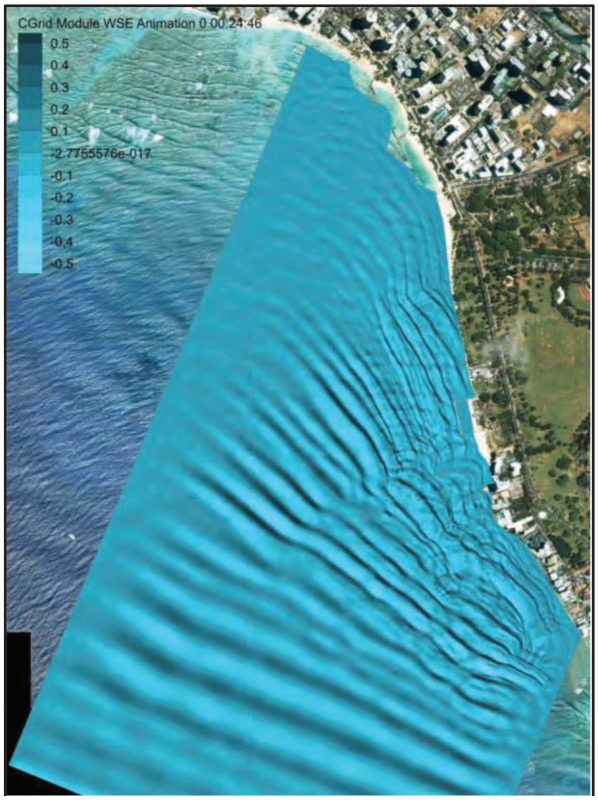
YOGI KWONG ENGINEERS, LLC.

FIGURE D-4

Appendix E:
Coastal Assessment and Basis of Design

Natatorium Coastal Assessment and Basis of Design
Waikiki, Oahu, Hawaii

October 2019



Prepared for:
AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, HI 96813

Prepared by:
Sea Engineering, Inc.
Makai Research Pier
Waimanalo, HI 96795

Job No. 25219

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LIST OF ABBREVIATIONS

ACES	Automated Coastal Engineering System
ADCP	Acoustic Doppler Current Profiler
AMAP	Applicable Monitoring and Assessment Program
BMP	Best Management Practice
CEDAS	Coastal Engineering Design and Analysis System
CGG	Coastal Geology Group
CHL	Coastal & Hydraulic Laboratory
City	City and County of Honolulu

cot	Cotangent
CRM	Concrete Rubble Masonry
Dir	Direction
DLNR	Department of Land and Natural Resources
DOH	Department of Health
EIS	Environmental Impact Statement
EISPN	EIS Preparation Notice
FIRM	Flood Insurance Rate Maps
ft	Feet
G	Gap Width
GPS	Global Positioning System
H	Horizontal
H	Wave Height
HAR	Hawaii Administrative Rules
HARN	High Accuracy Reference Network
HLA	Harding Lawson Associates
H_s	Significant Wave Height
IPCC	Intergovernmental Panel on Climate Change
K_D	Armor Stone Stability Coefficient
LIDAR	Light Detecting and Ranging
m	Meters
mhhw	Mean Higher High Water
mhw	Mean High Water
mllw	Mean Lower Low Water
mlw	Mean Low Water
mm	Millimeters
msl	Mean Sea Level
NAD	North American Datum
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
RDI	Teledyne RD Instruments
RSLC	Rate of Sea-Level Change
SCRF	Shoreline Change Reference Feature
SE	Southeast
sec	Seconds
SHOALS	Scanning Hydrographic Operational Airborne LIDAR Survey
SEI	Sea Engineering, Inc.
SLC	Sea-Level Change
S_r	Specific Gravity
SSS	Side-Scan Sonar
SSW	South-Southwest
SW	Southwest
SWAN	Surfzone Water Attenuation Zone
SWL	Still Water Level
TN	True North

T_p	Peak Wave Period
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
V	Vertical
W	Weight
WIS	Wave Information Studies
WQC	Water Quality Certification
WWM	Waikiki War Memorial
w_r	Unit Weight of Stone
YKE	Yogi Kwong Engineers

1. INTRODUCTION

1.1 Project Area Location and General Description

The Waikiki War Memorial (WWM) complex was opened on August 24, 1927 as a monument to the fallen soldiers of World War I. The main features of the complex include an entrance archway, bleachers, and a 330 feet (ft) by 120 ft (100 meters [m] by 36 m) saltwater swimming pool referred to as the Natatorium. The WWM is located toward the eastern end of Waikiki, between the Waikiki Aquarium and the New Otani Kaimana Beach Hotel. The popular Sans Souci Beach is adjacent to the WWM on the Diamond Head side. The WWM underwent additions and renovations in 1949 and 2000, improvements which were mainly to the bleachers and archway. The Natatorium is under the management jurisdiction of the City and County of Honolulu. The project vicinity and features are shown on Figure 1-1.

Maintenance of the Natatorium became an issue soon after construction, and a major refurbishment was accomplished in 1949. In addition to the structural problems, the pool was plagued by poor water quality due to insufficient water circulation and exchange. It was temporarily closed in 1963 when the State Department of Health (DOH) said that the pool was unfit for swimming. Continuing and significant deterioration of the concrete structure, along with water quality concerns, have resulted in the pool and bleachers being closed to the public since 1979. The public restroom facilities and the office space utilized by the City & County Ocean Safety and Lifeguard Services Division were refurbished in 2000 and remain open.

The present condition of the WWM, specifically the Natatorium, is considered a health and safety hazard by City and County of Honolulu officials and, as such, has been closed to the public since 1979. There are large sections of the decking that have collapsed and rusted rebar is exposed (Figure 1-2). The Final Environmental Impact Statement (Leo Daly, 1995) completed for a planned restoration project states that a water quality analysis indicated that the water was unsafe for swimmers.

1.2 Background

To address the health and safety concerns posed by the Natatorium's deteriorated condition, the City & County of Honolulu (City) Department of Design and Construction is investigating multiple options. Various studies and assessments of what to do with the aging Natatorium have been conducted over the past 50 years, e.g., Donald Wolbrink & Associates (1965); U.S. Army Corps of Engineers Beach Erosion Control Plan (1973, 1992); Leo A. Daly (1995); and 1983 Kapiolani Park Master Plan (Waikiki 2000). In light of an impending U.S. Army Corps of Engineers (USACE) project to widen Waikiki Beach, a 1964 study recommended the pool area be filled to create a beach. The USACE's proposed beach widening project in 1972 included demolition of the Natatorium structure and creation of a beach. City master planning for the Kapiolani Regional Park in 1982 proposed demolition of the Natatorium and returning the shoreline to open beach park space.

Complete restoration of the Natatorium was proposed by the State Department of Land and Natural Resources (DLNR) in a 1995 Environmental Impact Statement. The 1995 design proposed by Leo A. Daly included a current-driven flushing system for the swimming area and spur groins to assist in directing the flow. That project included analyses by Scientific Environmental Analyses, Ltd. (Karl Bathen); Frans Gerritsen; Sea Engineering, Inc.; Erlin, Hime Associates; Harding Lawson Associates; and Wiss, Janney, Elstner Associates, Inc.

The City took over the project and provided funding for its implementation. Work began in 1999, but was soon halted by a lawsuit. Permit issues and the determination that the State DOH had to develop new swimming pool rules, specifically for public salt water pools, halted construction other than on-land repairs. DOH regulations for salt water pools went into effect in 2002, and the proposed design for the restored pool did not meet the new regulations.

The City subsequently renewed efforts to identify and analyze alternatives for the WWM. Under a cost-sharing agreement, the City contracted with the USACE to study how the shoreline would respond, particularly Sans Souci Beach, to various alternatives that modified or removed the Natatorium pool structure (Sea Engineering, 2008). The report concluded that it is feasible to retain Sans Souci Beach and to create a new beach adjacent to it using groin structures to stabilize the sand fill.

Pursuant to the alternative uses investigation, then Mayor Mufi Hannemann convened an advisory committee in 2009 to discuss the options for the Natatorium and provide direction on its future use. The committee was composed of a cross-section of stakeholders, including members from such groups as veterans, lifeguards, scientists, surfers, swimmers, lifeguards, preservationists, and historians. The committee met over several months and solutions offered included complete restoration, converting the Natatorium into an aquarium, and removal to construct a beach. In the end, each member offered his/her opinion on the best use of the Natatorium, and the majority of committee members voted to remove the Natatorium structures and create a beach.

The City and County of Honolulu subsequently commissioned the preparation of an Environmental Impact Statement (EIS) for the City's proposed action of beach creation, and Sea Engineering, Inc. (SEI) was contracted in 2010 to perform the design for the beach. The project had identified multiple combinations of structure and beach when the project was halted in 2012. The project was resumed in 2014 with the focus on refining the beach creation options. An interim design report presenting four 2016 beach creation options was submitted to the City, from which the City selected their preferred option.

Natatorium preservation supporters, however, challenged the City's decision on the preferred option, citing the lack of consideration for a preservation option. In response, the City developed a preservation option in 2018, which includes partial Natatorium wall removal and reconstruction of the deck. This alternative is called the Perimeter Deck. Three additional alternatives presented in the City's *Pre-Environmental Impact Statement Alternatives Technical Evaluation* (AECOM, January 2018) include the War Memorial Beach, Closed-System Pool, and No Action. SEI was contracted in 2018 to expand the coastal assessment report to include a comparison of oceanographic conditions resulting from each 2018 alternative.

This report contains a compilation of material developed by SEI since the EIS work for this project began in 2010. Much of the early work was focused on beach creation, and four 2016 beach creation options are presented in Section 4. The results of wave modeling from offshore to the existing Natatorium, however, are directly applicable to all alternatives. The report uses wave modeling and field studies to infer the oceanographic conditions for each of the four 2018 alternatives.

This report provides the basis of design for the beach and sand retention structures and a qualitative oceanographic assessment of the four proposed options that are included in the EIS.

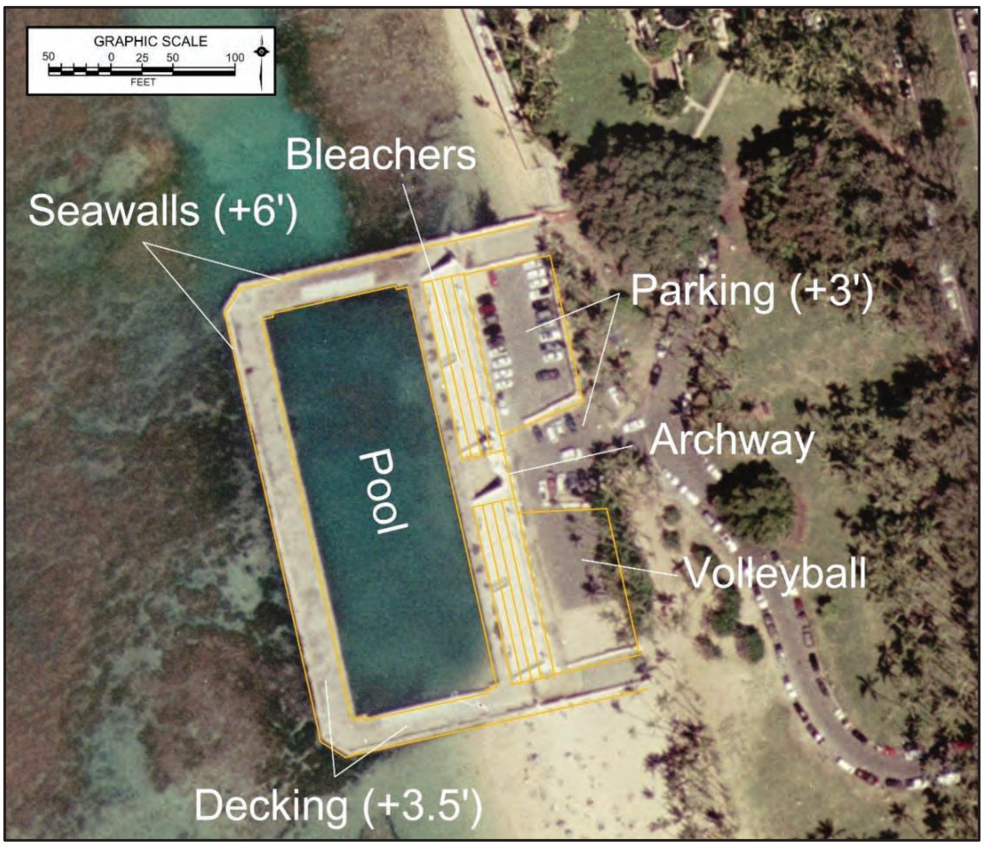


Figure 1-1. Existing Natatorium features.

Figure 1-2. Collapsed decking of Natatorium.

1.3 Purpose and Objectives

The purpose of the present study is to perform an oceanographic study of the project area and accomplish preliminary design of the beach and stabilizing structures. The report then evaluates the oceanographic conditions resulting from the 2018 alternatives presented in the Pre-Environmental Impact Statement Alternatives Technical Evaluation (AECOM, January 2018).

Key components of the present study include the following:

- Field investigations, including assessment of shoreline and Natatorium pool conditions, wave and current measurements, and offshore sand investigations
- Wave and circulation modeling
- Concept design of beach and stabilizing structures
- Assessment of oceanographic effects of the proposed 2018 alternatives
- Preliminary demolition and construction considerations
- Produce a final report of the findings

2. GENERAL SITE CONDITIONS

2.1 Original Design Features

The 330-foot-long by 120-foot-wide (100 by 36 meters) swimming pool with surrounding pool enclosure walls, decks, and adjacent bleacher structure were constructed of reinforced concrete. Structural investigations undertaken some years after construction have indicated the design did not adequately protect the reinforcing steel from the effects of salt water infiltration, and that the concrete itself was of poor quality. The pool is surrounded on four sides by a 20-foot-wide deck, which is enclosed on the ocean sides by a 3-foot-high wall. The fourth (landward) side is backed by the concrete bleachers. The original construction drawings show that the pool side walls are supported by 16-inch composite timber/concrete piles inserted into the bottom, and the north (Ewa) and south (Diamond Head) side walls were placed on the top of rock fill extending from the existing sea floor to the -2-foot mean lower low water (mllw) elevation, with the piles extending through the rock fill. The rock fill was presumably necessitated by a shore-parallel dredged channel which the pool spanned. The seaward side wall was placed directly on the shallow reef flat. A plan view of the Natatorium structure is shown on Figure 2-1, and a typical side wall section is shown on Figure 2-2. The existing topography/bathymetry is also shown on Figure 2-1.

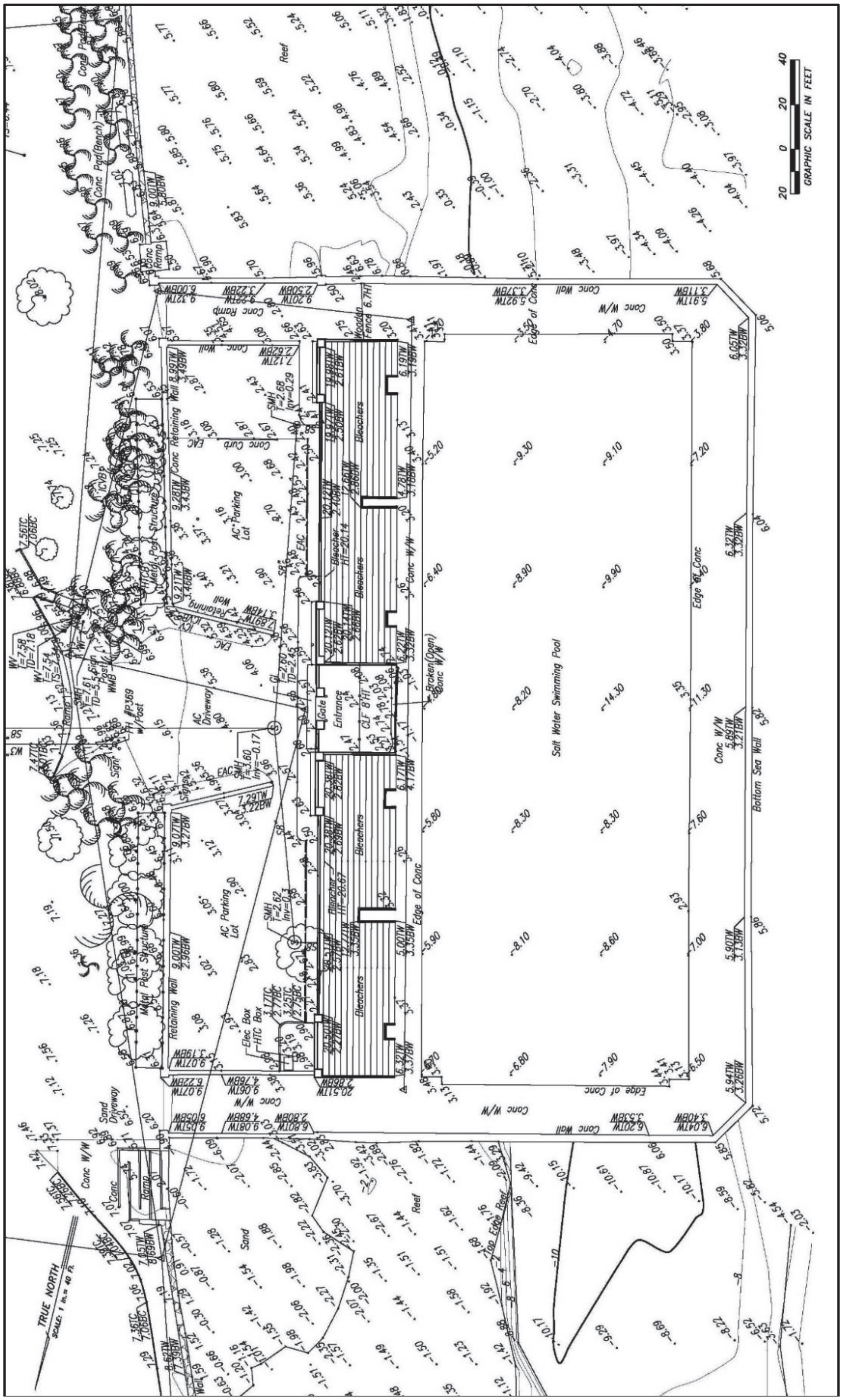


Figure 2-1. Natatorium – plan view. Survey dates: October 4 and 11, 2010.

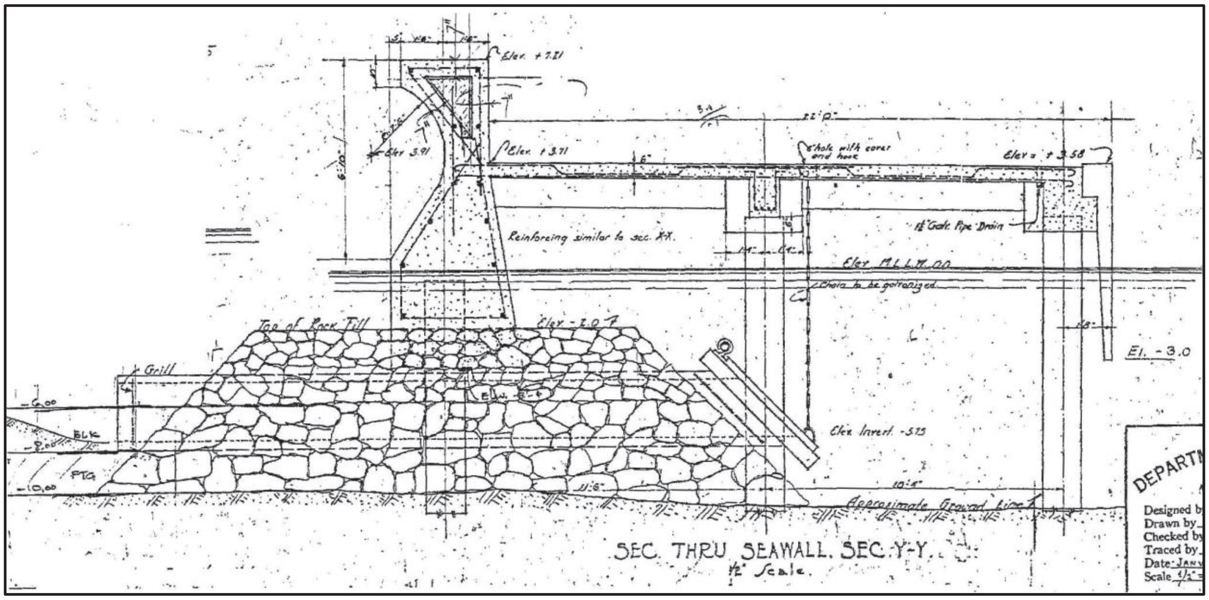


Figure 2-2. Typical existing pool wall section from 1927 plans.

2.2 Existing Facility Condition

In 2004 a section of the pool deck collapsed leading to temporary closure of the public restrooms (Figure 2-3). A subsequent inspection showed the following general structural conditions.

Concrete Deck Slab:

- Collapsed deck slabs and others showing signs of likely failure
- Extensive cracking, deflection, and obvious signs of reinforcing steel corrosion

Perimeter Walls:

- Extensive concrete spalling with numerous segments that have fallen into the water
- Sections visibly out of plumb
- Exposed corroded reinforcing steel
- Potential collapse

Bleachers:

- Cracks in beam supports
- Extensive cracking of the underlying slab-on-grade
- Deterioration of surface exhibited by extensive cracking and spalling

The present condition of the Natatorium is considered a health and safety hazard by the City, and as such continues to be closed to the public.

Figure 2-3. Collapsed pool deck.

2.3 Topography and Bathymetry

2.3.1 *Nearshore Bathymetry and Bottom Conditions*

Waikiki is located on the south shore of Oahu, west of Diamond Head, along a pronounced embayment in the shoreline. This embayment is evident in the 18-foot depth contour located approximately ½ mile offshore. Seaward of this, contours become straighter and bottom slope increases. A fringing fossil reef intersected by several relic stream channels extends approximately 1 mile offshore. Bottom slopes are generally mild inshore consisting mainly of reef and sand pockets. Figure 2-4 identifies features such as Sans Souci Beach, the channel from the beach offshore, and the shallow nearshore reef and wave breaker zone.

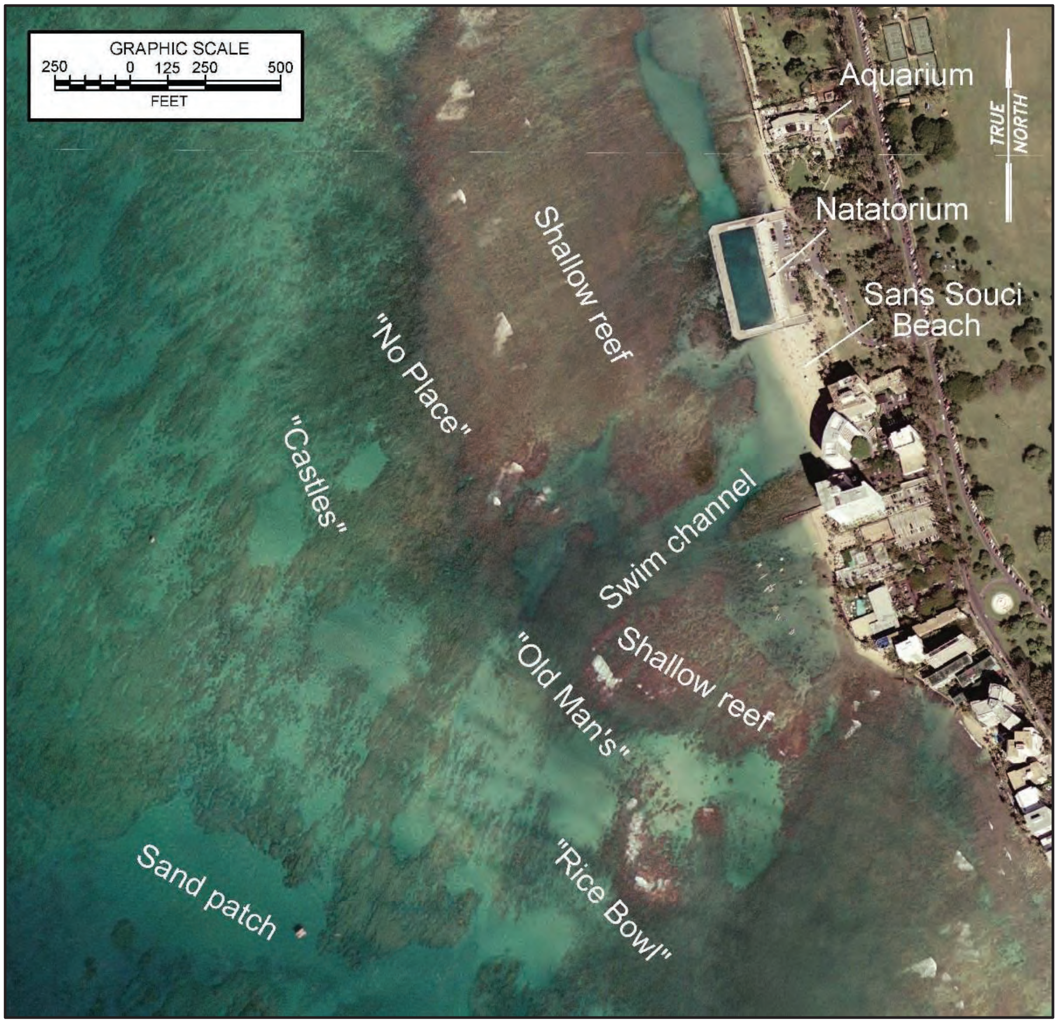


Figure 2-4. Waikiki War Memorial and surrounding site.

Detailed nearshore bathymetry information is available from the USACE Scanning Hydrographic Operational Airborne LIDAR Survey (SHOALS) dataset. Data exists for Waikiki from the shoreline to a depth of approximately 130 ft. The nearshore reef in this area is quite variable in depth and includes emergent outcrops at low tide and pockets and grooves in the reef several feet deep. Wave transformation is greatly affected by the large, shallow areas of reef, which were found to have typical depths of 2 to 4 ft below mean sea level (msl). Proper representation of the reef in the bathymetric data is necessary for the modeling to produce meaningful results. A survey on the reef offshore of the Natatorium was conducted to measure the shallow reef elevations. A grid with 50-ft spacing was developed and measurements were taken at the grid points.

A bathymetric map of the project site is shown on Figure 2-5 overlaid on a geo-referenced satellite photograph dated July 28, 2004. The depth contours are shown as yellow and orange lines and are in feet relative to msl. This bathymetry data was used as input to the numerical wave modeling discussed in Section 3.4.2.

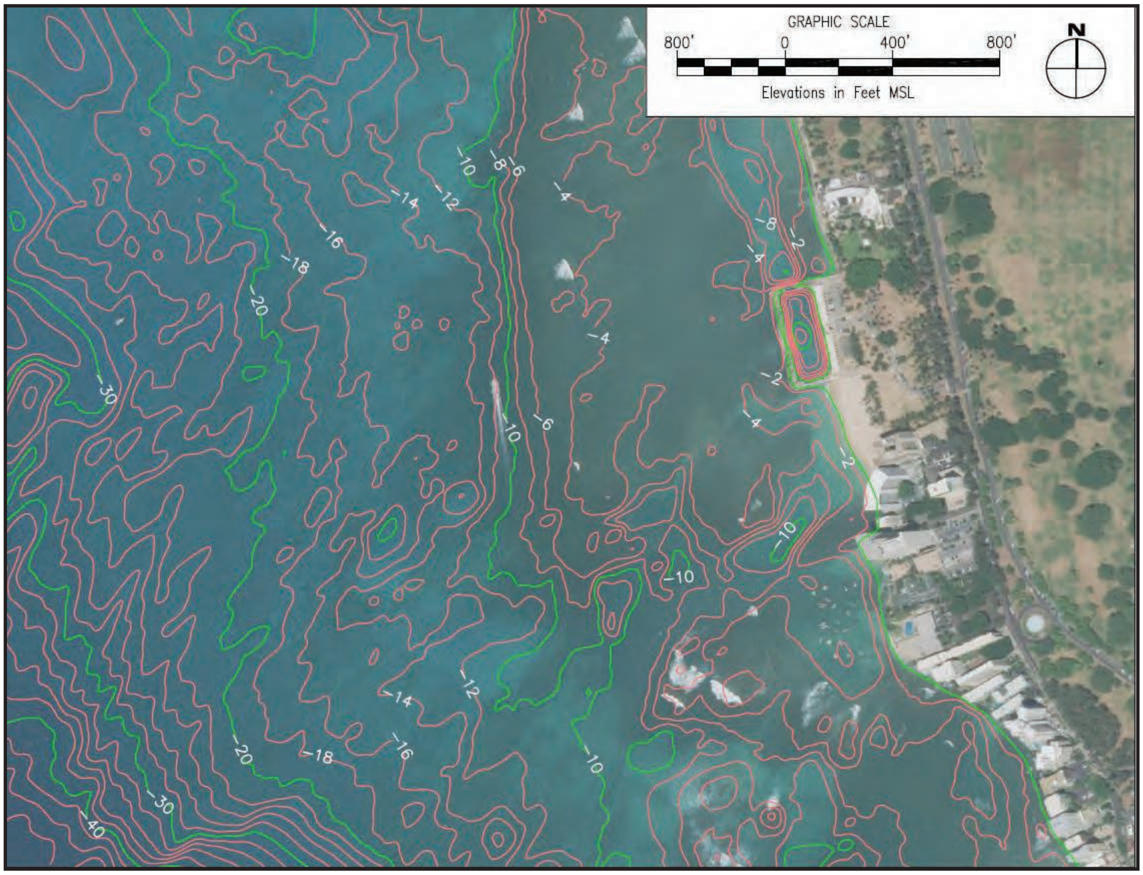


Figure 2-5. Bathymetric contours at the Waikiki War Memorial project site. Elevations in feet mllw.

2.4 Shoreline and Nearshore Characteristics

The shoreline on the Ewa side of the WWM consists of a narrow sandy beach fronting a seawall that protects the Waikiki Aquarium and the adjacent park (Figure 2-6). The narrow beach extends from the WWM approximately 300 ft along the seawall; there is no beach in front of the next 500 ft of seawall. The beach is submerged at high tide and wave run-up can reach the seawall at any phase of the tidal cycle. The beach's limited width and the shallow reef flat present little or no recreational value. Volunteers are occasionally seen clearing invasive seaweed from the area, and pedestrians frequent the walkway along the seawall.

The 150-ft-wide reef flat fronting the beach has typical depths ranging between about 1.0 and 2.5 ft msl. A 700-ft long dredge cut in the reef provides a protected swimming area on the Ewa side of the Natatorium. The channel width is between 110 and 165 ft for most of its length with typical depths of 6 to 11 ft msl. The channel has no direct outlet to the open ocean. Weigel (2000) reports that this dredged area may have been used for public bathing.

The beach on the Diamond Head side of the WWM (Figure 2-7 and Figure 2-8) is referred to as Sans Souci Beach and is popular with both locals and tourists. The beach, which is also sometimes called Kaimana Beach, extends more than 450 ft from the WWM past the New Otani Kaimana Beach Hotel. The beach and backshore park are separated by a concrete rubble masonry (CRM) wall. The littoral transport direction is toward the WWM where the beach is more than 140 ft wide measured from the CRM wall to the msl contour line. The beach is frequented by sunbathers and waders as well as swimmers who enjoy easy access to deeper water offshore.

The beach diminishes in the Diamond Head direction and the seawall fronting the Colony Beach condominiums is exposed to wave action. A 180-ft-long rock rubblemound groin is found on the reef between the Colony Beach and the Colony Surf. The groin was reported by Weigel (2000) to have been constructed by the Outrigger Canoe Club in 1963. On the Diamond Head side of the groin are a small beach and a protected boat mooring area.

The nearshore reef environment is characterized by a shallow reef flat that extends approximately 1,000 ft offshore of the WWM. Incident waves break on the offshore edge and dissipate energy over the reef. Surfing sites “Castles” and “No Place” are located on this portion of reef. A 100- to 200-ft-wide channel is present from Sans Souci Beach seaward and is frequented by paddlers and swimmers. This channel is referred to as Kapua Channel, and is believed to be an ancient stream bed. The inshore 450 ft of the channel has a sand bottom with depths up to 8 ft msl. The channel bottom transitions into a high-rugosity fossil reef zone with dramatic changes in relief over a distance of about 700 ft. Depths can be as shallow as about 5 to 6 ft msl; however, holes in the reef can penetrate several feet below the surface of the reef. Two submarine cables can be seen anchored to the bottom in this area. A dredged navigation channel near the inshore extent of this zone leads to the Outrigger Canoe Club.

Topographic surveys of the WWM, surrounding grounds, and nearshore waters were performed on October 4 and 11, 2010, by Sam O. Hirota, Inc. The purpose of the surveys was to obtain baseline topographic data for use with this report. A number of control points, including mag nails, chisel cuts, and existing disks, were used to construct the survey network. The horizontal survey controls were based on station TU1337, and the survey was performed with coordinates in State Plane, NAD83 HARN, feet. The vertical survey control was based on a 1971 monument near the Dillingham Fountain with reported vertical elevation of 10.53 ft msl. Prior to final plans, the accuracy of the vertical control should be verified against a more recent tidal benchmark.

The surveys showed the following key conditions (all elevations relative to msl):

- Park backshore elevation typically +7.5 ft
- Parking and volleyball court elevations typically +2.5 to +3.5 ft
- Sans Souci beach crest typically +5 to +6 ft on Waikiki side, lowering to +4 to +5 ft on the Diamond Head side
- Elevations of swimming area between Sans Souci Beach and reef typically -4 to -5 feet, with depths increasing into the swimming channel

- Top of outer Natatorium wall typically +6 ft
- Natatorium decking typically +3 to +3.5 ft
- Top of seawall fronting the Waikiki Aquarium typically +8.7 ft; the walkway is +7 to +8 ft
- Sans Souci Beach foreshore slope 1v:5h to 1v:8h

Figure 2-6. Beach and seawall on Ewa side of Waikiki War Memorial.

Figure 2-7. Sans Souci Beach looking toward the Waikiki War Memorial.

Figure 2-8. Sans Souci Beach looking toward Diamond Head.

2.5 Shoreline Trends

A series of historical aerial photographs can be used to show shoreline trends. The University of Hawaii Coastal Geology Group (CGG) has undertaken historical analysis of Oahu's shoreline and produced shoreline change maps based on survey data and aerial imagery from 1927 to 2005. Their analyses used the beach toe as the shoreline change reference feature (SCRF). The results for the project shoreline are presented as transects 16 through 23 on Figure 2-9. The figure shows Sans Souci Beach to have accreted for the full 78 years of data, and that the accretion is greater closer to the Natatorium where the long-term rate is presented to be approximately 2.5 ft per year. A fairly significant widening of the beach from March 1975 to December 1982 can also be seen. Miller and Fletcher (2003) believe that this was due to onshore sediment transport as a result of Hurricane Iwa noting that other beaches in Waikiki were also widest at the time of the December 1982 photo. There is little variability in the SCRF from December 1982 to December 2005 suggesting beach stability.

Oblique photographs presented by Weigel show no beach in 1902 prior to construction of the Natatorium and a narrow beach in 1962 where the waterline was an estimated 100 ft further inland than at present. These are consistent with the CGG shoreline locations presented on Figure 2-9.

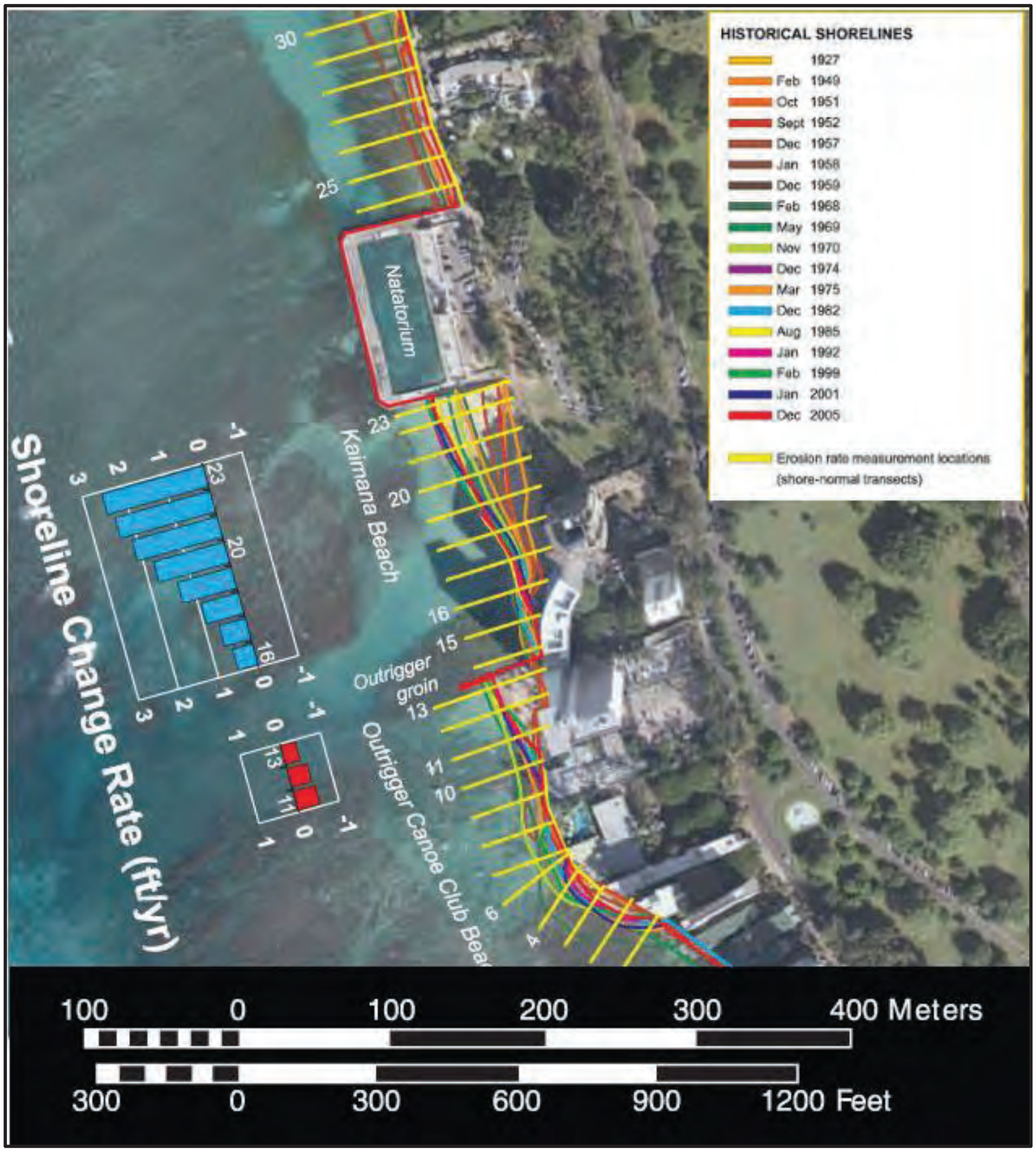


Figure 2-9. Historical shoreline change map (after Univ. of Hawaii Coastal Geology Group).

Geotechnical considerations play an important part in the design of beach stabilizing structures at this site. Previous geotechnical investigations and a preliminary geotechnical evaluation by Yogi Kwong Engineers (YKE) in support of the development of the beach concept plans presented in this report indicate primarily loose, unconsolidated sandy silt foundation conditions. The "Consultation Letter Report" prepared by YKE is included as Appendix D, and the results of investigations performed by Global Geophysics are included as an appendix to the YKE report. Previous geotechnical investigations (borings) performed by Harding Lawson Associates (HLA, 1991) at the project site are in Appendix E.

Borings drilled by HLA around the pool and within the perimeter walls indicated that a well cemented reef flat crust did not exist at the boring locations. The borings indicated that at some locations, only a relatively thin medium dense crust of coral sand and gravel detritus existed in the top portions of the borings. No substantial coral reef formation was encountered within the existing pool. In summary, the borings indicate poor foundation conditions with loose sandy soil and silty lagoonal deposits to a depth of about 30 ft below sea level. This material is moderately to highly compressible, with potential settlement under load of about 3 ft occurring rapidly after loading.

An overwater geophysical survey by Global Geophysics in April 2014 using resistivity techniques showed the presence of very soft or very porous lagoonal materials and the possible presence of sub-bottom voids or sinkholes.

2.6 Natatorium Pool Investigations

SEI performed a silt and sand survey of the Natatorium pool in May of 1989. Silt and sand thicknesses and water depth were measured at 55 locations spaced throughout the pool area. Among the findings reported were rubble on the bottom along the perimeter of the pool and a layer of silt along the bottom that ranged in thickness from a few inches to 1 ft. SEI performed an additional set of pool floor investigations of the Natatorium in August of 2019. The main purpose of the 2019 field work was to measure changes that may have occurred since the 1989 measurements. While sand accumulation in the Diamond Head corner of the Natatorium appears to be caused by wave uprush and wind pushing sand from Sans Souci Beach into the Natatorium, the sources of other material are unknown. Sediment inside the Natatorium could be from original construction, from runoff, or from biological activity. No other conclusions are drawn regarding the sources of material or when that material appeared in the Natatorium.

The investigations included a single-beam survey of water depth and air jet probe penetration into the bottom. The jet probe system consisted of a SCUBA tank, air hose, and a 10-ft-long, ½-inch diameter probe. The probe was calibrated in 0.5-foot intervals. The same probe sampling grid was used as for the 1989 sampling. Water depth was measured over 5-ft tracklines. In addition, sediment samples were obtained in three locations inside the Natatorium and one location in the swimming channel in front of the Waikiki Aquarium.

The depth of penetration into the sediment is dictated by the type of sediment itself and the presence of hard substrate. The extent of the probe penetration is based on the underlying substrate and is generally classified as follows:

- Hard refusal—the probe encountered a distinct hard layer that could not be penetrated
- Compact refusal—the probe encountered a "crunchy" layer, such a rubble or gravel, that could not be penetrated
- Friction refusal—the probe could not penetrate any further but did not encounter hard refusal
- Soft refusal—the full length of the probe penetrated into the bottom and could have penetrated further

The difference in measured water depth between the two data sets is used as a proxy to determine the amount of change of the sediment volume inside the pool. The 1989 and 2019 sampling grids and surfaces are presented on Figure 2-10. and Figure 2-11. The measurements from 2019 are listed in Table 2-1. Computational surfaces were produced using the two water depth data sets and comparison of the surfaces shows that there was an increase in sediment volume of approximately 540 cubic yards over the 30 years between the surveys. To avoid including concrete deck rubble in the estimate, a 5-foot offset was applied to the 2019 survey boundary. The most significant change occurred near the makai center of the pool area, where the 1927 construction drawings show a 36 ft by 50 ft diving pit was to be dredged to a depth of 15 feet. The present measurements show this area to have filled in by up to 2 ft of sediment between 1989 and 2019; however, the presence of the pit is still clearly visible and it is unclear why the pit has not become completely filled with sediment. Table 2-1 also shows that jet probes penetrated in excess of 10 ft in some areas of the Natatorium pool area. The jet probe penetration, however, should not be interpreted as representing sediment that has accumulated since construction.

Figure 2-12 shows the change in water depth between the 1989 survey and the 2019 survey. As previously stated, the boundary of the 2019 survey was offset by 5 feet to avoid including concrete deck rubble in the sediment accumulation estimate. In this figure, red/orange refers to areas where the water depth has decreased from 1989 to 2019, which would indicate accretion. Blue shows where the water depth has increased. Sand washing over the Diamond Head wall may be a major source of the sediment increase. Wave uprush along Sans Souci Beach can be seen to move sand upward and against the Natatorium wall and, until boards were placed along the upper portion of the wall, sand could go over that wall and into the Natatorium. The pool deck inside the Diamond Head wall is presently covered with sand and is now a source for filling in that corner of the pool. Since that wall was boarded up, the sand buildup in the mauka Diamond Head corner of the pool is believed to have been distributed away from that corner. Water was noted in 2019 to be flowing through that area, which could help move sand from the corner.

In the 2019 field study, push core sediment samples were obtained at three locations in the basin, shown in Figure 2-11, and one sample was obtained from the swim channel approximately 20 ft north of the Natatorium's Ewa wall. Size distributions of five samples obtained in 2010 are also presented. The size distributions from the 2010 and 2019 field studies are shown on Figure 2-13 and Figure 2-14, respectively. The data shows the samples in the Natatorium to be poorly sorted with median diameter ranging from 0.03 millimeters (mm) to 0.35 mm from the 2010 study and 0.17 mm to 0.24 mm from the 2019 study. The 2010 samples contained between 10 and 95 percent fine material defined as having diameters less than 0.075 mm. The 2019 samples had fine material ranging from 30 to 36 percent. The samples from inside the Natatorium can be categorized as a silty sand material that was generally dark colored. The push cores obtained from inside the Natatorium were also noted to contain gravel-sized pieces of fossil coral. Damaged ends of the acrylic push core tubes was further evidence of rubble presence; tube damage had not been observed in sand deposits. The 2019 sample taken in front of the Aquarium was well sorted with a median diameter of 0.54 mm and only one percent was considered fine material. That sample was tan and sandy with a small amount of gray material that is believed to be from an anoxic layer. Photos of the push cores from the 2019 field study are shown in Figure 2-15 through Figure 2-18 respectively.

The push cores were obtained using a percussive device that drives a tube into the seafloor. Push core penetration is typically limited to about 24 inches in well-packed sand, while jet probes, which are accomplished by an air or water jet displacing the bottom material, can extend more than 10 feet in sand. Depth of penetration of the three push cores in the Natatorium was noted to vary as shown in Figure 2-15 through Figure 2-17; however, the push core penetration should not be considered a proxy for relative grain size or composition.

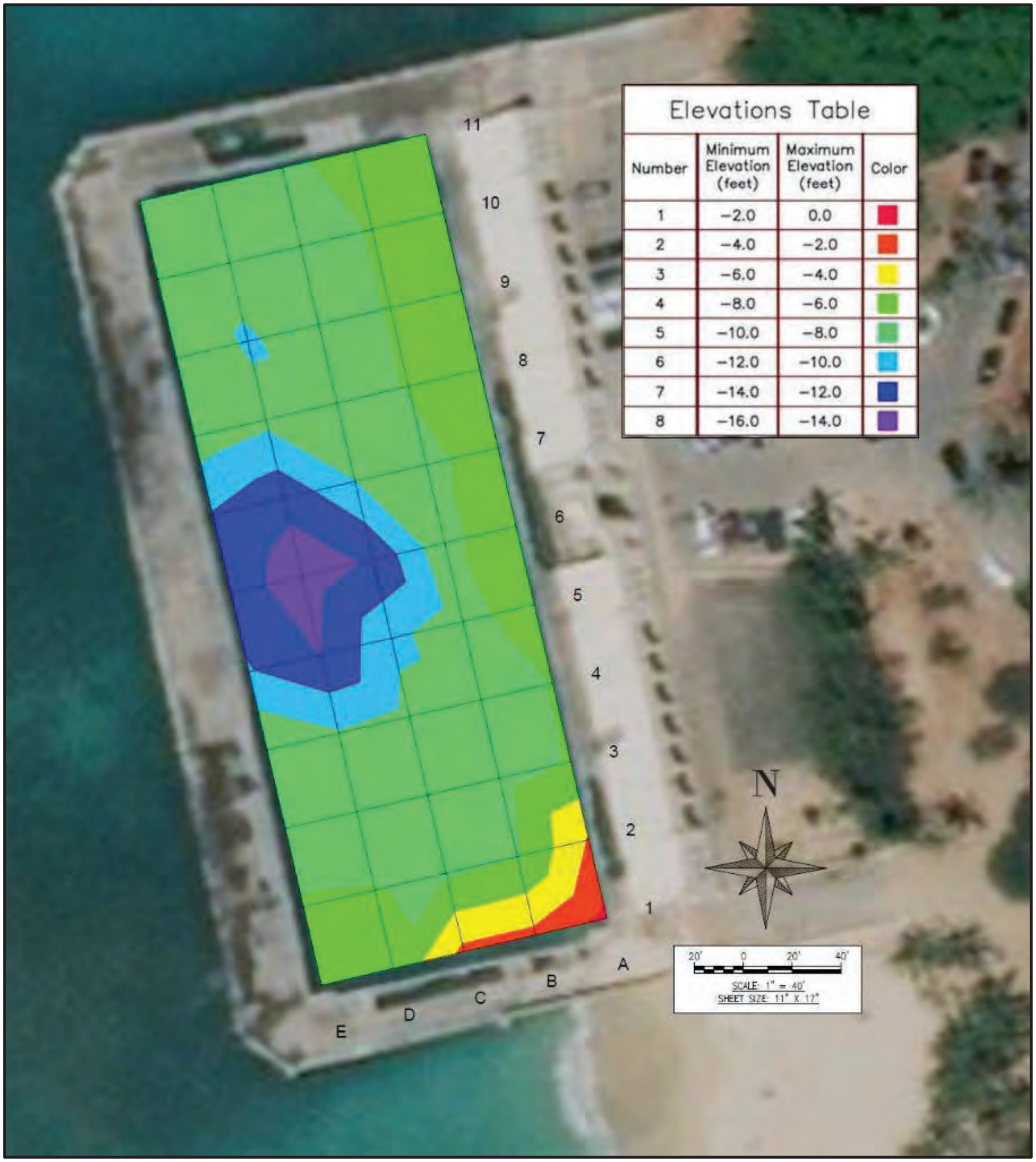


Figure 2-10. Natatorium pool bottom elevations from the 1989 survey (relative to msl).

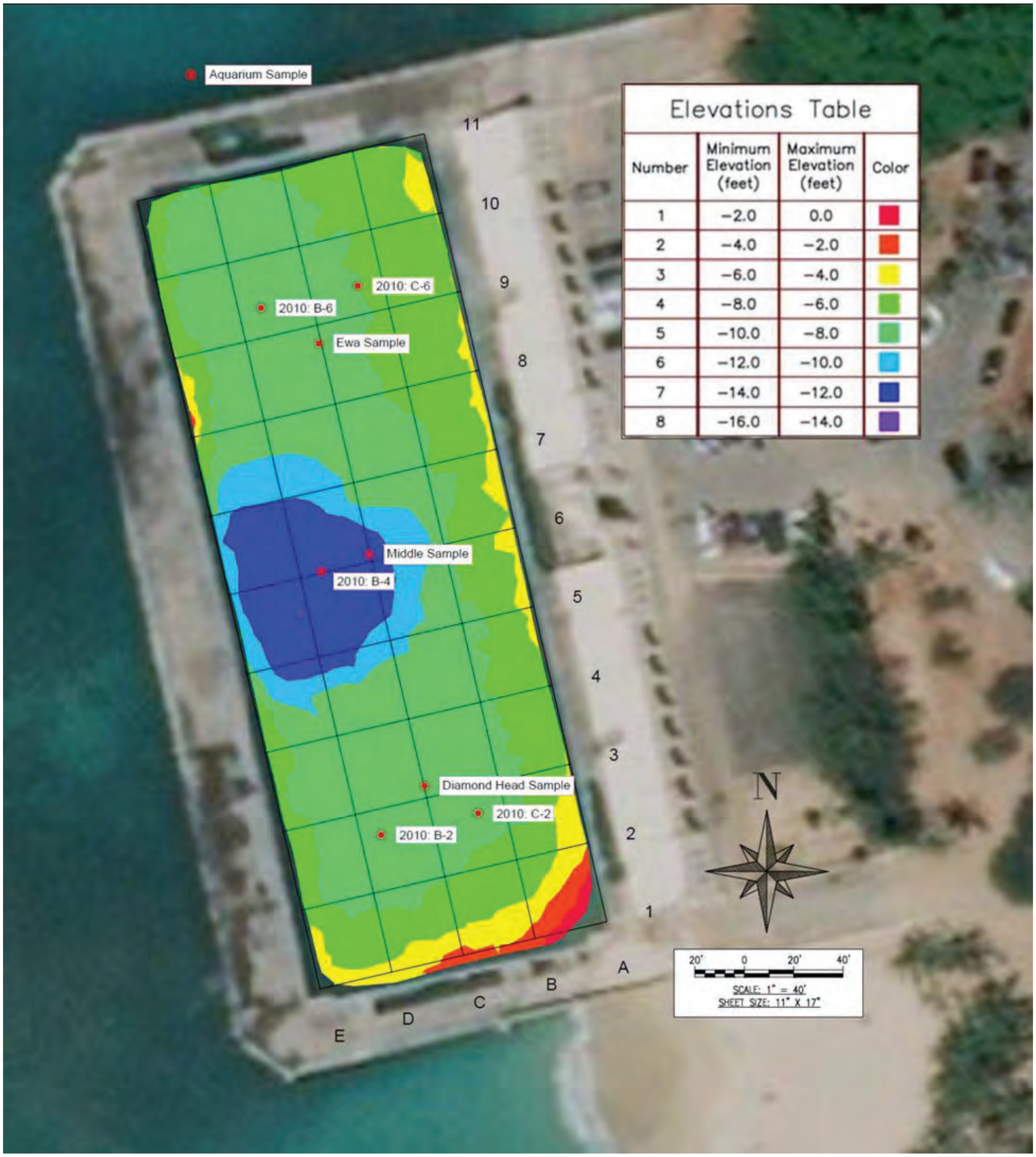


Figure 2-11. Natatorium pool bottom elevations from the 2019 survey (relative to msl) and sediment sample locations.

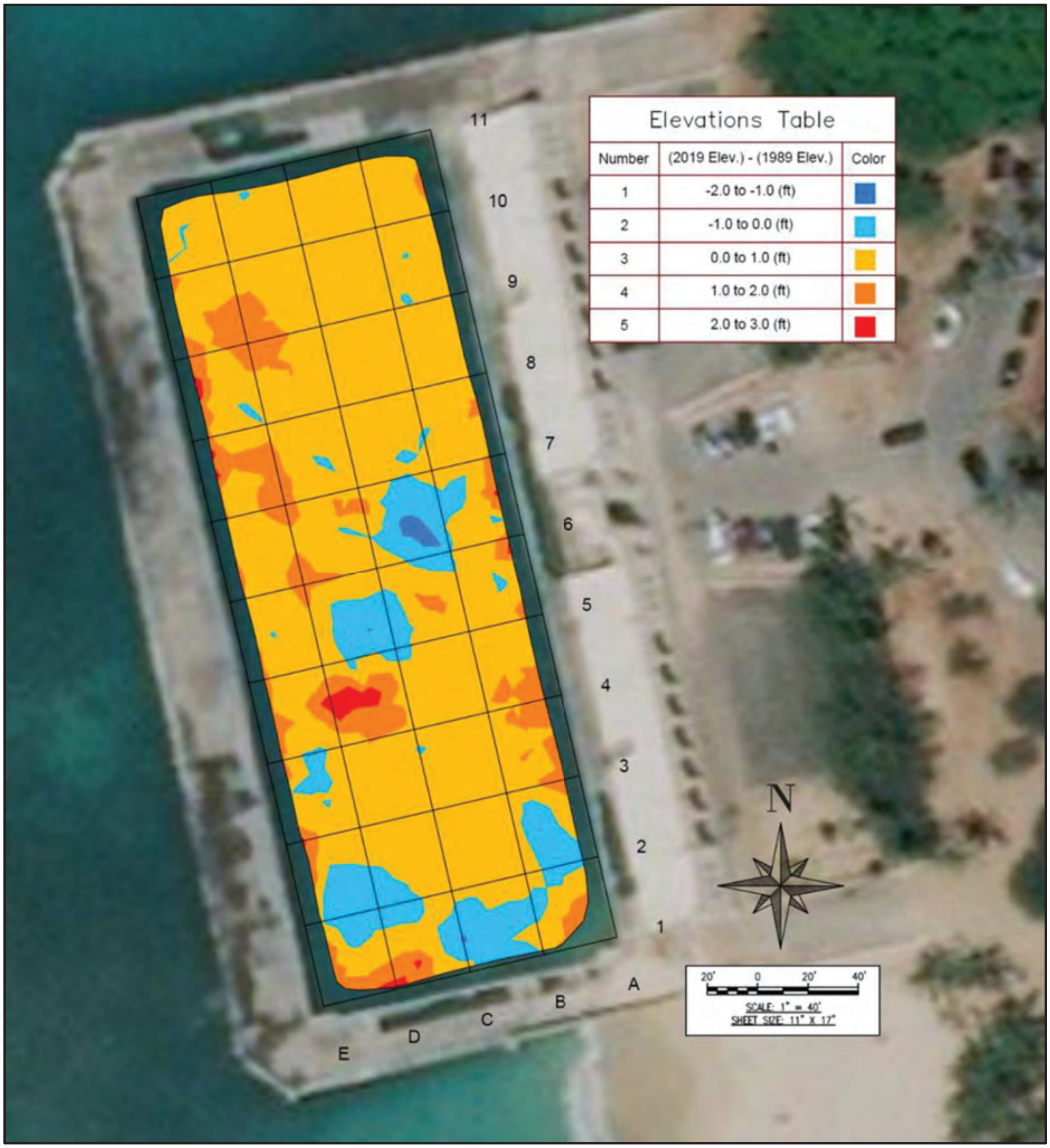


Figure 2-12. Natatorium pool bottom elevation change, 1989 to 2019
(Blue color signifies an elevation decrease; red color signifies an elevation increase).

Table 2-1. 2019 Natatorium pool investigation data.

Row	Column	Water Depth (feet msl)	Jet Probe Penetration (feet)	Refusal Type
A	1	1.04	8	Resistance
B		3.46	8.5	Resistance
C		3.62	7	Hard
D		5.23	5	Hard
E		5.36	3	Hard
A	2	4.11	7	Hard
B		7.51	2.5	Hard
C		8.14	10	Resistance
D		8.25	8	Resistance
E		6.42	3	Hard
A	3	5.89	6	Hard
B		8.49	3	Hard
C		9.03	6	Hard
D		9.1	10	Soft
E		6.7	10	Soft
A	4	6.47	1.5	Compact
B		8.63	2.5	Compact
C		9.02	1.5	Hard
D		9.59	3	Hard
E		6.33	2.5	Hard
A	5	5.34	3	Hard
B		8.36	1	Compact
C		11.21	2	Hard
D		13.71	5	Hard
E		9.44	9	Hard
A	6	4.9	1	Hard
B		8.63	2	Hard
C		12.79	6	Hard
D		13.71	9	Hard
E		11.36	4	Hard

Row	Column	Water Depth (feet msl)	Sediment Depth (feet)	Refusal
A	7	5.52	8.5	Hard
B		8.13	1	Hard
C		9.78	3	Compact
D		11.95	9.5	Hard
E		10.15	9	Hard
A	8	5.5	2	Hard
B		7.61	2	Hard
C		8.89	7	Hard
D		9.33	1	Hard
E		5.12	8	Hard
A	9	6.06	8	Resistance
B		7.74	10	Resistance
C		8.4	6	Compact
D		8.6	6	Hard
E		5.71	6	Hard
A	10	5.75	10	Soft
B		7.67	10	Soft
C		8.33	9	Resistance
D		8.84	8	Resistance
E		6.8	10	Soft
A	11	6.19	10	Soft
B		6.66	6	Resistance
C		7.27	8	Resistance
D		6.93	8	Hard
E		6.52	4.5	Hard

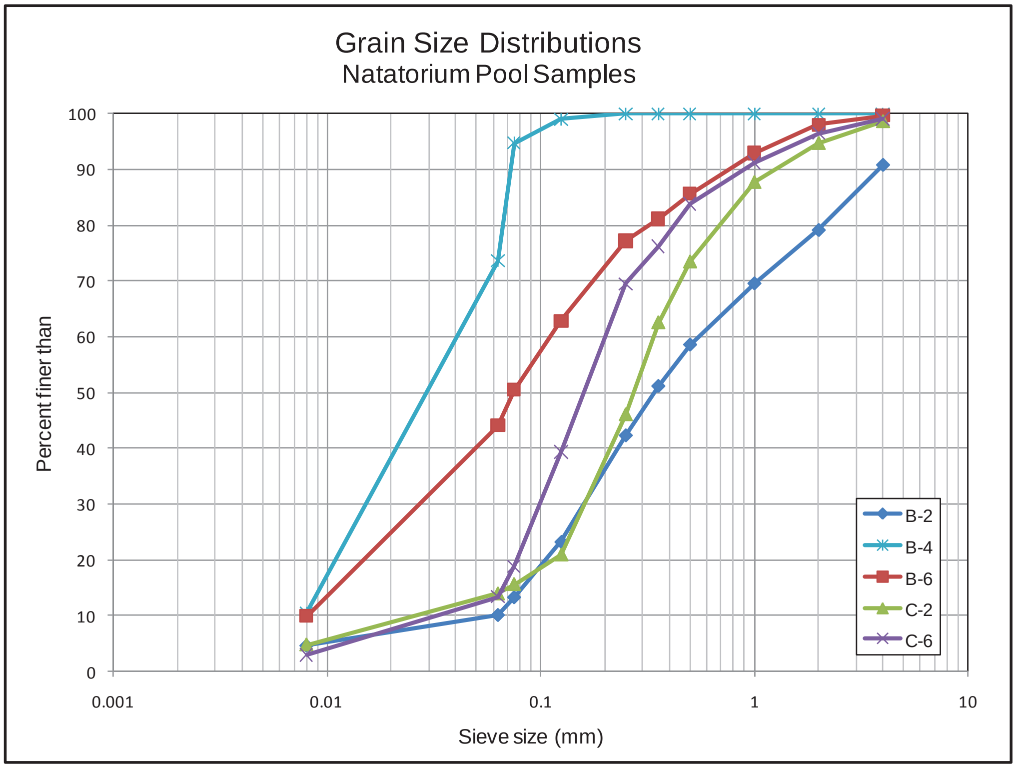


Figure 2-13. Sediment size distributions, 2010 Natatorium pool samples.

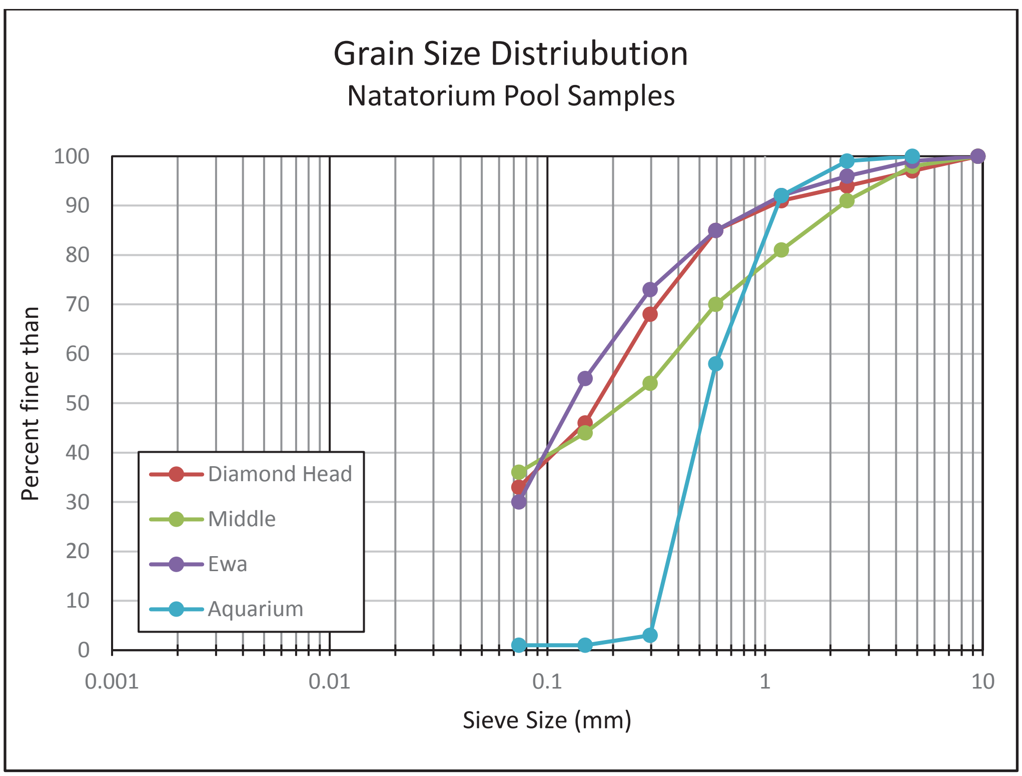


Figure 2-14. Sediment size distributions, 2019 Natatorium pool samples.

Figure 2-15. Photograph of sediment from "Diamond Head" push core.

Figure 2-16. Photograph of sediment from "Middle" push core.

Figure 2-17. Photograph of sediment from "Ewa" push core.

Figure 2-18. Sediment from "Aquarium" push core.

2.7 Sediment Disposition

The 1995 Natatorium EIS (Leo Daly, 1995) recommended dredging the sediment on the pool bottom to a depth of 11 ft mllw. That recommendation was based on restoring the Natatorium to a swimming pool, and producing that depth was necessary such that the Natatorium could successfully perform as a swimming pool. The design called for temporarily storing the dredged material onshore and then disposal in a landfill. Sediment testing at that time detected no toxic chemicals or heavy metals, and a landfill reportedly agreed to accept the material.

The depth requirement for producing a beach would require a certain amount of fill material to produce a stable beach toe. The pool seafloor investigations presented in Section 2.6 show an average depth of 8.6 ft msl; fill material would be required to raise the bottom to a depth of 4.5 ft to be consistent with the swimming area off Sans Souci Beach. While it is possible to use beach-quality sand for the complete fill project, it is more economical to use clean quarry (rock) fill to a certain level and then construct the beach on top of that.

Two options have been identified for dealing with the existing sediment inside the Natatorium pool. The first option is similar to that proposed in the 1995 EIS, which involves dredging the material to a certain depth then stockpiling and dewatering the dredged material. Following dewatering, the sediment would be trucked to a landfill. Removal of the existing sediment would be followed by filling with more material, such as gravel, to replace the volume that had been removed. A downside of this option is the smell. Anaerobic conditions and natural processes by bacteria are occurring in the sediment, producing a byproduct with a "rotten egg" smell which would be present while the sediment is being removed until it is trucked away.

The second option involves leaving the sediment in place, grading the sediment to a constant elevation, and "capping" it in a manner similar to that performed in the Duke Kahanamoku Lagoon at Hilton Hawaiian Village. Capping involves placing a geotextile filter fabric over the existing sediment, and then placing new material, such as gravel and sand, on top of the geotextile liner. A schematic of the concept is shown on Figure 2-19. Capping of the existing sediment would eliminate the need for dredging, space for dewatering, transport, and disposal. Additionally, this process would reduce the amount of fill material needed to construct the beach.

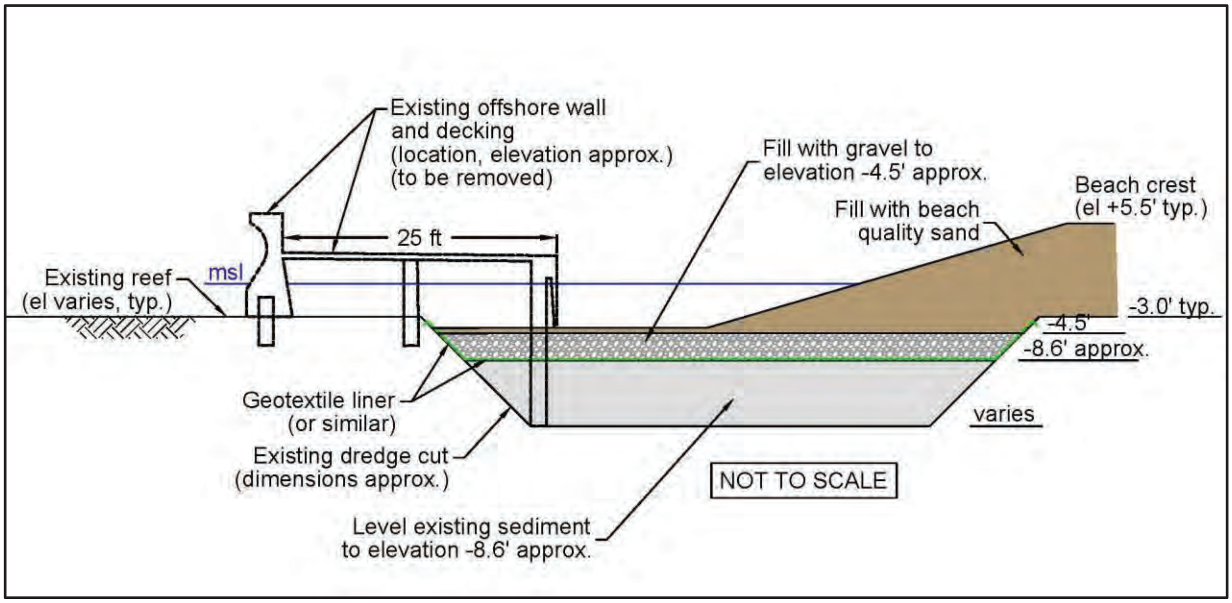


Figure 2-19. Concept capping schematic (beach alternative).

3. ENVIRONMENTAL SETTING

3.1 Winds

The prevailing wind throughout the year is the east-northeasterly trade wind. Its average frequency varies from more than 90 percent during the summer season to only 50 percent in January, with an overall annual frequency of 70 percent. Westerly, or Kona, winds occur primarily during the winter months generated by low pressure or cold fronts that typically move from west to east past the islands. Figure 3-1 shows a wind rose diagram applicable to the site based on wind data recorded at Honolulu International Airport between 1949 and 1995.

Tradewinds are produced by the outflow of air from the Pacific Anticyclone high-pressure system, also known as the Pacific High. The center of this system is located well north and east of the Hawaiian chain and moves to the north and south seasonally. In the summer months, the center moves to the north causing the tradewinds to be at their strongest from May through September. In the winter, the center moves to the south, resulting in decreasing tradewind frequency from October through April. During these months, the tradewinds continue to blow; however, their average monthly frequency decreases to 50 percent.

During the winter months, wind patterns of a more transient nature increase in prevalence. Winds from extra-tropical storms can be very strong from almost any direction, depending on the strength and position of the storm. The low-pressure systems associated with these storms typically track west to east across the North Pacific north of the Hawaiian Islands. At Honolulu International Airport, wind speeds resulting from these storms have on several occasions exceeded 60 miles per hour. Kona winds are generally from a southerly to southwesterly direction, usually associated with slow moving low-pressure systems known as Kona lows situated to the west of the island chain. These storms are often accompanied by heavy rains.

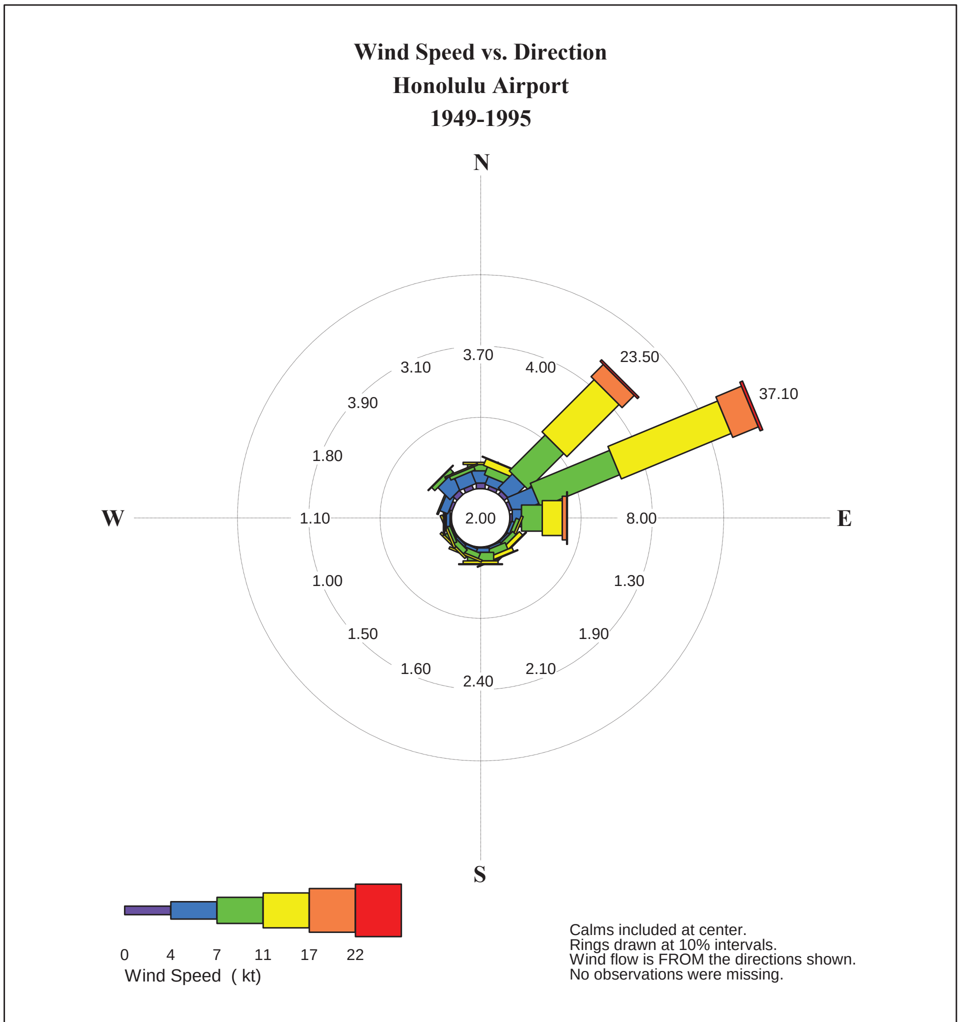
3.2 Tide

Hawaii tides are semi-diurnal with pronounced diurnal inequalities (i.e., two high and low tides each 24-hour period with different elevations). Tidal predictions and historical extreme water levels are given by the Center for Operational Oceanographic Products and Services, National Ocean Service, National Oceanic and Atmospheric Administration website. The nearest tide station to Waikiki is at Honolulu Harbor where the water level data, based on the 1983-2001 tidal epoch, is shown in Table 3-1.

Table 3-1. Water level data for Honolulu Harbor (relative to mean sea level).

Mean Higher High Water	1.1 ft.
Mean High Water	0.7 ft.
Mean Tide Level	0.0 ft.
Mean Low Water	-0.6 ft.
Mean Lower Low Water	-0.8 ft.

Hawaii is also subject to periodic extreme tide levels due to large-scale oceanic eddies that propagate through the islands. These eddies produce tide levels up to 0.5 to 1 ft higher than normal for periods of up to several weeks.



PERCENT OCCURRENCE: Wind Speed (kt)
LOWER BOUND OF CATEGORY

DIR	0	4	7	11	17	22
N	0.80	1.70	0.90	0.30	0.00	0.00
NNE	0.50	1.20	1.20	1.00	0.10	0.00
NE	0.60	2.80	7.10	10.30	2.40	0.30
ENE	0.40	3.80	12.00	16.60	3.90	0.40
E	0.30	1.30	2.90	2.80	0.60	0.10
ESE	0.10	0.40	0.50	0.30	0.00	0.00
SE	0.10	0.30	0.70	0.70	0.10	0.00
SSE	0.10	0.30	1.00	0.60	0.10	0.00

TOTAL OBS = 134736 MISSING OBS = 0

PERCENT OCCURRENCE: Wind Speed (kt)
LOWER BOUND OF CATEGORY

DIR	0	4	7	11	17	22
S	0.10	0.60	1.20	0.40	0.10	0.00
SSW	0.10	0.40	0.80	0.30	0.00	0.00
SW	0.10	0.30	0.80	0.30	0.00	0.00
WSW	0.10	0.20	0.40	0.30	0.00	0.00
W	0.20	0.50	0.20	0.20	0.00	0.00
WNW	0.40	1.20	0.20	0.00	0.00	0.00
NW	0.80	2.40	0.60	0.10	0.00	0.00
NNW	0.60	1.80	0.50	0.20	0.00	0.00

CALM OBS = 2695 PERCENT CALM = 2.00

Figure 3-1. Wind rose for Honolulu Airport (1949 to 1995).

3.3 Waves

3.3.1 *General Wave Climate*

The wave climate in Hawaii is dominated by long-period swells generated by distant storm systems, by relatively low amplitude short-period waves generated by more local winds, and the occasional bursts of energy associated with intense local storms. Typically, Hawaii receives five general surface gravity wave types: 1) northeast tradewind waves, 2) southeast tradewind waves, 3) southern swell, 4) North Pacific swell, and 5) Kona wind waves. The dominant swell regimes for Hawaii are shown on Figure 3-2.

Tradewind waves occur throughout the year and are the most persistent April through September when they usually dominate the local wave climate. They result from the strong and steady tradewinds blowing from the northeast quadrant over long fetches of open ocean. Tradewind deepwater waves are typically between 3 to 8 ft high with periods of 5 to 10 seconds depending upon the strength of the tradewinds and how far the fetch extends east of the Hawaiian Islands. The direction of approach, like the tradewinds themselves, varies between north-northeast and east-southeast and is centered on the east-northeast direction. The WWM site is well sheltered from the direct approach of tradewind waves by the island of Oahu itself, and only a portion of the tradewind wave energy refracting and diffracting around the southeast end of the island reaches Waikiki.

Southern swell is generated by storms in the southern hemisphere and is most prevalent during the summer months of April through September. Traveling distances of up to 5,000 miles, these waves arrive with relatively low deepwater wave heights of 1 to 4 ft and periods of 14 to 20 seconds. Depending on the positions and tracks of southern hemisphere storms, southern swells approach between the southeasterly and southwesterly directions. The WWM site is directly exposed to swell from the southerly direction and these waves represent the greatest source of wave energy reaching the project site.

During the winter months in the northern hemisphere, strong storms are frequent in the North Pacific in the mid latitudes and near the Aleutian Islands. These storms generate large North Pacific swells that range in direction from west-northwest to northeast and arrive at the northern Hawaiian shores with little attenuation of wave energy. These are the waves that have made surfing beaches on the north shores of Oahu and Maui famous. Deepwater wave heights often reach 15 ft and in extreme cases can reach 30 ft. Periods vary between 12 and 20 seconds depending on the location of the storm. The WWM site is sheltered by the island itself from swell approach from the north and northwest.

Kona storm waves also directly approach the project site; however, these waves are fairly infrequent occurring only about 10 percent of the time during a typical year. Kona waves typically approach from the southwest ranging in period from 6 to 10 seconds with heights of 5 to 10 ft. Deepwater wave heights during the severe Kona storm of January 1980 were about 17 ft. These waves had a significant impact on the south and west shores of Oahu.

Severe tropical storms and hurricanes obviously have the potential to generate extremely large waves, which in turn could potentially result in large waves at the WWM project site. Recent hurricanes impacting the Hawaiian Islands include Hurricane Iwa in 1982 and Hurricane Iniki in 1992. Iniki directly hit the island of Kauai and resulted in large waves along the southern shores of all the Hawaiian islands. Damage from these hurricanes was extensive. Although not a frequent or even likely event, they should be considered in the project design, particularly with regard to shoreline structures, both in the water and on land near the shore.

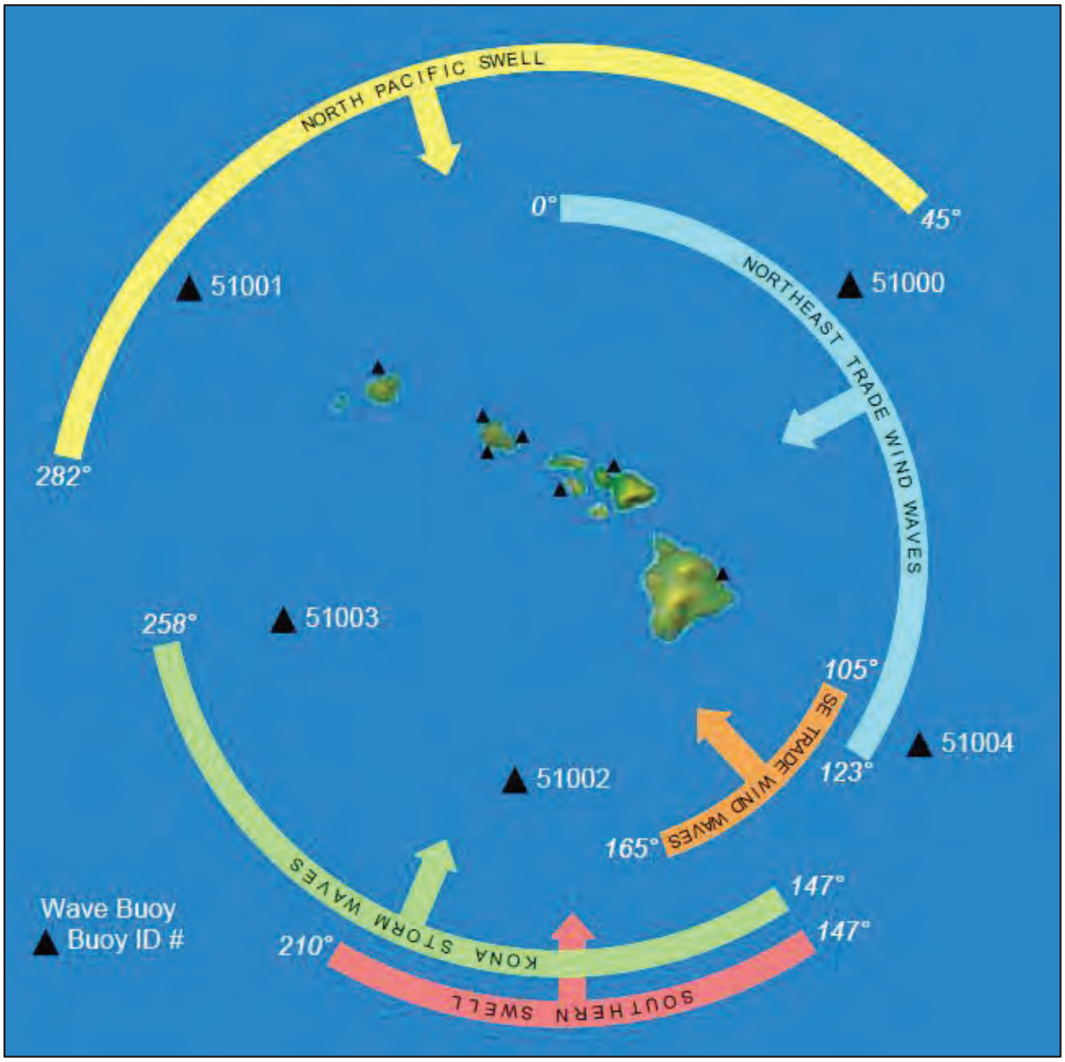


Figure 3-2. Hawaii dominant swell regimes.

3.3.2 *Prevailing Deepwater Waves*

Wave data available from the National Oceanographic and Atmospheric Administration (NOAA) was compiled and analyzed to identify the primary components of the wave climate affecting the project site. These data provide a 31-year wave record and were statistically analyzed to determine the frequency of occurrence of different wave heights, periods, and directions along the coast.

Wave hindcasting is a tool used to calculate past wave events based on weather models and historical data (Hubertz, 1992). With the proper inputs, wave hindcast models can calculate historical wave climates anywhere in the world. Hindcast model outputs are often recorded for a single location, known as a "virtual buoy".

WaveWatch III (WWIII) is a numerical wave model used to forecast and hindcast waves. Hindcast data for a 31-year period (1979-2010) are available around the Hawaiian Islands from NOAA/NCEP. For this study, hindcast data were obtained from the virtual buoy Station HNL11, located approximately 26 miles south-southwest of the project site at 21°N, 158.25°W.

It is rare for the sea state to consist of a singular wave condition. Wave events are described by wave height, peak period, and peak direction. The wave parameters from the hindcast model are calculated from a modeled wave spectrum. The spectrum shows the distribution of wave energy relative to wave frequency (wave frequency is the inverse of wave period) and wave direction. This methodology allows multiple wave conditions to be accounted for at the same time for a more accurate description of the sea state. Figure 3-3 is a wave height rose diagram that shows the percent occurrence of wave height and direction for waves as measured at Station HNL11. Table 3-2 is the corresponding histogram. Figure 3-4 is a wave period rose diagram that shows the percent occurrence of wave period and direction for waves as measured at Station HNL11. Table 3-3 is the corresponding histogram. A directional filter was applied within the analysis to only include waves approaching from the south direction between east (90°) and west (270°). The prevailing deepwater wave condition for the project site has a significant wave height of 2.0 feet, a peak period of 15 seconds, and a direction of SSW.

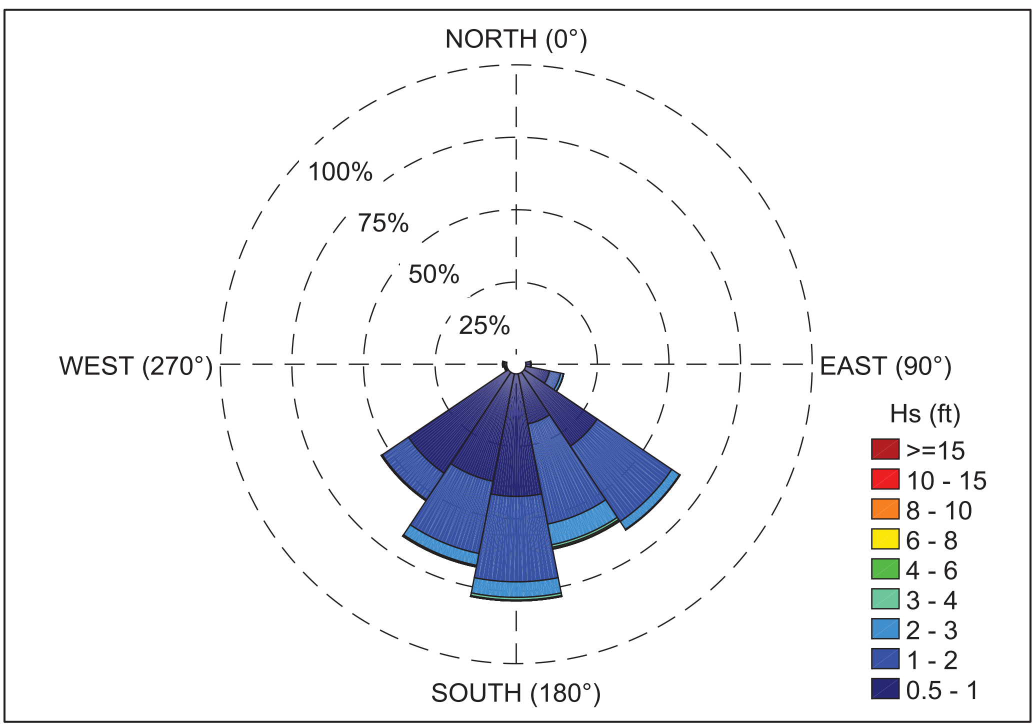


Figure 3-3. Station HNL11 virtual buoy wave height rose from Jan 1979 - Jan 2010.

Table 3-2. HNL11 wave height and direction histogram from Jan 1979 - Jan 2010.

Hs (ft) \ Dir (deg)	90	112.5	135	157.5	180	202.5	225	247.5	270
0.5-1.0	1.7	8.5	30.7	17.6	42.3	37.9	41.9	0.4	0.6
1-2	0.1	4.0	31.3	35.3	29.5	25.4	11.0	0.2	0.3
2-3	0.1	1.0	3.3	7.3	5.4	4.2	0.3	0.1	0.2
3-4	0.0	0.1	0.2	0.9	0.9	0.4	0.1	0.1	0.1
4-6	0.0	0.0	0.0	0.5	0.2	0.1	0.0	0.1	0.1
6-8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
8-10		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-12				0.0	0.0	0.0	0.0	0.0	0.0
12-14				0.0	0.0	0.0	0.0	0.0	0.0
14-16					0.0	0.0	0.0	0.0	0.0
16-20					0.0	0.0	0.0	0.0	0.0
20+					0.0	0.0	0.0		
Total	1.9	13.5	65.5	61.8	78.4	68.0	53.3	0.9	1.5
	90	112.5	135	157.5	180	202.5	225	247.5	270
Mean	0.78	1.01	1.13	1.42	1.13	1.09	0.83	2.57	2.04
Standard Deviation	0.66	0.58	0.48	0.71	0.63	0.56	0.40	2.93	2.15
Minimum	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Maximum	7.74	8.07	8.10	13.35	20.18	23.75	20.34	19.91	17.06

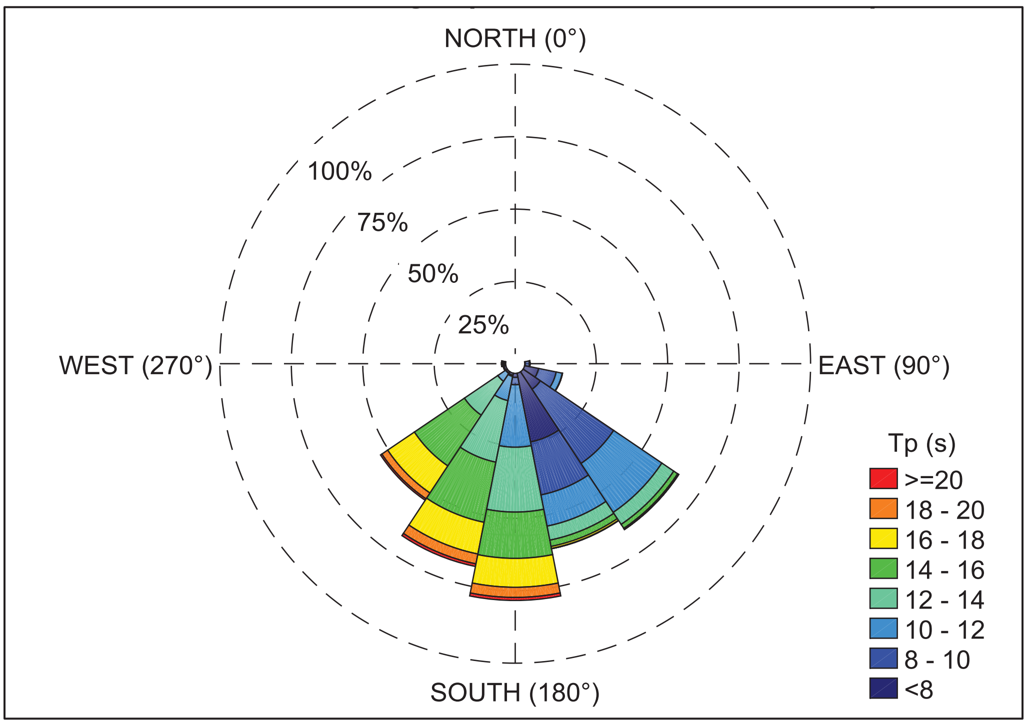


Figure 3-4. Station HNL11 virtual buoy wave period rose from Jan 1979 - Jan 2010.

Table 3-3. HNL11 wave period and direction histogram from Jan 1979 - Jan 2010.

Tp (s) \Dir (deg)	90	112.5	135	157.5	180	202.5	225	247.5	270
4-6	0.1	4.7	2.1	6.8	0.7	0.3	0.3	0.3	0.2
6-8	0.1	0.3	5.2	17.4	0.7	0.4	0.3	0.3	0.2
8-10	1.4	6.3	30.8	18.6	2.6	0.4	0.1	0.2	0.3
10-12	0.2	2.2	20.3	11.0	21.6	8.5	3.3	0.1	0.4
12-14	0.0	0.1	5.0	4.9	22.4	21.7	14.0	0.0	0.2
14-16	0.0	0.0	1.6	2.2	16.0	21.2	21.1	0.0	0.1
16-18			0.4	0.7	10.0	11.1	11.2	0.0	0.0
18-20			0.0	0.1	3.5	3.5	2.4		0.0
20+			0.0	0.0	1.0	0.9	0.6		0.0
Total	1.9	13.5	65.5	61.8	78.4	68.0	53.3	0.9	1.5
	90	112.5	135	157.5	180	202.5	225	247.5	270
Mean	9.16	7.91	9.84	8.97	13.52	14.36	14.79	7.32	9.69
Standard Deviation	1.35	2.44	1.91	2.61	2.71	2.36	2.16	2.17	3.04
Minimum	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01
Maximum	15.30	15.14	20.59	22.05	24.46	23.65	23.33	16.59	22.03

3.3.3 *Extreme Deepwater Waves*

The Hawaiian Islands are annually exposed to severe storms and storm waves generated by passing low-pressure systems (Kona storms) and tropical cyclonic storms (hurricanes). Kona storms occur when winter low-pressure systems that travel across the North Pacific Ocean dip south and approach the islands. Strong southerly and southwesterly winds generated by these storms result in large waves on exposed shorelines and often heavy rains. Hurricanes, the worst-case tropical cyclones, are caused by intense low-pressure vortices that are usually spawned in the eastern tropical Pacific Ocean and travel westward. While they typically pass south of the Hawaiian Islands, their paths are unpredictable, and they will occasionally pass near or over the islands. Hurricane Iwa (1982) and Hurricane Iniki (1992) directly hit the island of Kauai and resulted in large waves along Oahu's southern shores. Damage from these hurricanes was extensive not only on Kauai, which was subject to both high winds and waves, but also along coastal areas of other islands exposed to the large waves.

Detailed studies of hurricane storm wave inundation limits for the island of Oahu have been completed by Bretschneider and Noda (1985) for two hurricane scenarios – a model, or most probable type hurricane, and a worst-case hurricane. Deepwater hurricane wave heights, periods, and approach directions off the south shore of Oahu as reported by Bretschneider and Noda for the model and worst-case hurricanes are 31 ft, 12 seconds, 175 degrees and 41 ft, 14 seconds, 210 degrees, respectively.

Historical wave buoy data also allows the prediction of extreme wave events. These are infrequent, large, powerful, low probability wave events that are typically used for design purposes. For example, a 50-year return period wave event is an extreme event with a 1/50 (i.e., 2%) chance of occurring in any given year. Extreme wave heights were investigated by filtering the virtual buoy data by direction and period for waves within the project site's direct exposure window, between 90° and 270° (south swell), with periods of 12 seconds or greater.

The extreme wave height data from the HNL11 dataset were used to generate a Weibull extreme value distribution for return period wave heights. The Weibull Distribution is a tool for looking at the relationship between the size of waves and how frequently they occur at a given location. Analysis requires a long-term data set with well-documented wave events. These events are sorted by size, and frequency of occurrence can be assessed by how often these events occur in the record. The relationship is logarithmic, and a linear fit can be established with a best fit linear regression of the data. Though not all wave events will be co-located on the line, its general trend represents the nature of the size and frequency relationship of wave events at a specific location.

Wave height versus return period is shown in Figure 3-5 and Table 3-4. The ten largest wave events from directions east to west (90º to 270º TN) during the period of record are shown in Table 3-5.

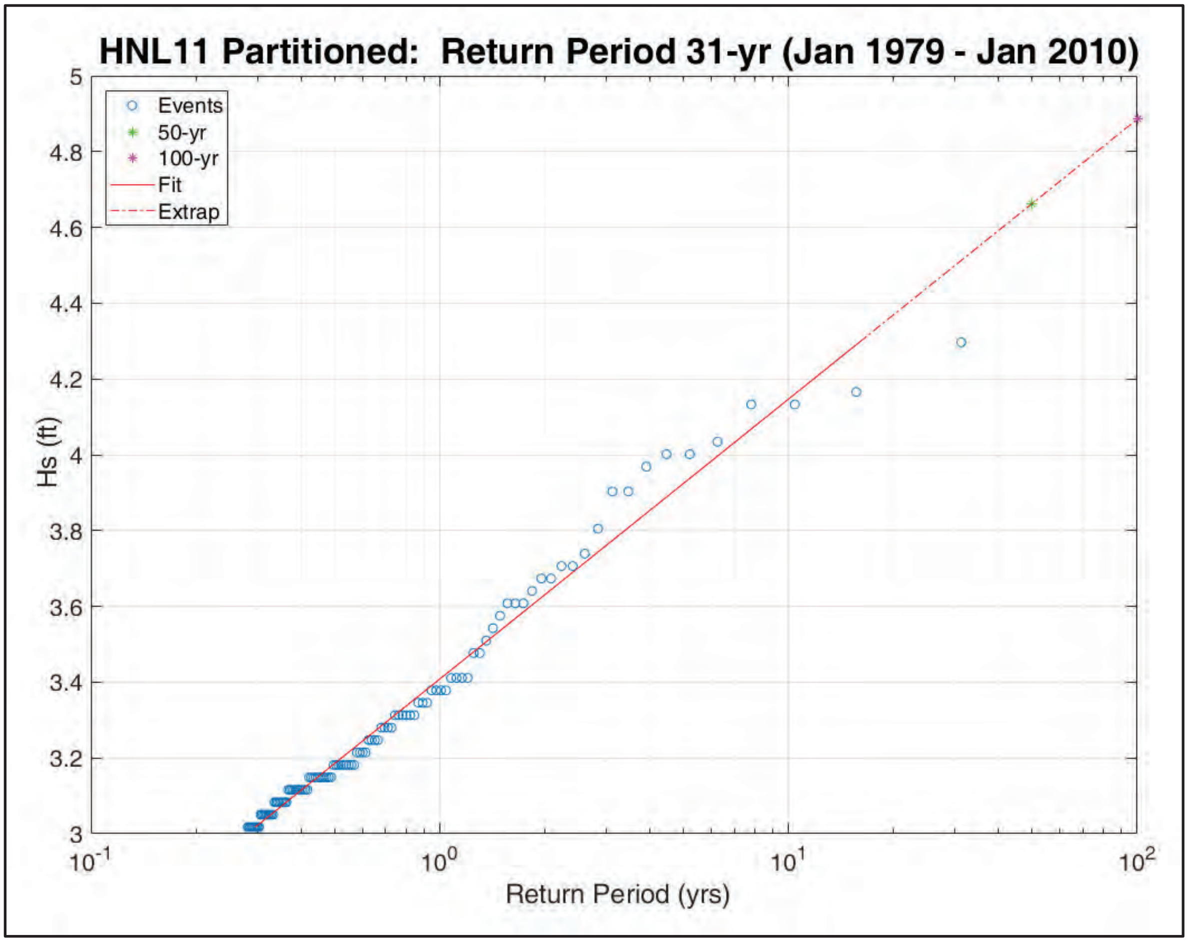


Figure 3-5. Virtual buoy HNL11 return period.

Table 3-4. Return period significant wave heights at HNL11.

Return Period	Wave Height (feet)
1	3.4
2	3.6
5	3.9
10	4.2
25	4.4
50	4.7
100	4.9

Table 3-5. Top 10 events recorded at HNL11.

Date	Wave Height (ft)	Period (s)	Direction (degrees)
5/12/1980	4.3	17.3	190.7
10/3/1987	4.2	17.6	189.6
5/5/1992	4.1	17.0	190.5
6/12/1998	4.1	17.5	185.5
2/13/1995	4.0	17.8	191.6
6/20/1982	4.0	16.4	186.4
5/4/2003	4.0	16.6	190.4
6/22/1988	4.0	15.4	182.1
8/3/1980	3.9	16.6	190.3
8/4/1980	3.9	16.5	190.3

The report *Hurricanes in Hawaii* (Haraguchi, 1984), prepared for the USACE, Honolulu Engineer District, presents hypothetical model and worst-case hurricane scenarios for the Hawaiian Islands. These scenario hurricanes have been used for detailed studies of hurricane storm wave inundation limits for the islands of Oahu and Kauai prepared by Bretschneider and Noda (1985) and SEI (1986, 1993, and 2000) for the USACE Honolulu Engineer District. The model hurricane is defined as the probable hurricane that will strike Hawaii in the future, based on the characteristics of storms previously approaching or striking the islands. The worst-case hurricane characteristics are based on subjective analysis of the data from 20 critical hurricanes in the Central Pacific and an understanding of the basic atmospheric and oceanic conditions surrounding the Hawaiian Islands. For this study, deepwater model hurricane wave parameters off the south shore of Oahu as reported by Bretschneider and Noda (1985) are selected as hurricane waves. Wave heights, periods, and approach directions for the model hurricanes are 30.8 feet, 12 seconds, 175 degrees, and 36.2 feet, 13.3 seconds, and 220 degrees, respectively.

The design wave conditions selected for further analysis are summarized in Table 3-6.

Table 3-6. Selected design wave conditions.

Type of Wave	Deepwater Wave Height (feet)	Wave Period (sec.)
1-Year Wave	3.4	17
50-Year Wave	4.7	17
Kona Storm Wave (1980)	17.0	9
Model Hurricane	30.8	12

3.3.4 *Wave Measurements (Sea Engineering, Inc. Field Study)*

To characterize wave conditions directly at the project site, SEI deployed a wave gauge offshore of the Natatorium during winter and summer seasons of 2010-2011. The deployment periods were late December 2010 through early April 2011 and mid-June 2011 through early October 2011. The wave gauge was deployed in a water depth of 55 ft, and its location is shown later on Figure 3-15.

The wave environment measured during the winter deployment consisted of two general conditions that typify winter on the south shore of Oahu. Wave roses of height and period are presented on Figure 3-6 and Figure 3-7; time series of the wave data are presented in Appendices A and B. The most common wave condition consists of low significant wave heights ranging from 2 to 3 ft and wave periods of 6 to 15 seconds. Direction ranged from south-southeast to south-southwest. The wave record also showed the occurrence of several events of increased significant wave height (January 11, January 13, February 6, February 16, and March 4, 2011). On each of these days, the measured significant wave height exceeded 4 ft and the wave period was measured to be consistently in the 5- to 10-second range. These wave conditions are typical of waves produced by nearby Kona storms, as described in Section 3.3.1.

Wave roses of height and period for the summer data are presented on Figure 3-8 and Figure 3-9. The summer wave data shows the occurrence of longer period waves than measured during the winter. Several periods of southern swell occurred during the deployment with significant wave heights exceeding 4 ft on June 22-23, July 6-8, July 16, August 4, August 23, August 29-September 2, and September 10-12, 2012. Unlike the winter high-wave events, the summer wave events had longer wave periods, generally in the 10- to 20-second range. The data for the late August wave event showed significant wave height exceeding 7 ft and wave period greater than 20 seconds. Surf on August 30, 2011 was reported to exceed 10 ft and this event is considered one of the biggest in the last 10 years.

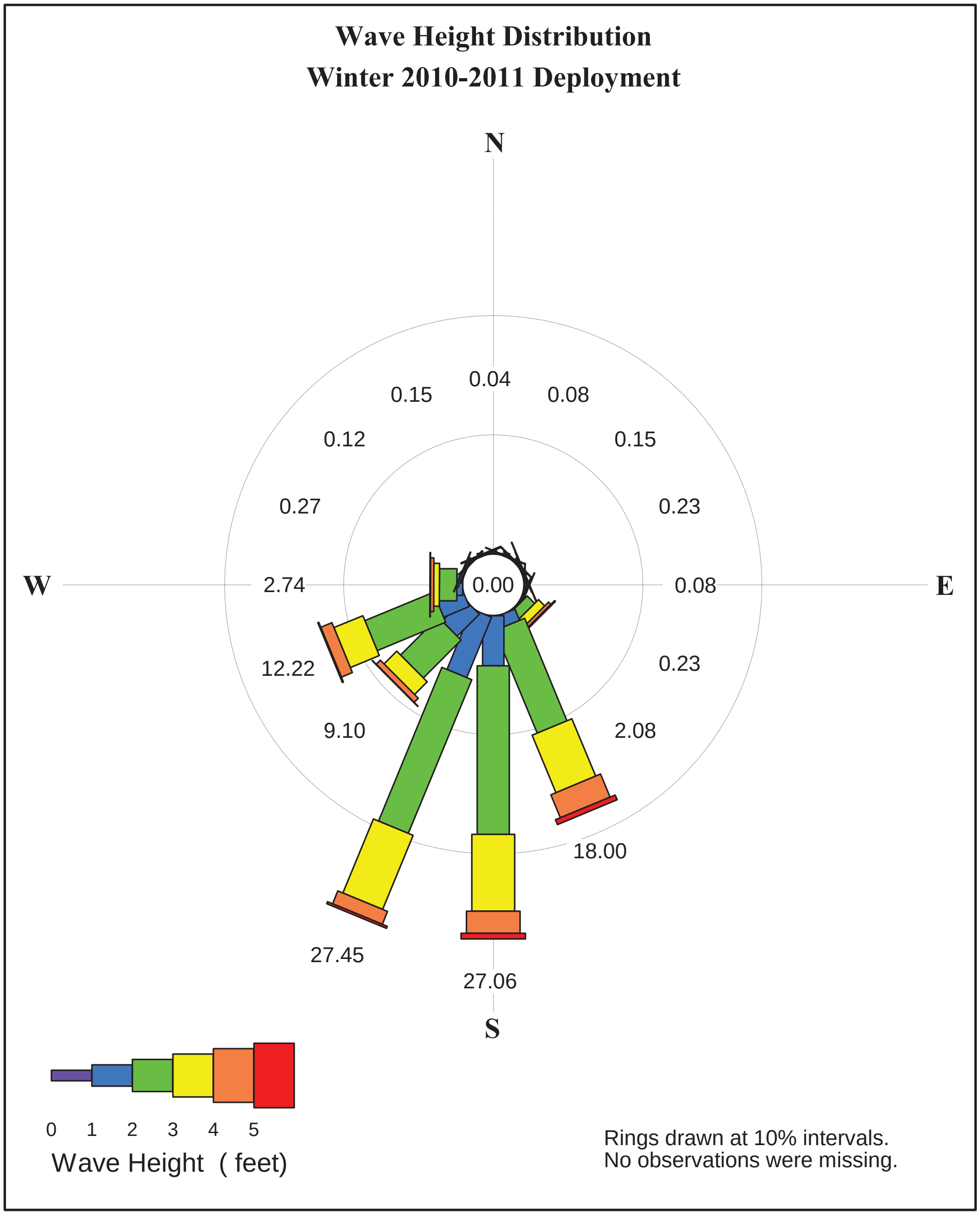


Figure 3-6. Wave height distribution, Teledyne RD Instruments (RDI) wave gauge, Winter 2010-2011.

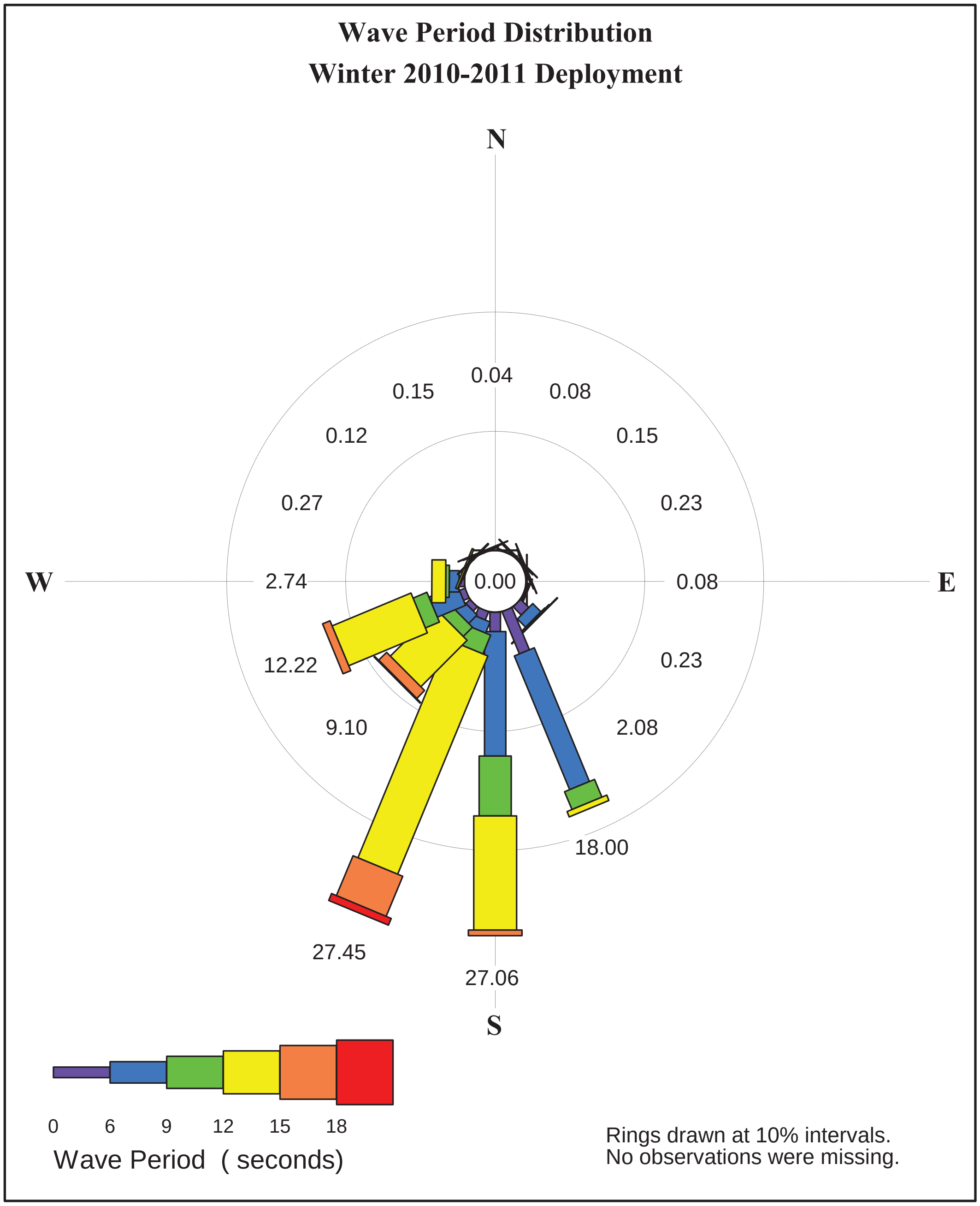


Figure 3-7. Wave period distribution, RDI wave gauge, Winter 2010-2011.

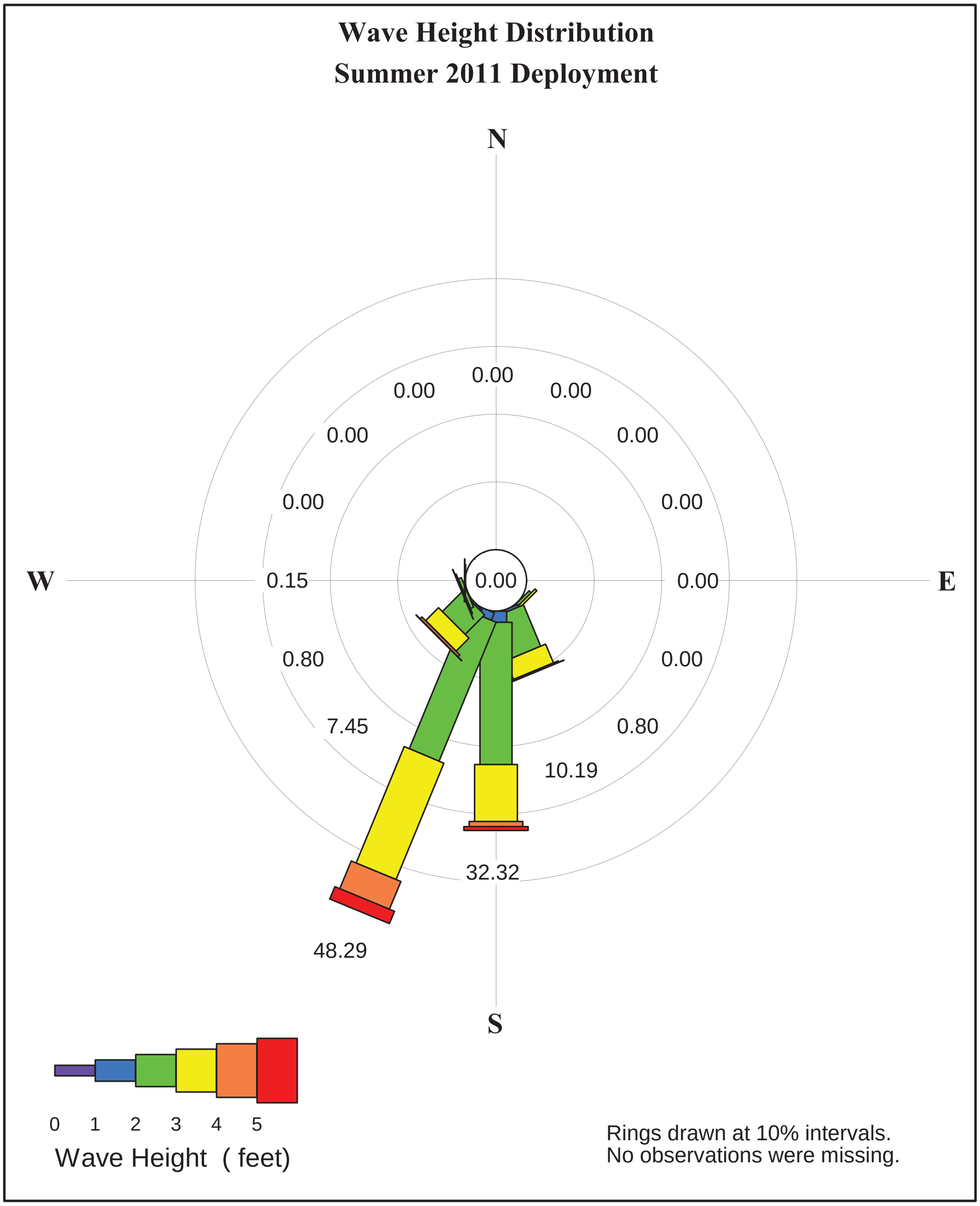


Figure 3-8. Wave height distribution, RDI wave gauge, Summer 2011.

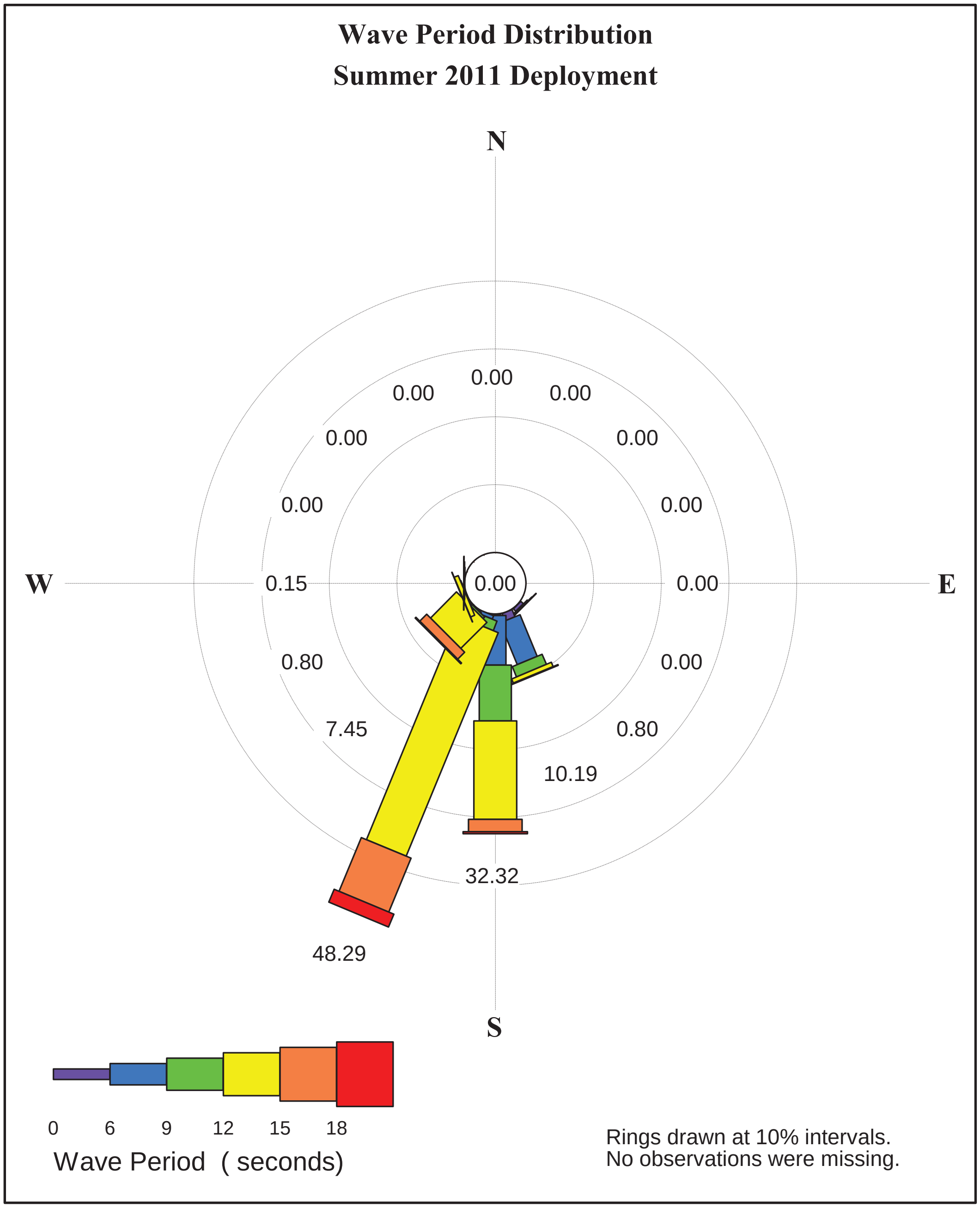


Figure 3-9. Wave period distribution, RDI wave gauge, Summer 2011.

3.4 Nearshore Water Levels and Wave Heights

3.4.1 *Wave Transformation to Shallow Water*

As deepwater waves approach the shoreline, they begin to transform due to the effects of shoaling, bottom friction, refraction, and diffraction. As waves shoal, heights increase and the wave crests steepen, to the point that the waves become unstable, leading to breaking and dissipation of wave energy. Wave energy can also be attenuated due to bottom friction. The approach direction can change as the wave front refracts, or becomes oriented parallel to the existing bathymetric contours. Lateral spreading of energy, known as diffraction, can occur behind a natural or man-made barrier.

While all of these waves would lose some energy through refraction, a wave approaching with a deepwater direction from the south-southwest would experience the least refraction, and for design purposes, the design waves are considered to approach from this direction. The design wave heights (presented later in Section 3.4.5) for the selected design wave conditions reflect the transformation that these waves undergo into the project site as determined through the Automated Coastal Engineering System (ACES) using site bathymetry.

3.4.2 *BOUSS2D Wave Modeling*

3.4.2.1 Introduction

The prevailing wave crest alignment and design wave height are key design parameters for beach and structure design. The wave modeling performed for the conceptual shoreline study (Sea Engineering, Inc., 2008) showed the wave field approaching the Natatorium to be very complex as evidenced by observations and aerial photos. That study employed the wave model BOUSS2D to analyze the nearshore waves. BOUSS2D, a component of the Surface-water Modeling System suite of modeling products, is a shallow-water non-linear wave model that also includes the processes of wave shoaling, refraction, diffraction, and breaking. BOUSS2D is a time-domain model and has been shown to be particularly useful in modeling wave/structure interaction. The model has the capability of outputting an animation of water surface elevations, which is very effective in showing wave propagation where complex wave patterns are present.

The BOUSS2D model was used in the present project to better define the wave conditions at the project site for beach and structure design. The improvements over the modeling in the 2008 project were based primarily on additional reef elevation data discussed in Section 2.1 and new studies regarding wave energy dissipation over nearshore reefs (Demirbilek and Nwogu, 2007; Cheung, 2012; Filipot and Cheung, 2012; Roeber and Cheung, 2012).

3.4.2.2 Model Validation

The BOUSS2D model was validated for the project by comparison with the satellite photo shown on Figure 3-10a using the conditions that occurred on the day of the photo, July 28, 2004. The estimated time of the photo is 10 AM. Data from WIS Station 114, which is about 80 miles south of the project site, showed significant wave height of 2.7 ft, peak period of 12.2 seconds, and direction of 202.5 degrees at 8 AM (travel time for a 12-second wave from WIS Station 114 to Waikiki is approximately 2 hours). ACES showed that wave refraction from deep water to a depth of 100 ft, the offshore boundary of the BOUSS2D model domain, was negligible and confirmed that the wave height at that location was 2.5 ft. The historical tide record for Honolulu Harbor shows a water level of +0.2 ft msl at 10 AM.

The BOUSS2D model was run using the above conditions. The model performance was evaluated by overlaying on the aerial photo a video animation of wave propagation. A snapshot from 19 minutes into the model simulation is presented on Figure 3-10b. The side-by-side comparison clearly shows the similarities in wave patterns and breaker zones. In addition to the complex wave environment in front of the WWM site, the results of the model runs show that Sans Souci Beach is maintained by wave energy that passes through the channel and diffracts around the reef producing a net longshore transport toward the WWM. The Diamond Head wall of the Natatorium pool provides a barrier to the transport producing a wider beach.

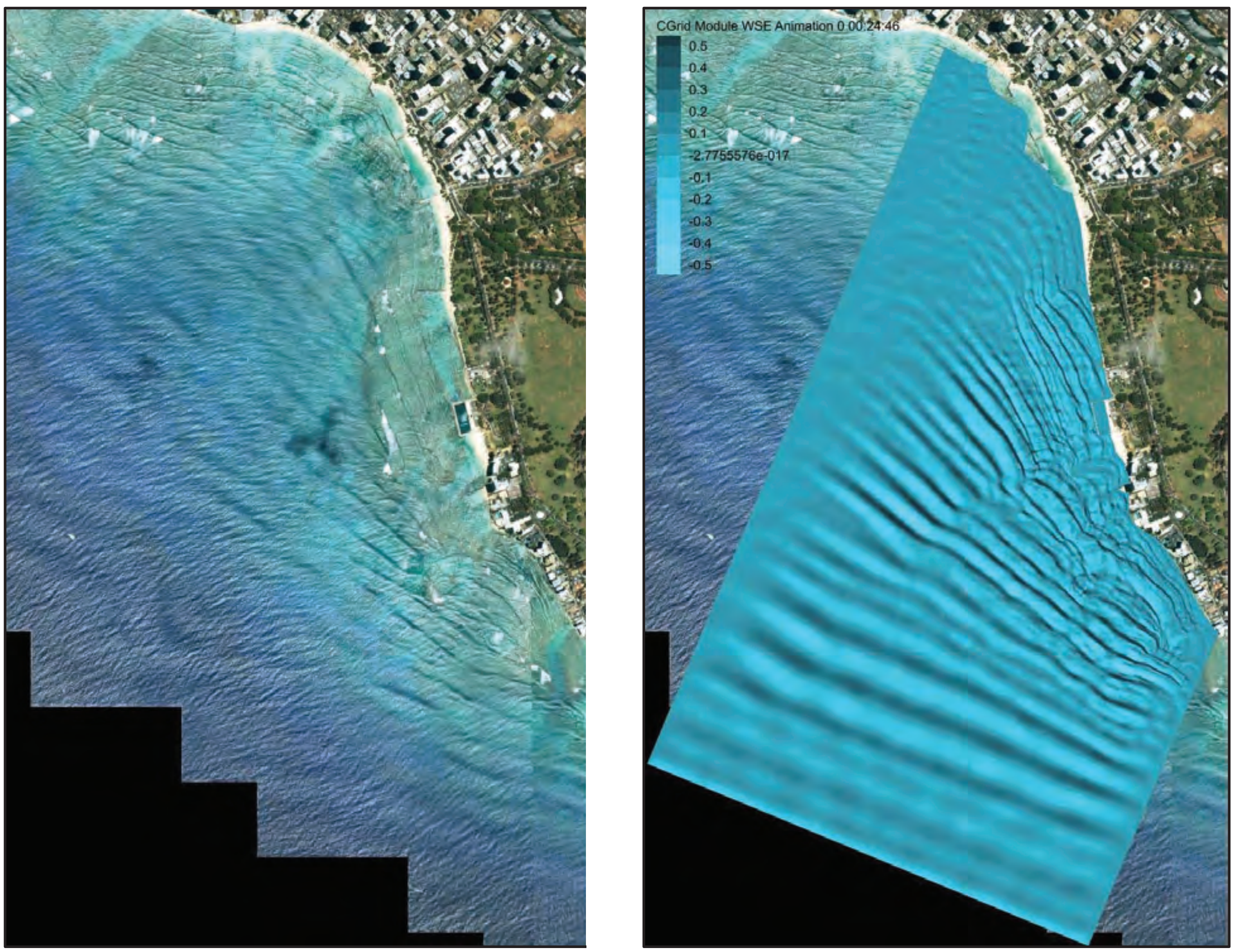


Figure 3-10. BOUSS2D model validation.

a) Satellite photograph from July 28, 2004;
b) BOUSS2D model validation results for comparison with photograph

3.4.2.3 Prevailing Wave Conditions

Refraction causes wave crests to approach a parallel orientation with the bathymetry as the waves propagate toward shore. This presents a limited range of wave crest orientations near shore at a given point. The wave crest orientations are important for determining proper gap orientation for the beach-stabilizing structures. BOUSS2D modeling was performed for the prevailing south-southwest and south wave conditions determined in Section 3.3.2 of H_s = 4 ft, T_p = 15 s, at a water level of mean high water (+0.7 feet msl). The mean high water (mhw) level is a commonly occurring water level which allows somewhat higher wave energy into the project site, and thus serves as the controlling water level for beach shape and stability. The incident wave crest orientation for each of the two modeled wave directions are shown on Figure 3-11. The modeling showed that the prevailing south-southwest deepwater wave condition produced waves that were typically incident upon the Natatorium with an approximate 15-degree angle (open in the Ewa direction). Within the model results, the individual wave angles ranged from 0 to 15 degrees. The waves incident upon the Natatorium produced by the south deepwater wave condition had angles somewhat greater, typically around 25 degrees.

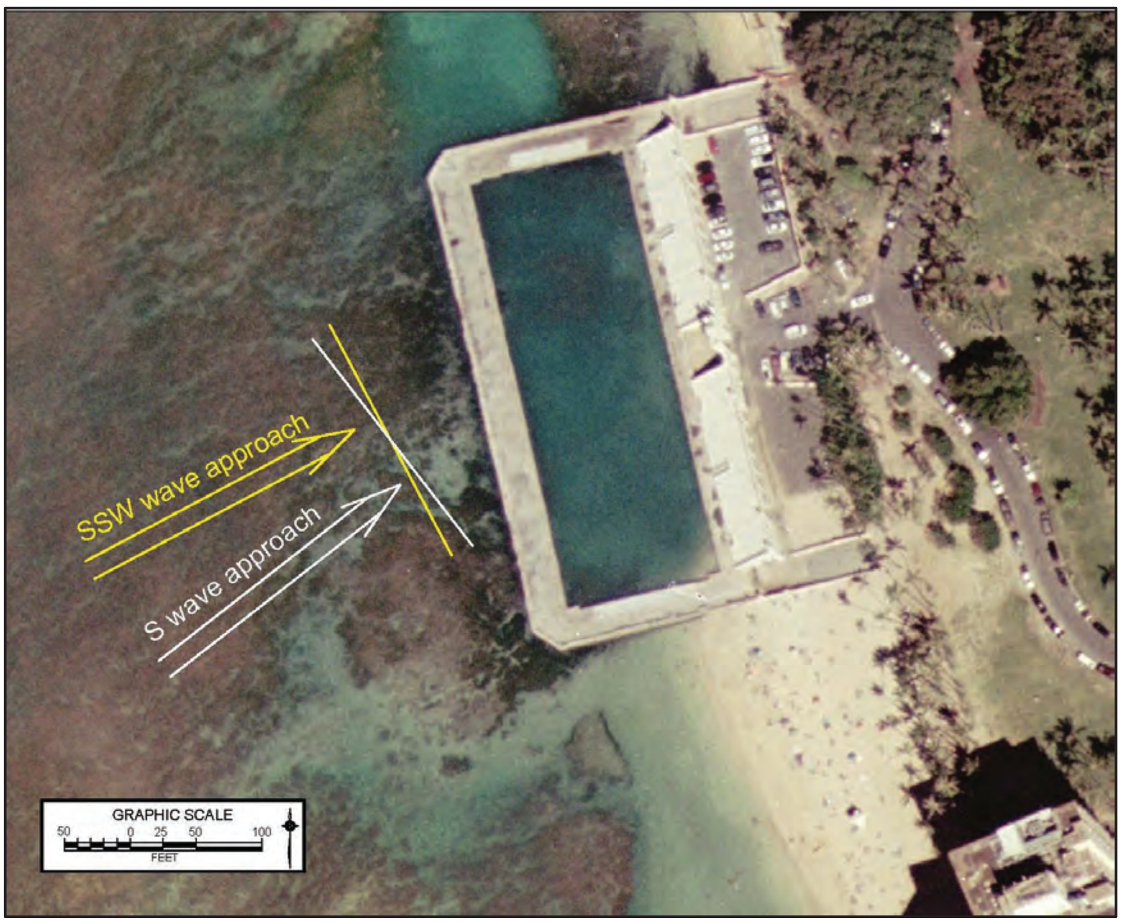


Figure 3-11. Incident and average wave crest orientation.

3.4.3 *Still Water Levels and Nearshore Wave Heights*

During high wave conditions, the nearshore water level may be elevated above the tide level by the action of breaking waves. This water level rise, termed wave setup, could be as much as 1 to 2 ft during severe storm wave conditions. During hurricane conditions, an additional water level rise due to wind stress and reduced atmospheric pressure can occur. Collectively termed "storm surge," this can potentially add another 1 to 2 ft to the still water level. For example, during the 1992 passage of Hurricane Iniki over Port Allen Harbor on the island of Kauai, a National Weather Service tide gauge recorded a water level rise of 4.4 ft above the predicted tide elevation.

During storm or large wave conditions, there may be multiple zones of wave breaking. Wave heights are said to be *depth-limited* because once the water depth becomes shallow enough the wave breaks, losing size and energy. The wave, however, may reform before it reaches the shoreline and break again when the depth-limited ratio is again attained. The still water level rise during storm events is an important design consideration because it allows larger wave heights to reach the shoreline than during lower water levels.

Estimation of still water level rise for the 50-year wave event may be accomplished by traditional methodology which uses bathymetry and wave heights as inputs. Still water level rise at the shoreline is a combination of astronomical tide, storm surge, and wave setup. The astronomical tide level chosen for design conditions is mean higher high water (mhhw) due to its frequency of occurrence, and the mhhw level was presented earlier as +1.1 ft msl in nearby Honolulu Harbor (Table 3-1).

Wave setup is a function of the breaking wave height, period, and bottom topography. The mass transport of water due to breaking waves produces wave setup—the increase in water depth shoreward of the breaker zone. The available analytical methods for calculating wave setup have been simplified and assume long, straight, parallel bathymetric contours, continuous breaking waves, and breaker zones relatively near shore; these methods are presented in the Shore Protection Manual (1984) and Coastal Engineering Manual (2006). Experience has shown that these methods tend to over-predict wave setup because the natural environment has discontinuous breaking zones, irregular bathymetry, channels, and gaps in the reef that allow for a relief of wave setup.

The limiting-water depth is found over the shallow reef flat fronting the Natatorium, described in Section 2.1, as this will cause larger waves to break before reaching the Natatorium. Depths over the reef flat are typically 3 to 4 ft msl and include irregularities. The maximum wave height that can pass over the reef is a function of the ratio of breaking wave height to water depth. For analytical purposes, the controlling elevation of the reef is taken to be -3.5 ft msl and a wave breaking index of 0.65 is used.

3.4.4 *Sea Level Rise*

The present rate of global mean sea-level change (SLC) is +3.4 ± 0.4 mm/year (Sweet et al., 2017), where a positive number represents a rising sea level. SLC appears to be accelerating compared to the mean of the 20th Century. Factors contributing to the measured rise in sea level include decreasing global ice volume and warming of the ocean. Sea level, however, is highly variable. The historical sea level trend for Honolulu Harbor, Station 1612340, is shown in Figure 3-12 (NOAA, 2017). The mean historical rate of sea level change (RSLC) is +1.48 ± 0.21 mm/yr based on monthly data for the period 1905 to 2017. The tide gauge data also shows interannual anomalies exceeding 0.5 feet (15 cm) in Honolulu Harbor.

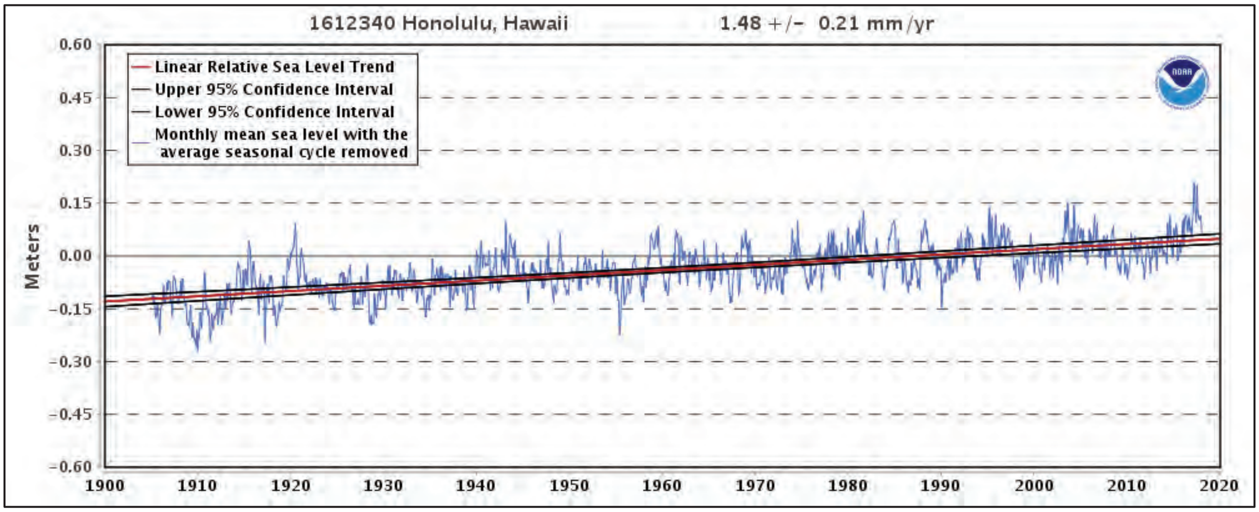


Figure 3-12. Mean sea level trend, Honolulu Harbor, 1905 to present (NOAA, 2017).

The National Oceanic and Atmospheric Administration (NOAA) recently revised their sea level change projections through 2100 taking into account up-to-date scientific research and measurements. NOAA is projecting that global sea level rise as shown by their "Extreme" scenario could be as high as about 8 feet by 2100. NOAA's recent report also identifies specific regions that are susceptible to a higher than average rise in sea level. Hawaii has thus far experienced a rate of sea level rise that is less than the global average; however, this is expected to change. Hawaii is in the "far field" of the effects of melting land ice. This means that those effects have been significantly less in Hawaii compared to areas closer to the ice melt. Over the next few decades, this effect is predicted to spread to Hawaii, which will then experience sea level rise greater than the global average.

Figure 3-13. presents mean sea level rise scenarios for Hawaii based on the revised NOAA projections, taking into account the far-field effects. While the projections are based on the most current scientific models and measurements, discretion is necessary in selecting the appropriate scenario. Selecting the appropriate sea level change projection is a function of many parameters, including topography, coastal setting, criticality of infrastructure, potential for resilience, budget, and function.

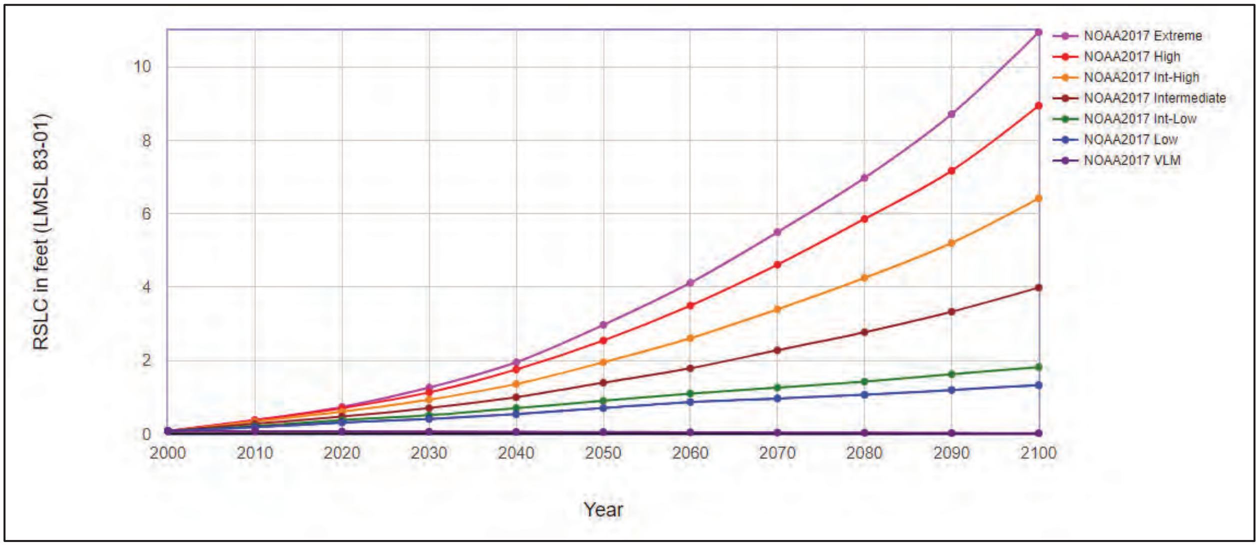


Figure 3-13. Hawaii sea level rise projections (adapted from NOAA, 2017).

Table 3-7 Hawaii Local Mean Sea Level rise scenarios (feet)

Scenario	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Extreme	0.38	0.74	1.26	1.95	2.97	4.12	5.50	6.97	8.71	10.94
High	0.38	0.71	1.13	1.76	2.54	3.50	4.61	5.86	7.17	8.94
Intermediate-High	0.35	0.61	0.94	1.36	1.95	2.61	3.40	4.25	5.20	6.42
Intermediate	**0.28**	**0.48**	**0.71**	**1.00**	**1.40**	**1.79**	**2.28**	**2.77**	**3.33**	**3.99**
Intermediate-Low	0.21	0.38	0.51	0.71	0.90	1.10	1.26	1.43	1.63	1.82
Low	0.18	0.31	0.41	0.54	0.71	0.87	0.97	1.07	1.20	1.33

An important conclusion of the regional climate assessment is that NOAA's revised *Intermediate* rate is recommended for planning and design purposes in Hawaii. The *Intermediate* rate projects that sea level in Hawaii will rise 2.3 feet by 2070 (Table 3-7). Given the recent upwardly revised projections and the potential for future revisions, consideration may also be given to the *Intermediate-High* rate for planning and design purposes, which projects that sea level in Hawaii will rise 3.4 feet by 2070.

Sea level rise has the potential to impact beaches and shorelines in Hawaii. Impacts may include beach narrowing and beach loss, loss of land due to erosion, and infrastructure damage due to inundation and flooding. The impacts from anomalous sea level events (e.g., king tides, mesoscale eddies, storm surge) are also likely to increase. A 2015 study found that, due to increasing sea level rise, average shoreline recession (erosion) in Hawaii is expected to be nearly twice the historical extrapolation by 2050, and nearly 2.5 times the historical extrapolation by 2100 (Anderson et al., 2015).

The State of Hawaii recently published the *Sea Level Rise Vulnerability and Adaptation Report for Hawaii*, which discusses the anticipated impacts of projected future sea level rise on coastal hazards, and the potential physical, economic, social, environmental, and cultural impacts of sea level rise in Hawaii (Hawaii Climate Change Mitigation and Adaptation Commission, 2017). The University of Hawaii conducted numerical modeling to estimate the potential impacts that a 3.2-foot rise in sea level would have on coastal hazards including passive flooding, annual high wave flooding, and coastal erosion. These three coastal hazards are combined to form the "Sea Level Rise Exposure Area" shown in blue in Figure 3-14.

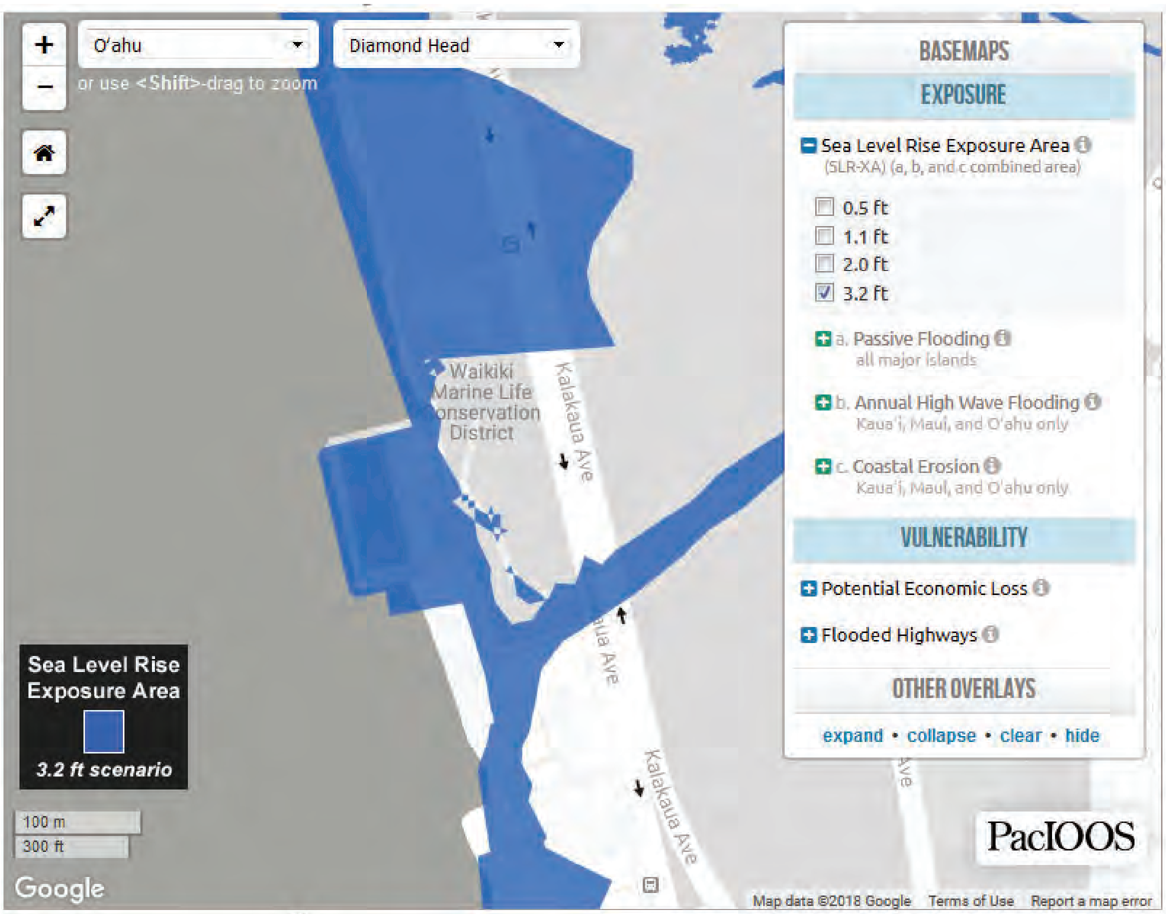


Figure 3-14. *Sea Level Rise Exposure Area* (Natatorium vicinity).

Since sea level rise predictions are changing as more information becomes available, the value of sea level rise used in the present study will be updated in the design phase.

3.4.5 *Design Still Water Level and Wave Height*

A summary of design parameters for the four wave conditions discussed previously in this section is presented in Table 3-8. The conditions in the table for the prevailing wave are those used in the wave modeling of the prevailing condition. The simplified method of using controlling water depth produces a wave height at the offshore wall of the Natatorium of 2.7 ft, consistent with the wave modeling, which showed a maximum significant wave height of 2.7 ft.

The difference between the 1-year wave and the 50-year wave deepwater wave heights are quite significant; however, the difference is quite small near the offshore wall of the Natatorium. This similarity of wave height illustrates the effectiveness of the shallow reef at reducing wave energy. This was confirmed during the large swell of August 2011, when surf was over 10 feet high, yet the waves at Sans Souci Beach and incident upon the Natatorium were quite small.

Table 3-8. Design wave conditions (relative to msl).

	Prevailing wave	1-year wave	50-year wave	Model Hurricane
Deepwater Wave Height H_o (ft)	2.0	3.4	4.7	30.8
Still Water Level Rise				
Astronomical tide (ft)	0.7	1.1	1.1	1.1
Large-scale eddy (ft)	0.0	0.5	0.5	0.5
Wave setup (ft)	0.0	0.5	1.0	4.4*
Sea Level Rise	n/a	0.7	0.7	0.7
Total SWL rise (ft)	0.7	2.8	3.3	6.7
Nominal Water Depth (ft)	3.5	3.5	3.5	3.5
Design Water Depth (ft)	4.2	6.3	6.8	10.2
Design Wave Height *H* (design, ft)	2.7	4.1	4.4	6.6

*Combined wave setup and storm surge

3.5 Currents and Circulation

Offshore tidal-driven currents in Waikiki generally flow toward the north-northwest (Ewa) during high tide and south-southwest (Diamond Head) during low tide, generally flowing parallel with the bottom contours (Noda, 1991a). Currents landward of the 30-ft bottom contour are weaker than the currents further offshore. Velocities are typically 0.15 to 0.5 ft/second (0.1 to 0.3 knots). Wind speed and direction influence the surface (top 3 ft) current creating eddies when opposed to the tide flow and strengthening the current when blowing in the same direction. Wave-induced currents predominate inside the breaker zone generating both longshore and onshore/offshore currents, which contribute to sediment transport.

3.5.1 *In-Situ Current Measurements (Sea Engineering, Inc. Field Program)*

A field program was developed to obtain site-specific wave and circulation data for the project site. The field program was divided into two parts, summer and winter deployments based on the wave exposure of the site. The winter deployment period was December 17, 2010 through April 5, 2011, and the summer deployment period was June 13, 2011 through October 1, 2011.

The instrumentation deployed included the following:

- RDI ADCP
  - Offshore of reef; 55-ft water depth

    - Recorded waves, tides, and current profiles
- Nortek ADCM
    - Located in swim channel; 8-ft water depth
    - Measured single-point currents
- Aanderaa ADCM
    - On reef, 125 ft offshore of the Natatorium; 3-ft water depth
    - Recorded single-point currents

Instrument locations are shown on Figure 3-15. The RDI ADCP was deployed in 55 ft of water south-southwest of the Natatorium. This offshore gauge was positioned to measure waves, tides, and currents outside the influence of the reef. The gauge location was also selected to be representative of waves near the offshore limit of the model domain. Every 20 minutes, the gauge recorded three-dimensional currents and average water surface elevation. Each hour, the gauge recorded water surface elevation and particle motion for 1,024 seconds (about 17 minutes), from which the wave statistics of significant wave height, peak period, and peak direction were calculated.

The Nortek and Aanderaa meters each recorded currents at a single location relative to the instrument. A 2008 field program at the WWM site undertaken by the USACE showed that the currents in the swim channel showed only small variation with depth; therefore, the Nortek's programmable sampling location was chosen to be at the approximate mid-water depth. The Aanderaa samples currents adjacent to the instrument head, which was also at approximately mid-water. Each meter recorded a 1-minute average current speed and direction at 10-minute intervals.

The winter instrument deployment covered the months of January through March 2011. The summer deployment covered the period of June 15, 2011 through October 1, 2011. Graphs of the time series data are presented in Appendices A and B.

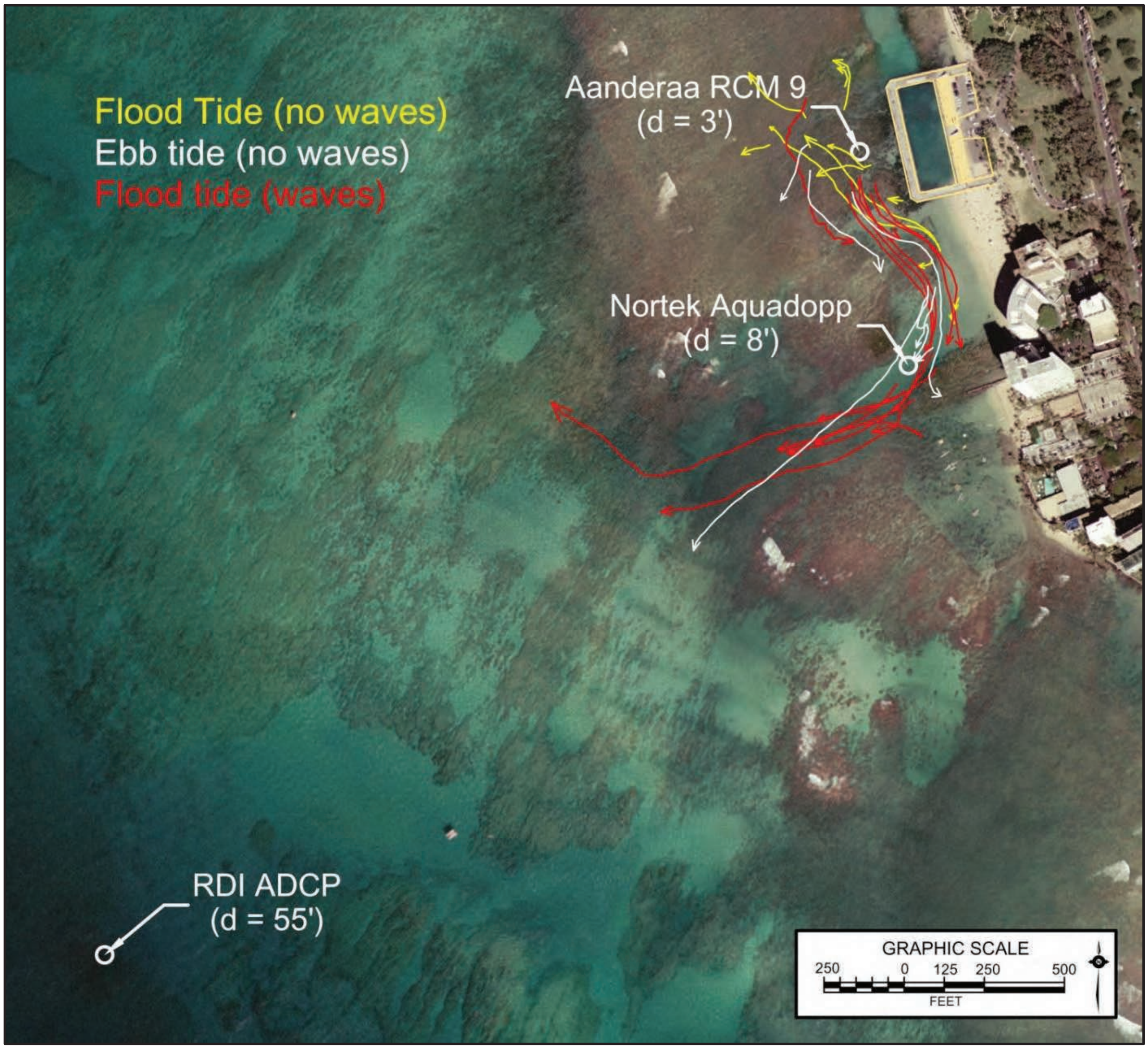


Figure 3-15. Sea Engineering, Inc. Field Program.
Instrument Locations and Typical Drogue Paths.

The offshore currents are typical for the mixed diurnal/semi-diurnal tides that Hawaii experiences. Water levels show approximately two high and two low tides per day, and the currents can be seen to reverse with the tidal phase. The data show that at the offshore current meter site, the high-tide current typically flows in the northwest direction, while the low-tide current flows in the southwest direction; speeds are typically up to 2 ft/second. Speed and direction were much more variable near the surface due to the effects of wind. There was little difference in the pattern, direction, and magnitude of these currents during the winter and summer deployments.

The nearshore currents did not follow the pattern of the offshore currents. The Nortek wave gauge, which was deployed in the swimming channel, showed that when wave conditions were mild, the current direction in the swimming channel was correlated with the tides—flood tide would produce a current in the channel toward shore and ebb tide would produce a current away from shore. When wave height increased, the breaking waves produced a mass transport of water toward shore that resulted in an outflow through the channel to balance the mass transport. During these periods of higher waves, the current meter consistently measured current direction in the range of south to west with the values being fairly tightly centered around the southwest direction, which is the same as the orientation of the swim channel in that location. It was not unusual for the current to be flowing predominately seaward for several days at a time without reversing, including the period of January 13-16, 2011, when waves were high. During low-wave conditions, speeds were typically around 0.2 ft/second, while the speeds exceeded 0.4 ft/second during higher wave conditions, reaching as much as 1.4 ft/second.

The gauge failed during the summer deployment, and no valid data was recovered.

The Aanderaa current meter was located on the reef 125 ft offshore of the Natatorium. The measured currents were generally weak with typical speeds of less than about 0.1 ft/second and maximum speeds of over 0.2 ft/second. Speeds were seen to increase in the presence of high surf. The current direction varied, with a primary component toward the swim channel to the south-southeast. This direction was particularly persistent during periods of surf. During calm periods, the direction was also shown to move toward the northwest, and the currents appeared to be correlated with the tidal elevation.

3.5.2 *Current Drogues*

Specialized current drogues were fabricated specifically for use in this project. The drogues were designed following consultation with Michael Twardowski, Vice President of WET Labs, Inc., which designs and markets drogues for use in the nearshore environment. The drogues used at the Natatorium were designed to perform in a similar manner to the WET Labs surfzone water attenuation node (SWAN) drifters.

The drogue case consisted of 3-inch-diameter ABS pipe with rubber pipe caps that provided a water-tight seal while allowing easy access to the interior. One end of the drifter was ballasted with lead weight to produce an upright position with 6 inches of freeboard, which limited wind drag. The top 6 inches were painted with high-visibility paint. A GPS tracker was inserted inside the top cap of each drifter.

Two drifters of lengths 18 and 24 inches were used at the Natatorium project site. The shorter drogue was designed for shallower water depths, such as over the reef offshore of the Natatorium, while the longer drogue was designed for use in the deeper swimming area.

The drogues were deployed over a total of nine tide and wave conditions as shown in Table 3-9. Previous studies (Gerritsen, 1978; Bathen, 1978; Hathaway and Boc, 2008) have shown that the nearshore circulation in the vicinity of the Natatorium is controlled by the reef structure, the tidal phase, and the presence of waves. The conditions for the drogue study were chosen to give the range of circulation patterns that could be expected in the vicinity of the Natatorium and included flooding, ebbing, and high tide, and with and without surf.

Table 3-9. Drogue study conditions.

Date	Tide condition	Wave condition
February 18, 2011	Ebb	No surf
March 2, 2011	Flood	No surf
March 2, 2011	Ebb	No surf
March 7, 2011	Flood	No surf
March 7, 2011	Ebb	No surf
June 23, 2011	Flood	Surf
August 18, 2011	High	Surf
August 25, 2011	High	Large surf
October 6, 2011	High	Surf

The global positioning system (GPS) receivers recorded internally their geographic positions (Latitude and Longitude) and time of day every 10 seconds. The high sampling rate was chosen to provide additional data in the event that the GPS recorder briefly lost the satellite signal, which was not uncommon. Positions were reduced into approximate 30-ft intervals and the average speed over a 60-ft long path centered at each of those positions was calculated.

The drogue data showed patterns consistent with the inshore current meters and added a spatial component to the data set. Typical drogue paths are shown on Figure 3-15 and complete figures of the drogue paths are presented in Appendix C.

Under an ebbing tide or any tide with high waves, the drogue deployed near Sans Souci Beach had a strong tendency to move offshore through the swim channel, a pattern consistent with that measured by the Nortek current meter deployed in the channel. The drogue deployed over the reef in front of the Natatorium tended to either move offshore or to move toward the swim channel during these same conditions. During flood tides with no waves, the drogue in the swimming channel traveled shoreward, while the drogue over the reef moved in a more variable pattern with slow speeds.

Overall, the drogue data from the variety of conditions sampled is sufficient to conclude that any of the alternatives presented in this report should not cause any noticeable change in circulation patterns outside of the present footprint of the Natatorium, therefore, no degradation of the water quality over the reef or in front of Sans Souci Beach is expected.

3.6 2008 USACE Field Program

The USACE (2008) performed a 1-week field study to obtain data for validating their computer hydrodynamic model of the circulation in the vicinity of the Natatorium. The first phase of the field program consisted of deploying three gauges to measure waves and currents. The three gauges were deployed on the reef 100 ft offshore of the Natatorium, offshore of the reef, and in the swimming channel.

The offshore gauge showed a fairly consistent mean wave direction of 210 degrees TN over the field study period, while the channel gauge showed a mean direction that was slightly more northerly (about 230 degrees TN) and more variable in direction. This difference in direction was attributed to wave refraction and diffraction due to the channel bathymetry. The reef gauge showed similar wave direction as the offshore gauge.

The currents at all three sites appeared to be tidal influenced. The offshore gauge showed higher velocities during ebb tides, which were primarily toward the south. Flood tide velocities were much weaker and predominately toward the north. The current direction at this location was constrained to approximately north-south by the reef bathymetry, which is similarly aligned in that vicinity. Maximum speeds of about 1.3 ft/second were measured.

The data from the channel gauge shows a somewhat different relationship between measured currents and tides. The currents in the channel were also seen to typically reverse nearly in phase with the high and low tides; however, the current direction was limited to 210 degrees to 270 degrees TN, indicating that the current flow was out the channel for the full field program. At all phases of the tidal cycle, the currents were directed offshore. On a rising tide, the current direction was generally toward the west with peak velocities ranging from 0.2 to 0.7 ft/second. The current direction was more toward the southwest during a falling tide, with the currents ranging from 0.5 to 0.8 ft/second. The currents in the channel were also shown to be uniform with depth.

In the second phase of their field program, drifters were deployed to track currents spatially. The drifters were deployed strategically during either flood tide or ebb tide and each drifter recorded its GPS position every 5 seconds. The drifters were typically deployed over the reef near the Natatorium or in the deeper swimming area off Sans Souci Beach.

During falling tides, the drifters consistently moved toward the swimming channel and then followed the channel offshore. During rising tides, the centerline of the Natatorium seemed to be a dividing line of drifter direction. Drifters deployed over the reef to the north of the centerline moved northward toward the dredged channel north of the Natatorium or moved offshore. Drifters deployed south of the centerline moved south into the swimming channel and then offshore.

3.7 Tsunami

Loomis (1976) presented runup elevations for tsunamis that have affected the Hawaiian Islands. Runup elevations were measured near Kuhio Beach Park for the 1946 and 1960 tsunamis. The 1946 tsunami was generated near the Aleutian Islands and produced runup of +8 feet msl, while the 1960 tsunami was generated near Chile and also produced runup of +8 feet msl. Based on these historical tsunamis, a tsunami of similar size would likely cause overtopping and inundation into the backshore.

Lifeguards and local tsunami observers confirmed that the 2011 Japan tsunami produced insignificant runup at Sans Souci Beach.

3.8 Flood Insurance Rate Map

The National Flood Insurance Program (NFIP) has accepted updates to the Flood Insurance Rate Maps (FIRM). The Natatorium and backshore park area are presently zoned as AE with a base flood elevation of 10 ft. The updated FIRM, which took effect in January of 2011 and is presented as Figure 3-16, show that the Natatorium structure and a portion of the Sans Souci shoreline is zoned as VE with a base flood elevation of 11 feet. The backshore park area is zoned AE with a base flood elevation of 8 feet.

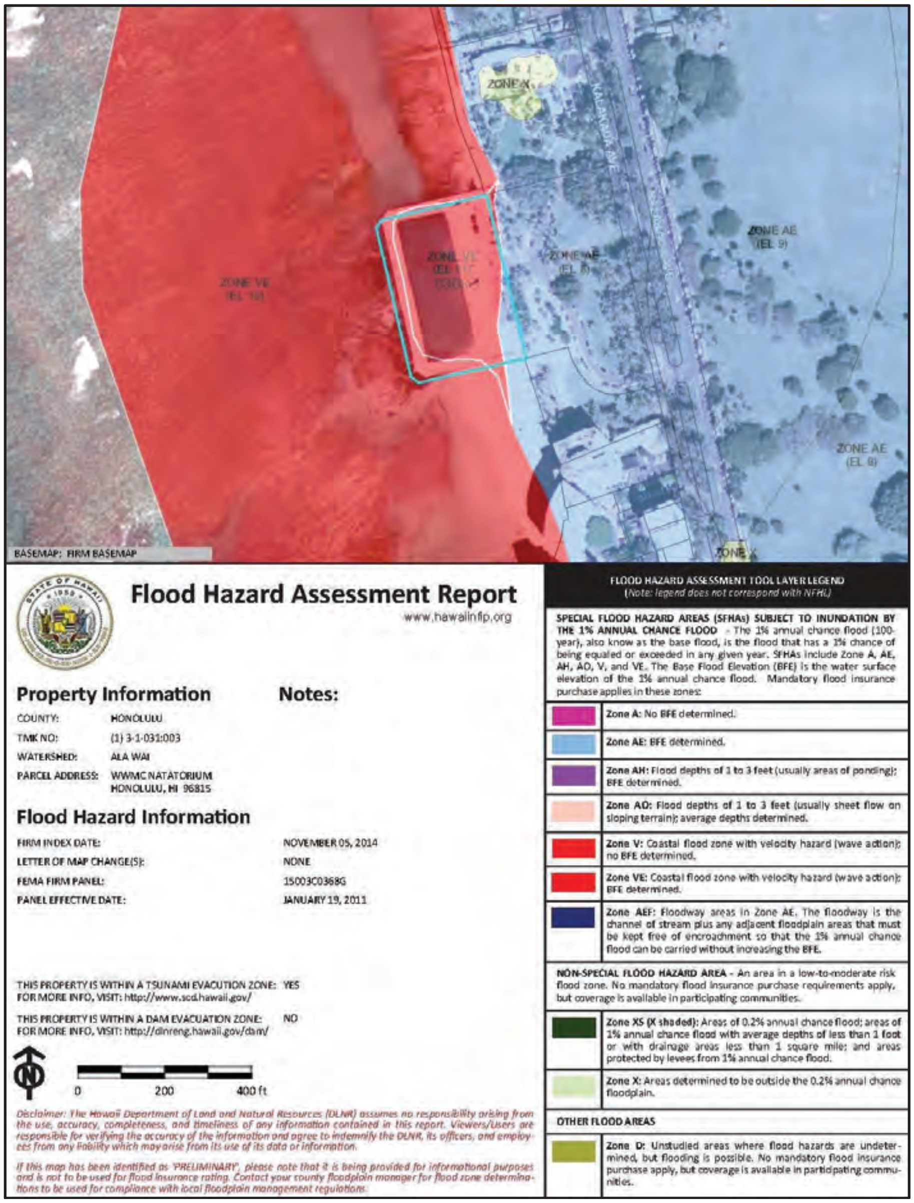


Figure 3-16. Flood Hazard Assessment Report (retrieved July 20, 2018).

4. STRUCTURE AND BEACH DESIGN ANALYSIS (2016)

This section pertains to the design analysis for the beach creation option. Four beach and structure configurations were developed for the 2016 interim report and are presented below. Option 1 of this section, a stabilized beach with the Natatorium walls and bleachers removed, was the City's preferred alternative in 2016 and is presented as Alternative 2 of the 2018 draft EIS. This alternative is included in the oceanographic condition analysis for the four 2018 alternatives in Section 5.

4.1 Planning and Design Considerations

In 2008 the City, in conjunction with the USACE, evaluated alternative beach fill and stabilization structure layouts as well as the impact of simply removing the Waikiki War Memorial structures. This evaluation was done using computer modeling techniques. The stabilization plans consisted of various groin and offshore breakwater configurations. It was determined that a stable beach could be created without affecting Sans Souci Beach. The most effective configuration was to use two L-head groins in the approximate location of the existing Natatorium pool-side walls. This study further evaluates site-specific design considerations and develops variations of the L-head groins for comparative and analysis purposes to facilitate the identification of a functional concept plan that best meets the needs of the proposed project. Considerations that have influenced the planning and design of the beach stabilization structure plan include:

- Minimizing impacts to Sans Souci Beach.
- Staying within the existing Natatorium footprint as much as practicable/possible.
- Utilizing existing Natatorium structures, or portions thereof, if possible.
- Visible portions of the existing Natatorium pool structure are very deteriorated, and investigations have shown that the concrete is weak and seawater infiltration has resulted in severe reinforcing steel corrosion. On the Ewa side significant portions of the rock fill on which the wall rests is missing and the wall foundation is severely undermined.
- Water depths on the Ewa side are highly variable ranging from 1 to 3 ft on the nearshore reef flat to more than 10 ft in the offshore dredged channel.
- Existing geotechnical information indicates poor foundation conditions with loose sandy soil and silty lagoonal deposits to a depth of about 30 ft below sea level. This material is moderately to highly compressible with potential settlement of about 3 ft occurring rapidly after loading, and possible further settlement over time.

4.2 Groin Design

Construction of two rock rubblemound groins within the Natatorium footprint is the preferred plan. Geotechnical investigations, however, indicate that the existing sea floor in the vicinity of the Natatorium and the pool bottom is composed primarily of soft, loose, and very compressible silt and sand to a depth of more than 30 ft below sea level. This material does not provide a suitable foundation for a gravity structure such as a conventional rock rubblemound groin as significant and differential settlement due to the soft and varying subsurface soil conditions can be expected. In addition, the existing rock fill underlying the present Natatorium walls cannot be relied upon to support new loading. In summary, the seafloor within the footprint of the Natatorium is not considered suitable for construction of traditional rock rubblemound groin structures without the inclusion of a stable support foundation.

Given the poor foundation conditions, the groin stems are proposed to be constructed using structural concrete supported by hollow steel pipe piles. Hollow steel pipe piles will minimize ground vibration during the driving process, and reduce possible impacts to nearby structures such as the Waikiki Aquarium. The tops of the piles will be covered by a concrete pile cap, which will support a horizontal concrete seawall footing and a vertical concrete seawall. The seawall crest elevation will vary from +7.5 ft at the shoreline to +6 ft at the seaward end. The seawall footing is designed to permit the placement of sloping rock riprap to buttress the vertical wall and reduce wave reflection. Precast concrete units will be utilized to the maximum extent practicable to reduce potential water quality impacts and to reduce on-site construction time and cost.

The groin heads are recommended to be constructed as conventional rock rubblemound structures, which will dissipate wave energy and reduce reflection seaward. In order to construct effective groin heads within the Natatorium footprint, a portion of each head would extend into the swimming area where the seafloor is composed of soft sediment discussed above. Construction would therefore require pile-supported concrete structures to serve as the foundation for the rubblemound heads with the construction similar to that presented for the groin stems.

Design wave heights are discussed in Section 3.4.5. The design wave condition for armor stone stability is the model hurricane ($H = 6.6$ ft), while the structure crest elevation is based on the runup and overtopping produced by the 1-year wave event ($H = 4.1$ ft).

Key groin head design parameters include height, slope, composition, stone size, and crest width. The groins are designed as rock rubblemound structures with side slopes of 1V:1.5H, a single stone thick keyed-and-fit armor layer over an underlayer, or core, of smaller stone. The rock will be situated on a concrete platform with curbing to prevent the toe stones from sliding.

4.2.1 *Armor Stone Size*

Armor stone size is based on the design wave height of 6.6 ft. The required groin armor stone weight for stability under this design wave height is given by the Hudson Formula (USACE, 2006):

$$W = \frac{w_r H^3}{K_D (S_r - 1)^3 \cot\theta}$$

where:

W = weight in pounds of an individual armor stone
w_r = unit weight of the stone, 160 pounds per cubic foot
H = wave height, 6.6 ft

K_D = armor stone stability coefficient, 1.5
S_r = specific gravity of the stone relative to seawater, use 2.5
$\cot\theta$ = cotangent of the groin side slope, 1.5

The resultant armor stone weight would be approximately 6,000 pounds with a corresponding nominal diameter of about 3.3 ft. A range of ±25 percent of the median weight is typically utilized, which yields a stone weight range of 4,500 to 7,500 pounds. The armor stone would be carefully placed (keyed-and-fit) for an added level of stability.

4.2.2 *Underlayer Stone*

Underlayer stone is sized at approximately 1/10 the armor weight, resulting in underlayer stone size between about 450 to 750 pounds. The sizing is important for providing porosity for energy dissipation rather than reflection to achieve interlocking between the armor and underlayer and to insure that the underlayer material cannot be removed through voids in the armor layer.

4.2.3 *Crest Elevation*

The elevation of the structures determines the amount of wave overtopping that will occur at the wave conditions presented in Section 3.4. Runup elevation was calculated using the ACES module in the Coastal Engineering Design and Analysis System (CEDAS) package, both of which were developed by the USACE's Coastal & Hydraulic Laboratory (CHL).

Runup is a function of the design wave height at the project site at the corresponding water level presented in Table 3-8; the shallow reef limits the wave height that can impact the structures. Using the information in the table, wave runup is calculated to be 5.2 ft above msl for the prevailing condition and 7.8 ft above msl for the annual condition. For the 50-year condition, wave runup is calculated to be 8.8 ft above msl.

Based on the range of wave runup, a structure crest height of +6 ft is selected. This elevation is adequate for minimizing overtopping during prevailing conditions and will allow the overtopping equivalent of 1.8 ft of runup during the annual wave condition. While structures with higher crest elevations will reduce overtopping, they present a larger footprint and are more costly. Additionally, from an aesthetics perspective, structures with lower crest elevations provide less visual impact.

For reference, the top of the existing Natatorium walls have typical elevations of +5.9 to +6.3 ft msl consistent with the recommended groin crest elevation. The elevations of the architectural wall that runs along the Ewa side of Sans Souci Beach and the CRM wall at the mauka extent of Sans Souci Beach are about +9 ft msl near the Natatorium.

A crest width equal to three stone diameters is typically utilized for crest stability, about 10 feet for this project.

4.2.4 *Beach and Structure Design Analysis*

The experience gained from studying natural crenulate-shaped bays provides a design tool for coastal engineers to produce stable shorelines. Silvester and Hsu (1993) present methods for determining the stable beach planform between headlands, thus facilitating the engineering use of headlands as shore stabilization structures. Whereas natural beaches obtain a stable shape in response to the wave climate and headland orientation, engineered beaches can be developed by selecting the headland orientation that produces the desired beach shape. Bodge (2003) proposed the use of T-head groins as artificial headlands to produce stable beaches, an approach that has been implemented successfully on numerous beaches in Florida and the Caribbean (Bodge, 1998). An example of T-head groins to produce arc-shaped beaches is shown on Figure 4-1.

The heads of the T-groins can be aligned or "tuned" according to the prevailing wave crest orientation to produce the desired beach configuration. Rubblemound T-head groins are recommended to reduce rip currents and the subsequent offshore sand losses and the beach should be nourished with sand to achieve the predicted shoreline shape. According to Bodge (1998), tuned structures work well in the following situations:

- Erosion stress is so severe that renourishment would be too frequent to be economical or practical
- A wide beach would affect an environmentally-sensitive area
- The shoreline is no longer conducive to having beaches such as at a hardened shoreline

These criteria are generally met at the WWM site particularly if the Natatorium structures were to be removed.

Key design parameters for T-head groin design include groin length, head length and orientation, gap width between the heads, and beach shape and width. In general, the beach shape responds more to the gap width (opening) between the groin heads than it does to the heads themselves. Thus, the stable beach is a function of the length and orientation of the gaps. Orientation of the gaps is primarily dictated by the shape of the shoreline and the prevailing wave approach direction.

The groin layout and head angles should be oriented such that the gap opening is as close to parallel with the average prevailing wave crest approach as possible. This "tuning" of the heads helps to ensure the predictability of the beach shape and yields potentially greater shoreline stability within the beach cell. In many cases, it is not possible to achieve a perfect match between gap orientation and incident wave crest, because of the directional variability of waves approaching the project site. In practice, this difference should be no more than 25 degrees and differences of up to 15 degrees have been consistently shown to produce a stable beach (Bodge, 2012).

The beach design process thus includes establishing the desired physical characteristics of the beach, then applying coastal engineering analysis and tools to orient structures to achieve the desired beach planform. The requirement that the structures not extend beyond the present

Natatorium footprint means that there will be an angle between the gap and the dominant incident waves. Deviation of the gap from parallel with the wave crests will result in a less uniform beach in the planform view, and wave modeling will be used to approximate the stable beach configuration.

Figure 4-1. T-head groins used for beach stabilization in Miami, FL (www.olsen-associates.com).

4.2.5 *Beach Physical Characteristics*

Beach physical characteristics include crest height, dry beach width, beach slope, and sand grain size. Standard methodology typically involves trying to match adjacent beach characteristics both because this indicates what is naturally stable for local conditions and because it is aesthetically more pleasing to match the adjacent beach. Site observations at Sans Souci Beach indicate a beach crest elevation of approximately +5.5 ft above msl, a typical beach crest width of about 100 ft, and a beach foreshore slope of about 1v:7.5h toward the center of the beach. For comparison, the foreshore slope of the narrow beach fronting the Waikiki Aquarium is typically about 1v:10h.

The empirical relationships show that the mean low water (low tide) shoreline will be located between one-third and two-thirds of the gap width, *G*, behind the groin head, i.e., 0.35*G* to 0.65*G*. Larger values in the range are appropriate for 1) energetic open coasts directly exposed to wave action, 2) larger gap openings, 3) large angles between the wave approach and the gap orientation, 4) poor beach fill sand compatibility, and 5) a greater level of conservatism. The groin head length should be long enough so that the mean low water shoreline approaches the head while maintaining a minimum ratio of gap width to head width of about 60:40 for aesthetic reasons so that the groins do not appear to dominate the viewscape. A schematic of the components of a tuned T-head groin system is presented as Figure 4-2.

The groin stems should extend landward of the design beach crest to eliminate flanking and loss of sand from the cell around the back of the groin. The groin crest elevation should be above the high-tide elevation and high enough to prevent significant overtopping during typically prevailing (non-storm) water level and wave conditions. A crest elevation of +6.0 ft is recommended as discussed in Section 4.2.3.

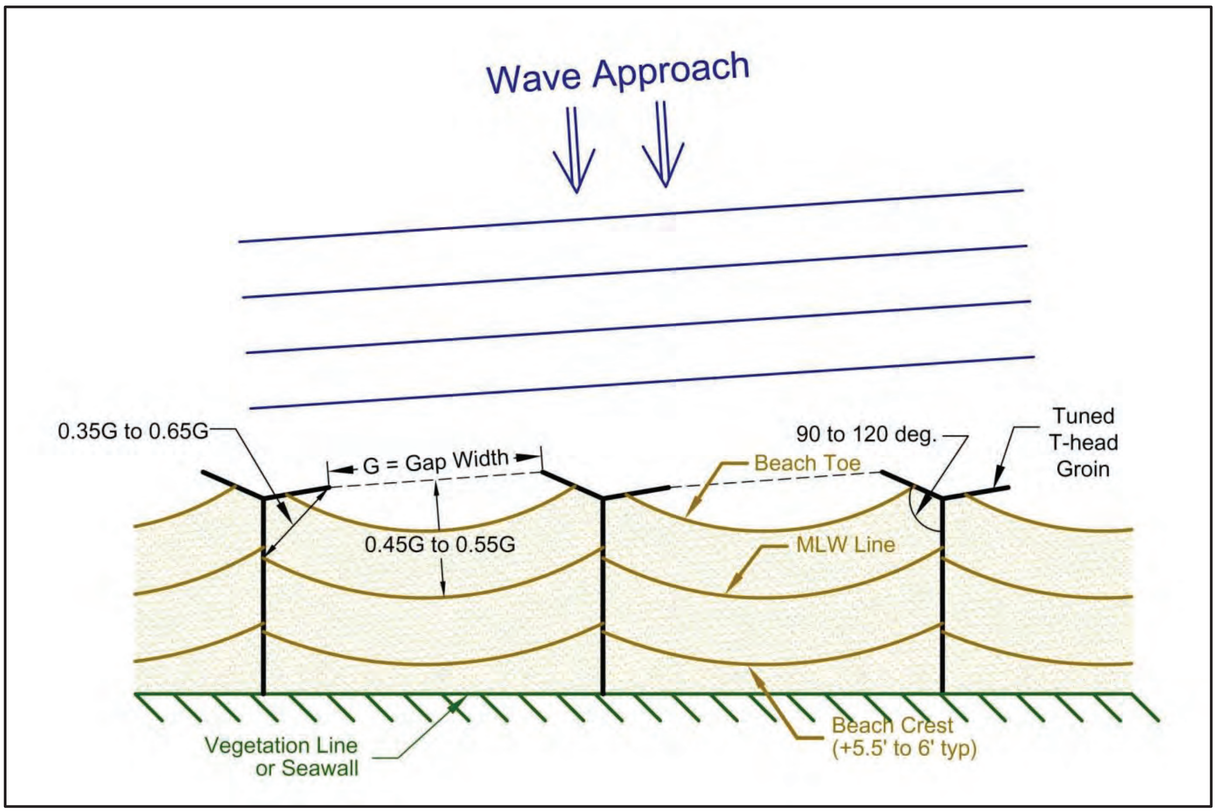


Figure 4-2. Schematic of typical tuned T-head groin system.

4.3 Beach Plan Layouts

Based on the above planning and design considerations, the following three general beach plan layout options are presented:

- Option 1: Two equal length L-head groins situated within the Natatorium pool footprint
- Option 2: Two equal length L-head groins that extend beyond the Natatorium pool footprint
- Option 3: An L-head west (Ewa) groin that extends beyond the Natatorium pool footprint and a straight east (Diamond Head) groin that is situated within the Natatorium pool footprint

In the following figures, gray dashed lines indicate parts of the structures to be removed, while solid black lines indicate new or retained structure elements.

4.3.1 *Option 1 – Sand Fill with Two L-head Groins within the Natatorium Pool Footprint*

Option 1, as shown on Figure 4-3, consists of two L-head groins stabilizing sand fill. A key component of this design is that all new structures are located within the existing footprint of the Natatorium pool structure.

In order to position the groins within the pool footprint, a portion of the groin heads would have to extend into the swimming area. Given the soft sediment characteristics within that area, the groin heads would have to be supported to prevent settling. This could be accomplished by constructing pile-supported platforms to support the rubblemound heads.

General Plan features include:

- Two 170-ft-long pile-supported concrete with riprap groin stems constructed inside the existing Natatorium walls. This plan would require approximately 102 piles per stem (204 piles total).
- Two 60-ft-long pile-supported concrete with rock rubblemound groin heads. This plan would require approximately 121 piles per head (242 piles total).
- Approximately 10,500 cubic yards of sand fill creating about 50,000 square feet (1.1 acres) of beach area above msl.
- Following completion of the new groins the existing Natatorium walls would be removed.

Figure 4-3 shows that the projected beach crest for this option would be inshore of the existing face of the bleachers by as much as about 17 ft. The projected beach crest location in the figure represents the extent of wave uprush.

In this option, the bleachers would have to be removed in order to produce and maintain a stable beach. If the bleacher structures were retained, as shown on Figure 4-4, waves would be expected to impact more than 175 ft of the bleacher face. This would produce wave reflection, scouring, a flattening of the foreshore slope, and likely a chronic erosion problem, none of which is conducive to producing or maintaining a stable beach. The most likely result would be that any initial sand fill along the bleacher face would migrate offshore resulting in a submerged sandy area with no dry beach area as indicated on Figure 4-4.

Typical groin stem and head cross-sections are shown on Figure 4-5 and Figure 4-6, respectively.

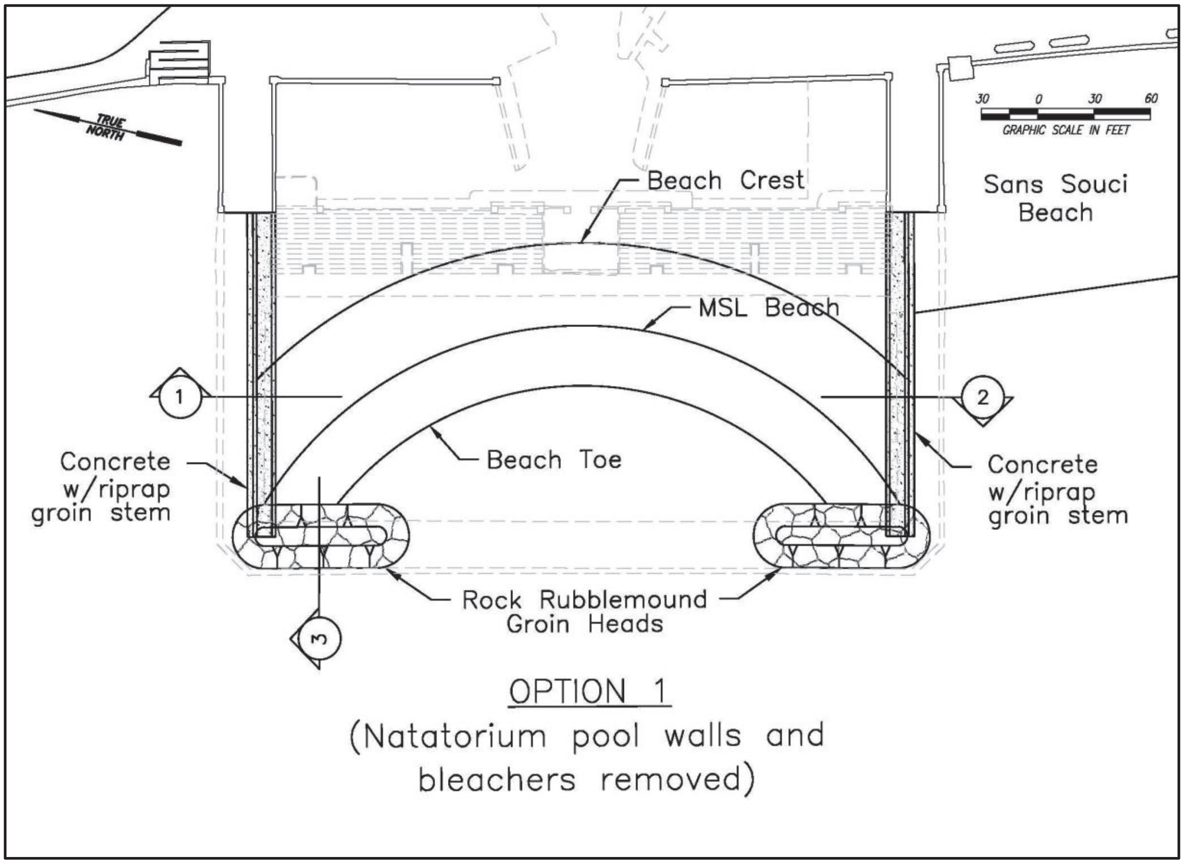


Figure 4-3. Plan view – Option 1 with pool walls and bleachers removed.

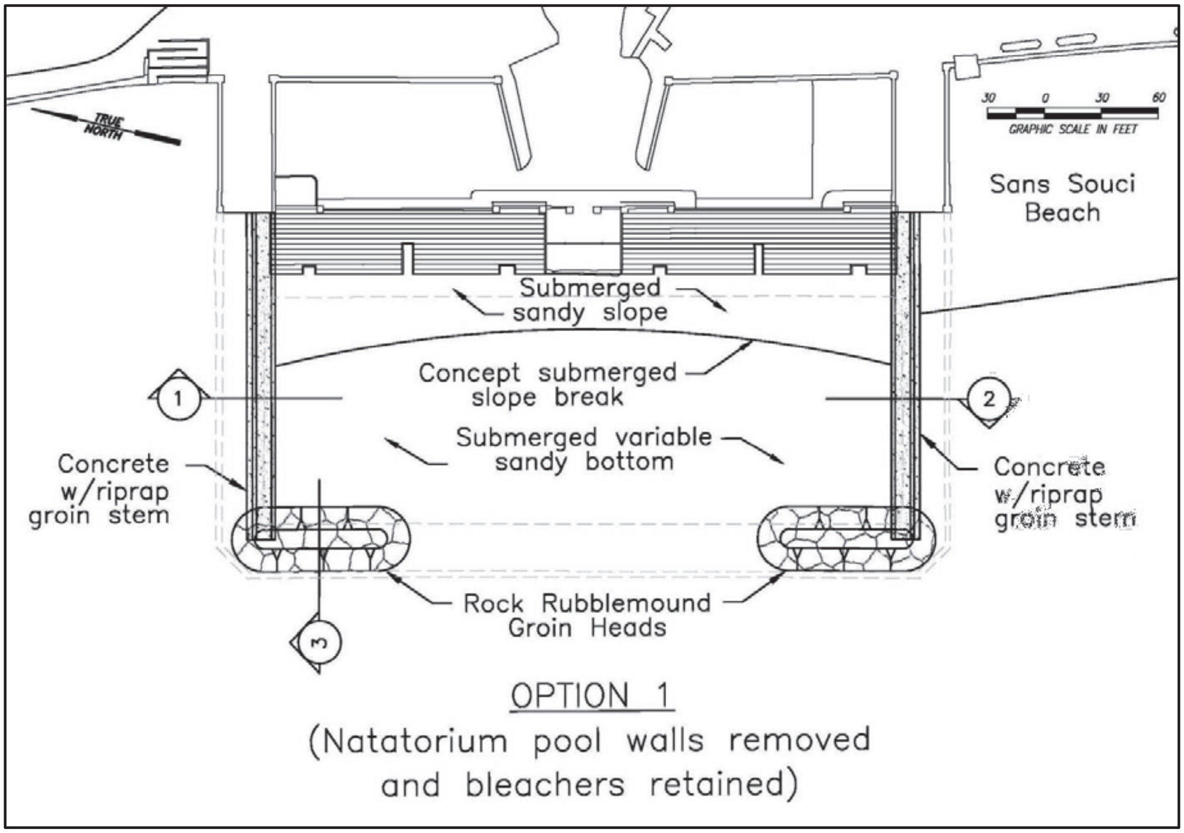


Figure 4-4. Plan view – Option 1 with pool walls removed and bleachers retained.

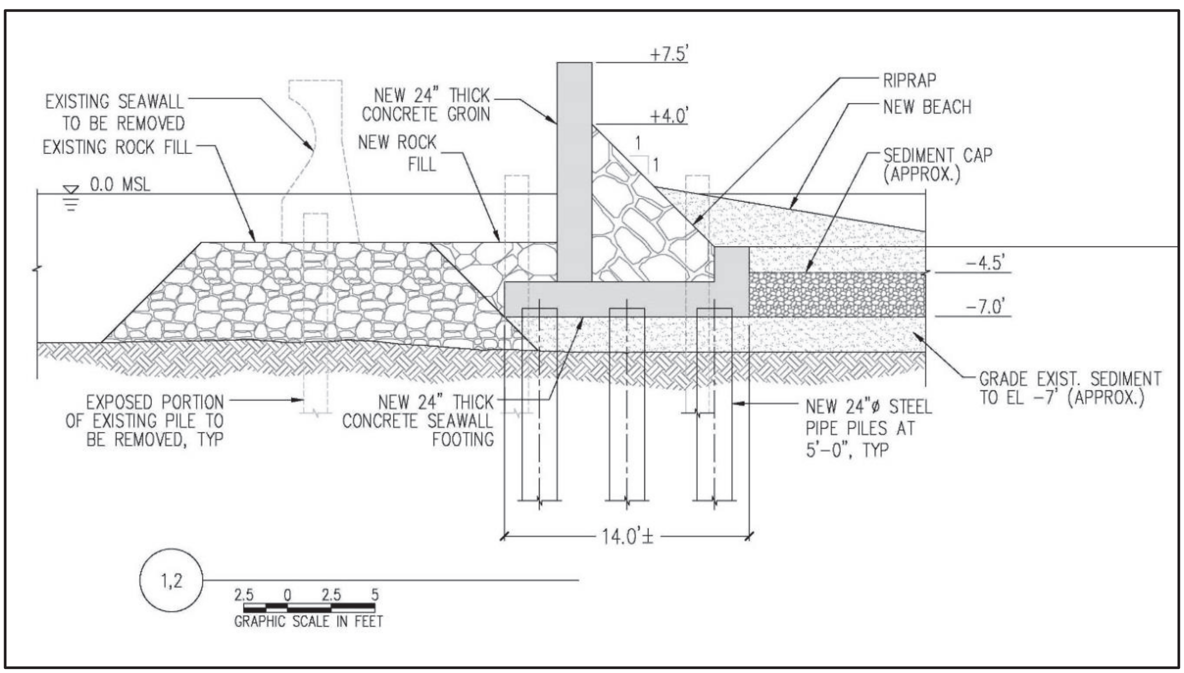


Figure 4-5. Typical concrete groin stem section, Option 1, Option 2, and Option 3.

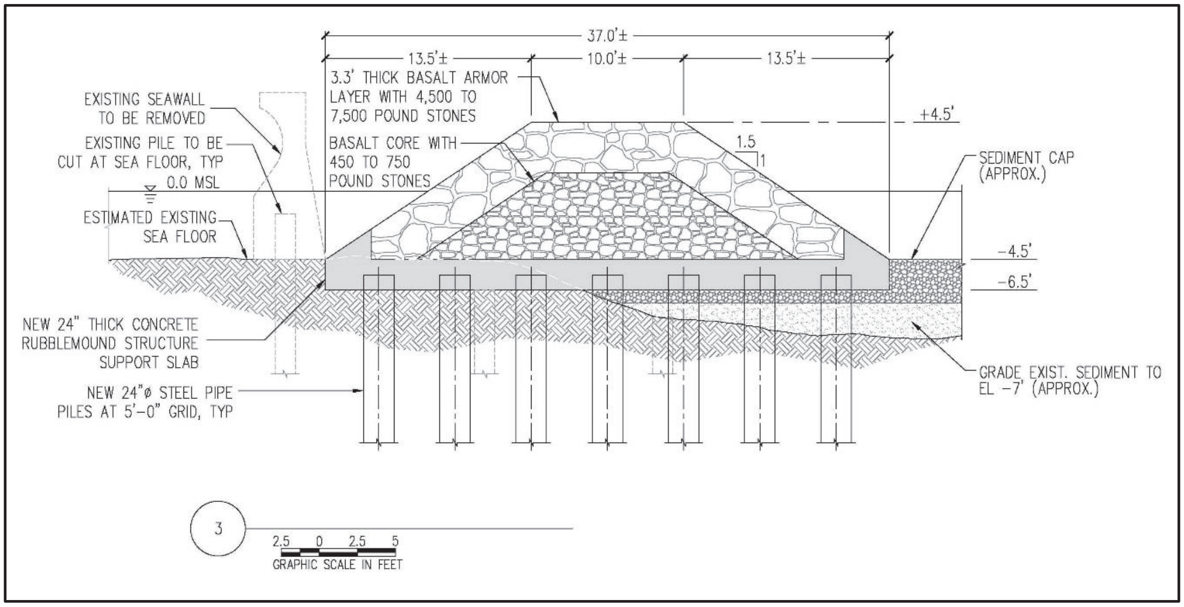


Figure 4-6. Typical concrete groin head section, Option 1.

4.3.2 *Option 2 – Sand Fill with Two L-head Groins*

Option 2, as shown on Figure 4-7, also consists of two L-head groins stabilizing sand fill. A key component of this design is that the groin heads are located outside the existing footprint of the Natatorium pool structure. General Plan features include:

- Two 230-ft-long pile-supported concrete with riprap groin stems constructed inside the existing Natatorium walls. This plan would require approximately 138 piles per stem (276 piles total).
- Two 60-ft-long rock rubblemound groin heads constructed on the reef flat immediately seaward of the existing Natatorium wall.
- Approximately 18,000 cubic yards of sand fill creating about 70,000 square feet (1.6 acres) of beach area above msl.
- Following completion of the new groins, the existing Natatorium walls would be removed.

If desired, the bleachers and existing features landward of them could be retained while still creating a stable beach, albeit a much smaller one. Figure 4-8 shows the configuration of this option with the bleachers retained. Retaining the bleachers would result in a beach area above msl of about 34,000 square feet or about half as much area as would be possible with the bleachers removed. The middle of the beach would also be narrow, about 25 ft wide from the beach crest (top of beach foreshore slope) to the bleachers. However, the required sand fill volume would also be less at about 13,000 cubic yards.

The typical groin stem section is the same as that shown on Figure 4-5 and the head cross-section is shown on Figure 4-9.

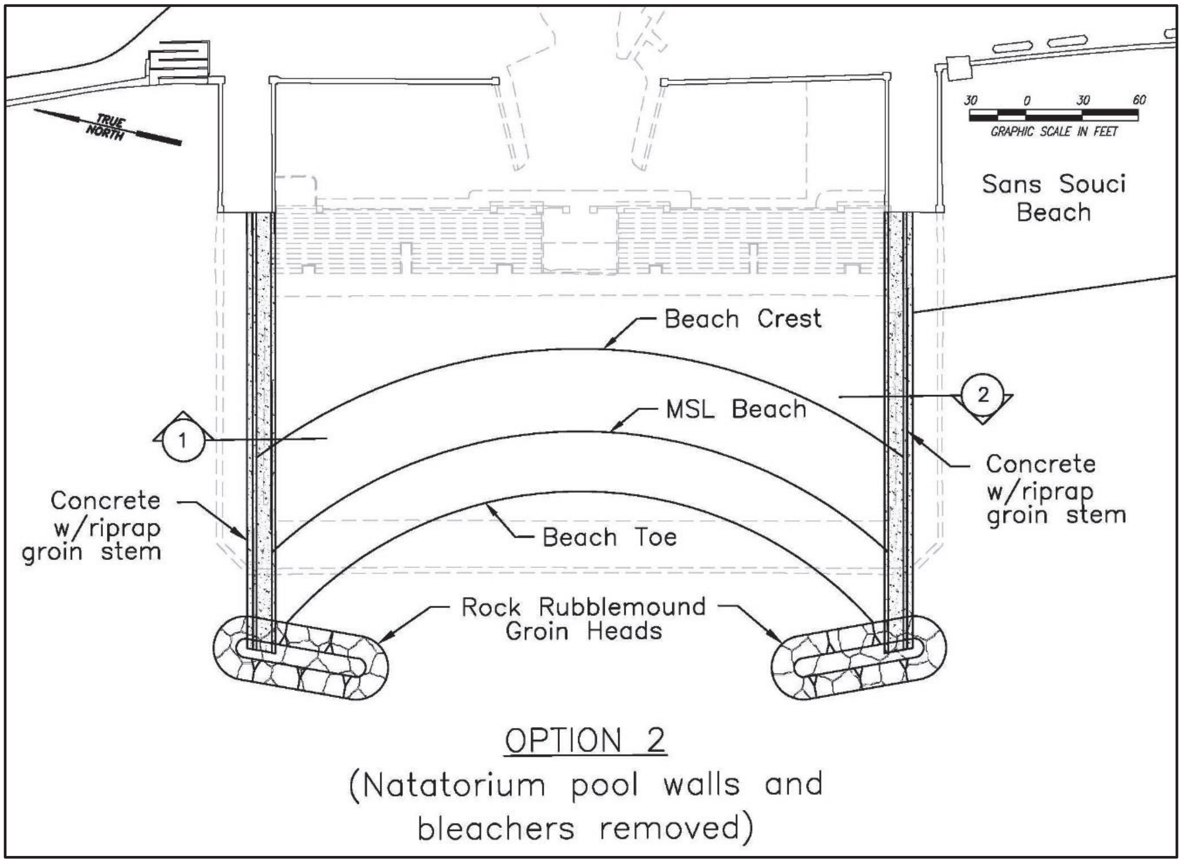


Figure 4-7. Plan view – Option 2.

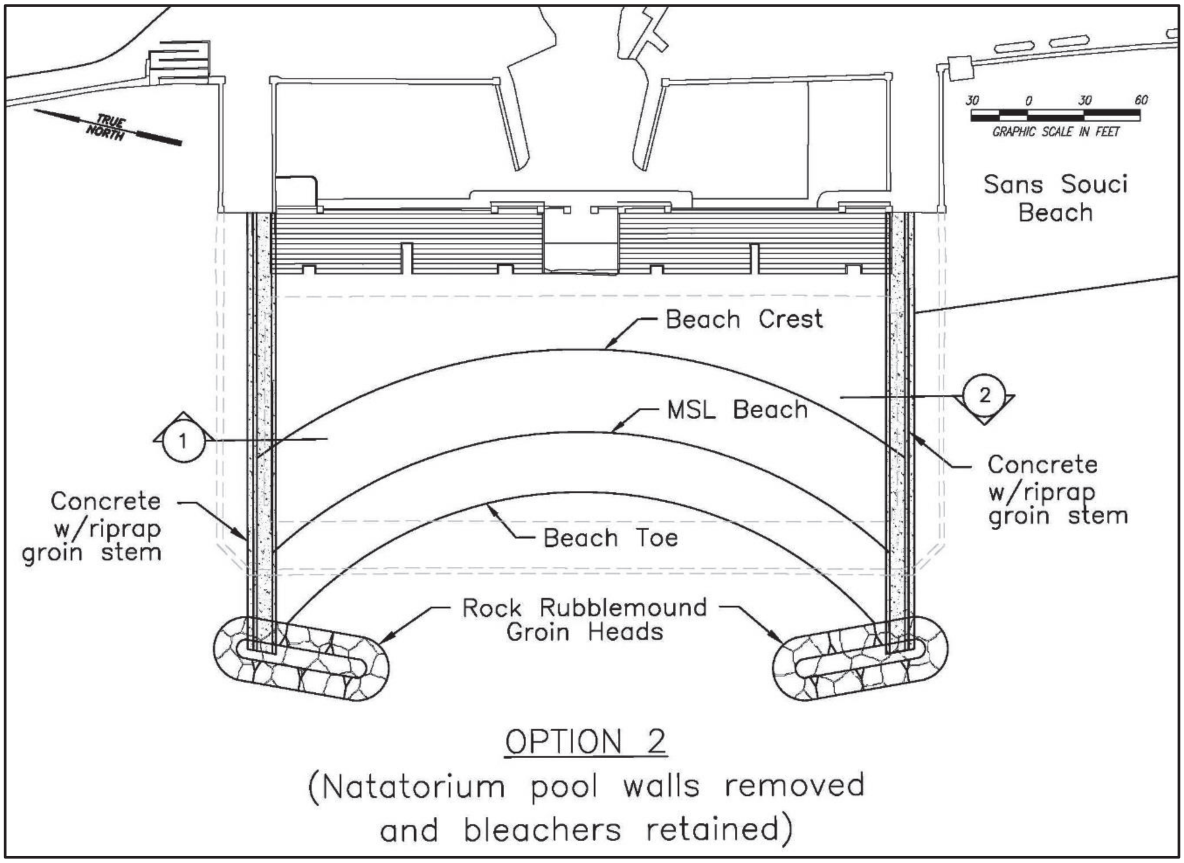


Figure 4-8. Plan view – Option 2 with bleachers retained.

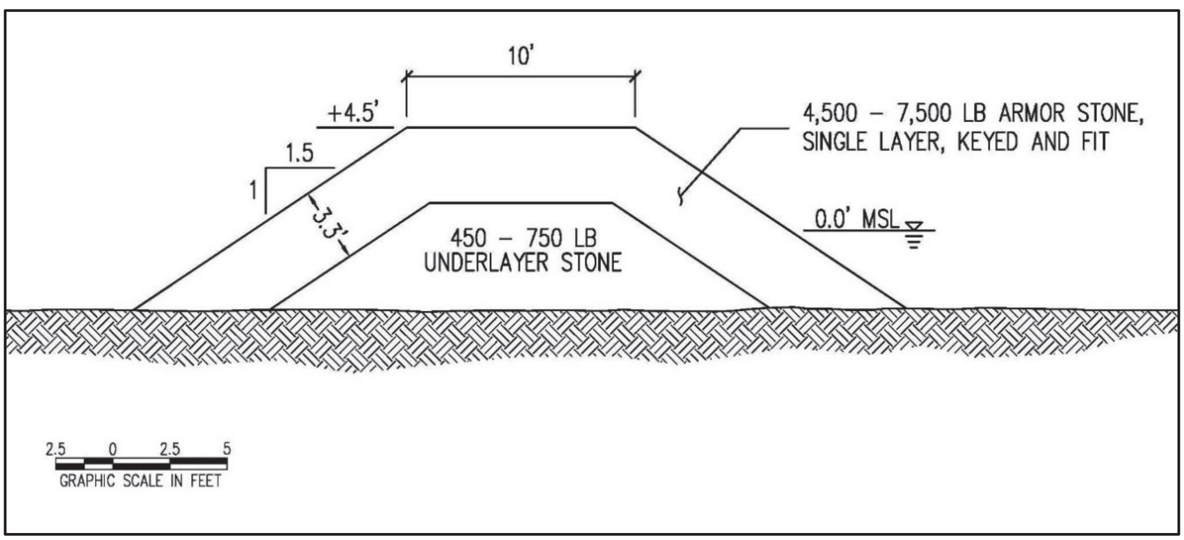


Figure 4-9. Typical rock groin head section, Option 2 and Option 3.

4.3.3 *Option 3 – Sand Fill with One L-head and One Straight Groin*

Option 3, as shown on Figure 4-10, consists of two groins stabilizing sand fill. The west (Ewa) groin is similar to the west groin in Option 2, an L-head groin with a pile-supported concrete stem and a longer rock rubblemound head. The east (Diamond Head) groin is straight and terminates landward of the shallow reef to allow for swimmer access around the head to Sans Souci Beach. General plan features include:

- West groin – 230-ft-long pile-supported concrete with riprap groin stem constructed inside the existing Natatorium walls (would require approximately 138 piles). Rock rubblemound groin head 80 ft long constructed on the reef flat immediately seaward of the Natatorium wall.
- East groin – 140-ft-long pile-supported concrete with riprap groin constructed inside the existing Natatorium walls (would require approximately 84 piles).
- 10,000 cubic yards of sand fill, creating approximately 45,000 square feet of beach area above msl.

The stem and head cross-sections are as shown on Figure 4-5 and Figure 4-9, respectively. Following completion of the new groins, the existing Natatorium walls would be removed.

This option would not allow for creation of a stable beach configuration while retaining the bleacher structure.

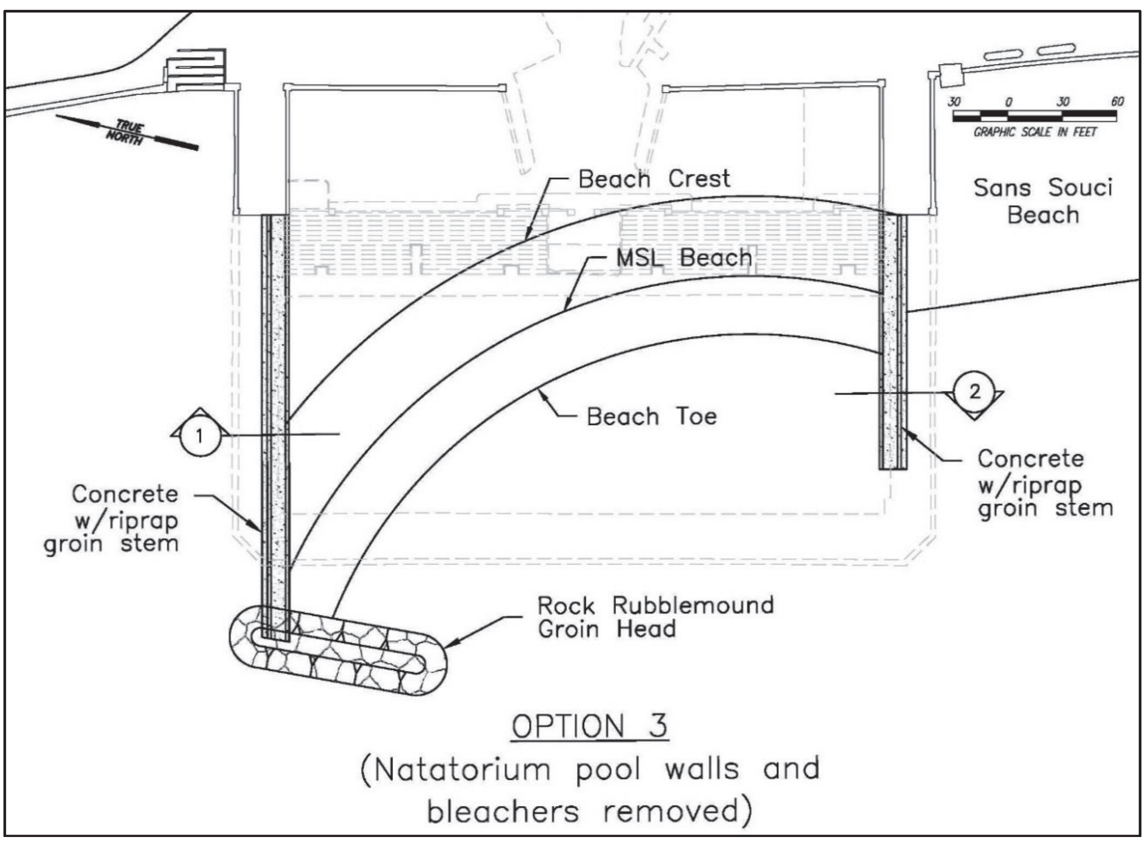


Figure 4-10. Plan view – Option 3.

4.4 Construction Methodology

Access to the site from the water side is not possible due to the shallow water depth and wave action; thus, construction equipment and material will have to be brought in from the land side. A floating work platform could be assembled inside the Natatorium using a crane to lift and place "Flexifloats" into the pool. The Flexifloat construction system is a combination of portable, interlocking modular barges used in marine heavy construction applications. The components of the sectional barge system are portable and are designed for road transport by standard truck and trailer. Flexifloats can be easily and quickly connected into larger assemblies of various sizes and shapes, and the resulting platforms are capable of supporting all types of heavy equipment in areas that are inaccessible to conventional deck barges. A ramp would extend from shore to provide access to the floating platform for equipment and materials. Thus almost all the required groin construction work, with the exception of construction of the rock rubblemound groin heads, can be done within the confines of the existing Natatorium walls prior to their removal. A temporary stone access causeway extending from the seaside wall could be used for rock groin head construction access.

5. ALTERNATIVES DISCUSSION (2018)

SEI was contracted to assess the oceanographic conditions associated with the four alternatives presented Section 1.2.

These alternatives include:

- *Perimeter Deck* Alternative
- *War Memorial Beach* Alternative
- *Closed-System Pool* Alternative
- *No Action* Alternative

The oceanographic impacts of and on the alternatives are qualitatively assessed in the following sections. The following are the criteria used in the assessments:

- Waves and currents in and around the Natatorium
- Sediment transport and beach stability
- Water quality
- Recreational opportunities
- Effects of Sea Level Rise
- Loss of waters of the United States

5.1 Oceanographic Conditions

The primary oceanographic processes affecting performance of the alternatives are waves and currents. Wave modeling and field investigations were undertaken previously to gain a better understanding of these processes. The results of the modeling and field investigations presented earlier in this report are used in the following sections to infer the oceanographic conditions resulting from each alternative.

5.1.1 *Incident waves*

The WWM Natatorium shoreline is primarily exposed to south swell. The prevailing deepwater wave was shown in Section 3.3 to approach from the south-southwest direction. Wave modeling further showed that wave propagation to shore was a function of the nearshore reef and the wave incident upon the Natatorium had an angle of approximately 15 degrees from the offshore Natatorium wall (open in the Ewa direction).

5.1.2 *Currents*

The offshore currents are typical for the mixed diurnal/semi-diurnal tides that Hawaii experiences. Water levels show approximately two high and two low tides per day, and the currents can be seen to reverse with the tidal phase. The data shows that offshore of the reef, the high-tide current typically flows in the northwest direction, while the low-tide current flows in the southwest direction; speeds are typically up to 2 ft/second. Speed and direction were much more variable near the surface due to the effects of wind. There was little difference in the pattern, direction, and magnitude these currents during the winter and summer deployments.

The nearshore currents did not follow the pattern of the offshore currents. When wave conditions were mild, the current direction in the swimming channel was correlated with the tides—flood tide would produce a current in the channel toward shore and ebb tide would produce a current away from shore. When wave heights increased, the breaking waves produced a mass transport of water toward shore that resulted in an outflow through the channel to balance the mass transport. During these periods of higher waves, the currents were consistently directed out the swim channel regardless of tidal phase. Currents in front of the Natatorium were generally weak. Speeds were seen to increase in the presence of high surf. The current direction varied with a primary component toward the swim channel to the south-southeast. This direction was particularly persistent during periods of surf. During calm periods, the direction was also shown to move toward the northwest and the currents appeared to be correlated with the tidal phase.

5.2 Perimeter Deck

The Perimeter Deck (Figure 5-1 through Figure 5-5) was developed in 2018 by the City in response to concerns that Natatorium rehabilitation was not being adequately considered. The 2018 perimeter deck design presented in the *Pre-Environmental Impact Statement Alternatives Technical Evaluation* (AECOM, January 2018) is intended to keep the visual features of the Natatorium Complex while also opening the walls to improve water quality in the swimming area. The makai and Ewa side walls of the swim basin would be demolished and the deck would be reconstructed on support piles so waves and currents could flow between the ocean and the swim basin area. The lower portion of the Diamond Head seawall and rock fill would remain and the seawall would be structurally improved to retain Sans Souci Beach. The general appearance would otherwise remain consistent with the original design.

The average water depth in the swimming basin was measured in 2010 to be 8.6 ft msl; however, the basin bottom was found to be uneven with significant high and low spots. The 1998 Natatorium EIS proposed dredging the pool swimming basin to -11 ft msl. The City may wish to level or remove the sediment to make the basin deeper if this alternative is selected for final design.

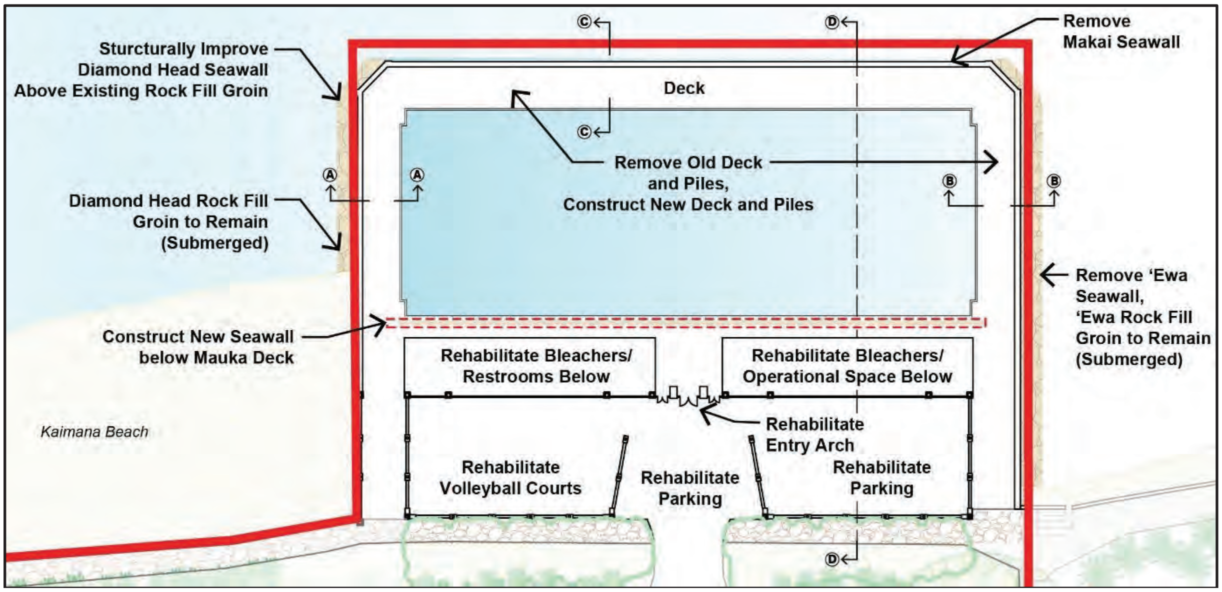


Figure 5-1. ***Alternative 1 – Perimeter Deck*, plan view.**

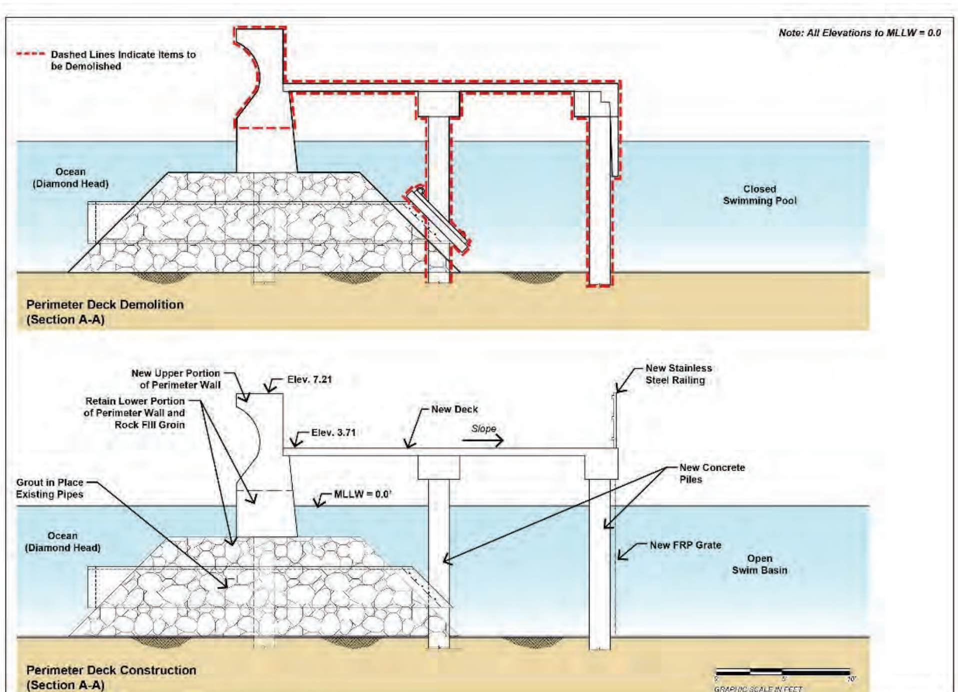


FIGURE 3.2.1-2: PERIMETER DECK SECTION A-A
Waikiki War Memorial Complex EIS
Source: AECOM, August 2018

Figure 5-2. ***Alternative 1 – Perimeter Deck*, section view A-A.**

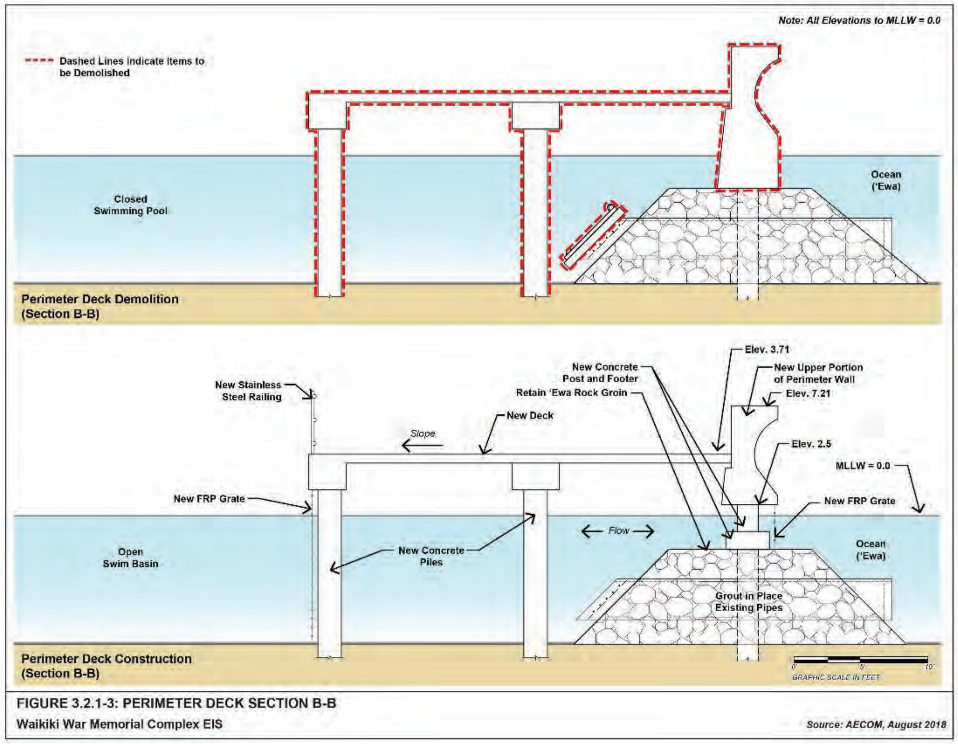


Figure 5-3. ***Alternative 1 – Perimeter Deck*, section view B-B.**

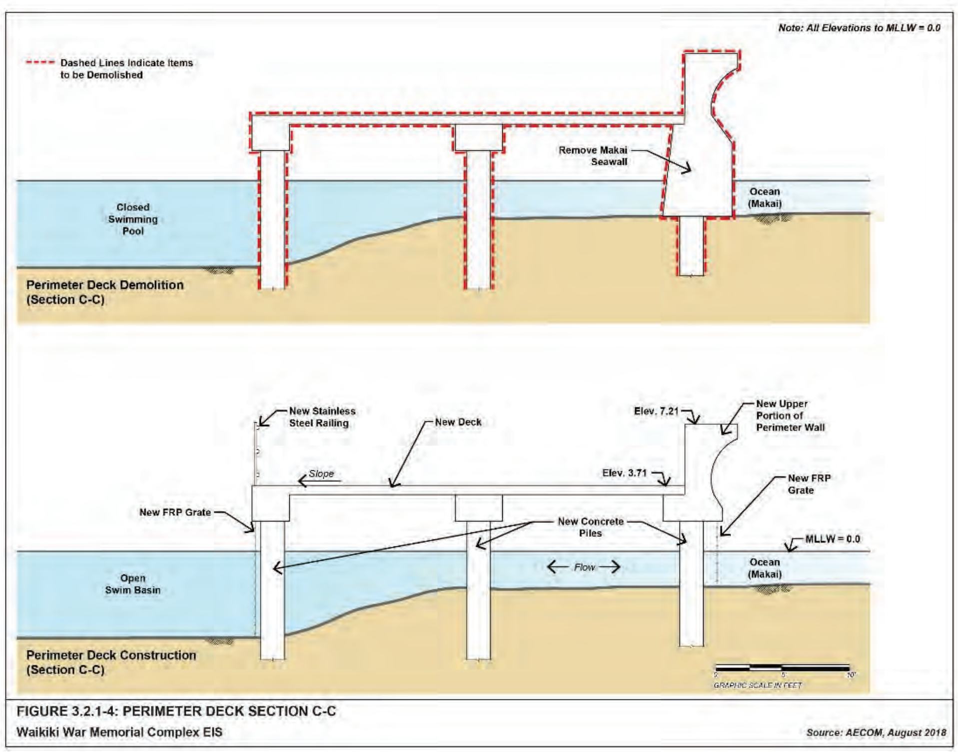


Figure 5-4. ***Alternative 1 – Perimeter Deck*, section view C-C.**

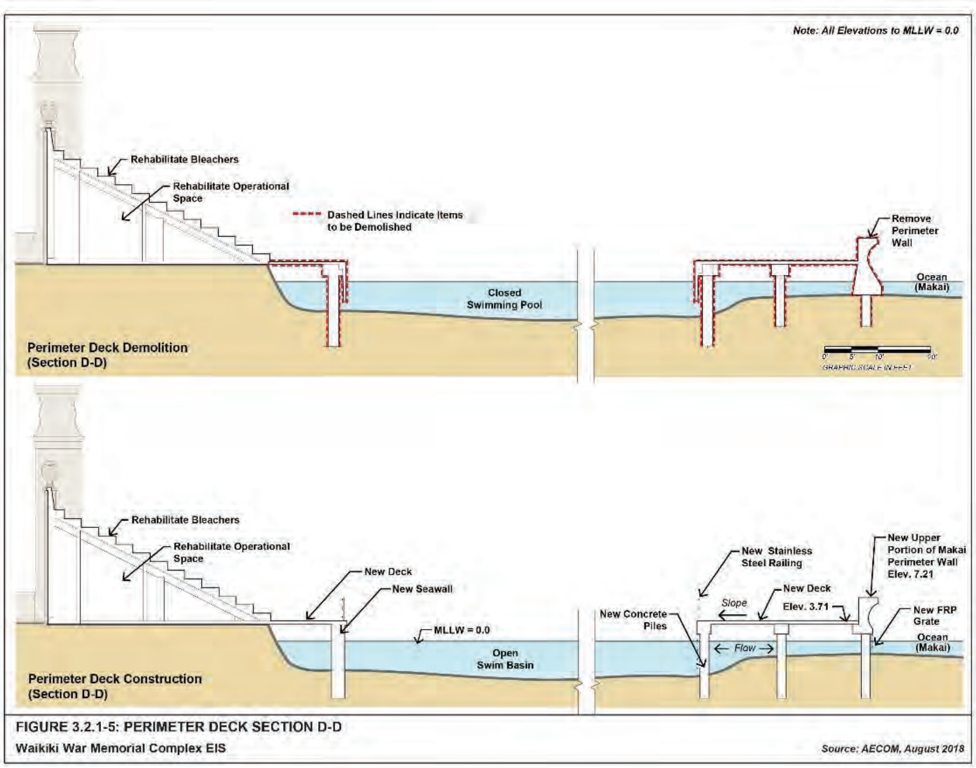


Figure 5-5. ***Alternative 1 – Perimeter Deck*, section view D-D.**

5.2.1 *Affected Oceanographic Environment (Perimeter Deck alternative)*

Waves

Wave patterns approaching the Natatorium were presented in Section 3.3. This alternative calls for removing the makai and Ewa walls and reconstructing the Diamond Head wall (above mllw). Waves approach the makai wall of the Natatorium at an oblique angle, open in the Ewa direction. Seaward reflection of wave energy is expected to be greatly diminished as the wave energy that would have been reflected off the makai wall would now propagate into the pool area. The waves inside the swimming area are generally expected to propagate obliquely toward the bleachers and reflect off the mauka seawall. The swimming area can be expected to have a complex and possibly choppy water surface in the swimming area when waves are present.

The swimming area should be expected to have more wave energy than the existing condition or when the Natatorium was open to the public. A schematic of the projected wave patterns is shown as Figure 5-6, where the solid and dashed lines represent the incident and reflected waves, respectively.

Removal of the makai and the Ewa walls could also allow waves to pass through the swimming pool area and impact the Waikiki Aquarium beach. This wave energy is presently blocked by the makai and Ewa walls of the pool structure. Wave energy on the Ewa side of the Natatorium is therefore expected to be somewhat greater than at present.

Waves entering the swimming basin could suspend pool bottom sediment and create turbidity. This will be discussed further under Water Quality.

A temporary barrier should be constructed along the existing Diamond Head wall to prevent waves from transporting sand into the swim basin until the modifications to the Diamond Head wall are complete.

Currents

Currents in the near vicinity of the Natatorium are driven primarily by tides, waves, and bathymetry. Waves breaking on the reef produce a net mass transport of water toward shore that tends to return seaward through the swimming channel fronting Sans Souci Beach. Flow during falling tide with little wave action produces a similar pattern. In the presence of waves, such as during summer south swell, the flow can be directed out the swim channel for prolonged periods regardless of tide.

The makai and Ewa walls will be removed in this alternative. Waves and currents are expected to more freely enter and exit the swimming pool area after the walls have been removed. The path shown on Figure 5-6 is the expected current path under wave conditions. As illustrated, under wave conditions, current flow from the swimming basin is likely toward the swimming channel fronting Sans Souci Beach and then to sea.

Sans Souci Beach and Waikiki Aquarium Beach

Sans Souci Beach is maintained by the interaction of the incident waves with the Diamond Head wall of the Natatorium swimming basin. Waves propagate through the swim channel and refract toward the Natatorium where the oblique angle with shore transports sand toward and against the Diamond Head wall. Wave reflection from the wall also drives sand toward shore along the wall and limits the amount of sand that passes offshore of the Natatorium.

The Perimeter Deck Diamond Head wall would have the same reflection characteristics as the existing wall; therefore, wave patterns should be unchanged. During the construction phase, the existing upper portion of the Natatorium's Diamond Head seawall would be demolished and replaced. The lower portion of the Diamond Head wall would remain if it is determined to be in good condition. Care should be taken to retain the beach-stabilizing effect of the Diamond Head wall during the construction phase. A temporary barrier could be installed during construction to maintain stability of the beach and to prevent beach sand from being washed into the swimming area. This alternative is expected to have no short- or long-term impacts to Sans Souci Beach if the function of the existing Diamond Head rock fill and wall is maintained.

The beach fronting the Waikiki Aquarium is narrow and submerged at most tide levels. The beach shape is maintained by diffraction of waves passing the Natatorium's makai and Ewa walls. The makai and Ewa pool walls would be removed in this alternative allowing waves to pass through the swimming pool area and impact the Waikiki Aquarium beach, possibly resulting in the transport of sand in the Ewa direction, which is expected to result in a narrowing of the beach.

Sea Level Rise

The present rate of global sea level rise is 3.4 mm/year and that rate is expected to accelerate. Since maximum wave height is a function of water depth, waves can be expected to increase in size with sea level rise. For the Perimeter Deck alternative, the makai and Ewa walls would be removed and increased wave energy would be expected to enter the swimming area as sea level rises.

Unless the new wall heights are also increased, wave overtopping would be expected to occur more frequently as sea level rises. The new deck would be designed to delay the effect of passive flooding due to sea level rise. NOAA's most recent sea level rise projections were shown previously in Table 3-7.

Water Quality

Natatorium pool investigations found the swimming basin bottom sediment to contain a minimum of 10 percent fines (and up to 95 percent). This sediment was dark in color and samples were described as muck. The Perimeter Deck includes the removal of broken concrete and other debris. A sand cap placed over the regraded sediments could be considered, based on further design or water quality concerns. During construction, Best Management Practices (BMPs) will be in place in accordance with Clean Water Act Section 401 and, as needed, beach closures may be prudent for intermittent periods of time and as coordinated with neighboring beach stakeholders. Without such project designs and controls, wave action may be sufficient to suspend this fine sediment from the existing pool bottom creating turbidity that could then be transported out of the swimming area by currents during and following construction. The most likely fate of the turbidity is in the Diamond Head direction in front of Sans Souci Beach and then in the offshore direction out the swim channel.

Recreational Activities

Water-based recreation activities in the vicinity of the Natatorium include swimming, snorkeling, paddle boarding, and surfing. The quality of surf sites can be affected by reflected waves. The removal of the makai wall is expected to reduce the reflected wave energy, though reflected waves are not believed to presently affect any surf sites.

In this alternative, the openings along the makai and Ewa sides would have a protective grating that extends from the perimeter deck vertically to the seafloor. Incident waves and currents are expected to pass through the grating with only limited energy dissipation. Ocean users along the grating could be pushed against the grating as a wave passes. In the existing configuration, the incident wave would reflect off the makai wall and ultimately push the user away from that wall. There would be no reflection expected with the grating in place.

During construction, water users would be required to stay a safe distance from the construction. Elevated turbidity levels could impact recreational water sport activities by affecting visibility.

Loss of Waters of the U.S.

The water inside the Natatorium is considered waters of the United States, and as such certain activities are regulated by the Department of the Army. Section 404 of the Clean Water Act regulates dredging and filling within waters of the United States, while Section 10 of the Rivers and Harbors Act of 1898 regulates construction of structures within navigable waters.

There would be no loss of waters of the United States for the Perimeter Deck alternative.

Figure 5-6. *Alternative 1 – Perimeter Deck*, expected generalized wave and current patterns.

5.3 War Memorial Beach

The War Memorial Beach alternative (Figure 5-7) would create a stable beach between two concrete and rock groins within the Natatorium footprint. The entire concrete deck surrounding the pool, including beams, pile caps, and portions of the seawall would be removed. In order to position the groins within the pool footprint, the groin stems and a portion of the groin heads would have to extend into the swimming area. Given the soft sediment characteristics within that area, the groin heads and stems would have to be supported to prevent settling. This could be accomplished by constructing pile-supported platforms for the groins.

The existing rock fill below the Diamond Head and Ewa seawalls would remain. The new Diamond Head groin stem would help to retain neighboring Sans Souci Beach. Exposed portions of the existing piles would be removed. The plan would also include grading and capping the existing sediment in the basin and filling with beach quality sand. The new beach would be stable while still allowing enough wave energy to produce water exchange with the coastal waters.

This alternative was shown previously as Option 1 in Section 4.3.1 of this report.

This evaluation presumes that prior to any in-water work, BMPs will be set in place; existing Natatorium walls will serve to contain any resuspended sediment while the basin is regraded and possibly capped; and demolition of existing walls will occur subsequent to any basin sediment stabilization.

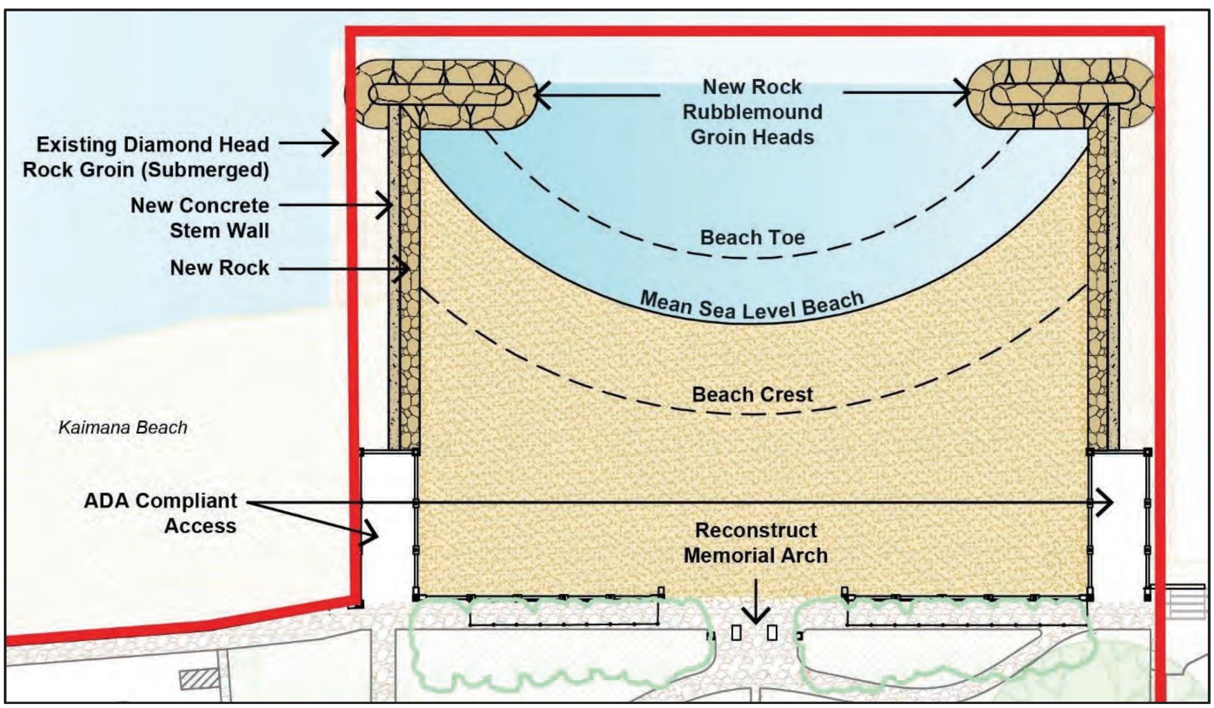


Figure 5-7. *Alternative 2 – War Memorial Beach*, plan view.

5.3.1 *Affected Oceanographic Environment*

Waves

Wave patterns approaching the Natatorium were presented in Section 3.3. The beach alternative calls for replacing the existing pool walls with T-head groins. The new groins would be situated to allow wave energy to propagate toward shore. As the incident wave passes through the gap between the groin heads, the wave will diffract taking an arc shape. This wave shape will produce and maintain an arc-shaped beach. Wave reflection is expected to be reduced by the rubblemound groin heads, which would also reduce the portion of the wave propagating through the gap between the heads.

During construction, the existing walls would essentially serve as BMPs, turbidity barriers, and coffer dams. The existing walls would be removed toward the end of construction.

Currents

Currents in the near vicinity of the Natatorium are driven primarily by tides, waves, and bathymetry. Waves breaking on the reef produce a net mass transport of water toward shore that tends to return seaward through the swimming channel fronting Sans Souci Beach. Flow during falling tide with little wave action produces the same pattern. In the presence of waves, such as during summer south swell, the flow can be directed out the swim channel for prolonged periods regardless of tide.

The Natatorium pool walls would be replaced in this alternative with T-head groins within the existing Natatorium footprint. No long-term change in current patterns outside the Natatorium footprint compared to the existing condition is expected. There is the possibility of return flow from within the swimming area along the groin heads producing a mild rip current. The rubblemound heads, however, are designed to help reduce the strength of the current.

Sans Souci Beach and Waikiki Aquarium Beach

Sans Souci Beach is maintained by the interaction of the incident waves with the Diamond Head wall of the Natatorium swimming pool. Waves propagate through the swim channel and refract toward the Natatorium, where the oblique angle with shore transports sand toward and against the Diamond Head wall. Wave reflection from the wall also drives sand toward shore along the wall and limits the amount of sand that passes offshore of the Natatorium.

The War Memorial Beach Diamond Head groin stem would have similar reflection characteristics as the existing Diamond Head wall; consequently, wave patterns at Sans Souci Beach should be unchanged. During the construction phase, the Diamond Head wall should remain until construction of the new groin is complete. Care should be taken to retain the beach-stabilizing effect of the Diamond Head wall during the construction phase. This alternative is expected to have no short- or long-term impacts to Sans Souci Beach if the function of the existing Diamond Head wall is maintained.

The beach fronting the Waikiki Aquarium is narrow and submerged at most tide levels. The beach shape is maintained by diffraction of waves passing the Natatorium's makai and Ewa walls. The Ewa pool wall in this alternative would be replaced with a new groin in approximately the same location as the Ewa wall; therefore, no long-term change would be expected based on configuration alone. During construction, the existing walls would remain in place and serve as BMPs, turbidity barriers, and coffer dams. The existing walls would be removed at the end of construction. This construction method is expected to have no short- or long-term effects on the Waikiki Aquarium beach. If the makai and Ewa walls were removed prior to construction of the new Ewa groin, waves could pass through the swimming pool area and impact the Waikiki Aquarium beach, possibly resulting in the transport of sand in the Ewa direction. This would result in narrowing of the beach.

Sea Level Rise

The present rate of global sea level rise is 3.4 mm/year and that rate is expected to accelerate. Since maximum wave height is a function of water depth, waves can be expected to increase in size with sea level rise. As sea level rises, the groins and the beach would be expected to overtop more frequently. Wave heights would also be expected to be greater as sea level rises, and maintenance of the beach and groins may become more frequent. NOAA's most recent sea level rise projections were shown previously in Table 3-7.

Water Quality

Natatorium pool investigations found the swimming basin bottom sediment to contain a minimum of 10 percent fines (and up to 95 percent). This sediment was dark in color and samples were described as muck. The War Memorial Beach includes the removal of broken concrete and other debris and grading of the existing sediment to minimize high spots. The regraded bottom could be overlain with a geotextile liner and clean gravel or rock, then covered with beach-quality sand to form the new swim area bottom and beach, based on further design or water quality concerns. During construction, BMPs will be in place in accordance with Clean Water Act Section 401 and, as needed, beach closures may be prudent for intermittent periods of time and as coordinated with neighboring beach stakeholders. Without such project designs and controls, wave action may be sufficient to suspend this fine sediment from the existing pool bottom creating turbidity that could then be transported out of the swimming area by currents during and following construction. The most likely fate of the turbidity is in the Diamond Head direction in front of Sans Souci Beach and then in the offshore direction out the swim channel.

The nourishment sand may also contain a fraction of fine material that could become suspended and mobilized, causing elevated turbidity levels.

Recreational Activities

Water-based recreation activities in the vicinity of the Natatorium include swimming, snorkeling, paddle boarding, and surfing. Since there should be no long-term change to waves and currents outside the Natatorium, there should be no long-term change to these recreational activities caused by this alternative. Within the swimming area, users may experience wave conditions greater than exist now. There is also the potential for rip currents to form along the groin heads.

During construction, water users would be required to stay a safe distance from the construction. Elevated turbidity levels could impact recreational water sport activities by affecting visibility.

Loss of Waters of the U.S.

The water inside the Natatorium is considered waters of the United States and, as such, certain activities are regulated by the Department of the Army. Section 404 of the Clean Water Act regulates dredging and filling within waters of the United States while Section 10 of the Rivers and Harbors Act of 1898 regulates construction of structures within navigable waters.

The loss of waters of the United States amounts to about 38,000 square feet for the War Memorial Beach alternative.

5.4 Closed-System Pool

The Closed-System Pool (Figure 5-8) would create an enclosed disinfected fresh water swimming pool in the location of the existing salt water swimming basin. The new swimming pool would be concrete lined to prevent the pool water from entering the ocean. The walls and bottom of the swimming basin would be lined with concrete to completely separate the swimming area from the ocean. The dimensions of the complex would be consistent with the original and 1998 designs.

This evaluation presumes that prior to any in-water work, BMPs will be set in place; existing Natatorium walls will serve to contain any resuspended sediment while the basin is regraded and possibly capped; and demolition of existing seawalls will occur subsequent to any basin sediment stabilization.

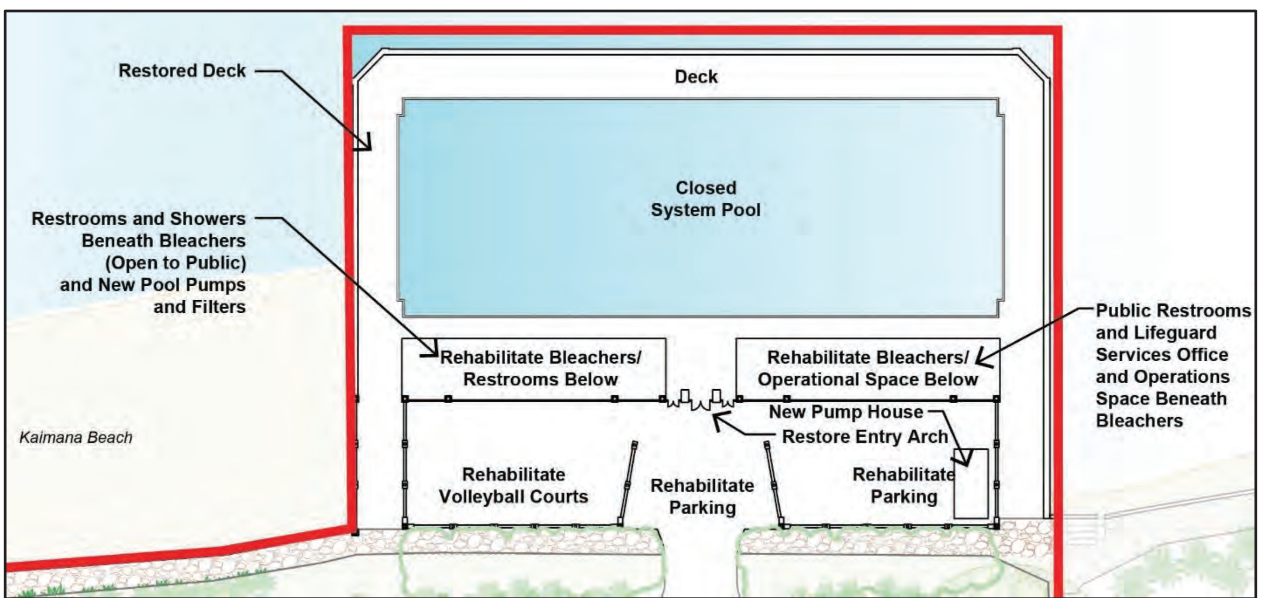


Figure 5-8. Alternative 3 – Closed System Pool.

5.4.1 *Affected Oceanographic Environment (Closed-System Pool alternative)*

Waves

Wave patterns approaching the Natatorium were presented in Section 3.3. The closed-system pool alternative calls for replacing the existing pool walls with new walls in similar locations and with the same orientations. The new walls would have the same general cross-sectional shape as the existing walls (i.e., a "recurved" face), which would result in similar wave reflection characteristics. Reflection is therefore expected to be of similar magnitude and direction as in the existing condition. Wave patterns resulting from this alternative are expected to be consistent with those in the existing conditions.

Currents

Currents in the near vicinity of the Natatorium are driven primarily by tides, waves, and bathymetry. Waves breaking on the reef produce a net mass transport of water toward shore that tends to return seaward through the swimming channel fronting Sans Souci Beach. Flow during falling tide with little wave action produces the same pattern. In the presence of waves, such as during summer south swell, the flow can be directed out the swim channel for prolonged periods regardless of tide.

The Natatorium pool walls would be replaced in this alternative with nearly identical walls in similar locations and orientations. No long-term change in current patterns compared to the existing condition is expected.

During construction, the existing walls would prevent waves and currents from entering the swimming pool area, so the Closed-System Pool would not affect currents in a temporary or short-term manner.

Sans Souci Beach and Waikiki Aquarium Beach

Sans Souci Beach is maintained by the interaction of the incident waves with the Diamond Head wall of the Natatorium swimming pool. Waves propagate through the swim channel and refract toward the Natatorium where the oblique angle with shore transports sand toward and against the Diamond Head wall. Wave reflection from the wall also drives sand toward shore along the wall and limits the amount of sand that passes offshore of the Natatorium.

The Closed-System Pool would include walls in similar locations and with the same orientations; consequently, wave patterns at Sans Souci Beach and Waikiki Aquarium Beach should be unchanged and no long-term effects would occur.

Care should be taken to retain the beach-stabilizing effect of the Diamond Head wall during the construction phase. A temporary barrier could be installed during construction to maintain stability of the beach and to prevent beach sand from being washed into the swimming area. This alternative is expected to have no short- or long-term impacts to Sans Souci Beach if the function of the existing Diamond Head wall is maintained.

Sea Level Rise

The present rate of global sea level rise is 3.4 mm/year and that rate is expected to accelerate. Since maximum wave height is a function of water depth, waves can be expected to increase in size with sea level rise. For the closed-system pool alternative, the Natatorium pool walls will be replaced with similar walls in the same locations and with the same orientations. Unless the new wall heights are also increased, wave overtopping would be expected to occur when sea level exceeds a certain elevation. The new deck would be designed to delay the effect of passive flooding due to sea level rise. NOAA's most recent sea level rise projections were shown previously in Table 3-7.

Water Quality

Natatorium pool investigations found the swimming basin bottom sediment to contain a minimum of 10 percent fines (and up to 95 percent). This sediment was dark in color and samples were described as muck. During construction, BMPs will be in place in accordance with Clean Water Act Section 401 and, as needed, beach closures may be prudent for intermittent periods of time and as coordinated with neighboring beach stakeholders. Without such project designs and controls, wave action is expected to suspend this fine sediment from the existing pool bottom creating turbidity that could then be transported out of the swimming area by currents during construction. The most likely fate of the turbidity is in the Diamond Head direction in front of Sans Souci Beach and then in the offshore direction out the swim channel. Construction is expected to result in walls around the swimming basin and a concrete pool bottom over the sediment effectively trapping the sediment in place.

Recreational Activities

Water-based recreation activities in the vicinity of the Natatorium include swimming, snorkeling, paddle boarding, and surfing. Since there should be no long-term change to waves and currents, there should also be no long-term change to these recreational activities caused by this alternative.

During construction, water users would be required to stay a safe distance from the construction. Elevated turbidity levels could impact recreational water sport activities by affecting visibility.

Loss of Waters of the U.S.

The water inside the Natatorium is considered waters of the United States and, as such, certain activities are regulated by the Department of the Army. Section 404 of the Clean Water Act regulates dredging and filling within waters of the United States while Section 10 of the Rivers and Harbors Act of 1898 regulates construction of structures within navigable waters.

The loss of waters of the United States amounts to about 62,000 square feet for the Closed-System Pool alternative.

5.5 No Action

Under No Action, the WWM complex would remain in its current dilapidated condition and the pool and bleachers would remain closed to the public. There would be no change to the land use or facilities that currently exist at the site. This alternative would maintain the status quo and all structures would remain in place and continue to deteriorate.

Due to the public safety hazards presented by the current condition of the complex and related liability borne by the City, monitoring of the structural condition would continue and, if warranted, imminent hazards would be mitigated in accordance with the recommendations of the 2008 Waikiki War Memorial Complex (Natatorium) Emergency Preparedness Contingency Plan.

5.5.1 *Affected Oceanographic Environment*

Waves

Wave patterns approaching the Natatorium were presented in Section 3.3. The No Action alternative calls for no change to the existing pool walls; therefore, there should be no difference in wave patterns between the no action alternative and the existing condition.

Currents

Currents in the near vicinity of the Natatorium are driven primarily by tides, waves, and bathymetry. Waves breaking on the reef produce a net mass transport of water toward shore that tends to return seaward through the swimming channel fronting Sans Souci Beach. Flow during falling tide with little wave action produces the same pattern. In the presence of waves, such as during summer south swell, the flow can be directed out the swim channel for prolonged periods regardless of tide.

The No Action alternative calls for no change to the existing pool walls; therefore, there should be no difference in current patterns between the No Action alternative and the existing condition.

Sans Souci Beach and Waikiki Aquarium Beach

Sans Souci Beach is maintained by the interaction of the incident waves with the Diamond Head wall of the Natatorium swimming pool. Waves propagate through the swim channel and refract toward the Natatorium where the oblique angle with shore transports sand toward and against the Diamond Head wall. Wave reflection from the wall also drives sand toward shore along the wall and limits the amount of sand that passes offshore of the Natatorium. The beach fronting the Waikiki Aquarium is narrow and submerged at most tide levels. The beach shape is maintained by diffraction of waves passing the Natatorium’s makai and Ewa walls.

The No Action alternative calls for no change to the existing pool walls; therefore, there should be no change to the neighboring beaches between the No Action alternative and the existing condition.

Sea Level Rise

The present rate of global sea level rise is 3.4 mm/year and that rate is expected to accelerate. Since maximum wave height is a function of water depth, waves can be expected to increase in size with sea level rise and the waves will overtop the existing walls as sea level increases. Wave forces on the wall would also increase and this would be expected to lead to further damage to and potential failure of the Natatorium walls.

Water Quality

Natatorium pool investigations found the swimming basin bottom sediment to contain a minimum of 10 percent fines (and up to 95 percent). This sediment was dark in color and samples were described as muck. The No Action alternative calls for no change to the existing pool walls; therefore, there should be no difference in water quality between the No Action alternative and the existing condition. Biological breakdown of sediment within the swimming basin would continue, anoxic conditions within that sediment would likely increase, and water quality would be expected to further degrade.

Recreational Activities

Water-based recreation activities in the vicinity of the Natatorium include swimming, snorkeling, paddle boarding, and surfing. Since there should be no long-term change to waves and currents, there should be no long-term change to these recreational activities caused by this alternative. The No Action alternative calls for no change to the existing pool walls; therefore, there should be no difference in recreational uses between the No Action alternative and the existing condition. Users, however, should be aware that the Natatorium's concrete would continue to degrade and pieces of concrete could fall off into the water.

Loss of Waters of the U.S.

The water inside the Natatorium is considered waters of the United States and, as such, certain activities are regulated by the Department of the Army. Section 404 of the Clean Water Act regulates dredging and filling within waters of the United States while Section 10 of the Rivers and Harbors Act of 1898 regulates construction of structures within navigable waters.

There would be no loss of waters of the United States with the No Action alternative.

5.6 Alternatives Previously Considered

The 2008 conceptual design study (Sea Engineering, Inc., 2008) was initiated to evaluate the shoreline response for six concept designs. An additional design was developed throughout the study. These designs are presented in the following sections. Each conceptual design was subjected to wave modeling and the relative merits of each were evaluated from the results. The criteria for analyzing these alternatives include projected beach stability, usable beach area, and stability of Sans Souci Beach. The estimates of new beach account for potential loss of sand at Sans Souci Beach and the values are based on the initial stability of the beach for each conceptual design, not necessarily long-term stability. Findings from the 2008 study are presented in the following sections and the names are kept the same to be consistent between reports.

5.6.1 *Conceptual Design 1 (2008)*

Conceptual Design 1 includes an L-groin and a detached breakwater with complete removal of the Natatorium structures. The rubblemound structures are oriented along the footprint of the existing Natatorium walls and have crest elevations of +6 ft MLLW. The L-groin extends 250 ft and its head is 60 ft long. The detached breakwater is 80 ft long. The wave orientation incident on the structures and beach is shown on Figure 5-9. The interaction of the incident waves with the L-groin produces a diffracted wave in the lee of the head. The detached breakwater causes the incident waves to diffract around both ends resulting in decreased wave energy in its lee. In addition, waves approach obliquely from the south after passing through the channel and propagate between the detached breakwater and the beach. The wave patterns are irregular and the waves passing over the reef and through the channel reach the beach at different times with different angles.

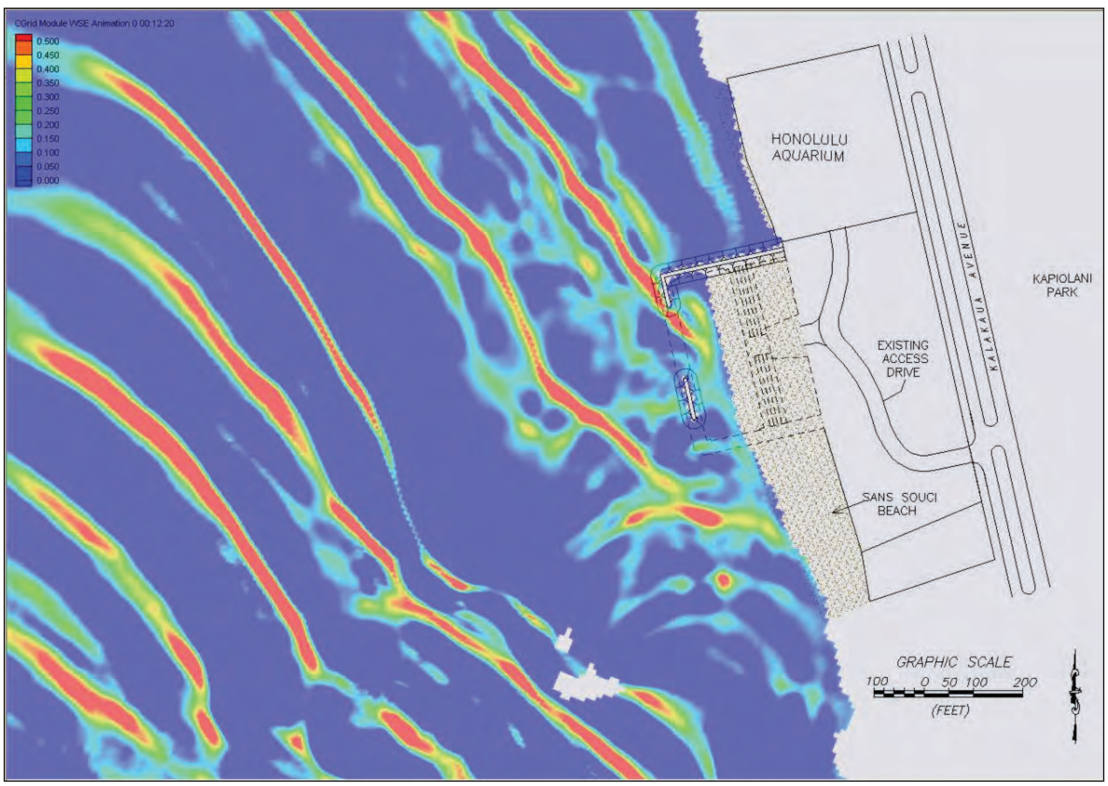


Figure 5-9. BOUSS2D wave pattern for Conceptual Design 1.

The L-groin serves as a barrier to sediment transport in the Ewa direction and the groin head helps to prevent sand from being transported around the end of the groin. The diffracted wave pattern behind the detached breakwater has the potential to produce a salient in its lee depending on the energy of the waves approaching from the swim channel. Sans Souci Beach is presently maintained by the interaction of the waves with the existing wall on the Diamond Head side of the Natatorium. Removal of this structure presents potential instability to Sans Souci Beach. Stability generally occurs when sediment is transported to the extent that the shoreline achieves the same orientation as the incident waves. The strongly oblique incident wave passing from Sans Souci Beach to the Natatorium is expected to produce sediment transport in the Ewa direction. In this situation, sand from Sans Souci Beach could fill the area behind the L-groin and the width of Sans Souci Beach would be decreased as the beach becomes aligned with the waves.

Removal of the Diamond Head wall might also affect circulation patterns in the vicinity. The swimming channel in front of Sans Souci Beach that extends offshore serves as a pathway for return flow during large wave events. Sans Souci Beach is presently stable during these events; however, the open design could cause the return flow to occur closer to shore and could serve to transport sediment away from the beach. Figure 5-10 presents an expected beach planform resulting from this design. Dry beach width at the Ewa groin is 200 ft measured to the +6 ft contour. The beach narrows in the Diamond Head direction, as shown on the figure, indicating that significant erosion of Sans Souci Beach is likely to occur.

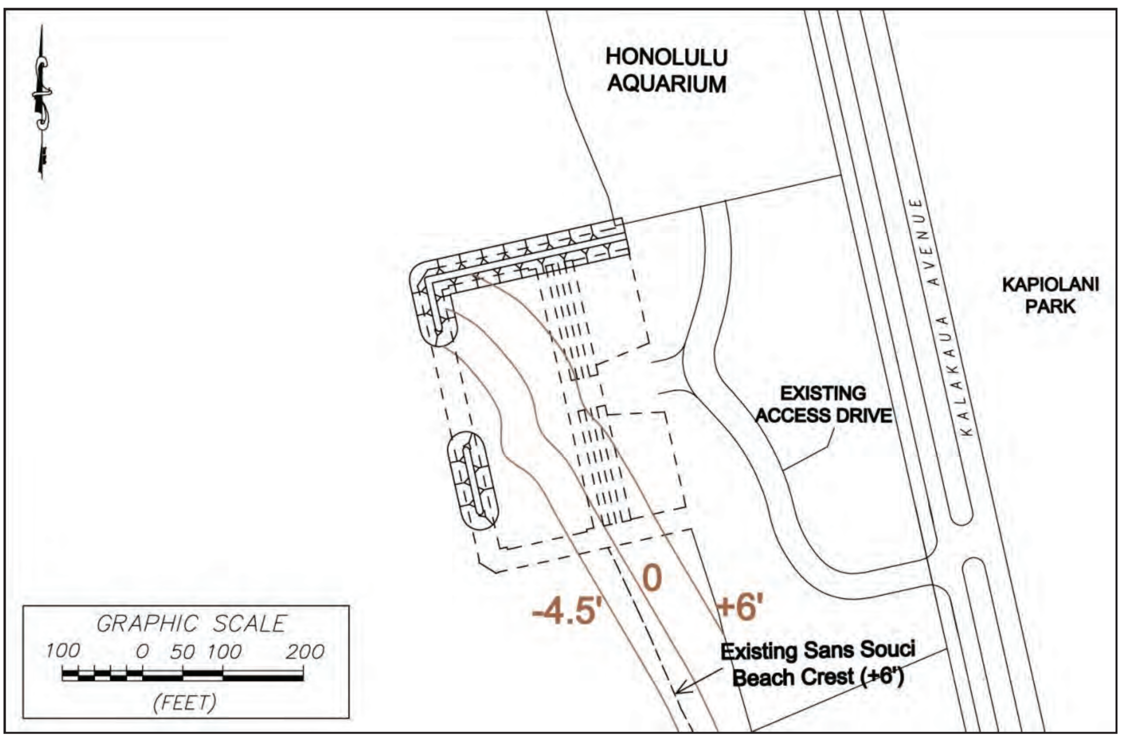


Figure 5-10. Conceptual Design 1 projected beach planform.

The structures are designed in-line with the existing Natatorium walls and the openings improve the visual impact and should produce water quality consistent with that near Sans Souci Beach.

Useable swimming area will likely be expanded with this design due to removal of the wall separating Sans Souci Beach from the Natatorium. Material estimates are presented in Table 5-1. Construction requires 6,700 cubic yards of sand fill in addition to the sand from Sans Souci Beach that is expected to be transported to the L-groin.

Table 5-1. Conceptual Design 1 material estimates.

Item	Quantity	Unit
Structures		
L-groin	3,000	cubic yard
Breakwater	250	cubic yard
Beach		
Quarry run	5,200	cubic yard
Sand fill	6,700	cubic yard

5.6.2 *Conceptual Design 2a (2008)*

Conceptual Design 2a includes the same L-groin as in Conceptual Design 1 with a straight 110-ft-long groin adjacent to Sans Souci Beach. As designed, groin crest elevations are +6 ft MLLW, the same as the adjacent Sans Souci Beach, and the straight groin extends only to the beach crest. The wave pattern approaching Conceptual Design 2a is shown on Figure 5-11. The waves incident on the structures include the wave passing over the reef and the obliquely-incident wave from the swimming channel. The incident wave orientation is from the straight groin toward the end of the L-groin.

The L-groin will function, as in Conceptual Design 1, by producing a diffracted wave in its lee and presenting a barrier to sediment transport. The groin head will help keep sand from being transported around the end. The stable beach orientation based on the model-predicted wave crest orientations entering the Natatorium will be from the straight groin toward the head of the L-groin as shown on Figure 5-12. Due to the oblique wave approach, a narrowed beach width can be expected at the south end of the Natatorium, and some recession of Sans Souci Beach is possible. This design is more open than Conceptual Design 1 and it allows more wave energy to reach the beach. Beach stability is therefore also a concern. During large wave events, the straight groin would do little to maintain sand within the Natatorium and sand could be swept offshore to the southwest.

Dry beach width at the Ewa groin is 210 ft and the beach narrows in the Diamond Head direction as shown on Figure 5-12. Performance of this design could be improved by lengthening the head of the L-groin to orient the gap with the incident wave and to reduce wave energy inside the Natatorium or by extending the Diamond Head groin to stabilize Sans Souci Beach.

The structures are designed in-line with the existing Natatorium walls and the openings improve the visual impact and should produce water quality consistent with that near Sans Souci Beach. This design would also expand the swimming area by removing the wall separating Sans Souci Beach from the Natatorium.

Material estimates are presented in Table 5-2. Construction of this conceptual design would require 15,100 cubic yards of sand fill in addition to the sand transported from Sans Souci Beach toward the L-groin. The impact to Sans Souci Beach is not expected to be as severe as in Conceptual Design 1.

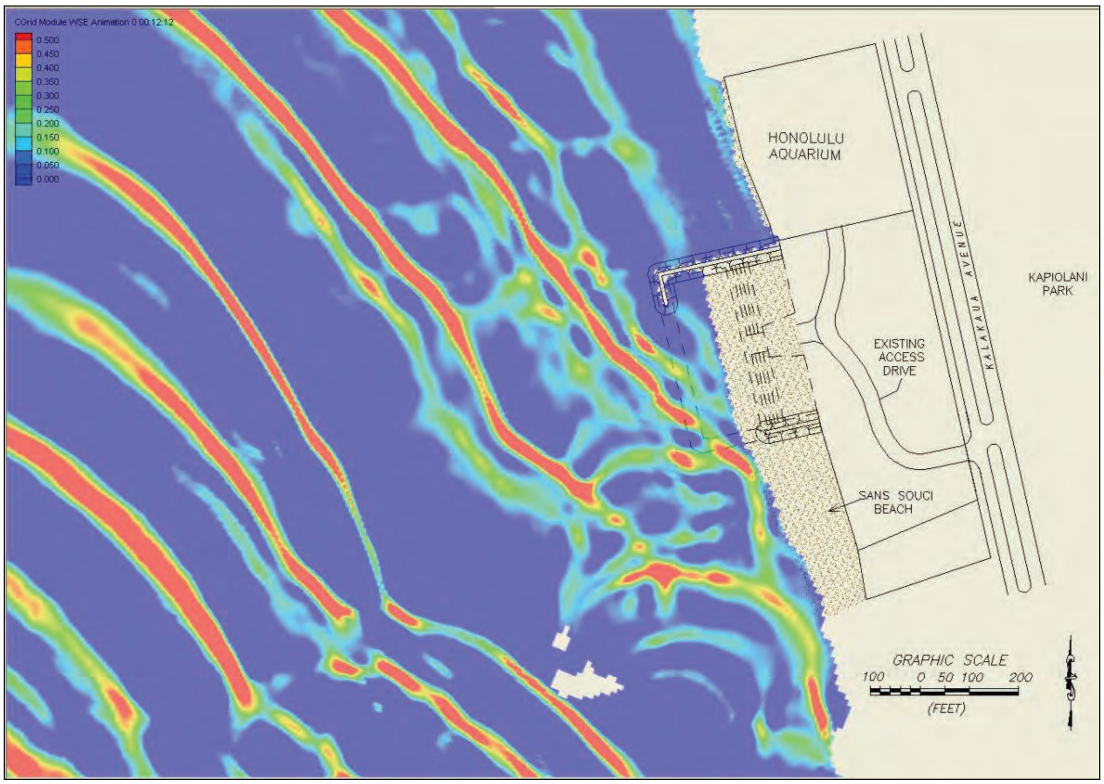


Figure 5-11. BOUSS2D wave pattern for Conceptual Design 2a.

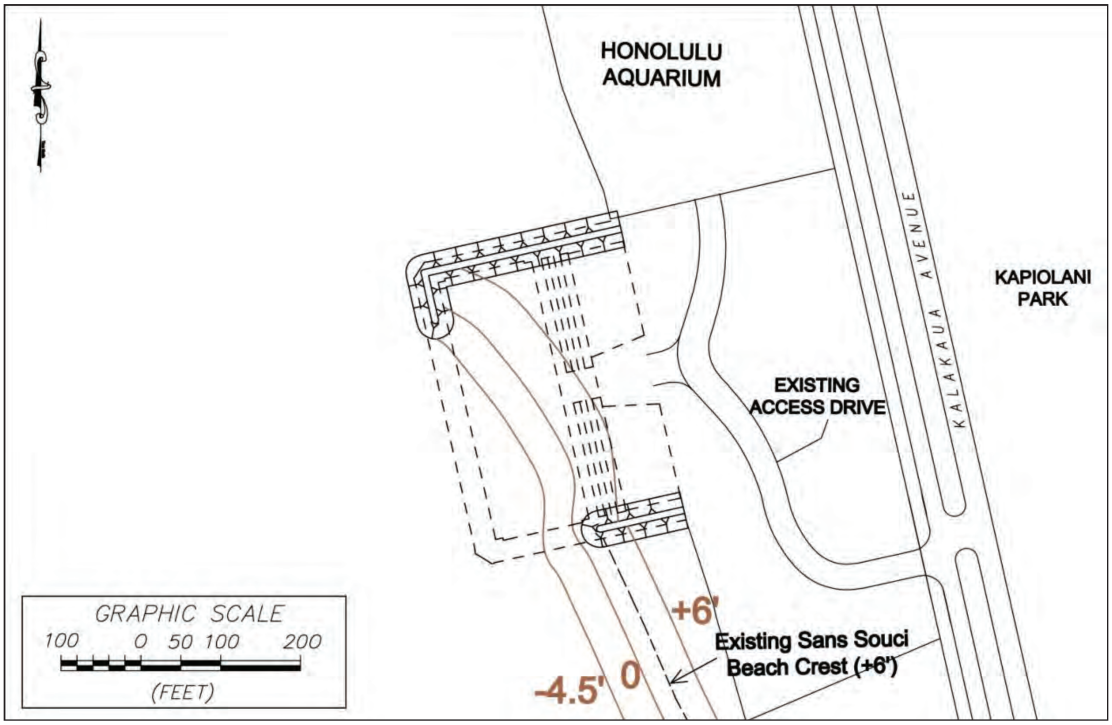


Figure 5-12. Conceptual Design 2a projected beach planform.

Table 5-2. Conceptual Design 2a material estimates.

Item	Quantity	Unit
Structures		
L-groin	3,000	cubic yard
Groin	1,100	cubic yard
Beach		
Quarry run	5,200	cubic yard
Sand fill	15,100	cubic yard

5.6.3 *Conceptual Design 2b*

This design was developed using methods presented by Silvester and Hsu (1993) and Bodge (2003) to determine gap width, structure length and alignment, and estimated stable beach alignment. The two L-groins in this design simulate the general configuration of natural landforms that produce arc-shaped beaches. Preliminary model runs showed that the wave incident on the seaward wall of the Natatorium was aligned 25 degrees from that wall and therefore the gap between the ends of the groin heads was oriented similarly. Design guidelines indicate that the total length of the groin heads should be 60-70 percent of the gap width. This also helps to limit the visual impact of the structures—along the horizon, there is more gap than structure. Based on the Natatorium length of 370 ft, the resulting gap width is about 210 ft. The Diamond Head groin is designed along the wall of the Natatorium with the goal of leaving Sans Souci Beach unaffected. The Ewa groin trunk extends 310 ft from shore and the 90 ft head is tuned by 25 degrees from the offshore Natatorium wall to produce the proper gap width and orientation. Groin crest elevation is +6 ft MLLW.

The location of the mean low water (MLW) beach is suggested by Bodge (2003) as being about 0.45 times the gap width measured from the ends of the groin heads. Experience has shown that the center of the beach is located about 0.55 times the gap width measured from the center of the gap to produce an arc-shaped beach. The beach is expected to take a 1V:10H slope and the beach toe and crest lines are drawn at elevations -4.5 ft and +6 ft MLLW respectively.

The BOUSS2D model run for this design shows that the incident wave is oriented parallel to the structure gap (Figure 5-13). The wave passing through the gap diffracts and its crest shape approaches the shape of the beach. The expected beach planform is presented on Figure 5-14. This design produces no change to Sans Souci Beach. The new beach is 110 ft wide at the Diamond Head groin and 210 ft wide at the Ewa groin. The design allows sufficient wave energy to promote flushing and circulation while the T-heads prevent sand from being transported around the ends. The footprint of the existing Natatorium is slightly exceeded by the Ewa groin in this design. To tune the gap orientation to the prevailing wave approach, the Ewa groin extends about 80 ft seaward of the existing wall.

Material estimates are presented in Table 5-3. Construction of this conceptual design requires 21,800 cubic yards of sand fill to achieve the projected beach orientation. There is no impact to Sans Souci Beach in this concept.

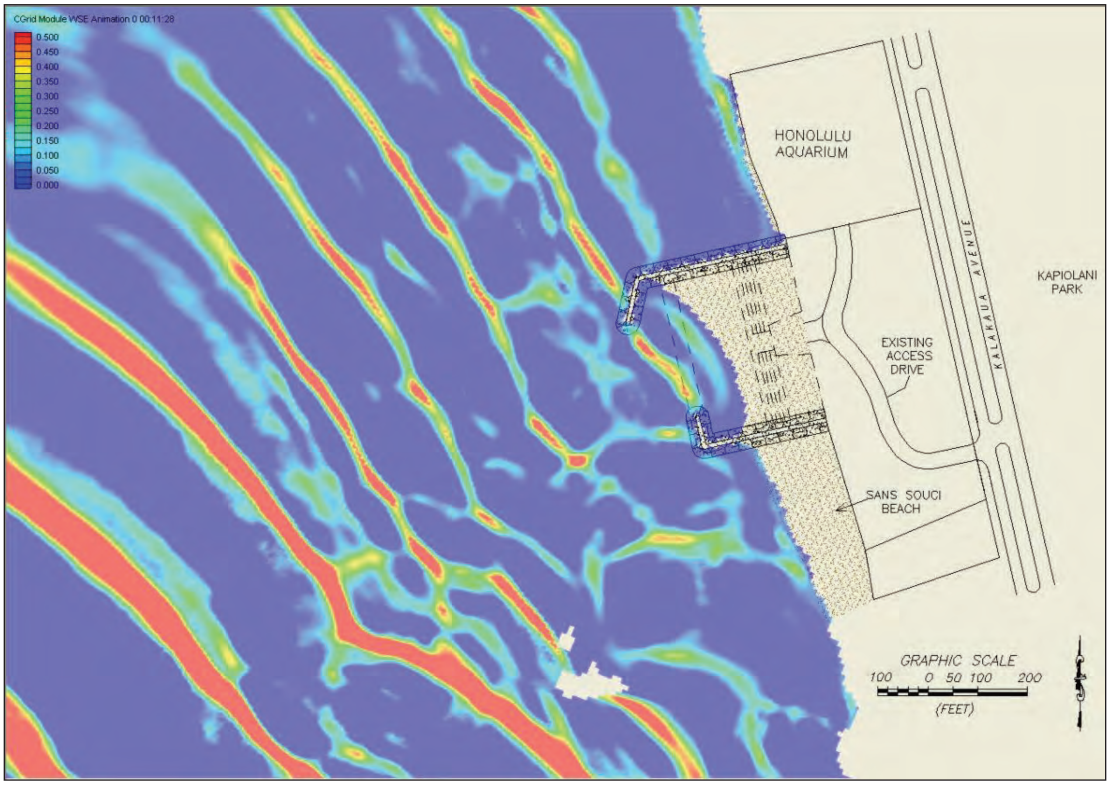


Figure 5-13. BOUSS2D wave patterns for Conceptual Design 2b.

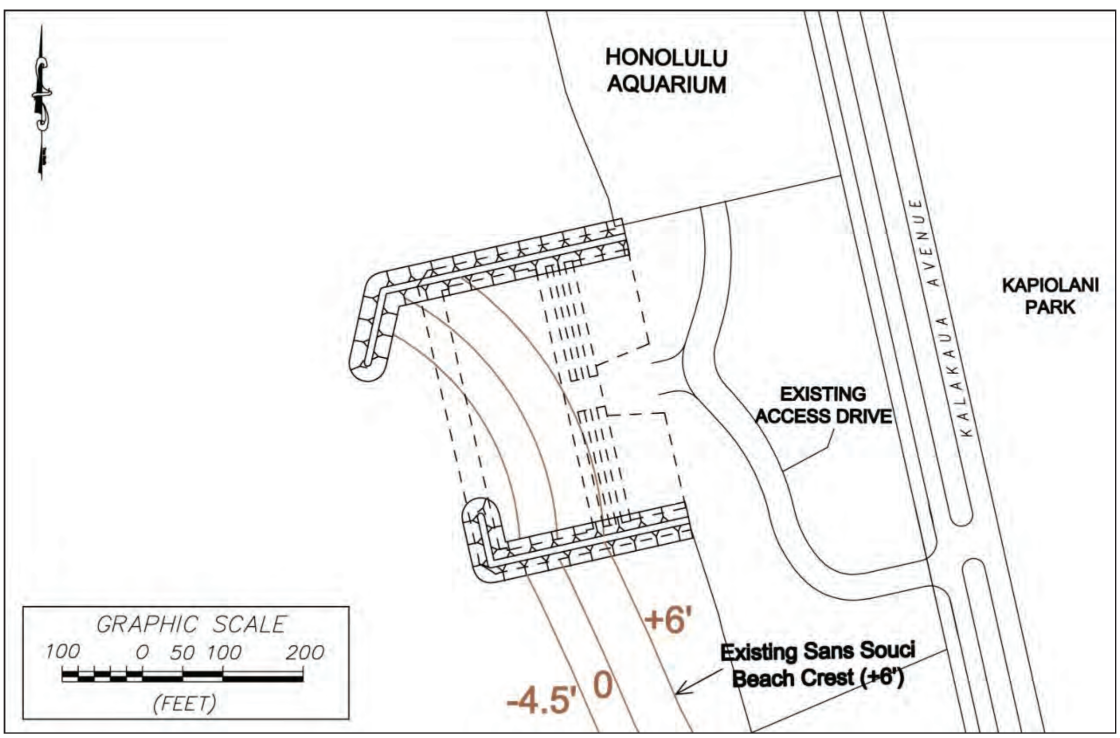


Figure 5-14. Conceptual Design 2b projected beach planform.

Table 5-3. Conceptual Design 2b material estimates.

Item	Quantity	Unit
Structures		
Tuned Ewa groin	3,600	cubic yard
L-groin	2,100	cubic yard
Beach		
Quarry run	5,200	cubic yard
Sand fill	21,800	cubic yard

5.6.4 *Conceptual Design 3a (2008)*

Conceptual Designs 3a and 3b consist of two 260-ft-long rubblemound groins with crest elevations of +6 ft MLLW. Conceptual Design 3a considers complete removal of the Natatorium structures while Conceptual Design 3b retains the bleachers. Figure 5-15 shows the incident wave approaching the structures. The figure also shows the complex wave pattern that maintains Sans Souci Beach, which is affected by waves passing over the reef as well as by waves passing through the channel and diffracting toward the Natatorium.

Straight groins are not generally effective at producing a contained beach as they do little to alter the wave pattern. The Diamond Head groin provides a barrier to transport past Sans Souci beach and is expected to maintain Sans Souci Beach at its present width. Between the groins, the wave angle will produce a beach that is narrow at the Diamond Head end of the beach, widening in the Ewa direction. The Diamond Head groin produces only slight diffraction causing insignificant sand buildup near the groin. Figure 5-16 shows the expected beach planform for this design. Initial dry beach width at the Ewa groin is about 165 ft. The beach narrows in the Diamond Head direction and near the Diamond Head wall, the beach narrows to 40 ft. During large wave events, straight groins are known to produce rip currents along the groin edges that can transport the sand seaward. Stability of the sand fill is therefore a concern with this design. Water quality and circulation are improved in this design as is the useable swimming area. The groins will follow the existing footprint of the Natatorium walls.

Material estimates are presented in Table 5-4. Conceptual Design 3a, which has no impact on Sans Souci Beach, requires 18,100 cubic yards of sand fill.

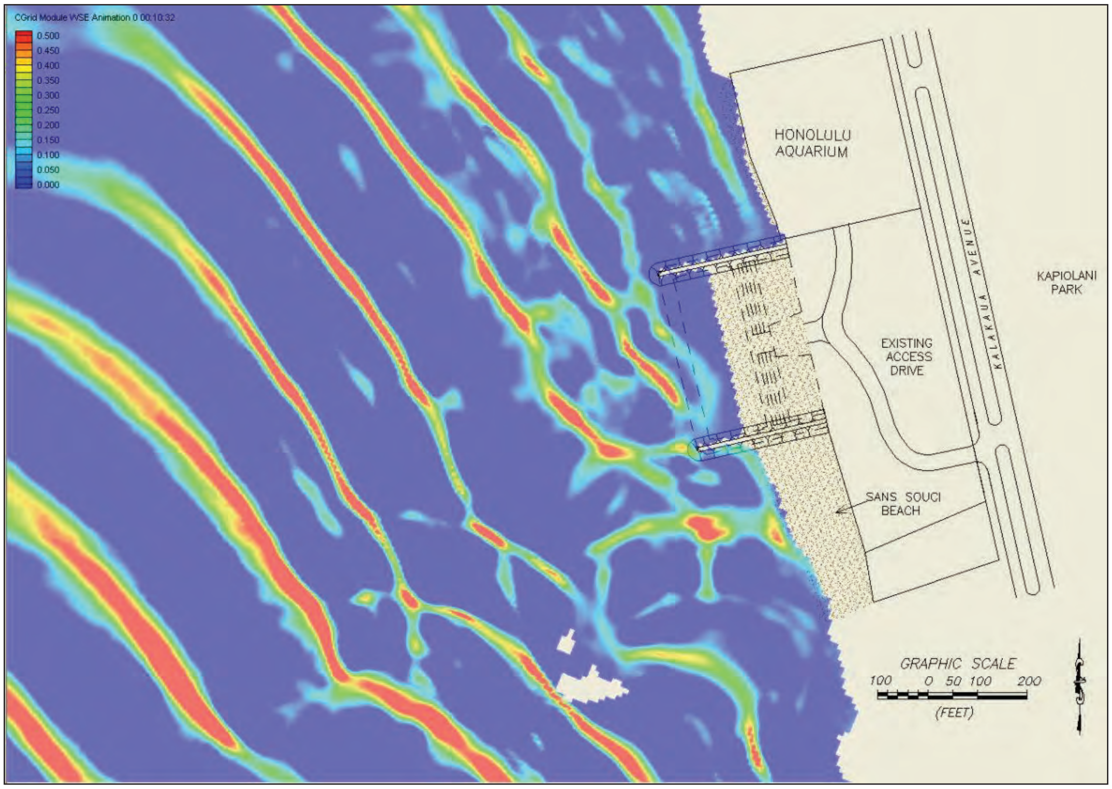


Figure 5-15. BOUSS2D wave pattern for Conceptual Design 3a.

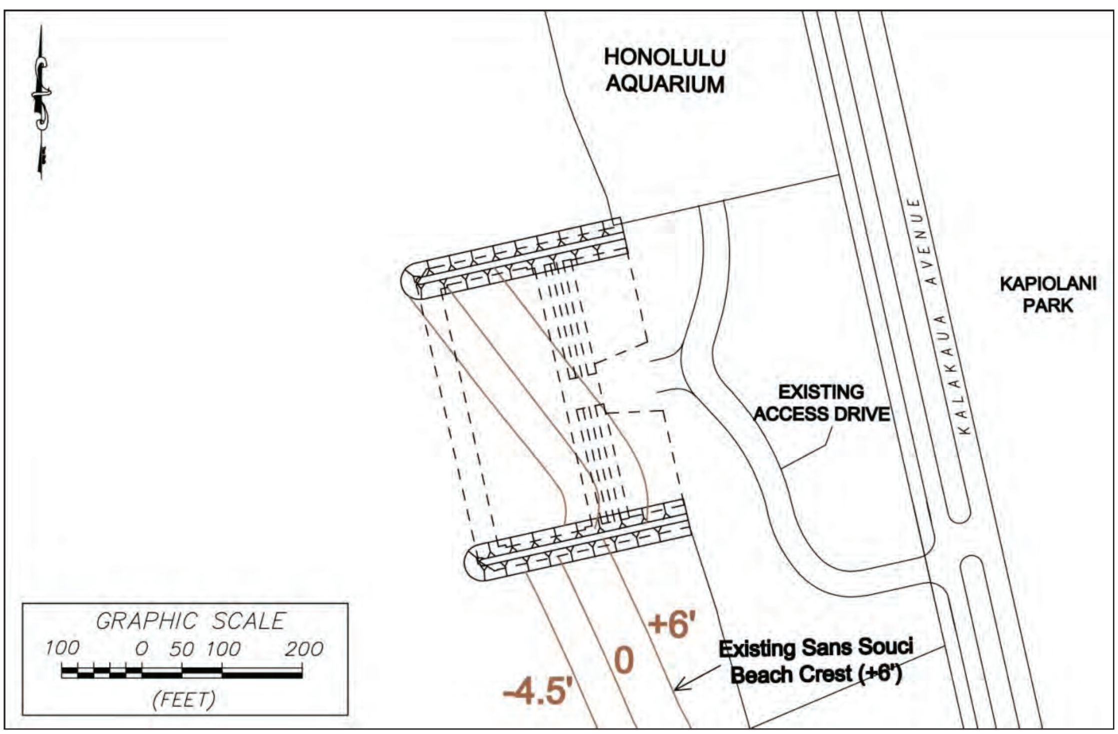


Figure 5-16. Conceptual Design 3a projected beach planform.

Table 5-4. Conceptual Design 3a material estimates.

Item	Quantity	Unit
Structures		
Ewa groin	2,550	cubic yard
DH Groin	1,850	cubic yard
Beach		
Quarry run	5,200	cubic yard
Sand fill	18,100	cubic yard

5.6.5 *Conceptual Design 3b (2008)*

The wave pattern for Conceptual Design 3b will be the same as for Conceptual Design 3a shown previously on Figure 5-15. Retention of the bleachers reduces the potential dry beach width by 120 ft and may require filling beneath the bleachers and construction of a seawall; design of these is beyond the scope of this project. In this case, the incident wave will cause the beach to intersect with the seawall and cause wave reflection. This will limit the beach area between the groins and could significantly diminish beach stability. The expected beach planform is illustrated on Figure 5-17.

While this design may not produce a stable beach, it has merits in producing an expanded swimming area without a beach. The swimming area, however, will not be continuous with the swimming area at Sans Souci Beach.

Material estimates are presented in Table 5-5. Only 3,900 cubic yards of sand fill is required for this concept; however, this also shows the resulting limited beach width.

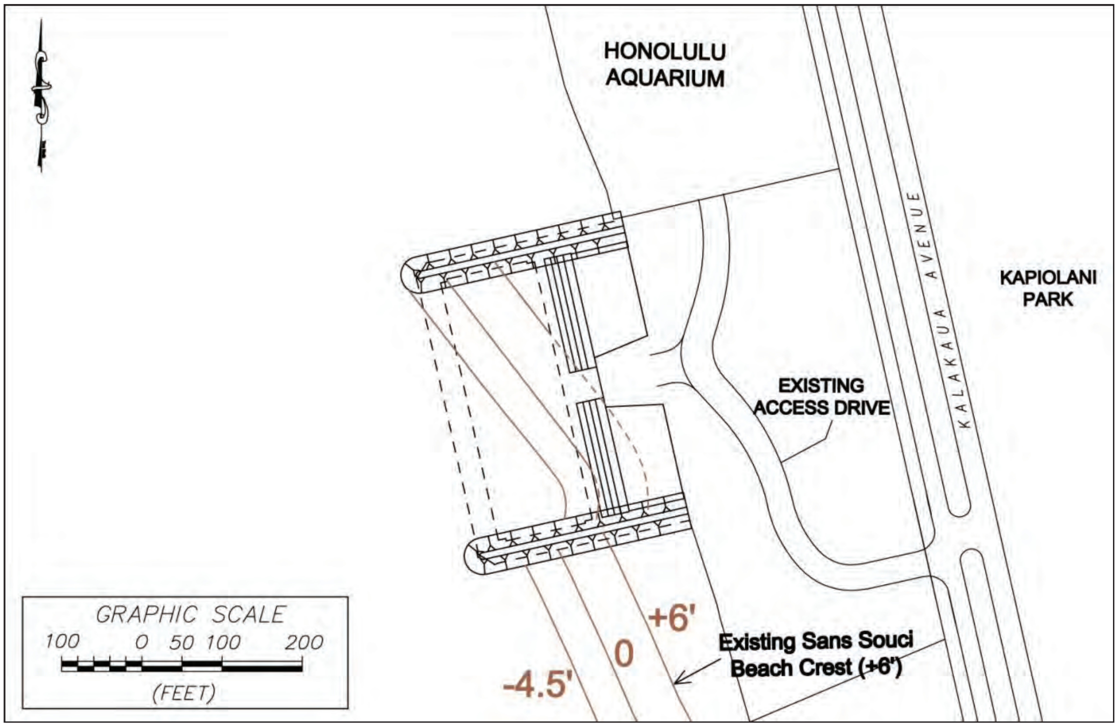


Figure 5-17. Conceptual Design 3b projected beach planform.

Table 5-5. Conceptual Design 3b material estimates.

Item	Quantity	Unit
Structures		
Ewa groin	1,950	cubic yard
DH groin	1,400	cubic yard
Beach		
Quarry run	5,200	cubic yard
Sand fill	3,900	cubic yard

5.6.6 *Conceptual Design 4 (2008)*

Conceptual Design 4 is composed of four structures—an L-groin, a straight groin, and two detached breakwaters—each with a crest elevation of +6 ft MLLW. This structure configuration was proposed as an alternative in the 1995 EIS for the Natatorium restoration project. The rubblemound structures retain many of the features of the existing walls while including two openings. The larger detached breakwater is located on the reef 80 ft offshore of the other breakwater. This design therefore requires significant expansion of the structure footprint out onto the reef.

Figure 5-18 presents the wave patterns for Conceptual Design 4. The incident waves lose significant energy by diffraction through the narrow gaps in the structures. The L-groin presents a barrier to sediment transport and will serve to maintain Sans Souci Beach in its stable form. The predicted stable shoreline is shown on Figure 5-19 and the sand fill is based partially on the intent of the original concept drawing. Filling much of the area with sand produces an extensive beach area at the loss of swimming area. Filling the lee of the L-groin with sand will also prevent weak circulation due to the low wave energy.

Material estimates are presented in Table 5-6. This conceptual design, which requires 26,250 cubic yards of sand fill, has no effect on the stability of Sans Souci Beach.

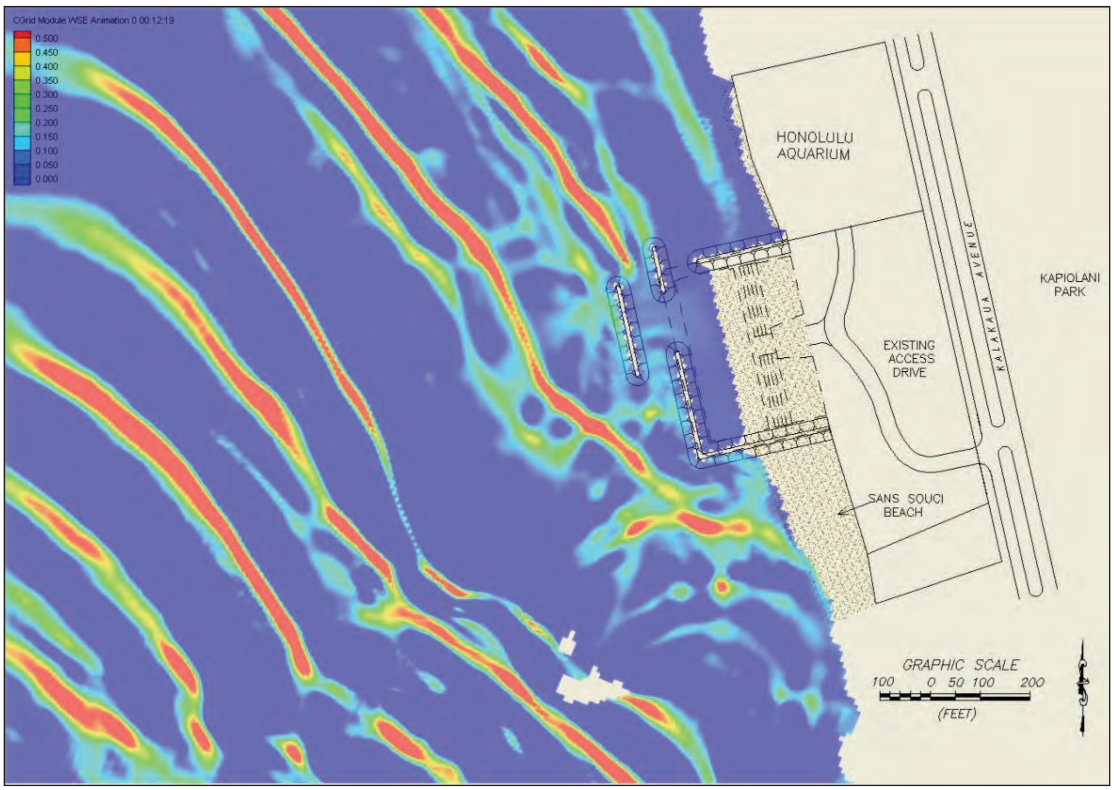


Figure 5-18. BOUSS2D wave patterns for Conceptual Design 4.

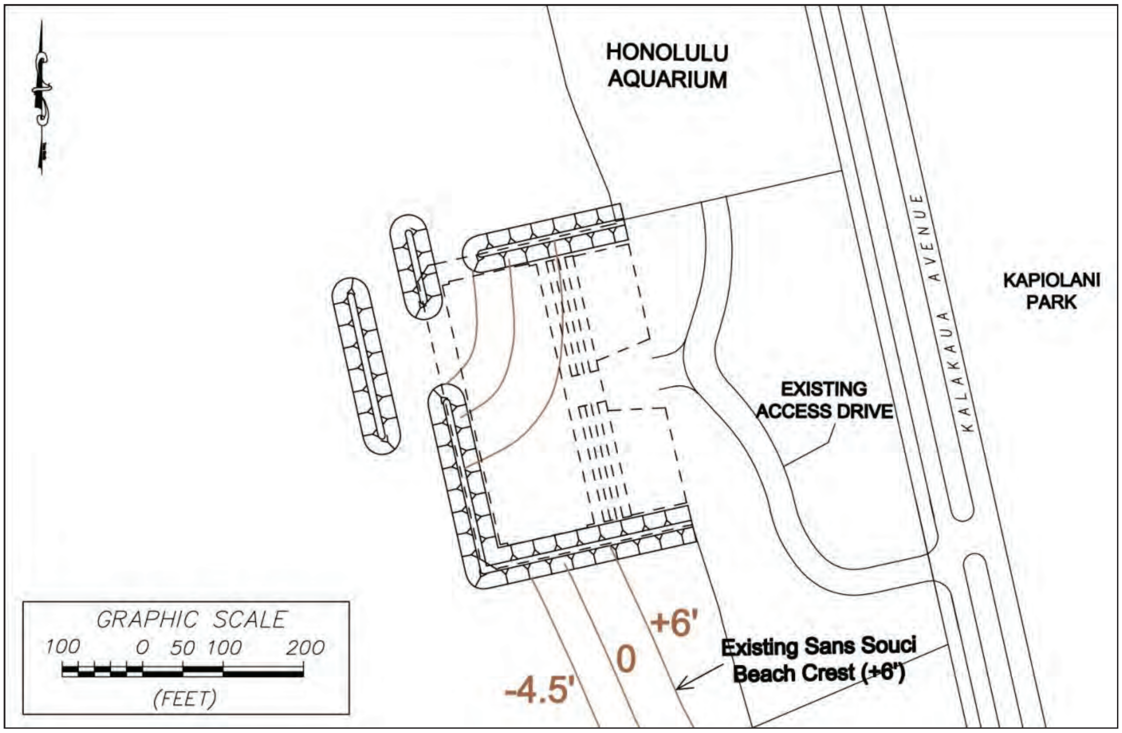


Figure 5-19. Conceptual Design 4 projected beach planform.

Table 5-6. Conceptual Design 4 material estimates.

Item	Quantity	Unit
Structures		
Ewa groin	1,650	cubic yard
Small breakwater	1,150	cubic yard
Large breakwater	1,350	cubic yard
DH L-groin	3,150	cubic yard
Beach		
Quarry run	5,200	cubic yard
Sand fill	26,250	cubic yard

5.6.7 *Conceptual Design 5 (2008)*

Conceptual Design 5 is very similar to Conceptual Design 1 consisting of a detached breakwater at the Diamond Head end and a T-groin on the Ewa end. Structure crest elevation is +6 ft

MLLW. Similar benefits and concerns arise from this design. The resulting wave pattern is shown on Figure 5-20. The interaction of the incident waves with the T-groin produces a diffracted wave in the lee of the head. The detached breakwater causes the incident waves to diffract around each end with decreased energy. In addition, waves approach obliquely from the south after passing through the channel and propagate between the detached breakwater and the beach. The wave patterns are irregular and the waves over the reef and through the channel reach the beach with different and irregular phase angles.

The T-groin serves as a barrier to sediment transport in the Ewa direction and the groin head helps to prevent sand from being transported around the end of the groin. Along the Ewa groin, the dry beach extends 200 ft. The diffracted wave pattern behind the detached breakwater has the potential to produce a salient in its lee depending on the energy of the waves approaching from the swim channel. Sans Souci Beach is presently maintained by the interaction of the waves with the existing wall on the Diamond Head side of the Natatorium. Removal of this structure presents potential instability to Sans Souci Beach. Stability generally occurs when sediment is transported to the extent that the shoreline achieves the same orientation as the incident waves. The strongly oblique incident wave passing from Sans Souci Beach to the Natatorium is expected to produce sediment transport in the Ewa direction. In this situation, sand from Sans Souci Beach could fill the area behind the structures and the width of Sans Souci Beach would be decreased as the beach becomes aligned with the waves. Depending on the available beach material, this could result in recession of Sans Souci Beach.

Removal of the Diamond Head wall might also affect the circulation patterns in the vicinity. The swimming channel in front of Sans Souci Beach that extends offshore serves as a pathway for return flow during large wave events. Sans Souci Beach is presently stable during these events; however, the open design could cause the return flow to occur closer to shore and could serve to transport sediment away from the beach. Stability of the beach fill is therefore a concern. Figure 5-21 presents an expected beach planform resulting from this design.

The structures are designed in-line with the existing Natatorium walls and the openings improve the visual impact and should produce water quality consistent with that near Sans Souci Beach. Useable swimming area will likely be expanded with this design due to the removal of the wall separating Sans Souci Beach from the Natatorium.

Material estimates are presented in Table 5-7. This conceptual design requires 9,100 cubic yards of sand fill in addition to the sand transported from Sans Souci Beach, as a narrowing of Sans Souci Beach is anticipated.

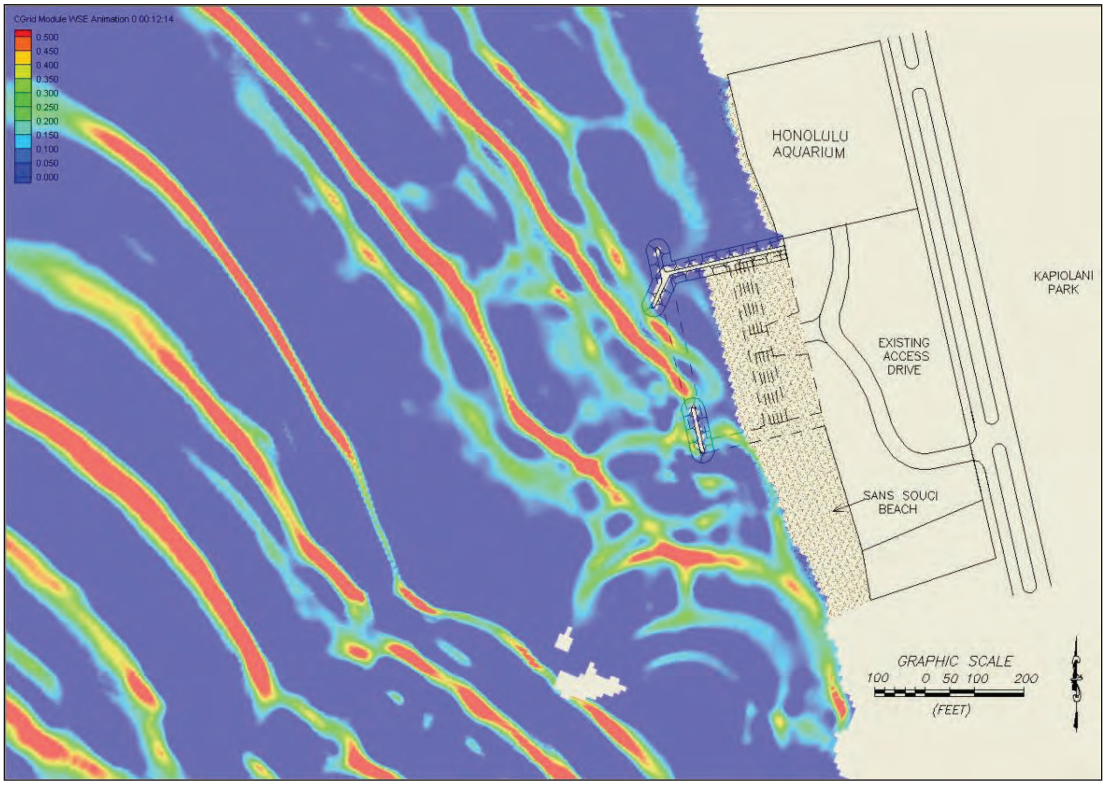


Figure 5-20. BOUSS2D wave patterns for Conceptual Design 5.

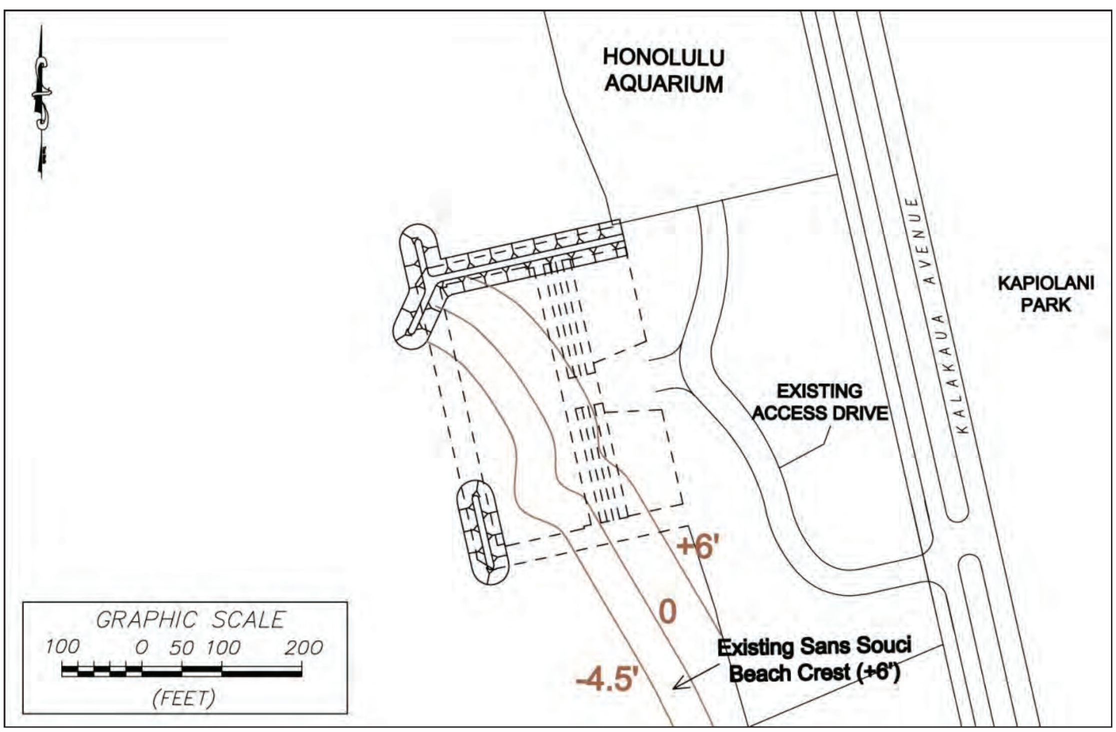


Figure 5-21. Conceptual Design 5 beach planform.

Table 5-7. Conceptual Design 5 material estimates.

Item	Quantity	Unit
Structures		
Tuned groin	3,650	cubic yard
Breakwater	400	cubic yard
Beach		
Quarry run	5,200	cubic yard
Sand fill	9,100	cubic yard

6. BEACH NOURISHMENT SAND SOURCES

Sand source investigations were performed beginning in 2010 to locate potential sand deposits for the 2016 beach options presented in Section 4 of this report. None of the other alternatives presented in the *Pre-Environmental Impact Statement Alternatives Technical Evaluation* (AECOM, January 2018) requires sand fill.

6.1 Introduction

A key component to the success of the beach options is the availability of suitable sand for beach nourishment. The potential sources of sand must be carefully evaluated in terms of quality, quantity, cost, and general feasibility. The majority of Hawaii beaches are composed of calcareous (calcium carbonate) sand made of skeletal fragments of marine organisms such as corals, coralline algae, mollusks, echinoids, and forams. The density of calcium carbonate is more than 2.7 grams per cubic centimeter; however, microscopic pores and hollow grains make the effective density somewhat lower. The composition of sand is determined by the relative abundance of each species and therefore varies with location.

In the past, sand for beach nourishment was typically obtained from on-land deposits that were commercially available. Mokuleia Inland Beach Sand, mined by Hawaiian Cement, was a high-quality relic beach sand deposit found several hundred meters inland of the beach. Published median grain size D_{50} is 0.60 mm and the sand is considered to be moderately sorted. This sand has been used for nourishment projects at the Hilton Hawaiian Village, Kuhio Beach, and Makaha Surfside. The deposit is still in existence; however, it is not actively being mined and is no longer available.

Maui Dune Sand is currently mined by Hawaiian Cement and Ameron. It is a fine to medium sand on the Wentworth scale with a D_{50} of 0.25 mm. It contains a relatively high percentage of fines, contains upland sediment (dirt), and has a medium to dark brown color. It has not been used for beach nourishment projects on Oahu and there are additional issues including restricted supply that further limit its use.

Offshore deposits present an alternative source of sand. These deposits can be dredged and pumped or otherwise transported to shore. Offshore sand deposits can present a suitable cost-effective source of sand for beach fill and nourishment particularly when considering the limited availability of suitable, natural sand from onshore sources. Offshore sand deposits occurring within the same littoral cell can have grain size characteristics and composition that are very similar to the adjacent beach sand.

6.2 Sand Characteristics and Quality

DLNR beach nourishment guidelines specify that fill sand used to nourish a beach must meet several specific requirements:

- The sand shall contain no more than six percent silt material (sand grain size smaller than 0.074 mm)

- The sand shall contain no more than ten percent coarse material (sand grain size greater than 4.76 mm)
- The grain size distribution will fall within 20 percent of the existing beach grain size distribution
- The overfill ratio of the fill sand to existing sand shall not exceed 1.5
- The sand will be free of contaminants such as silt, clay, sludge, organic matter, turbidity, grease, pollutants, and others
- The sand will be primarily composed of naturally occurring carbonate beach or dune sand

The majority of the current fill sand requirements are related to grain size. In order to ascertain the grain size characteristics, a sieve analysis is performed, which is done by mechanically shaking a sand sample through a series of sieves of decreasing screen size. The material captured on each sieve is weighed and this establishes the grain size distribution curves. The median diameter (grain diameter that is finer than 50 percent of the sample), or D_{50}, is often used by engineers to quantify the grain size of a sample. Similarly, D_{16} and D_{84} are obtained, and they are used to quantify the range of grain sizes present in a sample known as sorting, σ, defined by:

$$\sigma = \frac{\phi_{84} - \phi_{16}}{2}$$

where $\Phi = -\log_2(D)$ where D is given in millimeters. Descriptive sorting values are presented in Table 6-1.

Table 6-1. Sorting value descriptions.

Sorting Range (Φ units)	Description
0.00 – 0.35	very well sorted
0.35 – 0.50	well sorted
0.50 – 0.71	moderately well sorted
0.71 – 1.00	moderately sorted
1.00 – 2.00	poorly sorted
2.00 – 4.00	very poorly sorted
4.00 – ∞	extremely poorly sorted

Color and abrasion resistance are also important characteristics of fill sand. While natural calcareous beaches range in color from light brown to white, sand in offshore deposits usually turns a gray color as a result of anaerobic conditions typically produced by a lack of wave action and associated mixing. Even though an offshore sand source may be suitable in terms of grain size characteristics, a gray color can be undesirable.

6.3 Existing Sand Characteristics

There is very little, if any, "native" beach sand along Waikiki Beach. Sand characteristics vary widely, primarily a result of differing sand sources used in numerous nourishment projects since the early 1900s. Some of the sources were from the same littoral cell and some were from elsewhere. For example, in 1929 sand was pumped from a "reef flat" through the Halekulani Channel for beach fill at the Halekulani Hotel while in 1938 7,000 cubic yards of fill was placed on Kuhio Beach from "another part of Oahu." In 1960, pulverized coral was placed on the beach at Fort DeRussy. The resulting fill was described as "more like an airfield than a beach" (Wiegel, 2002).

In February of 2011, SEI obtained a set of beach sand samples along the project shoreline. One beach sample from the beach on the north side of the Natatorium ("Aquarium") and three along Sans Souci Beach were obtained. Grain size analyses were performed for each sample; the grain-size distributions are presented on Figure 6-1 and the median diameter and sorting of the samples are presented in Table 6-1.

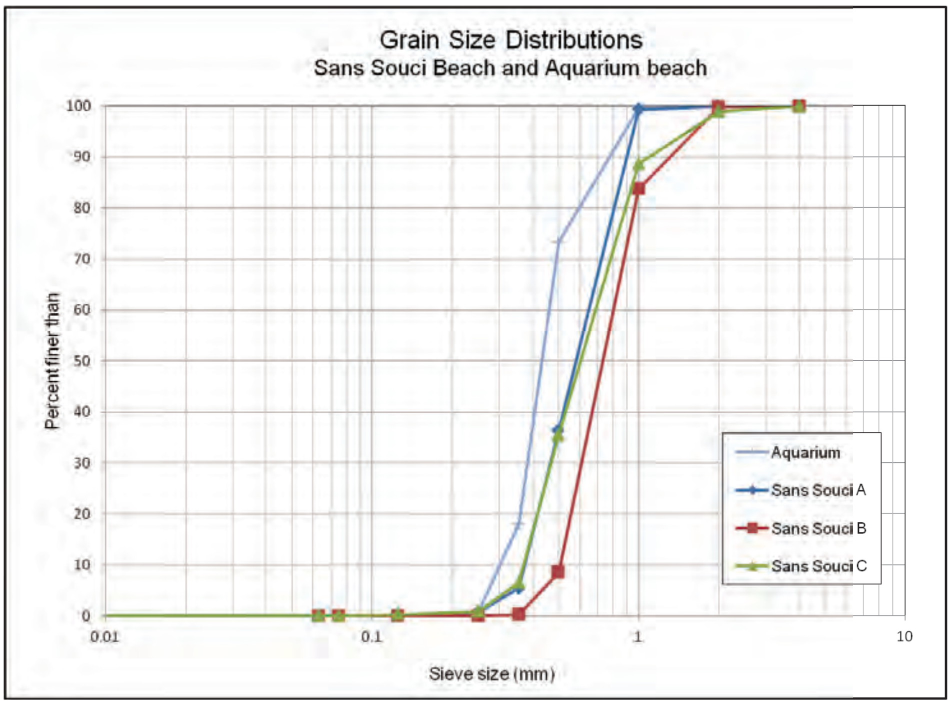


Figure 6-1. Grain size distributions, Sans Souci Beach and Waikiki Aquarium Beach.

Table 6-2. Sediment size characteristics, beach and offshore samples.

Location	D_{50} (mm)	Sorting (ϕ)	% Fine
Aquarium	0.43	0.48	0
Sans Souci A	0.58	0.54	0
Sans Souci B	0.74	0.44	0
Sans Souci C	0.61	0.62	0

Table 6-2 shows that the Sans Souci beach samples range in median diameter from 0.58 mm to 0.74 mm, and the beach samples are classified as moderately well sorted to well sorted. The Aquarium sand sample is slightly finer at 0.43 mm, and is considered well sorted. Additionally, none of the material was found to be finer than 0.074 mm, which is the size limit between sand and silt.

6.4 Offshore Calcareous Sand Source Investigations

6.4.1 *Introduction*

Offshore deposits present an alternative source of sand. These deposits can be dredged and pumped or transported to shore. Offshore sand deposits can present a suitable, cost-effective source of sand for beach fill and nourishment particularly when considering the limited availability of suitable, natural sand from onshore sources. Offshore sand deposits occurring within the same littoral cell can have grain size characteristics and composition that are very similar to the adjacent beach sand.

Jet probing is conducted to determine the thickness of sediments overlying consolidated or hard bottom substrate and is therefore an important means of testing and verifying sub-bottom profiling accomplished by remote sensing equipment. The jet probe consists of a length of pipe connected to a water pump by flexible hose. A diver jets the pipe and hose vertically into the sediment deposit until "refusal" is encountered. The refusal can be described as hard, crunchy, or soft; hard indicates a solid bottom, crunchy indicates a gravel layer, and soft indicates that the hole is collapsing and seizing the pipe or that there is insufficient hose to penetrate further.

6.4.2 *Present Seafloor Investigations*

A field program was conducted in December 2010, February 2011, and March 2011 to estimate the amount of sand that is presently available in offshore deposits in the vicinity of the Natatorium. Using aerial photography and a side-scan survey as guides, geophysical investigations were performed on specific offshore deposits using side-scan sonar and sub-bottom profiling. The surveys were performed within practical limits for sand recovery, including water depth and proximity to shore and the project site.

6.4.2.1 Side-scan Sonar

On December 17, 2010, SEI personnel conducted a survey utilizing a C-MAX CM2 side-scan sonar (SSS) system. Side-scan sonar transmits acoustic signals with wide vertical beam widths out to either side of the sonar towfish. A receiver then records the signals that are reflected back from the seafloor to the towfish. Hard bottom areas and features produce more intense reflections than sediments. The result is a plan view acoustic image of seafloor characteristics allowing mapping of bottom type across a swath of seafloor.

The planned side-scan sonar coverage area was determined based on bathymetry, aerial photographs, and proximity to the project site. The University of Hawaii CGG previously performed a side-scan sonar survey offshore of Waikiki between Diamond Head and Ala Wai

Small Boat Harbor in water depths as shallow as 12 ft and as deep as 300 ft. The December 2010 survey covered an area inshore of the CGG survey where potential sand deposits were identified using aerial photographs. The sonar results combined with an aerial view of the offshore deposits are shown on Figure 6-2 and the full coverage is shown on Figure 6-3.

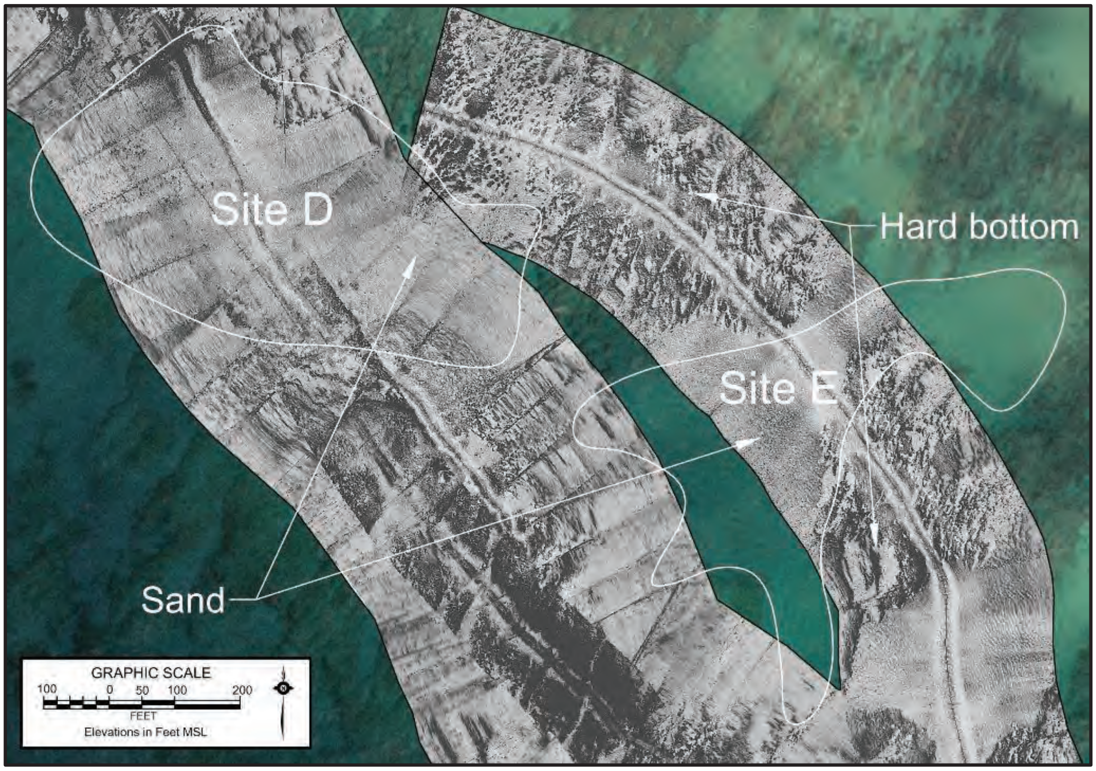


Figure 6-2. Side scan sonar mosaic for offshore sand deposits D and E.

6.4.2.2 Sub-bottom Profiling

On February 24, 2011, SEI conducted a sub-bottom survey utilizing an EdgeTech 0512i Sub-bottom Profiler. A sub-bottom profiler transmits an acoustic signal with a narrow beam directly below the towfish. A portion of the acoustic signal is reflected back from the seafloor while another portion of the signal penetrates sediment layers and reflects off the underlying substrate referred to as the "sub-bottom." A receiver records the signals that are reflected back from the seafloor and sub-bottom. The time delay between the signal returns allows for the differentiation of sediment layers. The EdgeTech 0512i is a specialized system designed for imaging thick sand deposits using a broad spectrum of acoustic frequencies between 500 Hz and 12 kHz. The lower frequencies allow deeper penetration into the sand while the higher frequencies are able to resolve thinner deposits and layers.

Tracklines from the February 2011 sub-bottom survey are shown on Figure 6-3. The sub-bottom data was reviewed with EdgeTech software, sub-bottom horizons were digitized for processing, and sand thicknesses were measured at discrete locations along the survey tracklines. This geo-referenced data was imported into AutoCAD and surfaces of the bottom and sub-bottom were produced. These two surfaces were compared to produce an estimate the volume of sand in each deposit.

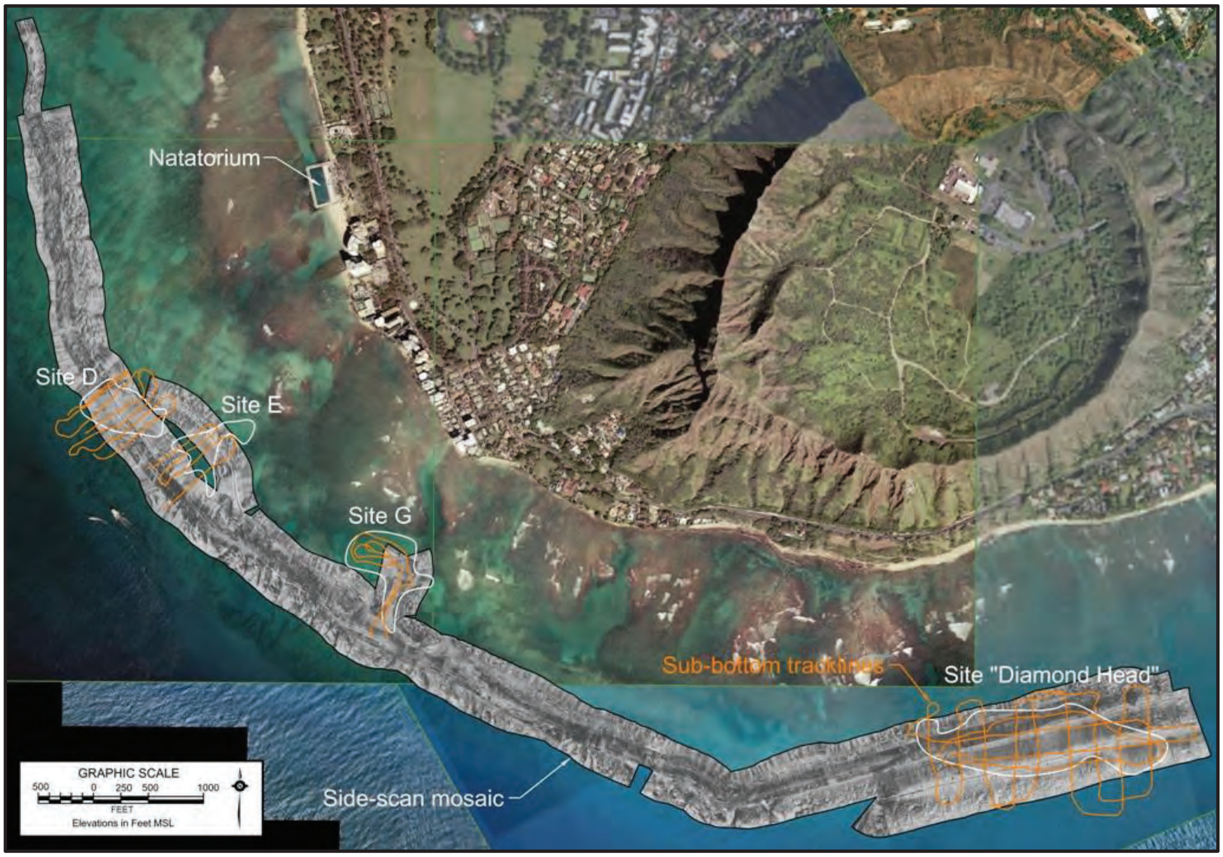


Figure 6-3. Side-scan sonar mosaic and sub-bottom profiler tracklines.

6.4.2.3 Offshore Sand Investigation Results

Several passes from west of the Natatorium to offshore of Diamond Head Beach Park were performed with the side-scan sonar survey. The tracklines were chosen to supplement the CGG survey and to specifically investigate the sand deposits identified from aerial imagery. The survey data was combined into a single mosaic that covered 2.7 miles parallel to shore with average cross-shore coverage of 670 ft. The subsequent sub-bottom profiling targeted the sand deposits identified from aerial imagery and the side-scan sonar mosaic, covering 2.7 miles offshore of the Natatorium and 4.1 miles offshore of Diamond Head Beach Park.

Alternative 1a and Alternative 1b were shown in Section 5 to require 11,190 cubic yards and 14,650 cubic yards of sand, respectively. Sand deposits in the near proximity of the Natatorium are desirable for recovery and transport to shore using a process similar to that used at Kuhio Beach Park in 2006 and Waikiki Beach in 2012. Sand deposits identified in the side-scan and sub-bottom surveys are shown on Figure 6-3 and labeled as sites D, E, G, and Diamond Head.

These potential deposits were outlined and the areas were calculated and, following the sub-bottom survey, estimates of the sand volumes were calculated. These values are shown in Table 6-3.

Table 6-3. Offshore sand deposit characteristics.

Location	Water depth (ft)	D_{50} (mm)	Area (sq. ft.)	Volume (cubic yard)
Site D	20-38	0.20	252,100	4,100
Site E	12-28	0.23	174,400	5,000
Site G	10-22	0.39	319,700	13,200
Diamond Head	20-30	---	1,019,800	110,300

Site D was initially viewed as a favorable sand source based on the large surface area; however, the sub-bottom profiling showed that much of the deposit was merely a thin veneer of sand and, therefore, was not a satisfactory sand source. The portion of the deposit where a sub-bottom could be detected was limited to a small area in the northeast section of the deposit. Site E was found to be generally similar to Site D.

Site G was found to contain a significant amount of sand—slightly more than 13,000 cubic yards The deposit is situated in a gap in the reef that measures 600 ft long by 380 ft wide. Access to the site would be through a 100-ft-wide gap in the reef on the offshore side of the deposit. The shallow water (typically between 7 and 11 ft deep over the sand deposit), the nearby reef, and limited access could make recovery a challenge. Additionally, it is expected that less than the full volume of sand would be recovered requiring sand from an additional site. Of the potential sand sources identified, Site G has grain size most compatible with neighboring Sans Souci Beach with a median grain size of 0.39 mm.

Considering that satisfactory sand deposits were not found offshore of the Natatorium, other sand deposits were investigated. Table 6-3 also shows the findings of the surveys for a sand deposit identified off Diamond Head Beach Park (see Figure 6-3). The estimated volume of sand in that deposit based on geophysical investigations is more than 110,000 cubic yards; however, the quality of the sand is presently unknown. Additionally, the proximity to popular surf sites could make permitting a challenge, and the area is shallow and exposed to tradewinds and waves, which is a concern for dredging operations.

6.4.3 *Alternative Sources*

6.4.3.1 Historical Data

Historical sand deposit data were reviewed to identify potential sand sources for use at the Natatorium. Several previous studies pertaining to the characterization and quantification of sand deposits in the Waikiki area were reviewed. Noda (1991b) investigated potential offshore sand sources for Waikiki Beach fill including locations adjacent to Waikiki as well as an area near the Reef Runway at Honolulu International Airport. SEI (2004) conducted a survey of offshore sand sources for the Hilton Hawaiian Village Lagoon Restoration Project. The United States Geological Survey (USGS) also investigated potential beach nourishment sand sources (Hampton, 2003), and the University of Hawaii CGG assessed offshore sand related to the Small-Scale Sand Pumping Project in Waikiki (DLNR, 2004). Most recently, SEI (2010) performed geophysical investigations for the Waikiki Beach Maintenance project.

As numerous sand sources of varying quantities exist, this discussion of sources will be limited to those of sufficient capacity to meet the requirements of this project. The designs presented in Section 5 show that up to about 15,000 cubic yards of sand will be required for this project. A map depicting possible source sand locations is presented as Figure 6-4.

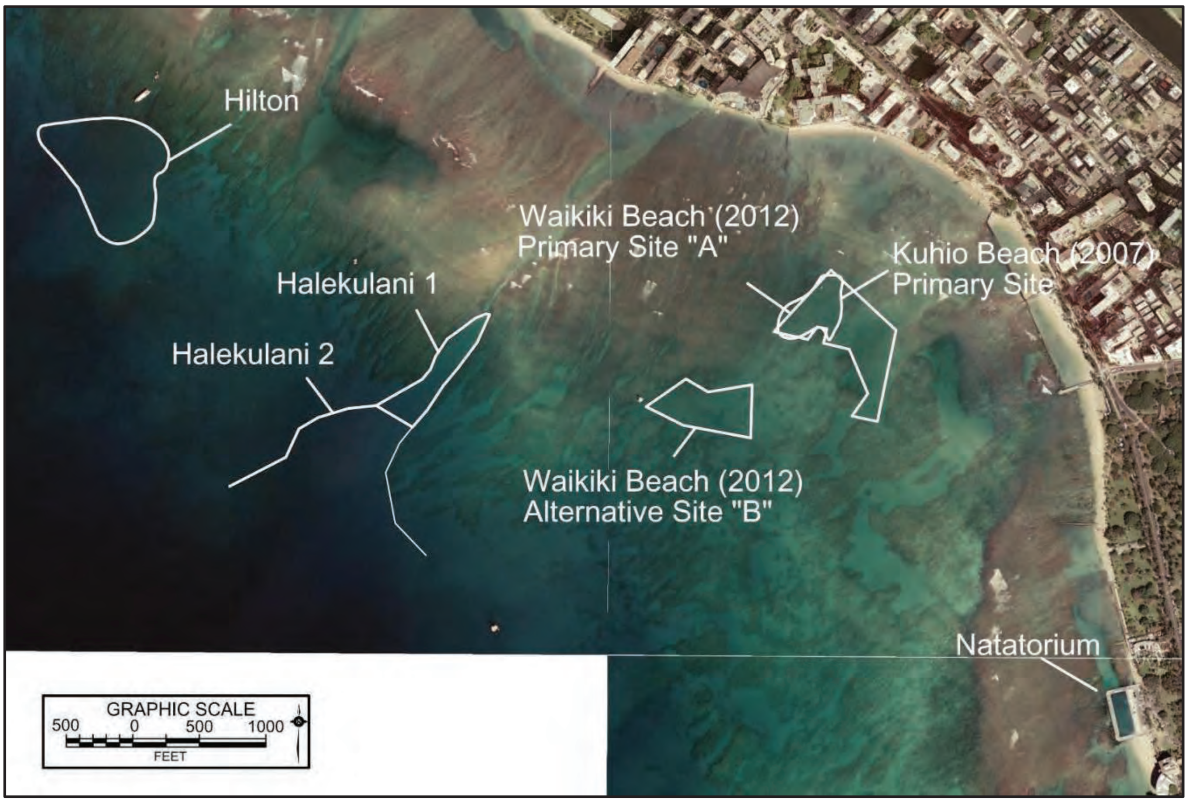


Figure 6-4. Alternative offshore sand source locations.

<u>*Hilton Area*</u>

SEI was contracted in 2004 to investigate possible inland and offshore sand sources for a project to improve the Hilton Hawaiian Village lagoon. A survey was conducted offshore of the Hilton Hawaiian Village to identify and map possible marine sand sources for the hotel's lagoon restoration project.

The survey was conducted with differential GPS and divers swimming transects and probing sand thicknesses. Sand probes were accomplished using a combination of water jet, air jet, and manual probes. Sand samples were collected using a push corer and hand trowels. Representative samples were submitted for laboratory grain size analyses.

The primary deposit investigated was approximately 850 ft by 620 ft in dimension located in water depths of 40 to 55 ft to the southwest of the Hilton Hawaiian Village beach. The maximum sand thickness probed was 5 ft, and the average sand thicknesses in the center of the deposit were about 4 ft. The total estimated volume of sand in the deposit was determined to be approximately 40,500 cubic yards. The size characteristics of a representative sample showed the sand to be very similar to the beach sand. The median grain size, D_{50}, was 0.55 mm and the sorting was considered moderate. The deposit was characterized by a gray color with visible shell fragments giving the appearance of coarser, poorly sorted sand.

The offshore sand was not used for the lagoon improvement project and the deposit remains intact.

Kuhio Beach Sources

DLNR sponsored nourishment of Kuhio Beach Park during the winter of 2006-2007. Approximately 10,000 cubic yards of sand were pumped to the beach from the site identified on Figure 6-4. The pumping project was completed in January of 2007 after a work period of 1 month. The sand reportedly was well-sorted with medium grain size of 0.35 mm to 0.40 mm. The sand exhibited a light grey color which became lighter upon exposure to sunlight and mixing with existing beach sand.

DLNR and SEI began investigations of additional borrow sites in 2009 for the recently-completed Waikiki Beach Maintenance project. This project widened a 1,730-ft-long stretch of shoreline between Kuhio Beach Park and the Royal Hawaiian groin. The investigations focused on Sites A and B as shown on Figure 6-4. Based on the geophysical investigations, Site A was estimated to contain 46,000 cubic yards of sand and Site B was estimated to contain 22,600 cubic yards of sand. A sand sample from Site A had a median diameter of 0.31 mm and was classified as moderately well sorted. DLNR received all necessary permits and approximately 24,000 cubic yards of sand were dredged from Site A. The Waikiki Beach widening project was performed from January to April 2012.

Halekulani Channel

The shoreward terminus of the Halekulani Channel is located at the Halekulani Hotel adjacent to the Sheraton Waikiki. The sand channel extends approximately 4,000 ft offshore where it widens into a broad sand field in approximately 120 ft of water. Noda (1991b) estimated that approximately 500,000 cubic yards of sand are contained between the 40-ft and 100-ft depth contours and 80,000 cubic yards are contained shoreward of the 40-ft depth contour. During the Noda study, median grain size, D_{50}, in this deposit was found to vary from 0.20 mm to 0.39 mm with the coarser samples found in depths of less than 10 ft. The average sorting parameter, σ, was 1.1, indicating a moderate to poorly sorted sand. The samples exhibited a gray color.

More recently, the USGS (Hampton et al., 2003) investigated the resource potential of deposits around Oahu particularly as a source of sand for beach replenishment. The Halekulani Channel was included in this study. Numerous vibracore samples up to 6 m long were obtained between 2,500 and 5,000 ft offshore, in water depths from 10 to 120 ft. The Halekulani Channel is divided into two sections as shown on Figure 6-4. "Halekulani 1" is about 900 ft long and up to about 160 ft wide. Water depths in this area range from 10 to 40 ft and the sand deposit is flanked by shallow reef. The USGS obtained four vibracores in Halekulani 1 with median diameters of the bulk samples ranging from 0.28 mm to 0.38 mm. The USGS also obtained seven samples from "Halekulani 2," which is a broader area offshore of Halekulani 1. Water depths where the samples were obtained ranged from 52 to 72 ft. Median diameters of the bulk samples ranged from 0.23 mm to 0.53 mm.

In October 2011, divers from SEI obtained sediment cores in two locations within the "Halekulani 2" deposit in water depths of 52 and 67 ft. Each core penetrated about 18 inches into the sediment and each sample was divided in half based on thickness. The four samples were analyzed for grain size and the results are presented on Figure 6-5. Little difference was seen between the two halves of each sample. The samples from the 52-ft depth show a median diameter of 0.20 mm, are classified as well to moderately well sorted, and contain 1.2 to 1.4 percent fine material (<0.075 mm). The samples from the 67-ft depth have a median diameter of 0.30 mm, are classified as moderately sorted, and contain 1.4 to 1.8 percent fine material. A composite of the data is also shown in the figure, and has a median diameter of 0.23 mm. The sand samples were gray colored, which is typical of offshore sand deposits.

The above samples were analyzed using a dry-sieving technique, which is standard practice for sand-sized particles. Dry sieve analysis, however, requires rinsing and drying of the sand prior to sieving, which may result in a loss of some fine material. Since a good estimate of fine material is important for beach nourishment projects, a composite sample from the 52-ft depth was re-analyzed using a specialized instrument. This instrument, termed a Beckman Coulter LS 13 320 Laser Diffraction Particle Size Analyzer, uses backscatter intensity to determine particle size distributions. The analysis produces much higher resolution results than dry sieve analysis and more accurately represents fine material. The results show the 52-ft composite to have a median diameter of 0.27 mm, with 2.3 percent of the material classified as fine.

The characteristics of offshore deposits are summarized in Table 6-4. The median diameters found in the SEI samples are at the finer end of the range of values reported by the USGS, who also obtained their data from deeper-penetrating cores. Additionally, up 2.3 percent of the material in the SEI samples was found to be finer than 0.074 mm, which is the size limit between sand and silt. Sans Souci Beach sand was shown in Section 6.3 to contain no fine material. Comparisons of Sans Souci and Waikiki Aquarium beach sand with the recent Halekulani sand composite are shown on Figure 6-6 where the composite is shown to be significantly finer than the beach sand.

Table 6-4. Waikiki offshore sand source summary.

Location	D_{50} (mm)	Sorting Σ	Volume (cy)	Color	Source	Year
Hilton	0.55	0.82	40,500	light gray	SEI[2]	2004
Halekulani 1	0.28–0.38	0.9–1.9	100,000	light olive to yellowish gray	USGS[3]	2003
Halekulani 2	0.23–0.53	0.9–1.2	500,000		USGS[3]	2003
Halekulani 2 (52 ft)	0.20	0.51	------	light gray	SEI[2]	2011
Halekulani 2 (67 ft)	0.30	0.88	------	Light gray	SEI[2]	2011
Halekulani 2 (52 ft)[1]	0.27	0.70	------	Light gray	SEI[2]	2011
Waikiki Site A	0.31	0.53	46,000	Light gray	SEI[2]	2009

[1]Analysis used a Beckman Coulter particle size analyzer. All others shown used dry sieve analysis.
[2]Sea Engineering, Inc.
[3]U.S. Geological Survey

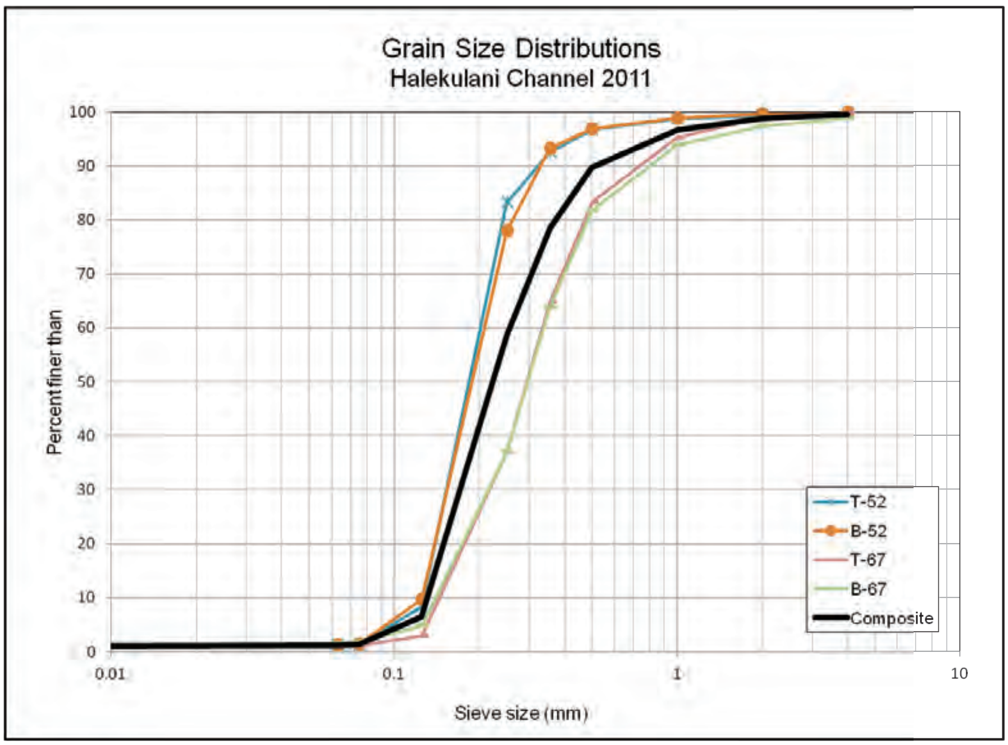


Figure 6-5. Grain size distribution of Halekulani sand (2011) using dry sieve analysis.

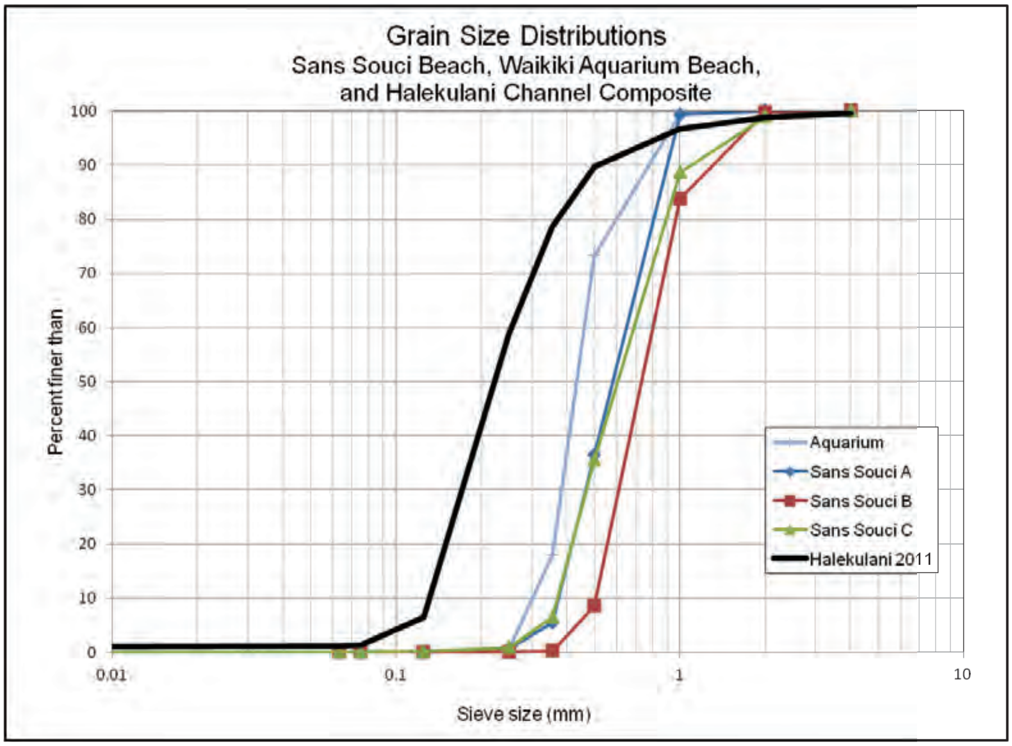


Figure 6-6. Grain size distributions, beach sand and Halekulani composite, using dry sieve analysis.

6.4.4 *Offshore Sand Source Summary*

Geophysical investigations of potential sand deposits in the general proximity of the Natatorium showed that no single deposit could produce the required volume of sand for Option 1. Data on other nearby sand deposits exists and have been reviewed for applicability to the present project. The Halekulani 2 sand deposit presented in Section 6.4.3 initially appeared to be a suitable source for use in the present project having a reported median diameter between 0.28 and 0.38 mm; however, the sand is generally moderately to poorly sorted and a composite of these samples contained about 3 percent fine material. More recent surface samples obtained by SEI showed the sand to be finer than reported by the USGS, and differences between analysis methods were found. The Halekulani 2 area has a sufficiently large supply containing an estimated 500,000 cubic yards of sand.

Sand from Site G presented in Section 6.4.2.3 has grain-size characteristics that would be compatible with this project; however, it is unlikely that there is enough sand to complete the project. An additional source would be Site A near Kuhio Beach Park that was used for the 2012 Waikiki Beach Maintenance Project for DLNR. That deposit is slightly finer than Site G and 24,000 cubic yards of sand were recovered recently so further investigation to the quantity of sand would be necessary.

The sand deposit offshore of Hilton Hawaiian Village is the recommended source of sand for the new beach at the Natatorium. The deposit has a compatible grain size and sufficient volume, and the deposit is conveniently located close to Magic Island where a barge could offload the sand. The dump truck trip to the Natatorium would then be up to 6 miles one way depending on the selected route.

7. SAND RECOVERY PLAN (BEACH ALTERNATIVE)

The Halekulani 2 site is shown in this section to illustrate potential sand recovery methods. The following discussion of dredging and distribution methods would generally apply to other offshore sand deposits. The final dredging plan would depend partially on permit conditions as well as the work plan prepared by the contractor hired to perform the work; thus, a range of techniques is presented herein.

7.1 Dredging System

Dredging systems for beach nourishment purposes are designed to recover sand from the seafloor and deliver it to an alternate site. There are various ways to accomplish these operations some of which store the sand onboard the dredging vessel or deliver it to nearby barges or ships, while others transport the sand directly through a pipeline to the shore. Storing the sand on the dredging vessel requires that the vessel return to a commercial harbor on a regular basis to discharge recovered materials requiring considerable time, energy, and harbor space. If the sand is pumped to shore, booster pumps and additional barges may be necessary if the distance to the project beach is excessive. The third strategy would be placement of the dredged sand in ships or barges that could be cycled through the recovery and delivery process close to the project site to increase dredging efficiency. This would allow for simultaneous loading and offloading of pairs of these barges and would allow the dredge barge to remain in place for the duration of the recovery effort.

All these techniques require that the dredge barge be anchored with a stable, minimum four-point mooring in the recovery area as shown on Figure 7-1. Anchors would be placed within the sand field and marked with floats or buoys as depicted on Figure 7-2. A four-point mooring would allow the barge to change locations within the recovery area and remain securely anchored without having to adjust anchor placement.

There are several potential dredging techniques that might be employed for the project area, all of which are discussed in the following sections.

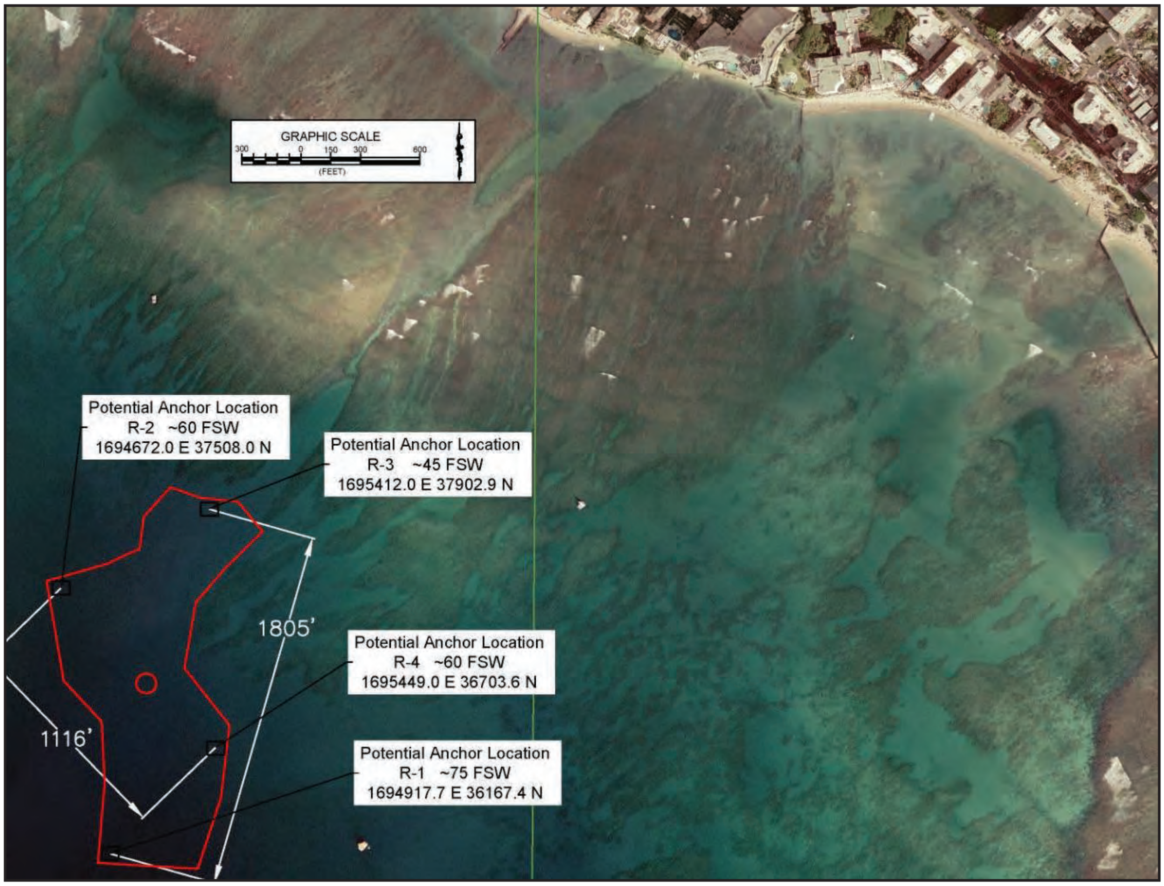


Figure 7-1. Sand Recovery Area and Potential Barge and Anchor Locations.

(Halekulani Channel location is shown as an example; other sites similar)

Figure 7-2. Example: Anchor and Anchor Float used in the 2012 Waikiki Beach Maintenance Project.

7.1.1 *Clamshell Dredging*

Clamshell dredging, shown on Figure 7-3, describes the process of mechanically scooping and lifting the sediment, in this case sand, from the seafloor. An environmental clamshell bucket, such as the one shown on Figure 7-4, is lowered from a crane in the open position and, upon the clamshell reaching the bottom, the crane operator closes the clamshell jaws and lifts the material out of the water. The operator then rotates the crane and opens the bucket to dispense the material into a waiting barge such as a hopper barge (Figure 7-5).

Clamshell bucket sizes vary from as small as 1 cubic yard to over 20 cubic yards and can be either sealed or open. A sealed bucket creates less turbidity; however, the recovered sand will include a large amount of water which then must be disposed of properly.

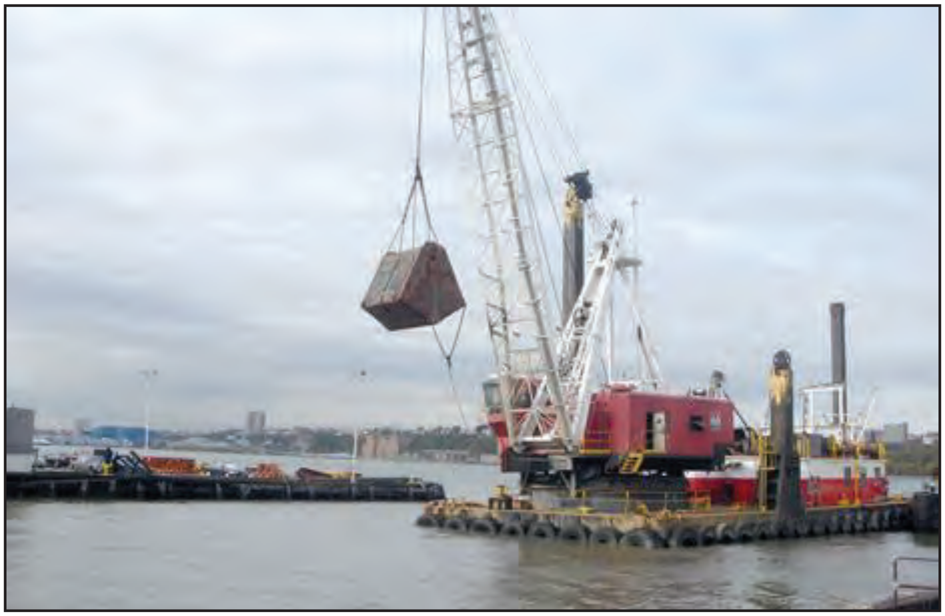


Figure 7-3. Example: Clamshell Dredge with Environmental Bucket.
(http://www.conedison.com/ehs/2009annualreport/environmental_stewardship)

Figure 7-4. Example: Environmental Clamshell Bucket.
(http://www.alibaba.com/product-free/107658423/Environmental_clamshell_grab.html)

Figure 7-5. Hopper Barge.
(http://www.thecargogroup.net/)

Clamshell dredging is often used in association with a large barge, such as the hopper barge shown on Figure 7-5, on which the sediment is deposited. Once the sediment is onboard the barge, transport is accomplished by either moving the barge to a dock and offloading or using a waterborne sand delivery system to deliver the sand to the shoreline.

The benefits of using clamshell dredging are that it is very mobile, it can operate at any depth that the crane cable can reach, it can be used in moderate swell conditions, and it can recover a wide variety of material types. Additionally, little specialized equipment beyond the clamshell is needed for dredging operations. The drawbacks are that it is less efficient than other dredging systems, such as those utilizing hydraulic or slurry pumps, and it requires sand deposits to be thick enough that the clamshell does not reach a hard substrate.

7.1.2 *Submersible Slurry Pump*

Submersible slurry pumps, referred to as "Toyo Pumps" after the largest supplier of such, are distinguishable by the way that they are lowered from overhead and suspended above the sediment they are pumping. The pumps can be hydraulically or electrically driven and are available in a range of sizes. Models are available with up to 400 horsepower. Toyo DP75B (75 horsepower) hydraulic pumps were used successfully for dredging both the 2007 Kuhio Beach restoration project and 2012 Waikiki Beach Maintenance Project. Respectively, the projects pumped approximately 10,000 and 24,000 cubic yards of sand from offshore onto the beach within the Kuhio Beach crib walls.

Several equipment elements are required to successfully recover sand utilizing a submersible pump. A barge and crane are necessary to position a hydraulic or electric-powered pump over the sand bottom. The crane can move the pump across a small area dependent on the crane size and length of its boom. Accessing different portions within the recovery area is achieved by repositioning the pump barge using a minimum four-point mooring array. Additionally, depending on the size of the slurry pump, a booster pump may be required if the distance to the shoreline is excessive. An additional piece of equipment called a "jet ring" can be mounted on the pump to aid in entraining sand to increase the percent of sand in the slurry. This jet ring requires a water pump on deck and an additional 4-inch-diameter water hose connected to the submersible pump. An illustration of this dredge system is shown on Figure 7-6 taken from the Kuhio Beach project after-action report (American Marine, 2007). Figure 7-7 shows the Healy Tibbitts dredge barge used during the 2012 Waikiki Beach Maintenance Project.

The benefit of the submersible pump is its precise positioning and ability to reach into tight spaces. Using a crane-tip GPS unit to locate the pump, the operator can accurately position the pump to within a few feet of any location to effectively remove the sand from near the edges and corners of the recovery area. In addition, sand recovery with a slurry pump can be more efficient than mechanical recovery when a high sand-to-water ratio can be achieved.

The primary drawbacks to the submersible pump are that the operation is labor-intensive and it requires dewatering. Operation requires a crane operator, a rigger, and several people to handle the pumps, generators, and pipelines on deck. Additionally, the pump must be held at a relatively constant height above the sand. If the pump is lifted too high it will not entrain the sand; if it is too low the slurry will become too concentrated and the pipeline may clog. Maintaining this balance is especially difficult for the crane operator in the presence of swells greater than 1 to 2 ft; however, the dredge equipment can be operated from an ocean-going barge, which provides reasonable seaworthiness. Submersible pumping requires that the slurry be properly dewatered, which increases on-land space requirements. For example, the 2012 Waikiki Maintenance project utilized a 1-acre dewatering basin within Kuhio Beach Park, requiring the Diamond Head basin to be completely closed to the public. Given the location of the offshore deposits identified in Section 6, hydraulically pumping sand to shore does not appear to be a viable option. If a submersible pump is used to dredge the sand, the sand and slurry would then have to be contained in a barge until the water can be released into the ocean.

Contractor production records for the 2012 Waikiki Maintenance project showed that the contractor recovered 400 to 800 cubic yards of sand in a 10-hour day, and placed sand on the beach at a rate of 1,500 to 2,000 cubic yards in a 5-hour day.

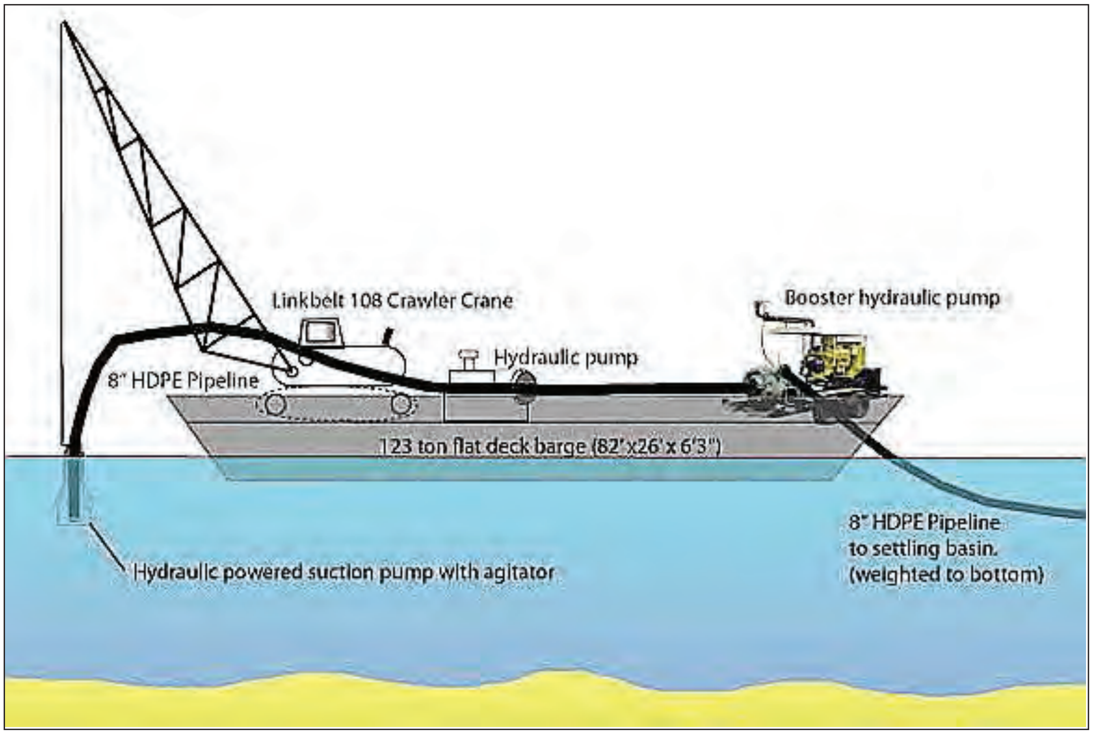


Figure 7-6. Schematic of sand pumping arrangement (American Marine, 2007).

Figure 7-7. Healy Tibbitts Crane Barge used in the 2012 Waikiki Beach Maintenance Project.

7.1.3 *Delivery to a Nearby Harbor*

The offshore sand sources identified in Section 6 as being satisfactory options for beach fill at the Natatorium are too far from the project site to consider pumping the sand to shore. The next best option is to dredge the sand and load it onto a barge. After the barge is loaded with sand, it would be transported to a commercial harbor where it would be offloaded, stockpiled, and transported to the Natatorium. Barging can require extensive time and energy towing the barge to a commercial harbor such as Honolulu Harbor or Kalaeloa (Barber's Point) Harbor. Barge travel distances are presented in Table 7-1.

Table 7-1. Barge distances from offshore sand sources to commercial harbors on Oahu.

	Barge distance (miles, roundtrip)			
	Reef Runway	**Hilton**	**Waikiki Maintenance**	**Diamond Head**
to Honolulu Harbor	13	8	10	15
to Kalaeloa Harbor	30	44	46	50
to Ala Wai Small Boat Harbor	14	2	4	9

An efficient delivery method would be through Ala Wai Small Boat Harbor and mooring alongside the Magic Island parking lot (Figure 7-8). The barge would be moored with two lines onshore and two anchors within the harbor. The sand would be offloaded onto a conveyor belt system and transported into waiting dump trucks which would then move the sand to the Natatorium. Sand conveyance and trucking could be performed during evening and early morning hours to limit the impact on park users. The Magic Island parking lot could stay open during the day with one area closed for equipment. This method would have the shortest barge and truck routes and it would be the fastest and least expensive of the delivery options. Production rates of greater than 1,000 cubic yards per day are anticipated with this method.

Alternatives are Honolulu and Kalaeloa Harbors. Pier space at Honolulu Harbor is limited and personnel at Honolulu Harbor reported that the harbor does not accept bulk product delivery such as sand. Kalaeloa Harbor would be the nearest commercial facility for offloading sand. Barging to Kalaeloa, however, would entail an ocean transit of as much as 25 miles to the harbor, offloading of the barge into dump trucks, and the 25-mile truck route back to the sand recovery site. This method would result in an involved and circuitous delivery to the project site, which is only a few miles from the sand deposits presented Section 6. In addition to the distance traveled to deliver the sand at pier side, additional travel may be required to dewater the barge at an acceptable offshore location prior to offloading.

Discussions between the City and the State are recommended to determine if a short-term offloading site at Honolulu Harbor could be developed for use during the project. It is possible that a temporary offloading site could be accommodated on the west side of Sand Island. There is some presently unutilized land where a barge could access the shoreline via the Kalihi channel and the seaplane runway adjacent to the shore. This possibility will be further evaluated with the State and the City if necessary.

Figure 7-8. Example of barge offloading at Ala Wai and Magic Island.

7.1.4 *Offloading and trucking to project site*

Pier side delivery of sand from a barge requires adequate space to offload sand into dump trucks. The sand could be loaded onto trucks with an excavator or similar equipment, or a conveyor system could be deployed for more efficient handling. Examples of sand conveyance from barge to shore are shown on Figure 7-9 and Figure 7-10. Conveyor belt systems can move an estimated 150 cubic yards of sand per hour.

Using mid-size (15-cubic-yard) or larger (20-cubic-yard) dump trucks to haul the sand would require between 525 and 700 truckloads for the 10,500 cubic yards required for beach Option 1. An estimated 20 days of trucking would then result in approximately 45 to 60 dump truck loads delivered to the project site each day. Based on a 10-hour workday, this would mean 4 to 6 dump truck deliveries per hour.

The advantage of truck hauling is that it minimizes impacts to the seafloor by eliminating delivery pipes to the shoreline. The disadvantages would include the increased cost due to time, equipment, and energy to move the sand by trucks rather than pipe it directly to the shoreline, and additional traffic impacts from moving 4 to 6 dump trucks into and out of the project area each hour.

Figure 7-9. Barge-mounted conveyor system.

Figure 7-10. Barge-mounted conveyor system.

7.1.5 *Sand Placement*

As it is trucked to the project site, the sand would be moved directly to the beach and placed to the design lines and grades. There is no dewatering associated with the truck hauling method. Sand movement and placement during the 2012 Waikiki Beach nourishment project was accomplished using standard mechanical equipment including a front-end bucket loader, dump trucks, and bulldozers. This method is proposed for use with the present project.

Sand movement and placement during the 2007 Kuhio Beach project was accomplished using standard mechanical equipment, a front-end bucket loader, bulldozers, and trucks (Figure 7-11 and Figure 7-12). The same method could be used to accomplish this project. Some noise and smell from the equipment and possibly some additional short-lived odor from the sand will be unavoidable.

The beach width would be increased from onshore to offshore thus building dry substrate for machinery to operate on as it is built seaward. Proper beach shape would be verified during construction with land surveys and by placing survey stakes with final beach height markings as references. Design beach profiles and volume calculations would be part of the construction drawings.

A containment system will be required in the area of active sand placement to reduce the potential for turbidity impacts to coastal waters during sand placement in the water. Silt curtains and fences will be required, consistent with previous requirements of the DOH. Schematics of these containment devices are shown on Figure 7-13 through Figure 7-15.

Figure 7-11. Sand placement, 2012 Waikiki Beach Maintenance Project.

Figure 7-12. Example: floating silt curtain and small bulldozer used for sand placement during the 2012 Waikiki Beach Maintenance project.

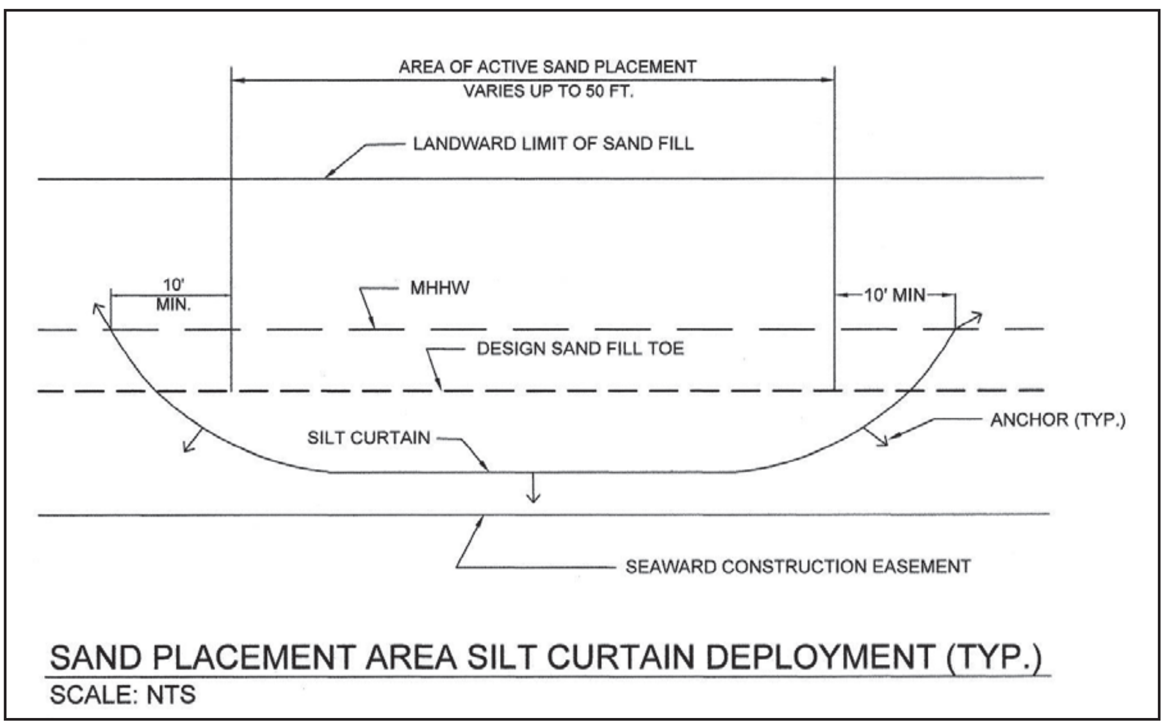


Figure 7-13. Silt curtain layout for sand placement.

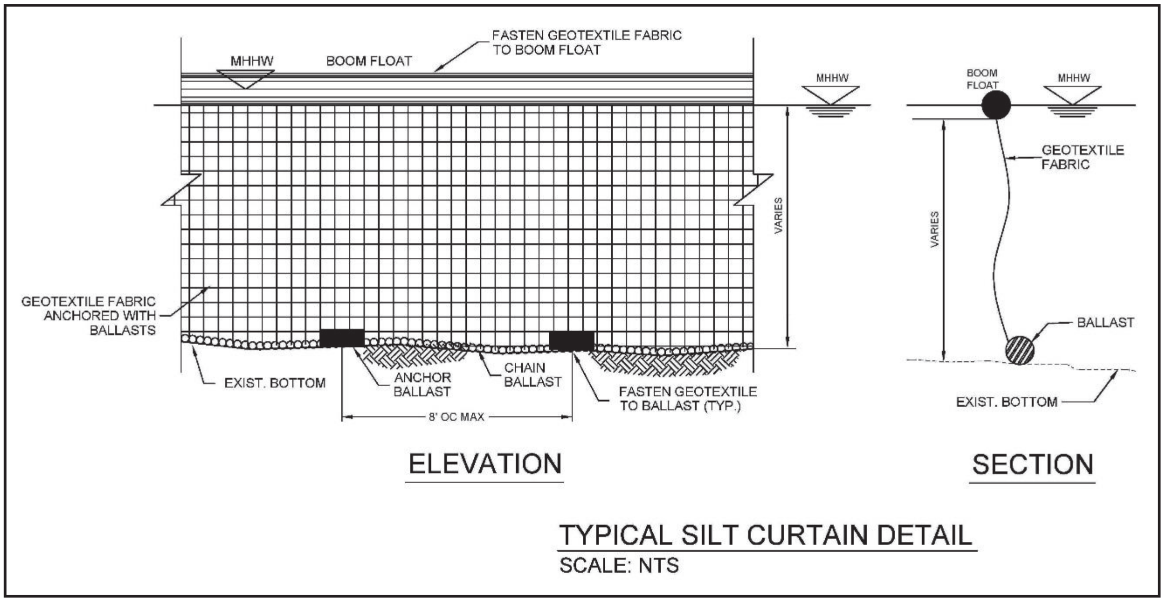


Figure 7-14. Typical silt curtain detail.

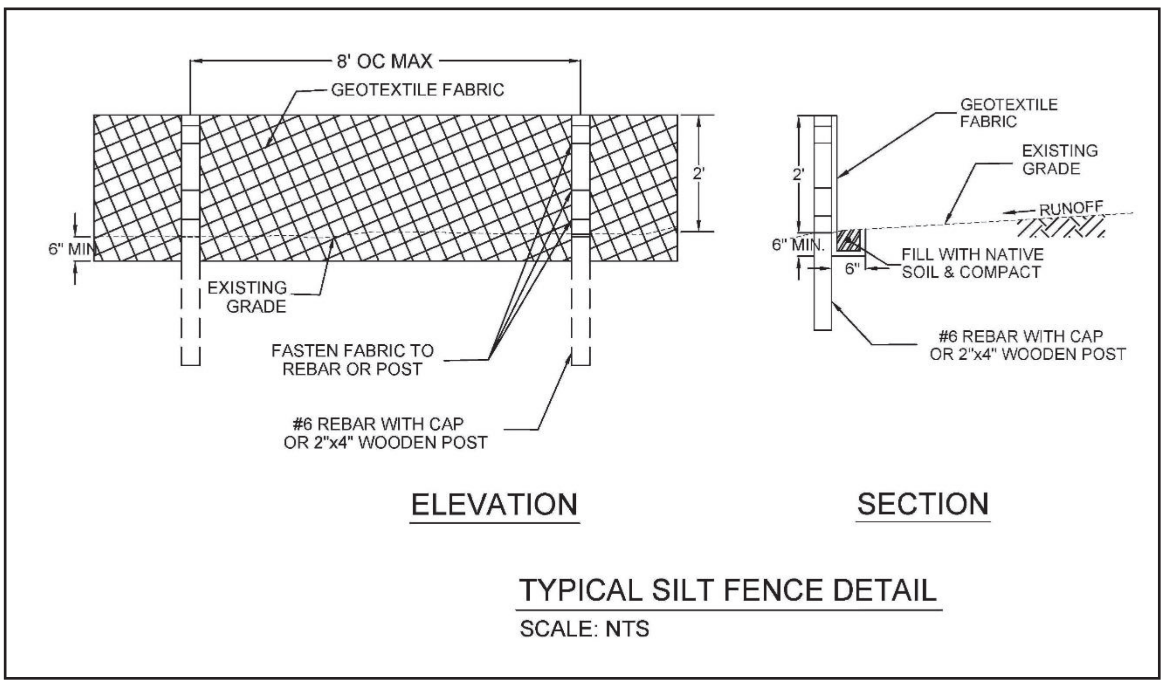


Figure 7-15. Typical silt fence detail.

7.1.6 *Operational Considerations*

The wave and wind environment at the sand recovery site presents a challenge for the dredging contractor. Dangerous conditions can occur from both south Pacific swell and tradewinds, and can be reasonably expected to occur at any point during project construction. The most advantageous work period is fall to early winter when southern swell and tradewinds can be expected to be the least intense. Strong tradewinds can also create seas and currents that would make it difficult to hold the dredge barge and scows in relatively stable positions. For this reason, the operation is proposed to occur during low wave and wind conditions in the fall months.

There are no oceanographic constraints to offloading in a commercial harbor, which would be expected to be sheltered from wave energy. Similarly, sand placement inside the Natatorium swim basin could be satisfactorily accomplished during any time of the year if the existing walls are intact at the time of sand placement. Other construction that would occur outside of the existing walls would be best performed during non-summer months to avoid summer swell.

8. NATATORIUM DEMOLITION AND CONSTRUCTION CONSIDERATIONS FOR WAR MEMORIAL BEACH

Typical demolition and construction considerations are presented in this chapter and are specific to the War Memorial Beach presented in Section 4, because they are details that were developed in the 2012 draft basis of design report for the development of the beach. Typical demolition and construction considerations demonstrate the specificity that will be needed and developed during design and required for in-water permits to protect the environment. Many of these considerations will be applicable to the other alternatives.

8.1 Methodology

The demolition and construction processes will take all necessary measures to maintain a healthy coastal environment, and minimize any potential impacts to the aquatic or terrestrial ecosystems, as well as minimizing interference with recreational activities. Each phase will have a specific objective and an associated method of accomplishing this objective while preventing any detrimental impacts upon the surrounding area. All applicable rules and regulations will be adhered to and all necessary permits will be satisfied. Development of official demolition and construction work plans is beyond the scope of the present study and certain aspects of the work may be left to the discretion of the selected contractor. The following sections identify considerations that should be addressed, and commonly-used techniques are presented.

8.2 Sequence of Events

The sequence of events would consist of site preparation, and three subsequent demolition phases:

Site Preparation

Before demolition can occur, certain preventative measures must be taken. To ensure public safety, the construction site would be secured prior to the start of demolition. Barriers would be erected to prevent human passage and to contain debris. BMPs, presented in Section 9, would be put in place prior to site demolition. Utilities would be located and identified prior to start of demolition, and all utility companies would be contacted. All utilities would be shut off and/or capped prior to the start of demolition.

Gaps in and under the existing Natatorium walls pool should be sealed to limit the release of potentially turbid water into the ocean waters. The Natatorium pool walls should be lined on the inside with turbidity barriers.

Phase 1

Demolition of the Natatorium's façade and bleachers would be the first major phase of the Natatorium removal. The contractor would have ease of equipment access and should be able to load refuse directly into dump trucks or rollaway containers reducing the amount of refuse stored on site. Demolition of this area would result in a large open staging area for subsequent phases of demolition and construction. Debris catch nets or staging would be used to prevent debris from falling to the water and dust control measures would be utilized.

Phase 2

Once the entrance and land-based section of the Natatorium have been removed, the contractor should be able to access the swimming basin inside of the seawalls and deck. Removal of the decking could be accomplished from within the Natatorium pool walls via a small construction barge deployed from land. The construction barge would be assembled on land and deployed inside of the basin. This barge would allow the contractor to use an excavator or similar equipment to remove poolside decking, pilings, and rubble. The decking, pilings, and rubble should be removed down to hard bottom so that the bottom is suitable for groin construction. All infrastructure would be removed except for the Natatorium pool walls, which would continue to act as physical containment barriers for turbidity or refuse. The barge would double as debris catchment and debris transport to the shoreside area of the construction site. An additional barge could be used to transport debris to shore if space permits. All debris must be collected and removed to ensure a safe beach and swimming place in the future.

Sediment grading can take place during this phase of demolition.

Phase 3

Following removal of decking, pilings, and debris, the pool area would be capped as described in Section 2.7. It is recommended that an expert be consulted to design the sediment cap. The Natatorium pool walls would also be removed at the end of this phase.

Phase 4

Construction of the rock rubblemound groins involves establishing a work platform from which to perform the construction. As with demolition, an option is for the construction to be performed from a barge deployed from land into the Natatorium pool. The stone would have to be transported by truck to the site then moved to the shoreline across park grounds. Trucks can transport about 20 tons of stone; therefore, approximately 470 truckloads will be required to transport the 5,100 cubic yards (or 9,300 tons) of stone required to construct the groins. Stockpiling the rock on the WWM grounds does not appear to be an option due to limited space and historical aspects. Stockpiling within Kapiolani Park across Kalakaua Avenue may be possible pending agreement from the various City departments.

Groin construction would proceed one at a time. Primary construction equipment would include trucks and a moderate sized front-end loader and excavator.

Work within the existing Natatorium walls would create a calm working environment.

Sand will be placed between the two groins to design lines and grades as outlined previously in Section 7.1.5.

Phase 5

The contractor will demolish Natatorium walls and any remaining infrastructure. All construction equipment and environmental controls will be removed.

8.2.1 *Tools and Equipment*

Demolition of the Natatorium and construction of the groins and beach will rely largely upon the use of track-mounted excavators and bulldozers. The excavators will be equipped with demolition buckets with thumbs and hoe-rams, and will be used in conjunction with rollaway refuse bins and dump trucks in all phases of demolition. Refuse materials will be hauled away on a regular basis preventing build-up of debris and site clutter. Phases 2 and 3 will require the use of small construction barges for excavator access and material removal. Additional barges may be used for ease of demolition and removal.

8.3 Estimated Disposal Quantities

Disposal quantities were estimated using as-built construction drawings from 1927 and 1949. Approximations were made where information was insufficient or incomplete. Table 8-1 shows estimated values for reinforced concrete removal totaling approximately 4,500 cubic yards or 9,100 tons. Additionally, "general refuse" such as sinks, toilets, metal or other non-concrete fixtures are expected to total less than 50 cubic yards of waste.

Table 8-1. Estimated volume of material from Natatorium demolition.

Feature	Volume (cubic yard)	Weight (ton)
Decks, Seawalls, and Piles	2,100	4,250
Bleachers, Slab, and Foundation	2,000	4,050
Walls, Main, Side, Interior	400	800
Totals	4,500	9,100

8.4 Material Disposal Options

Disposal options require consideration of pricing, and proximity of disposal facilities, and environmental impacts. The ability to reuse or recycle material can turn waste into a resource reducing the environmental demands upon the island. The majority of the refuse material generated from demolition will be concrete, which can be recycled at West Oahu Aggregate. Additional waste can be disposed of at Nanakuli Landfill (PVT Land Company Ltd.). PVT Land Company also has the ability to dispose of special waste if any is encountered.

9. MONITORING AND MITIGATION DURING CONSTRUCTION

9.1 Best Management Practices Plan

BMPs for construction operations would be developed to help minimize adverse impacts to coastal water quality and the marine ecosystem. The project specifications would require the construction contractor to adhere to environmental protection measures including, but not limited to, the following:

- The contractor shall perform the work in a manner that minimizes environmental pollution and damage as a result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of the construction period.
- Any construction related debris that may pose an entanglement hazard to marine protected species must be removed from the project site if not actively being used and/or at the conclusion of the construction work.
- The contractor shall submit a Best Management/Environmental Protection Plan for approval prior to initiation of construction. The plan shall include, but not be limited to:
    1. Protection of Land Resources
    2. Protection of Water Resources
    3. Disposal of Solid Waste
    4. Disposal of Sanitary Waste
    5. Disposal of Hazardous Waste
    6. Dust Control
    7. Noise Control
- The construction contractor shall be required to employ 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 operation near the water; proper location of storage, refueling, and servicing sites; and implementation of adequate spill response procedures, stormy weather preparation plans, and the use of silt curtains and other containment devices.
- No contamination (trash or debris disposal, alien species introductions, etc.) of marine (reef flats, lagoons, open oceans, etc.) environments adjacent to the project site shall result from project related activities.
- The contractor shall confine all construction activities to areas defined by the drawings and specifications. No construction materials shall be stockpiled in the marine environment outside of the immediate area of construction.
- The contractor shall keep construction activities under surveillance, management, and control to avoid pollution of surface or marine waters. Construction-related turbidity at the project site shall be controlled to meet water quality standards. All water areas affected by construction activities shall be monitored by the contractor. If monitoring indicates that the turbidity standards are being exceeded due to construction activities, the contractor shall suspend the operations causing excessive turbidity levels until the

condition is corrected. Effective silt containment devices shall be deployed where practicable to isolate the construction activity and to avoid degradation of marine water quality and impacts to the marine ecosystem. In-water construction shall be curtailed during sea conditions that are sufficiently adverse to render the silt containment devices ineffective.

- Underlayer fills shall be protected from erosion with armor units as soon after placement as practicable.
- Waste materials and waste waters directly derived from construction activities shall not be allowed to leak, leach, or otherwise enter marine waters.
- Fueling of project related vehicles and equipment should take place away from the water. A contingency plan to control the accidental spills of petroleum products at the construction site shall be developed. Absorbent pads, containment booms and skimmers shall be stored at the site to facilitate the cleanup of petroleum spills.
- The project shall be completed in accordance with all applicable State and City health and safety regulations.
- The sand shall be of beach-compatible quality, moderately well sorted with rounded and polished grains composed primarily of calcareous material. The sand shall be dominantly composed of naturally occurring carbonate beach or dune sand. Crushed limestone or other man-made or non-carbonate sands would not be allowed.
- All construction material including sand shall be free of contaminants of any kind including excessive silt, sludge, anoxic or decaying organic matter; turbidity, temperature, or abnormal water chemistry; clay, dirt, organic material, oil, floating debris, grease, or foam; or any other pollutant that would produce an undesirable condition to the beach or water quality. The sand shall have no discernable odor.
- Sand fill placement shall not be done during storms or periods of high surf.
- Any spills or other contaminations shall be immediately reported to the DOH Clean Water Branch (808-586-4309).
- BMPs shall be utilized to minimize adverse effects to air quality and noise levels including the use of emission control devices and noise attenuating devices.
- A dust control program shall be implemented, and windblown sand and dust shall be prevented from blowing offsite by watering when necessary.
- Public safety best practices shall be implemented, possibly including posted signs, areas cordoned off, and on-site safety personnel.
- Public access along the shoreline during construction shall be maintained so far as practicable and within the limitations necessary to ensure safety.
- The contractor shall review all BMPs with the project applicant/representative prior to the commencement of beach nourishment activities.

9.2 Protection of Endangered Species

Endangered species BMPs were recommended by the National Marine Fisheries Service (NMFS) in 2008 for another shoreline construction project on the south shore of Oahu. The BMPs pertaining to endangered species for the present project are expected to be similar to the following:

1. Conduct a survey for marine-protected species before any work starts and postpone or halt all work if a marine protected species is seen in the area. If a marine-protected species is in the area, either hauled out onshore or in the nearshore waters, a 150-ft buffer must be observed with no humans approaching them. If a monk seal/pup pair is seen, a minimum 300-ft buffer must be observed.

2. Establish a safety zone around the project area whereby observers would visually monitor this zone for marine-protected species 30 minutes prior to, during, and 30 minutes post daily project activity. Record information on the species, numbers, behavior, time of observation, location, start and end times of project activity, sex or age class (when possible), and any other disturbances (visual or acoustic).

3. Conduct activities only if the safety zone is clear of monk seals or turtles.

4. Upon sighting of a monk seal or turtle within the safety zone during project activity, immediately halt the activity until the animal has left the zone. In the event a marine-protected species enters the safety zone and the project activity cannot be halted, conduct observations and immediately contact NMFS staff in Honolulu to facilitate agency assessment of collected data. For monk seals contact the Marine Mammal Response Coordinator, David Schofield, at 808-944-2269, as well as the monk seal hotline at 808-220-7802. For turtles, contact the turtle hotline at 808-983-5730.

5. For on-site project personnel that may interact with a listed species potentially present in the action area, provide education on the status of any listed species and the protections afforded to those species under Federal laws. NMFS may be contacted for scheduling educational briefings to convey information on marine mammal behavior, and explain why and when to call NMFS and other resource agencies.

9.3 Water Quality Monitoring

Water quality monitoring is expected to be required for this project. BMPs for construction in coastal waters include daily inspection of equipment for conditions that could cause spills or leaks; cleaning of equipment prior to deployment near the water; proper location of storage, refueling, and servicing sites; and implementation of adequate spill response, storm weather preparation plans, and the use of silt curtains to minimize potential impacts.

Water quality monitoring will be required in a document generally referred to as an "Applicable Monitoring and Assessment Program" (AMAP) that would be prepared to accompany the Section 401 water quality certification (WQC) application to DOH. The plan would be prepared in accordance with water quality regulations promulgated in Hawaii Administrative Rules

(HAR) Chapter 11-54 (DOH, 2009) and the General Monitoring Guidelines for Section 401 Water Quality Certification Projects (DOH, 2000). The purpose of the AMAP would be:

1. To ascertain that BMPs for the project are adequate to comply with State of Hawaii water quality standards;
2. In the event that the BMPs prove inadequate, to determine such, so that modification of the BMPs can be implemented in a timely manner to bring the activity into compliance; and
3. To serve as a basis for self-compliance, so that construction can proceed within the parameters required by State water quality standards.

10. SUMMARY

This report presents the results of an oceanographic study of the project area and preliminary design of four beach creation options considered in 2016. Key components of the present study include wave, current, and circulation field studies and modeling; sand source investigations; groin and beach design; and preliminary demolition and construction considerations.

The Pre-Environmental Impact Statement Alternatives Technical Evaluation (AECOM, January 2018) presented the following four options to be assessed in the EIS:

- Perimeter Deck
- War Memorial Beach
- Closed-System Pool
- No Action

Data amassed from the oceanographic study of the project area and preliminary design of the four beach creation options in 2016 were used to evaluate each of the 2018 alternatives regarding effects on the following parameters and issues:

- Waves and currents in and around the Natatorium
- Sediment transport and beach stability
- Water quality
- Recreational opportunities
- Effects of sea level rise
- Loss of waters of the United States

This report contributes to the final EIS.

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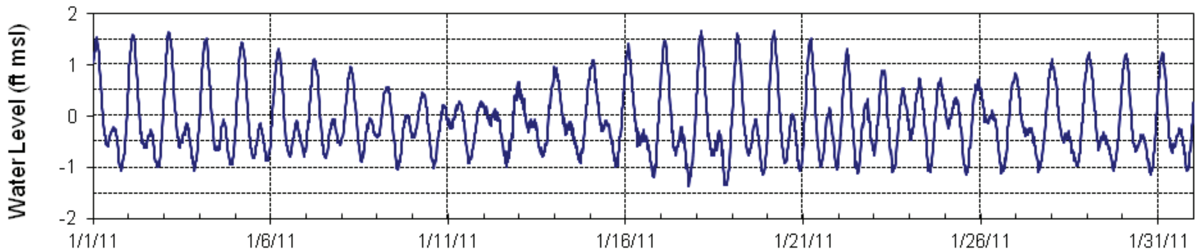
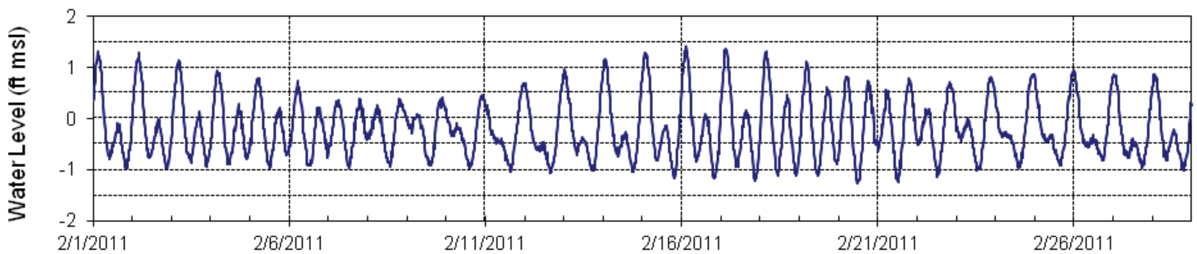
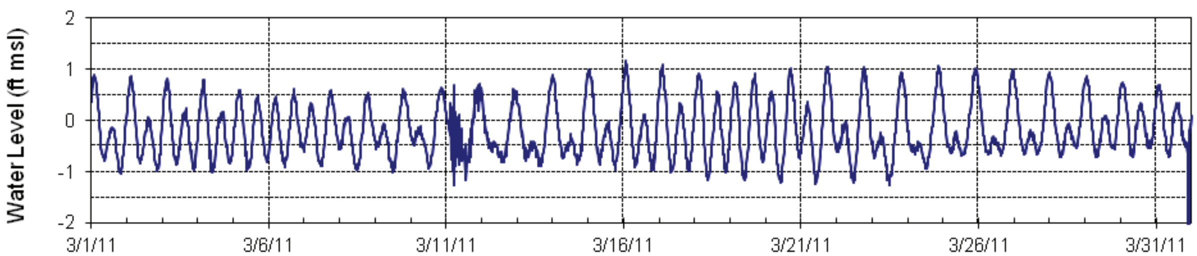
APPENDIX A.
SEA ENGINEERING, INC. FIELD INSTRUMENT DATA.
WINTER 2010-2011 DEPLOYMENT.

RDI Tides (January – March 2011)







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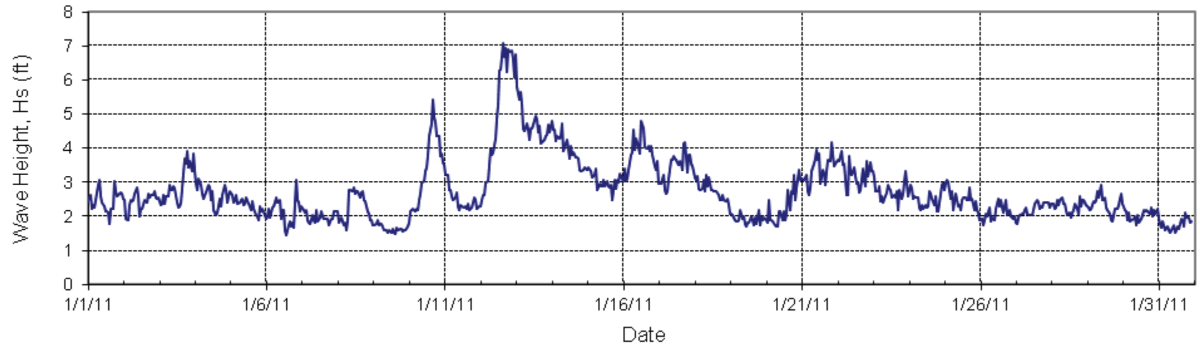

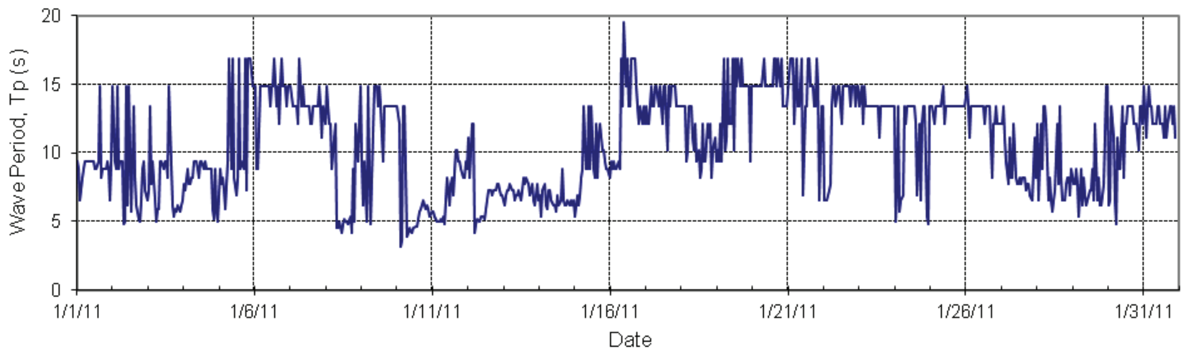

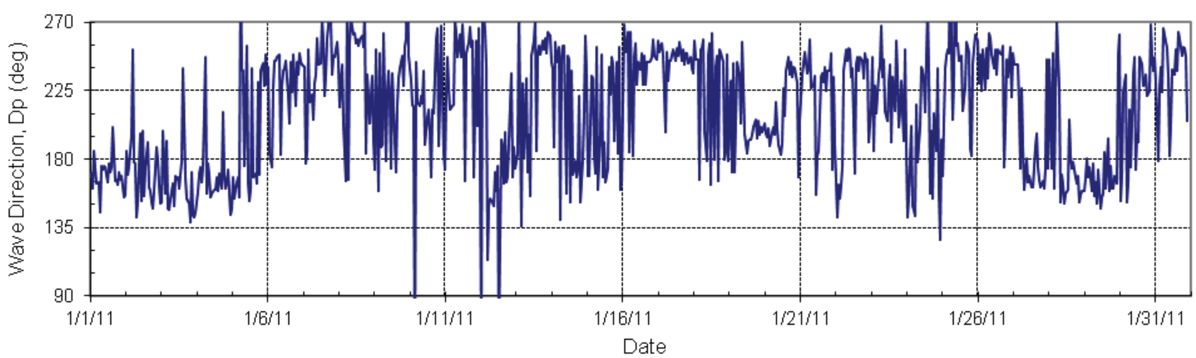

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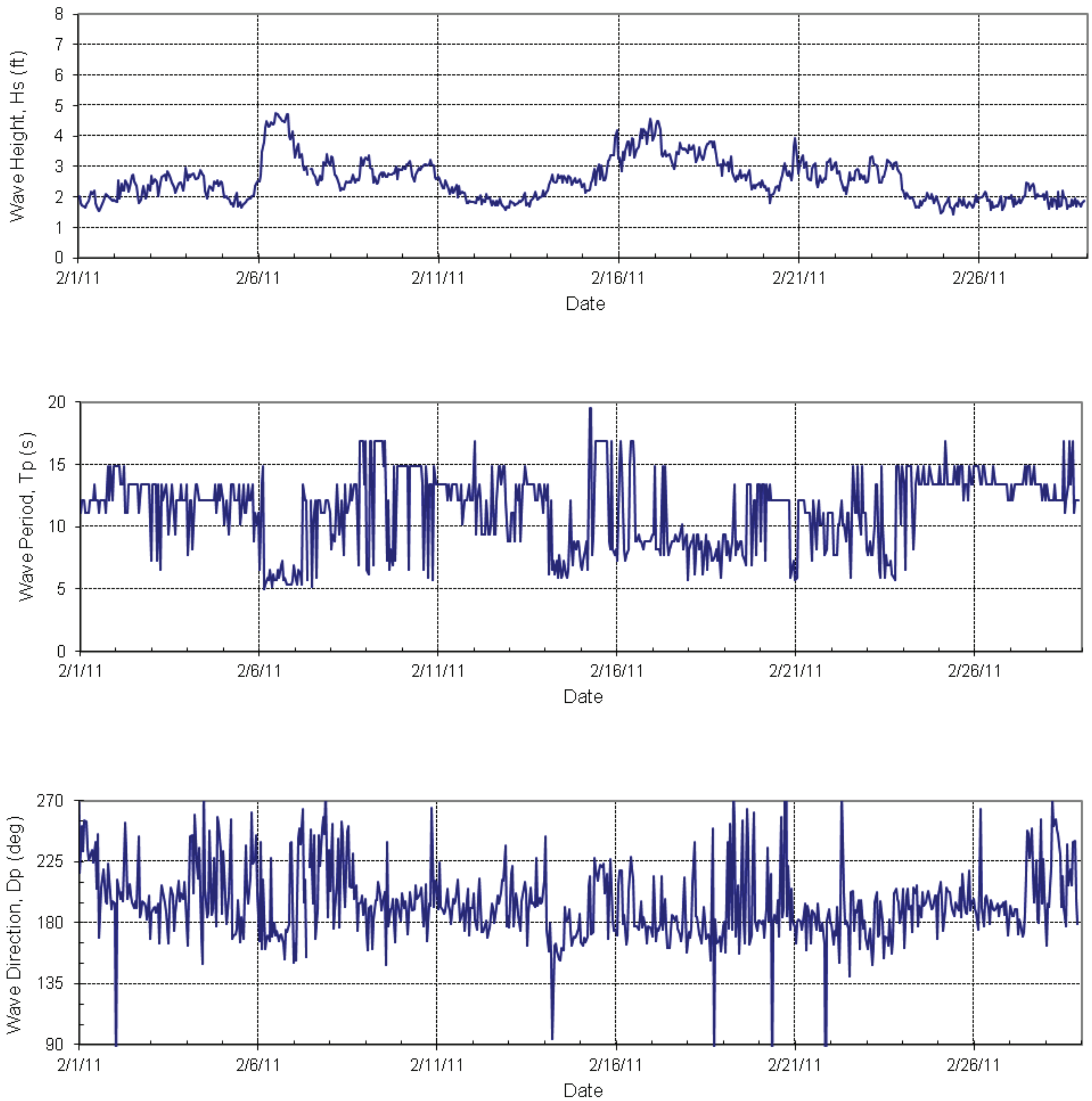

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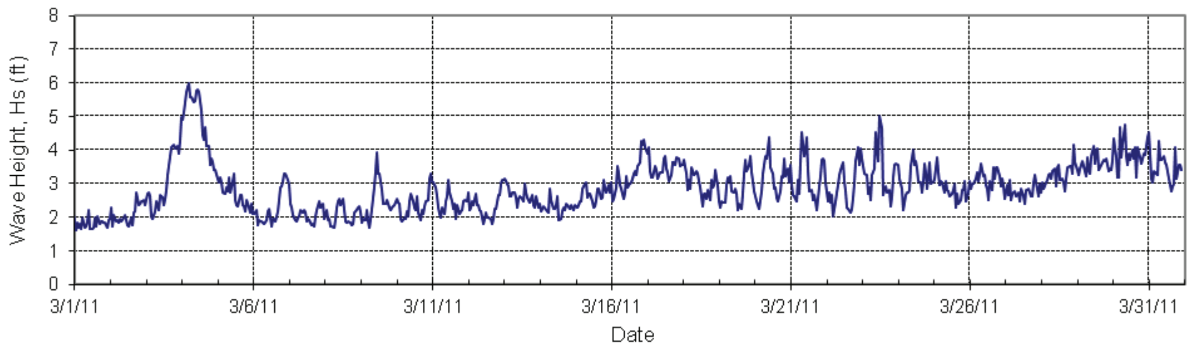

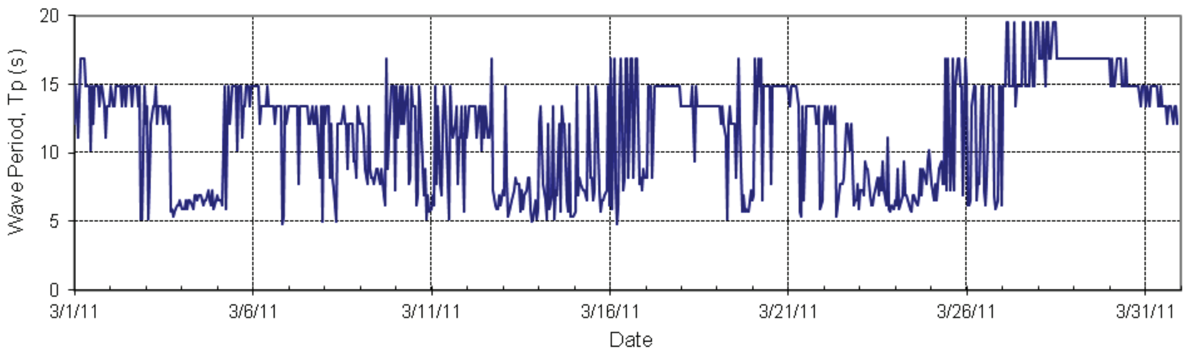

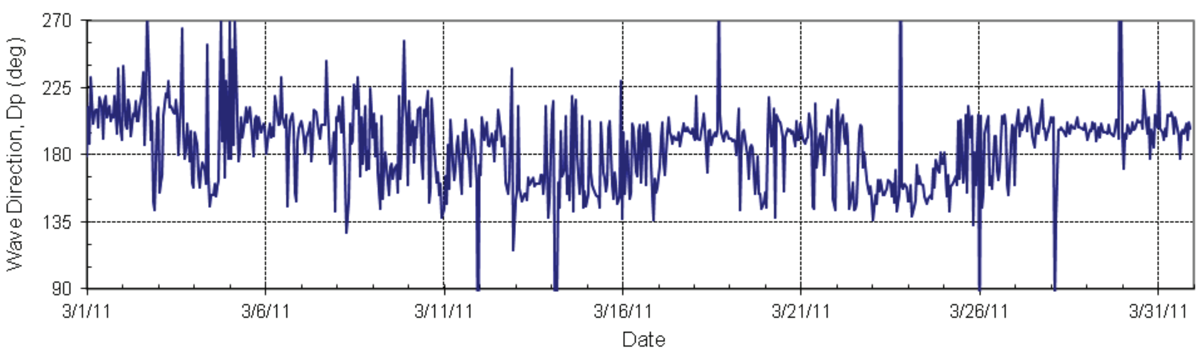

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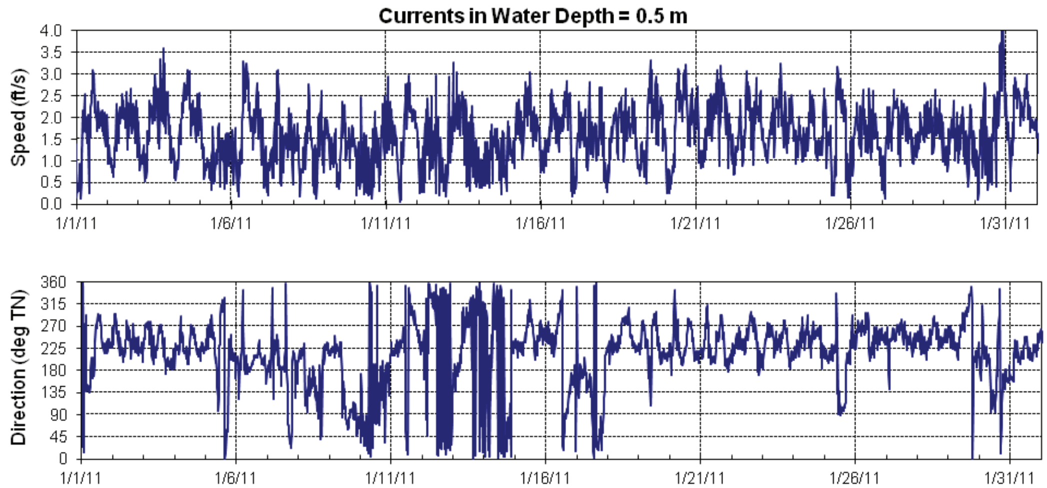

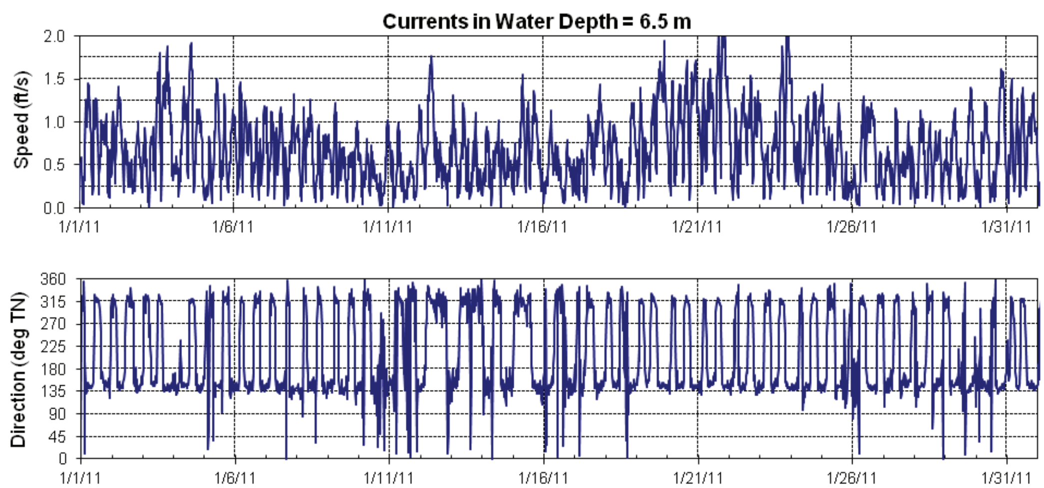

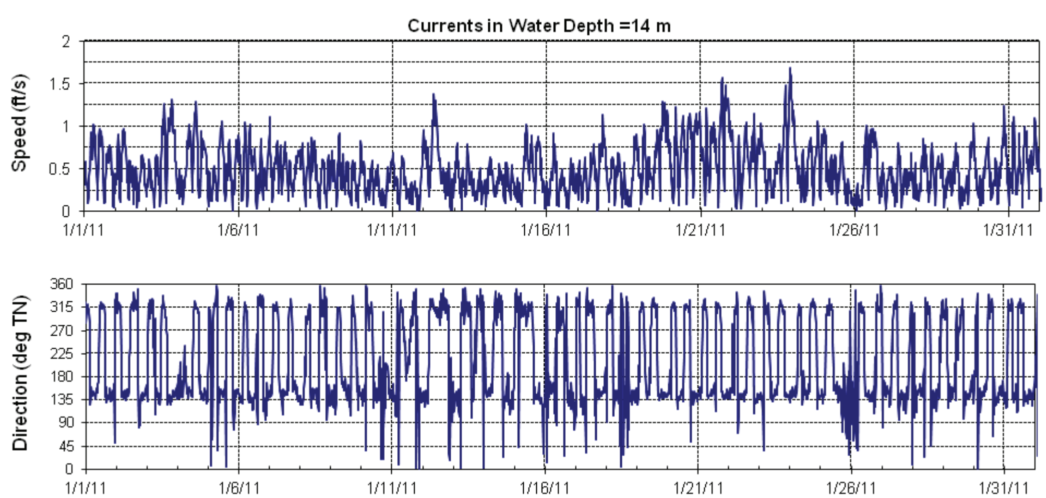

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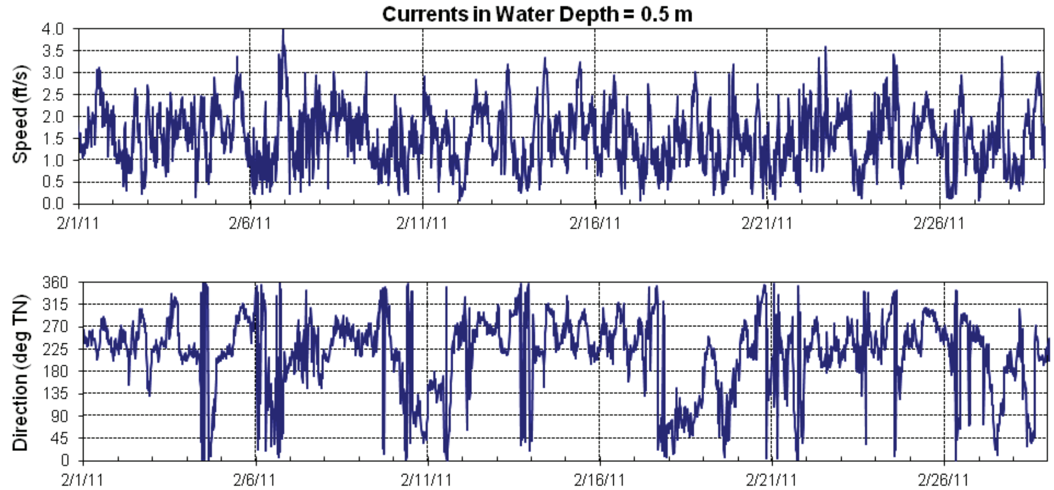

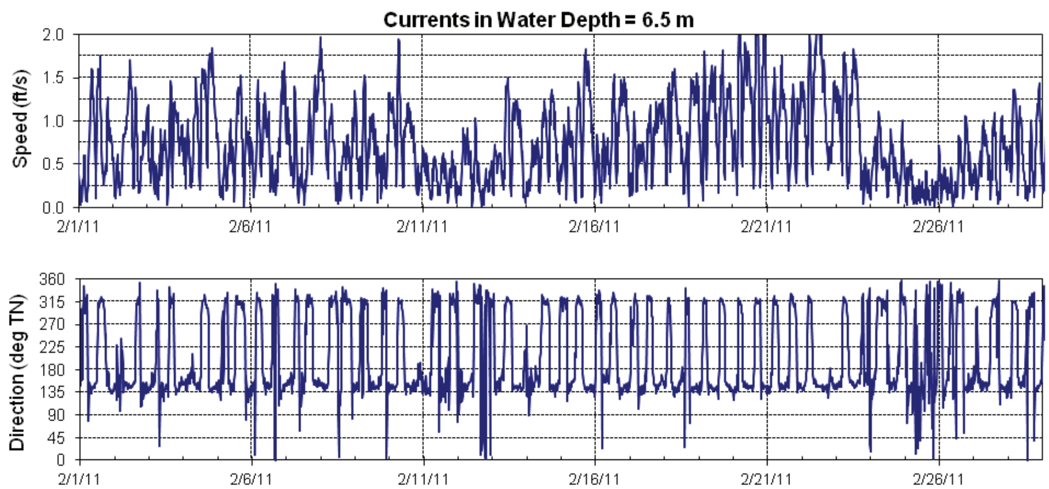

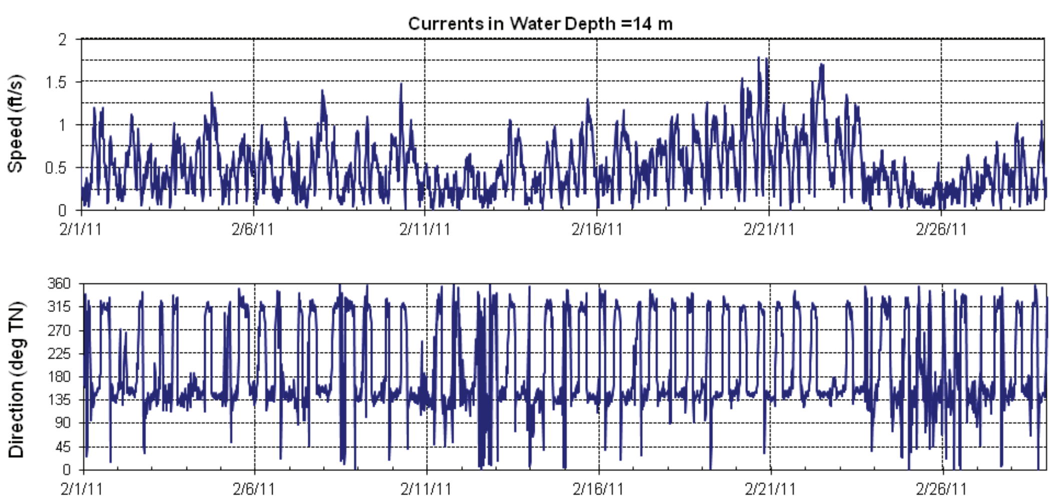

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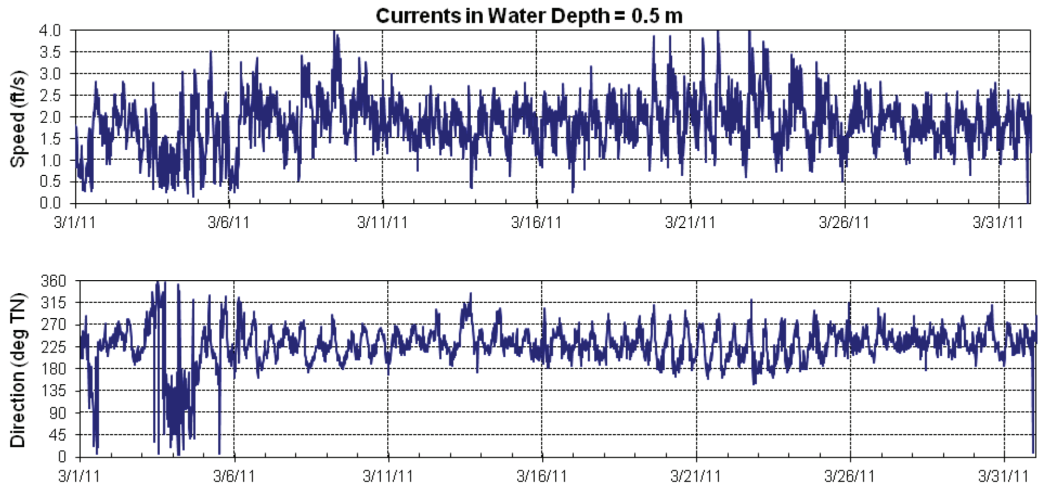

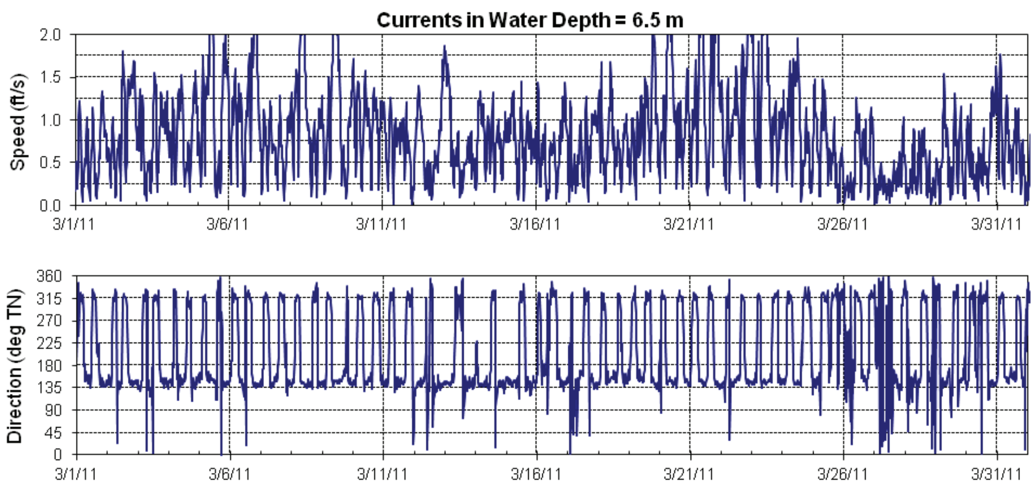

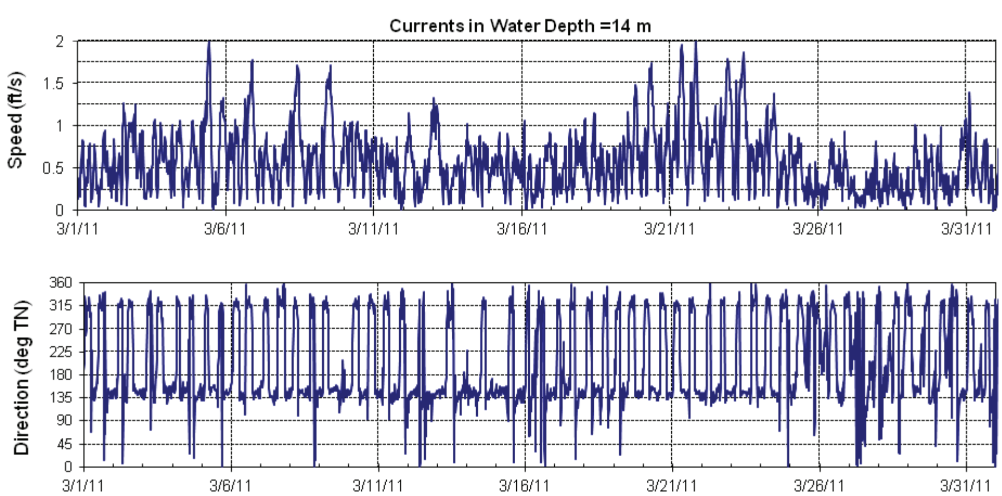

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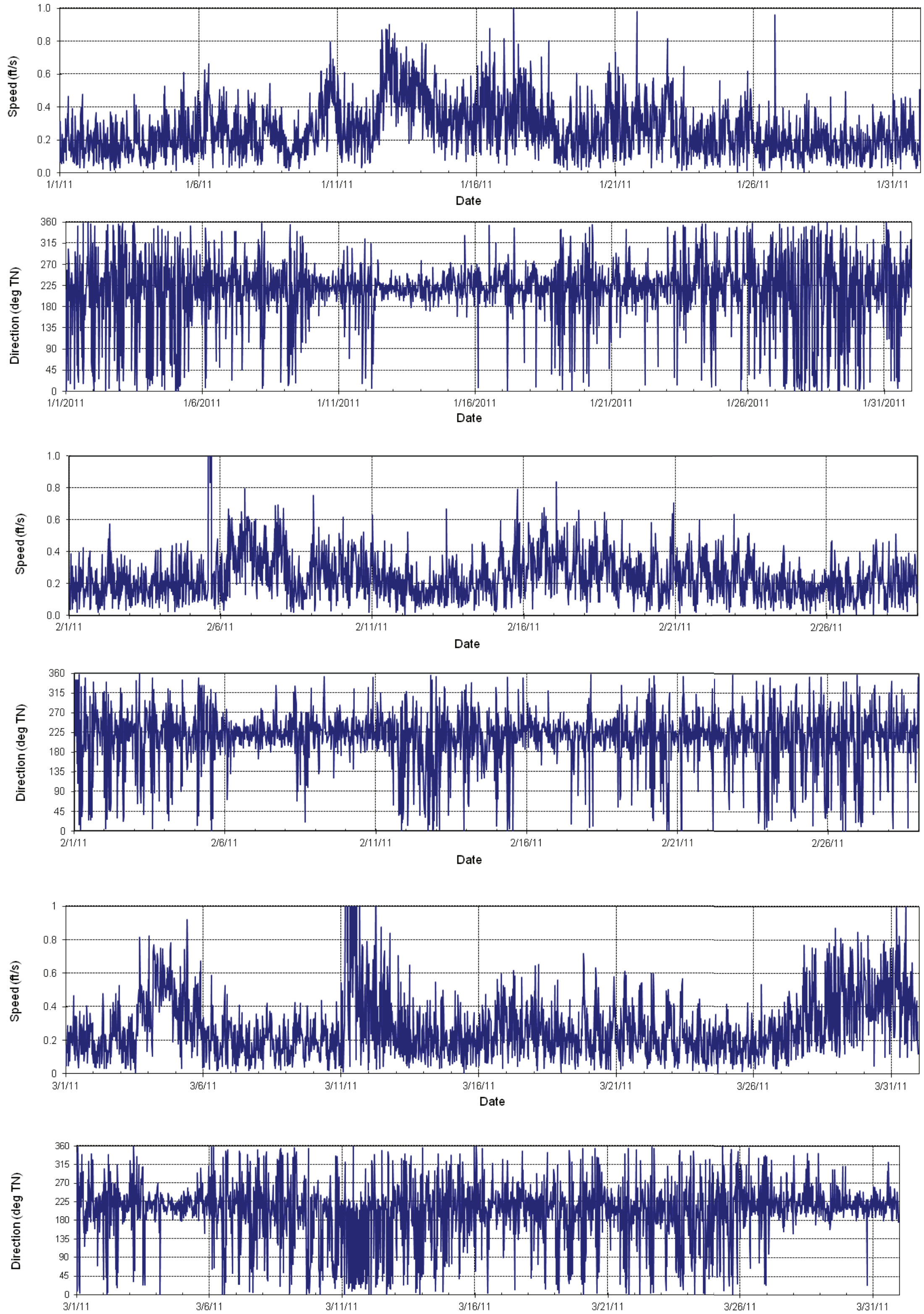

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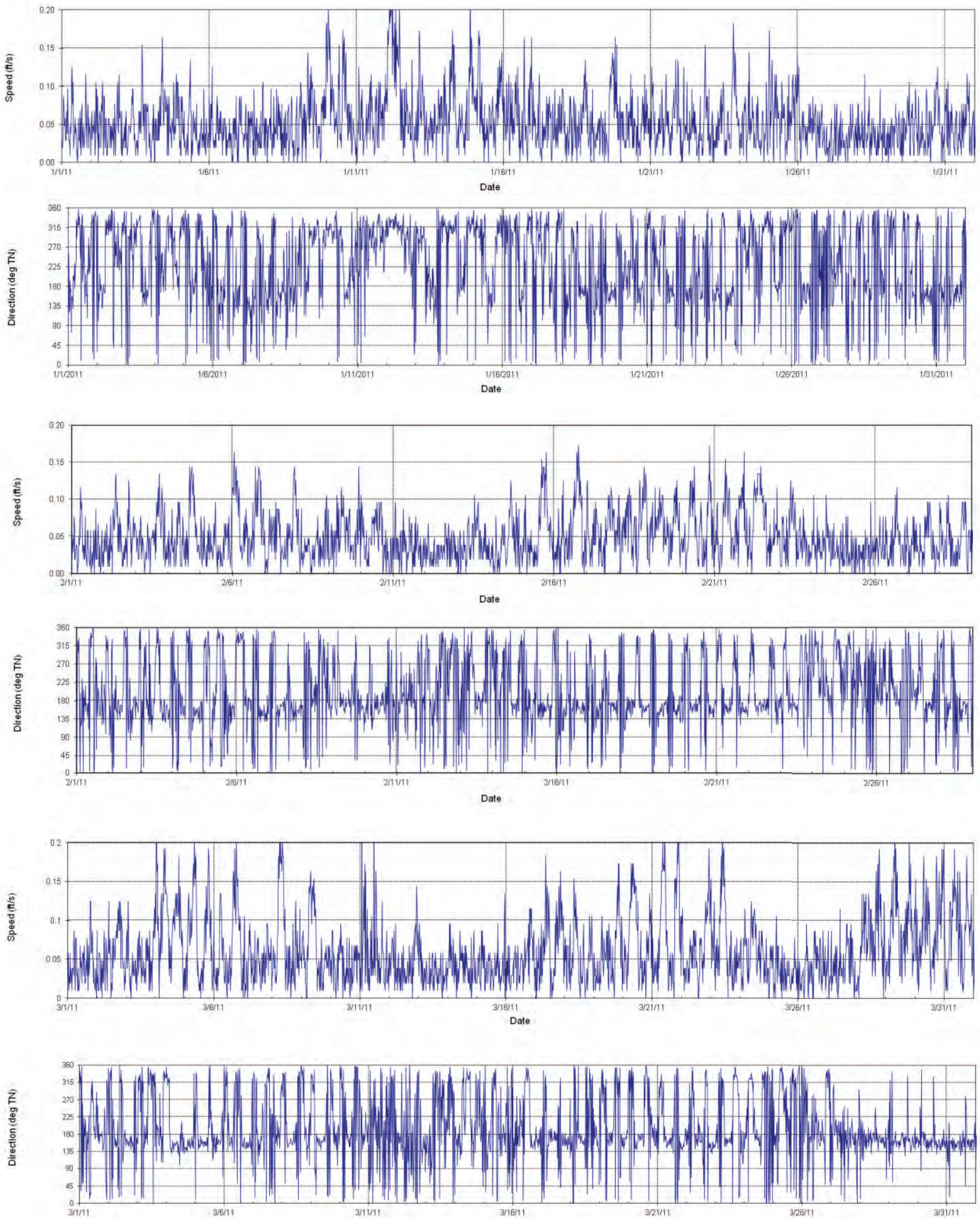
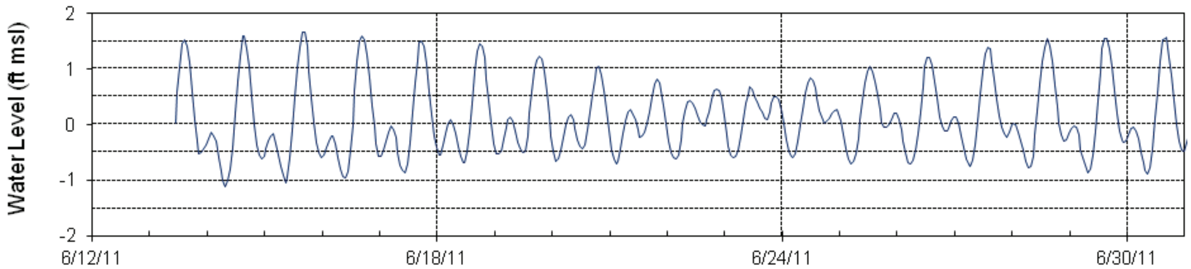
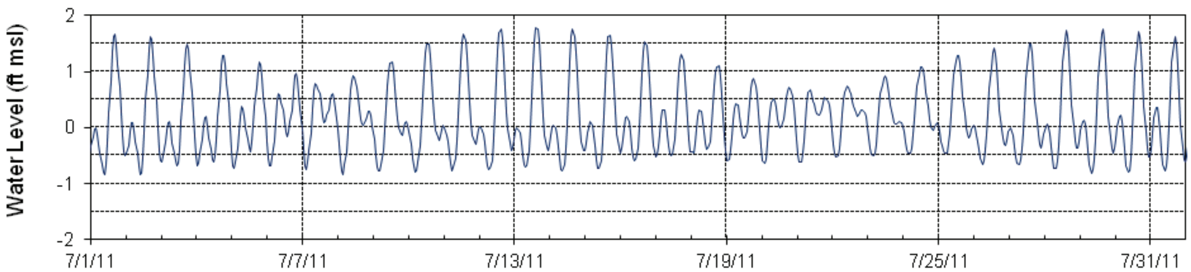
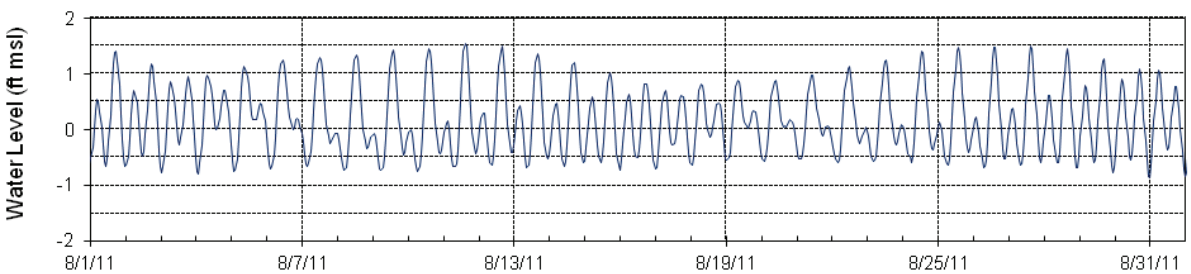


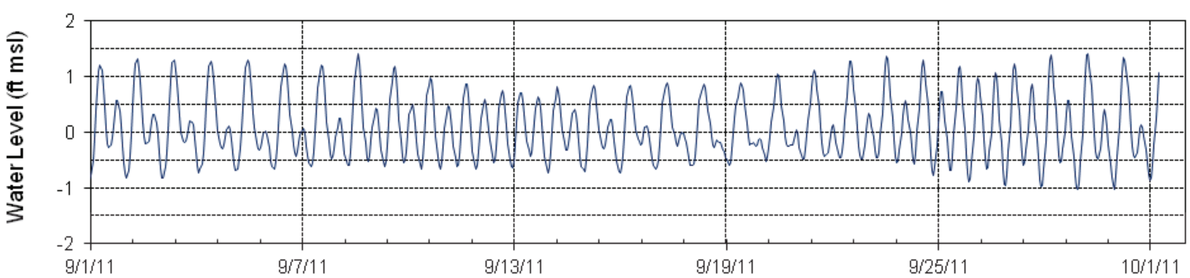
APPENDIX B.
SEA ENGINEERING, INC. FIELD INSTRUMENT DATA.
SUMMER 2011 DEPLOYMENT.

RDI Tides (June – September 2011)









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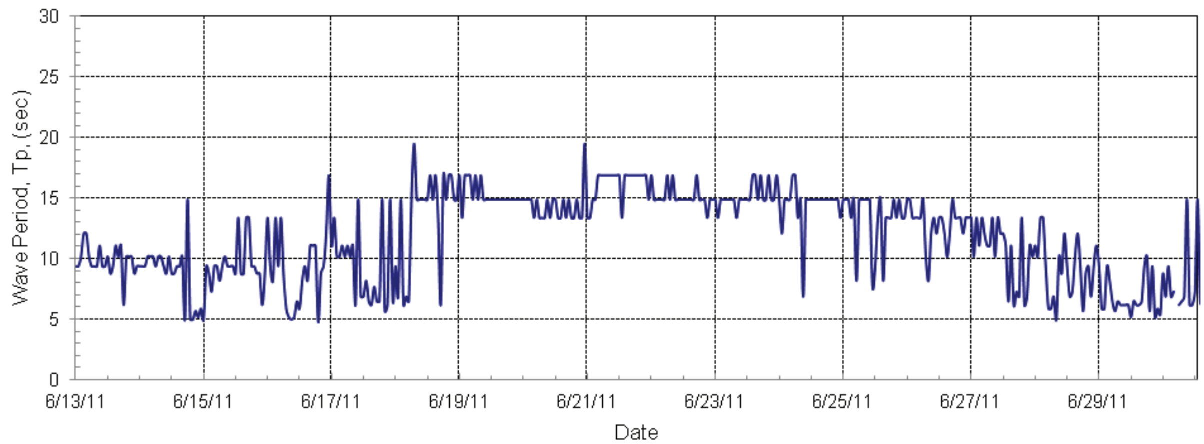

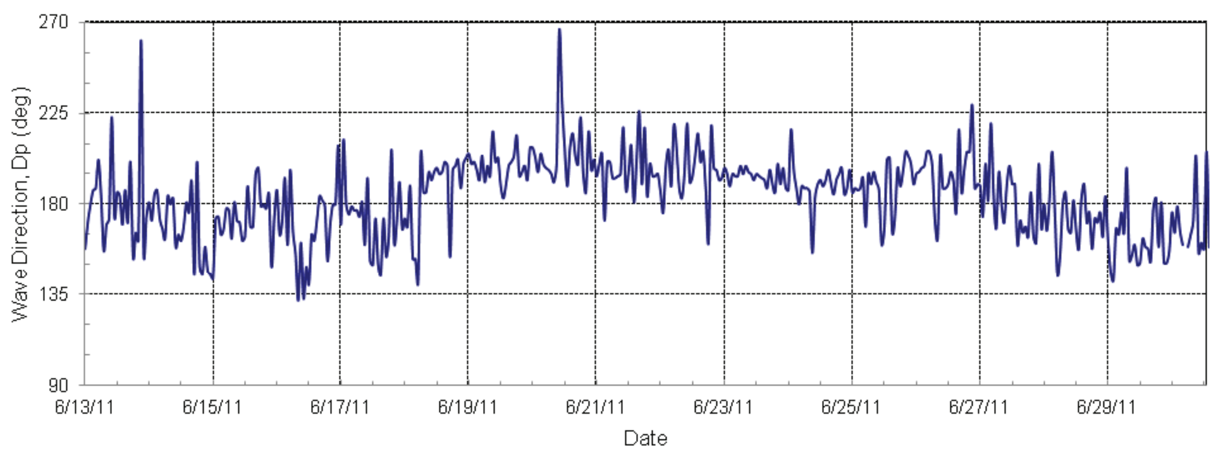

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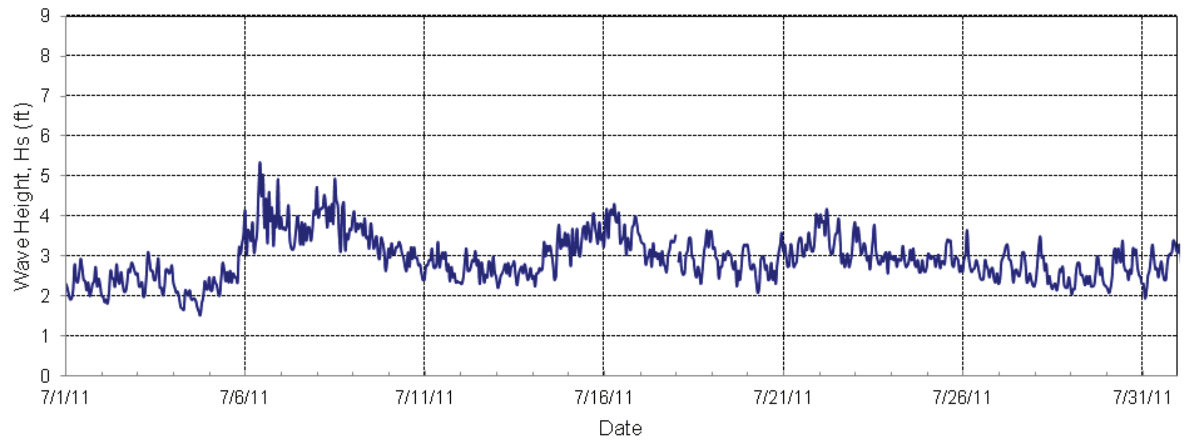

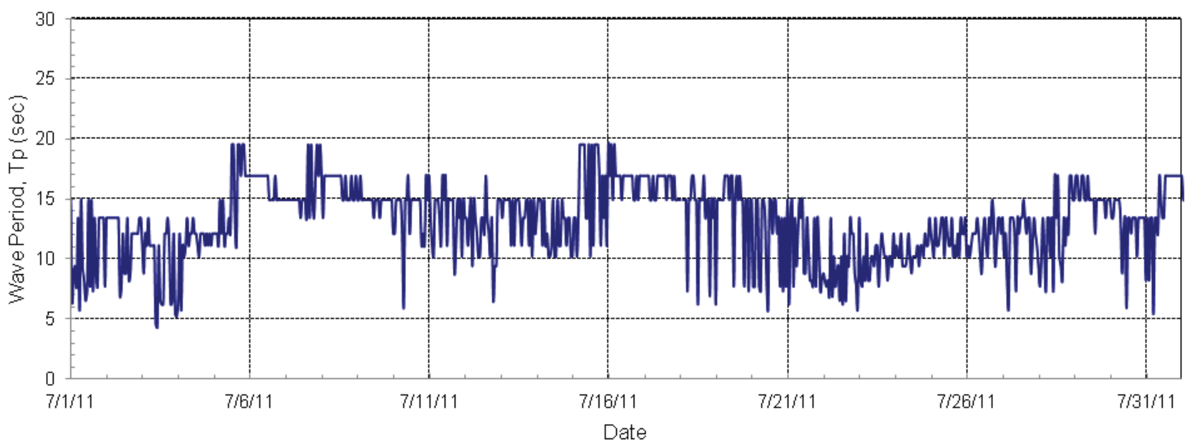

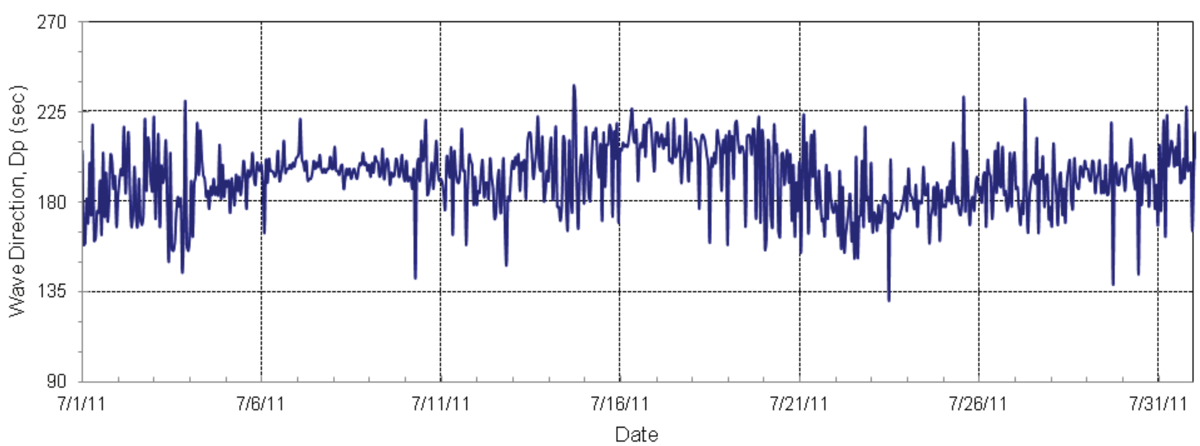

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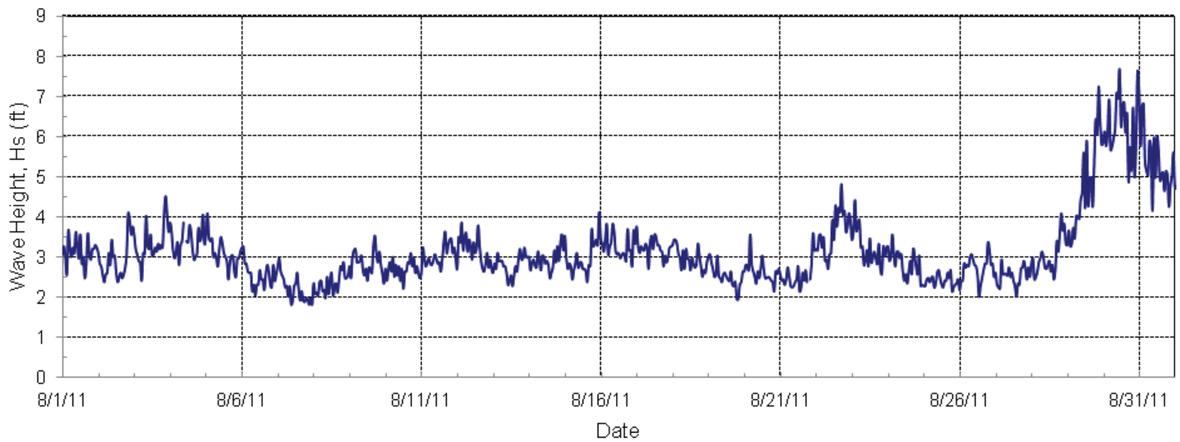

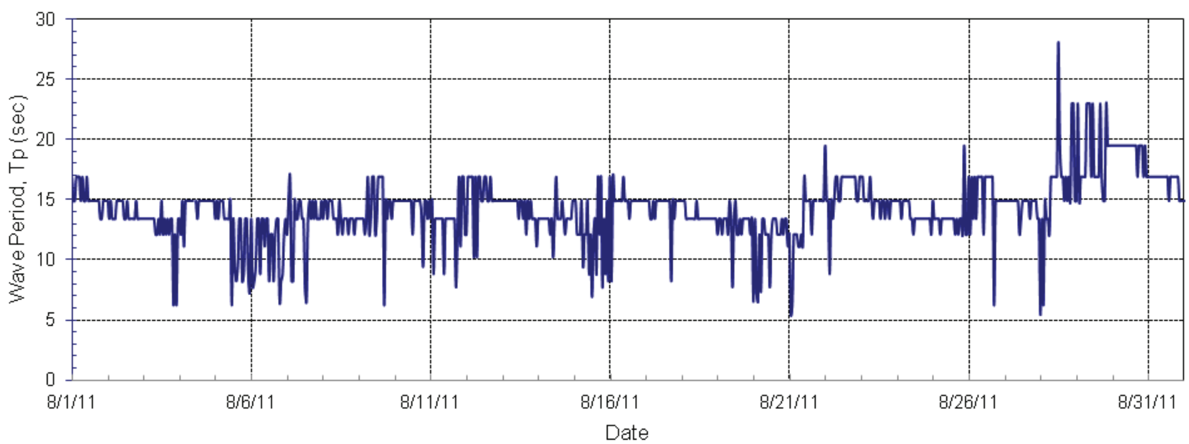

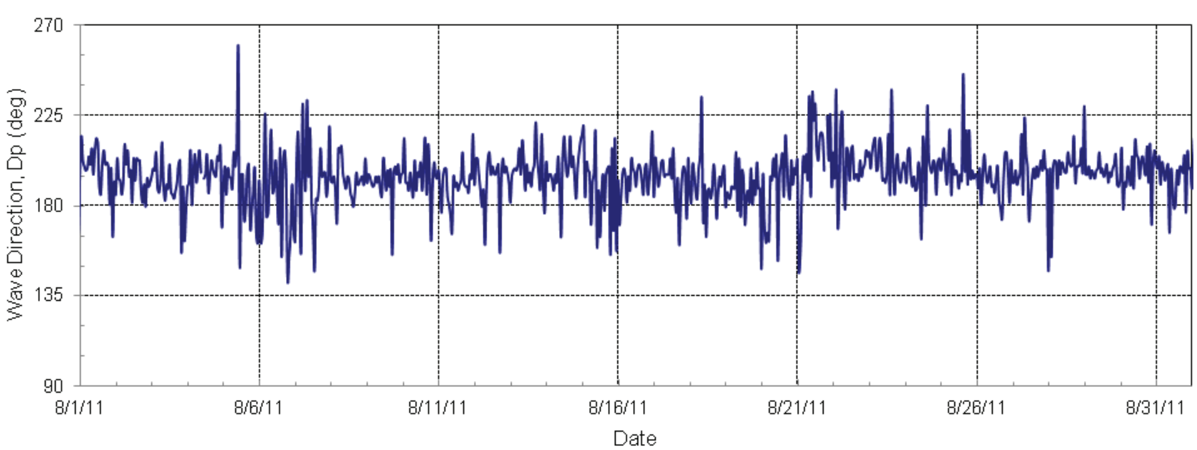

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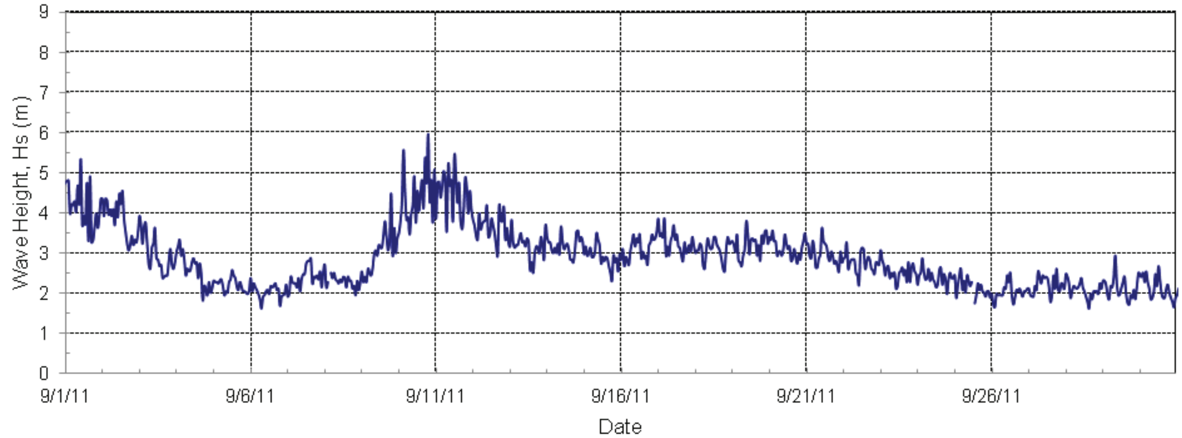

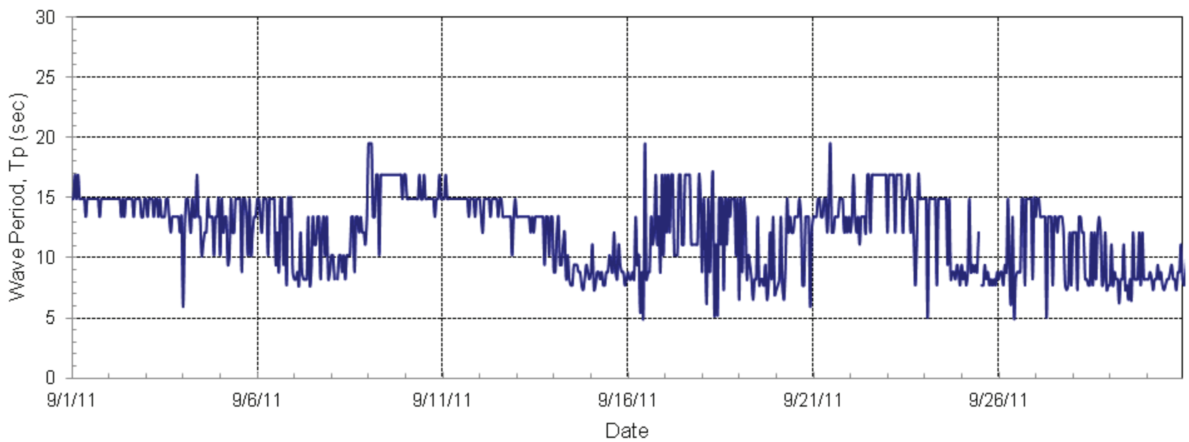

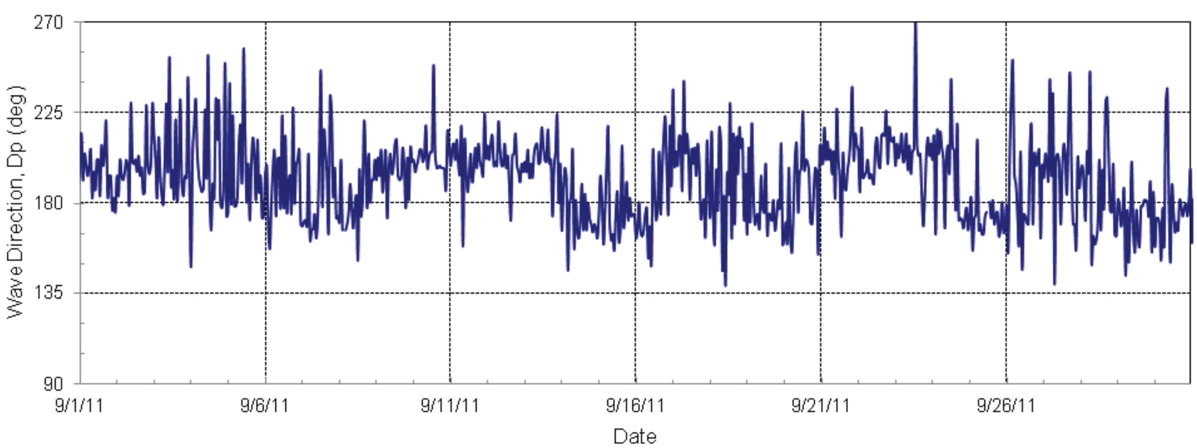

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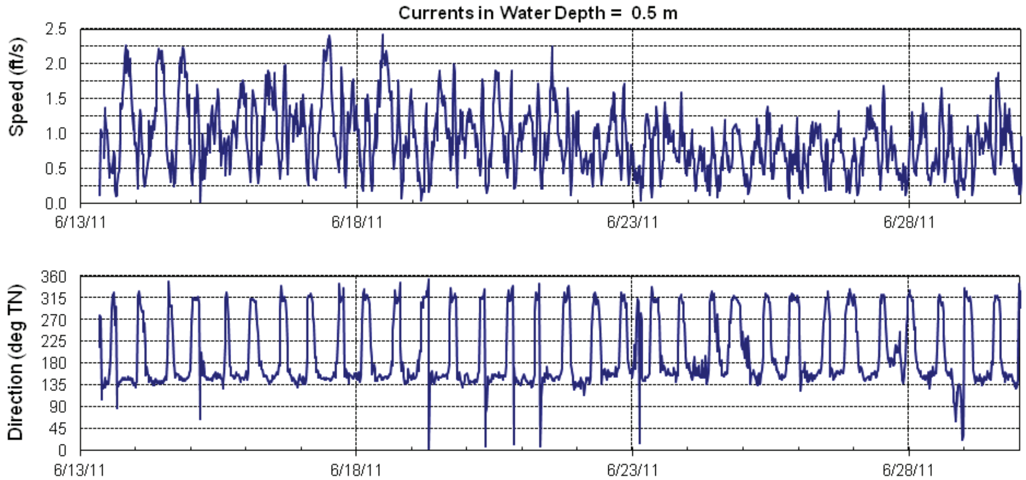

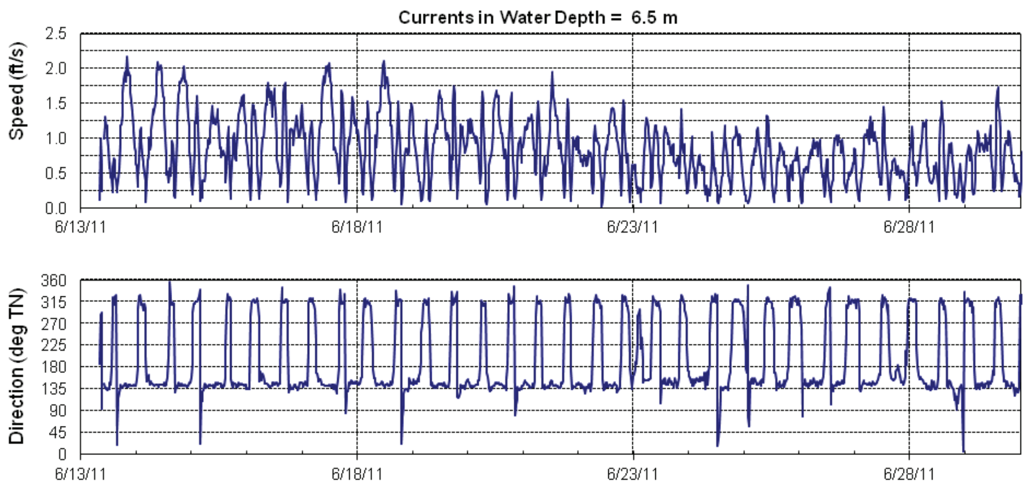

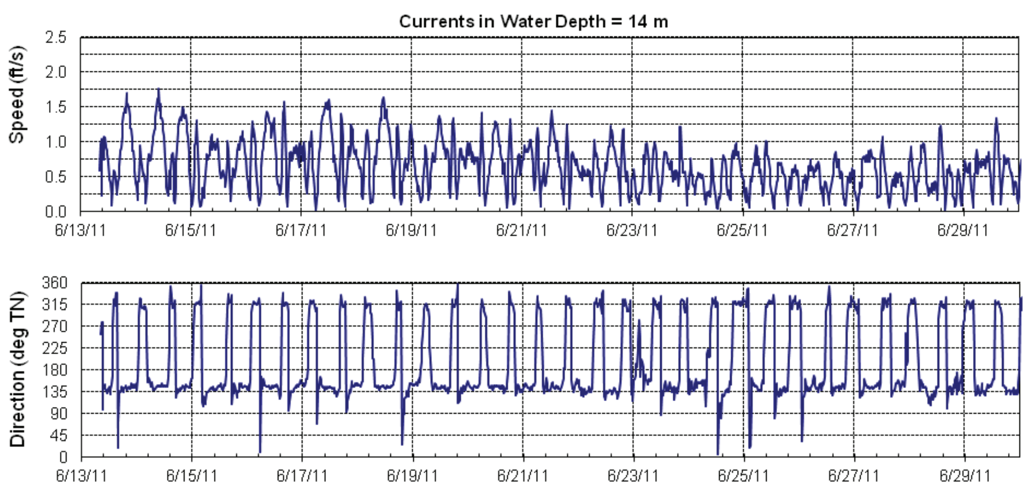

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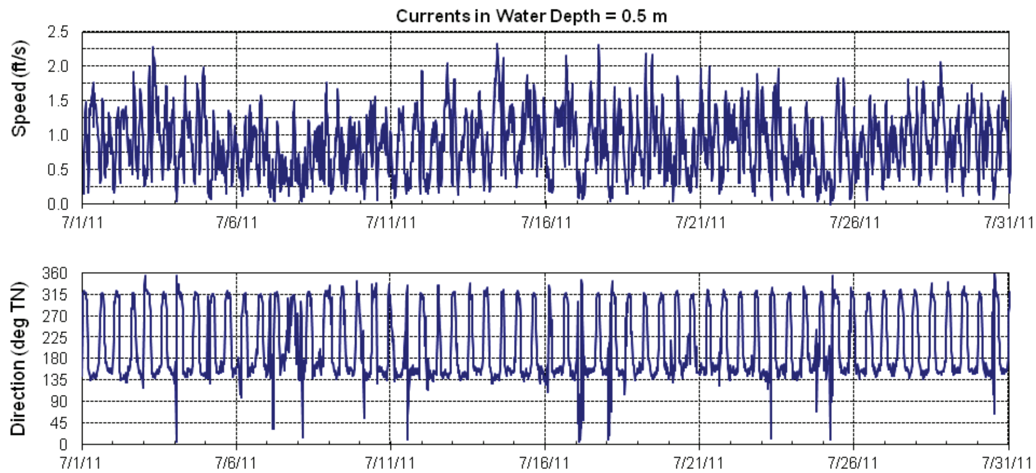

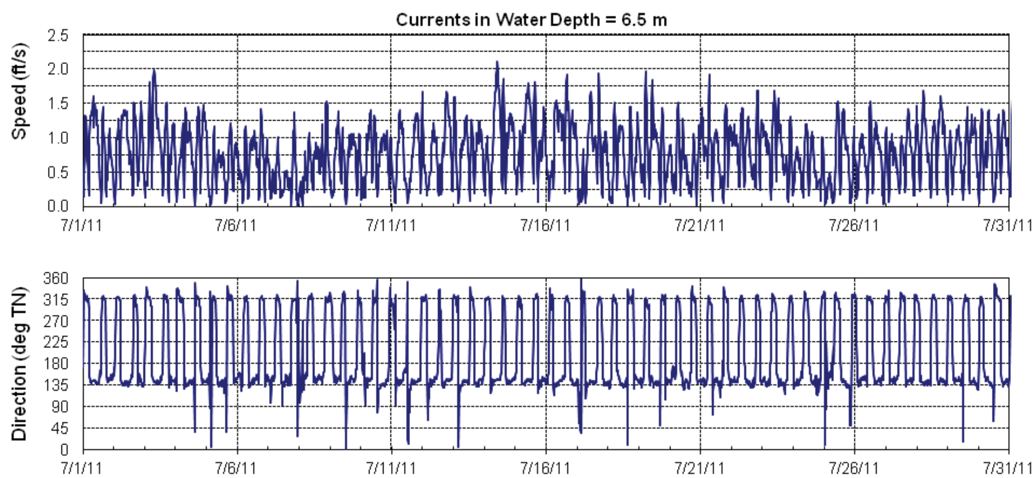

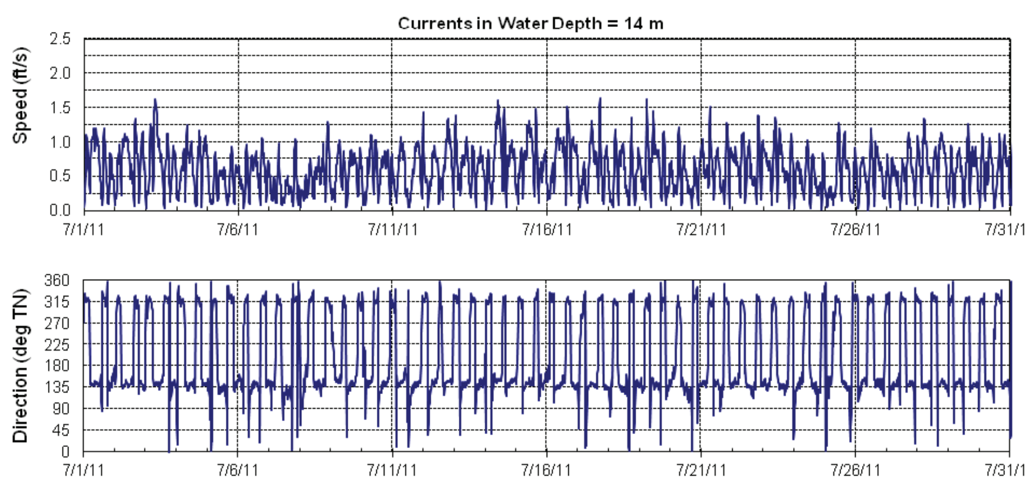

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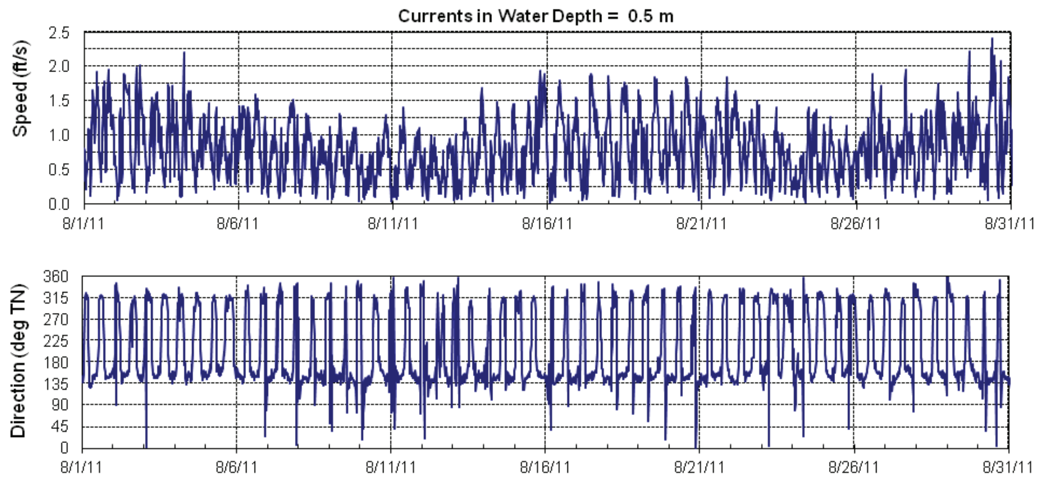
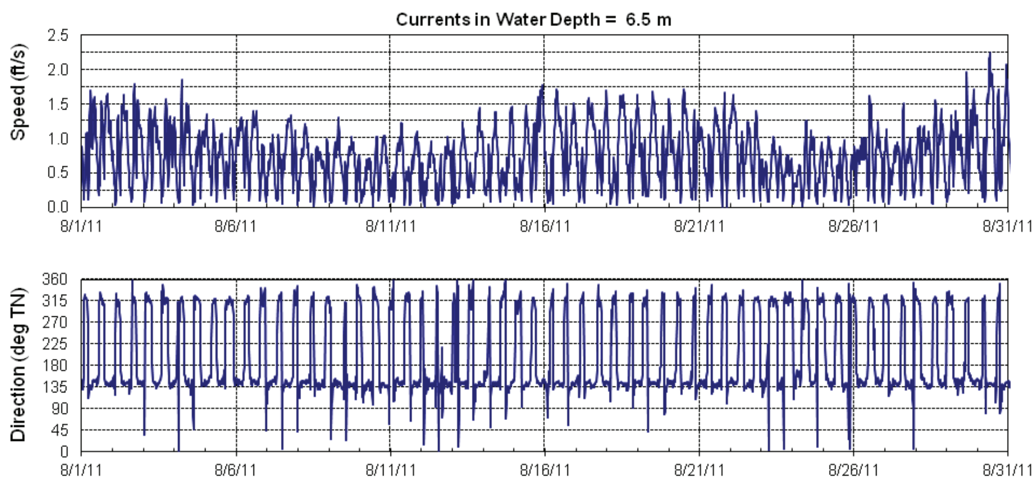
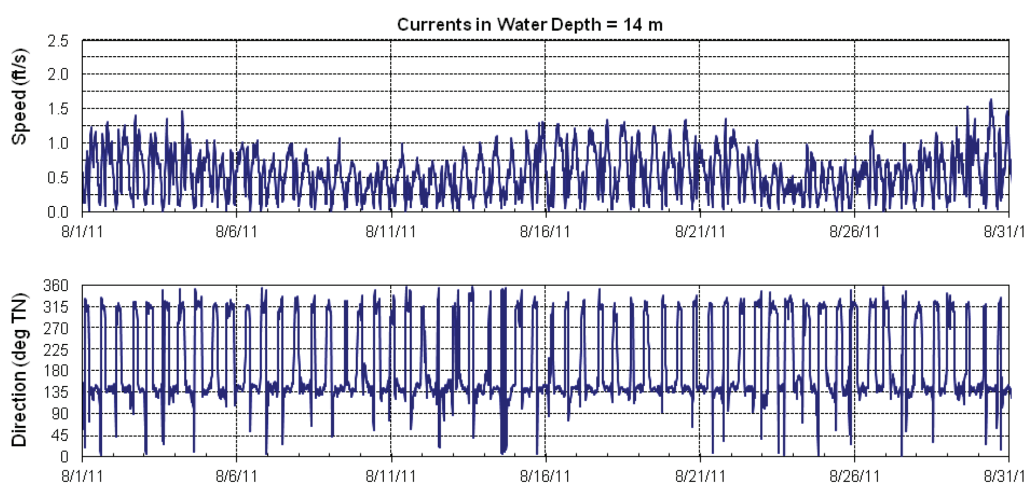
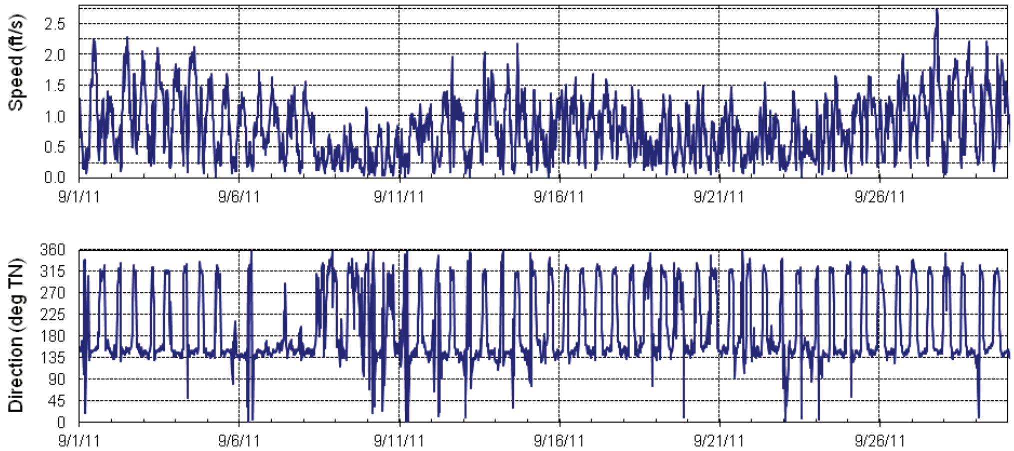




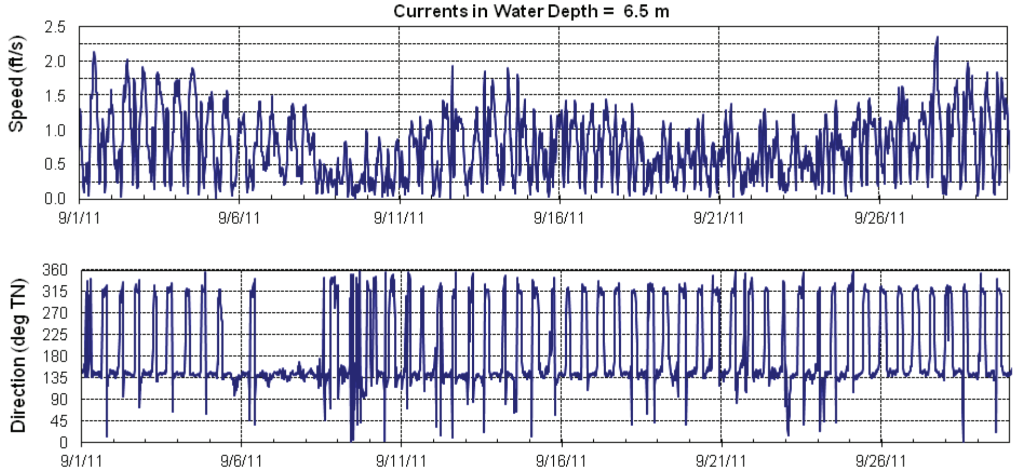


RDI Currents (September 2011)

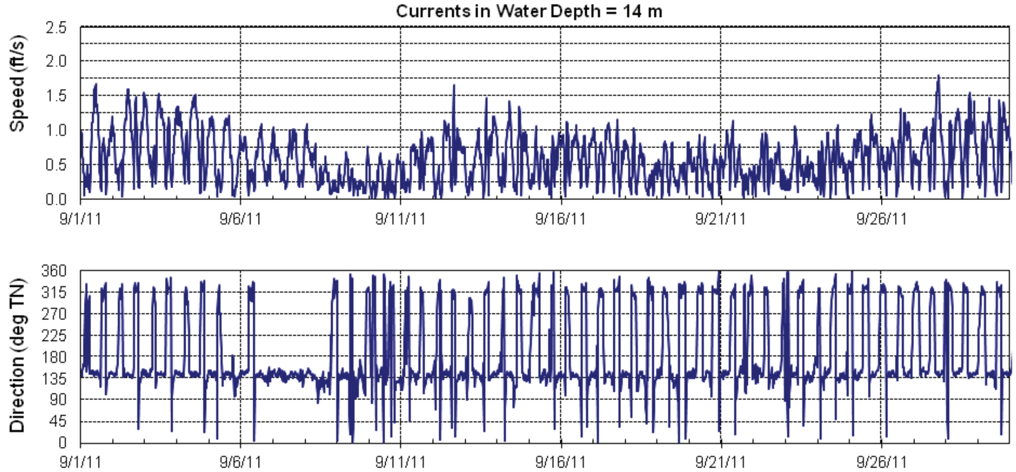
Currents in Water Depth = 0.5 m



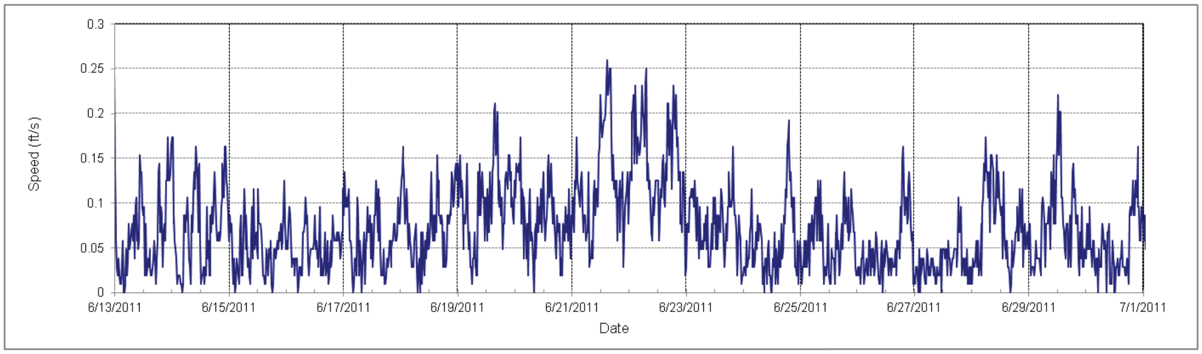
Currents in Water Depth = 6.5 m

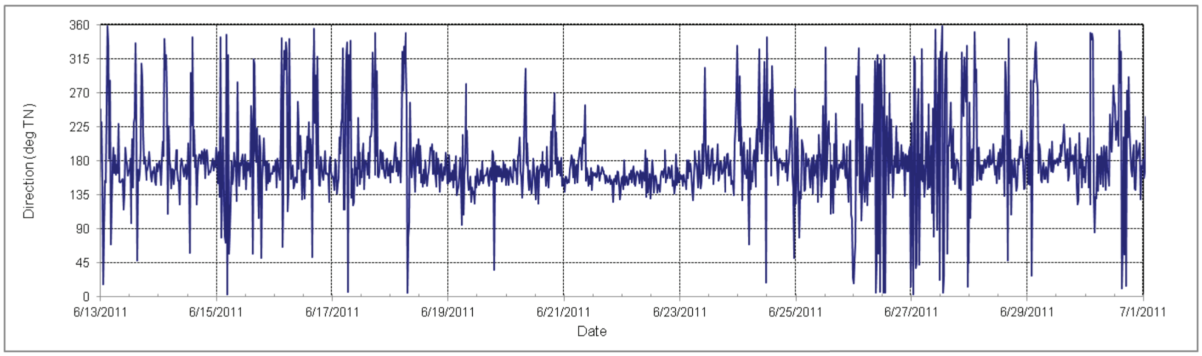


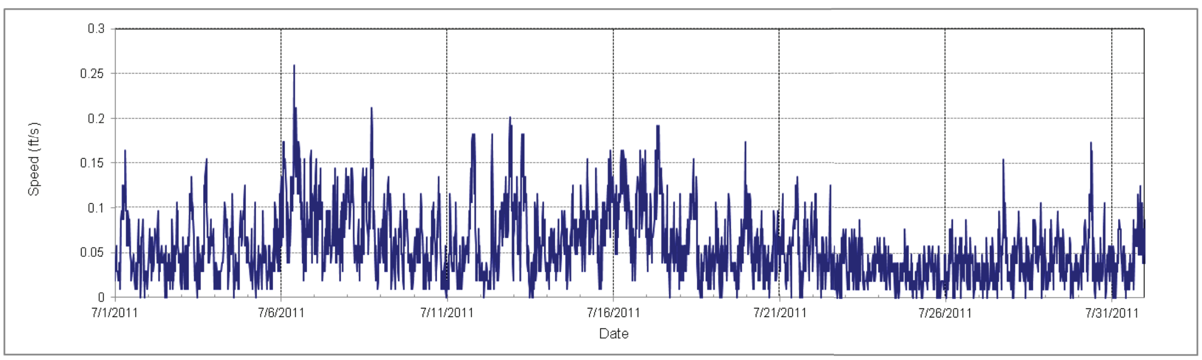
Currents in Water Depth = 14 m

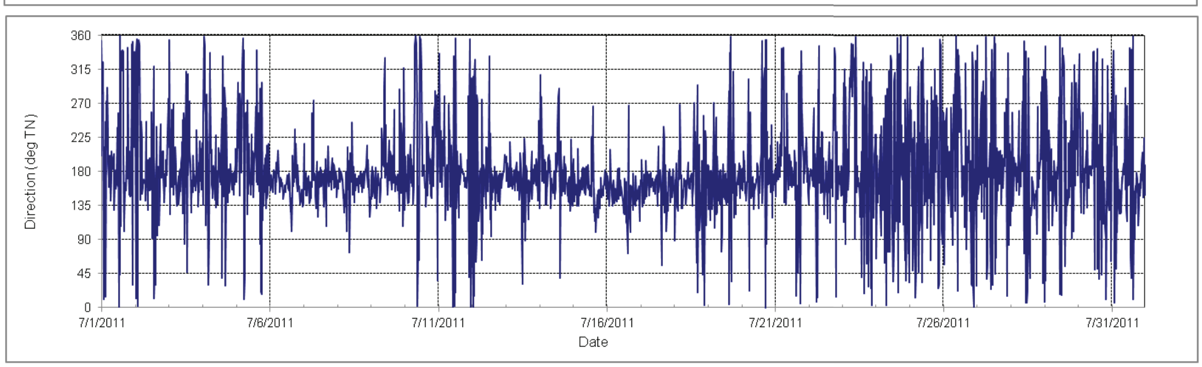


Aanderaa Currents (June – July 2011)

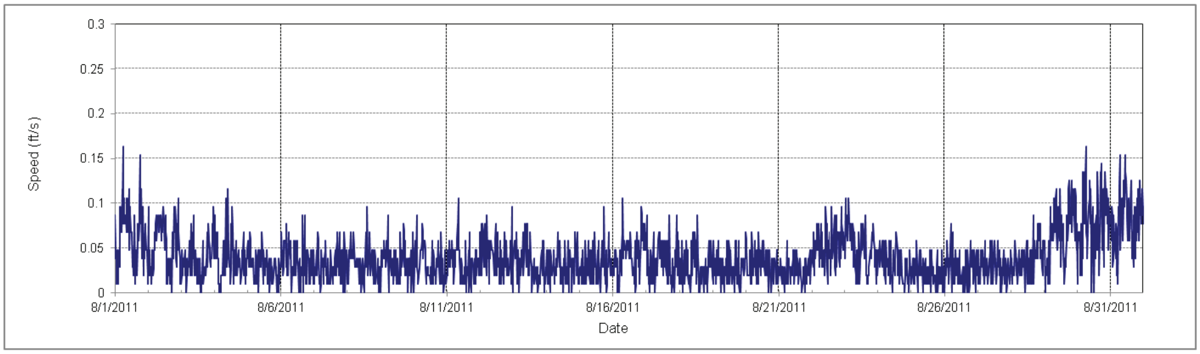


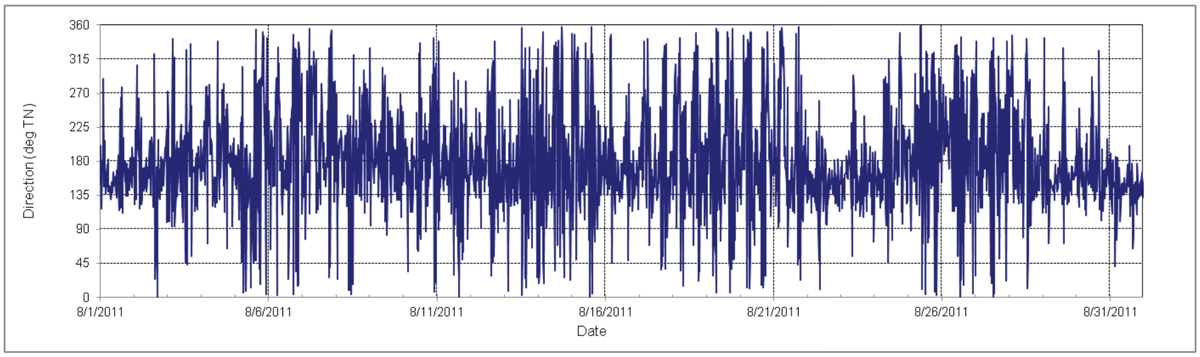


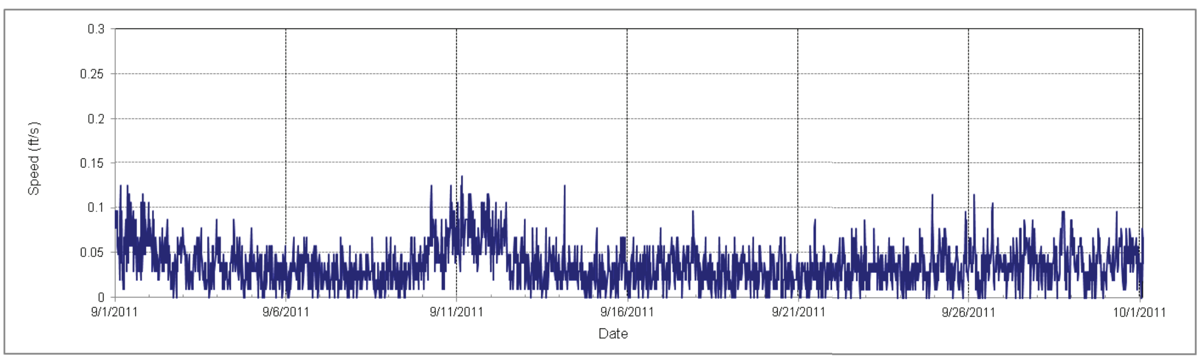


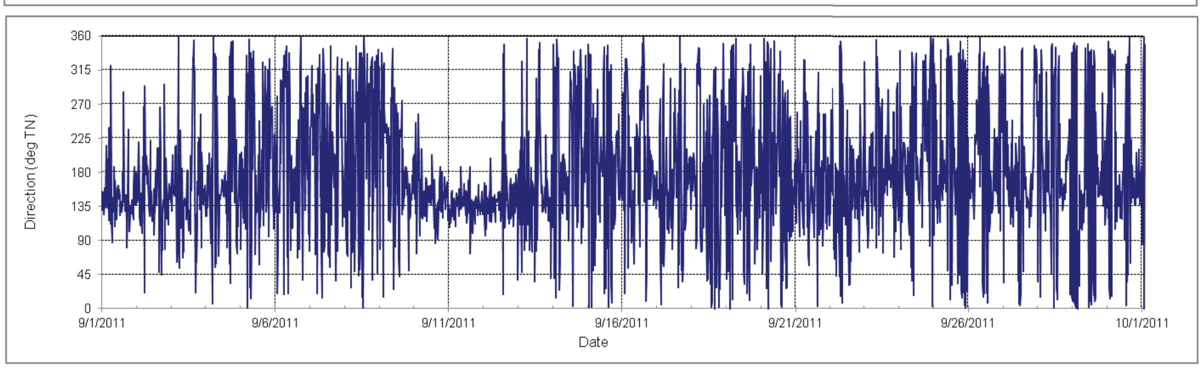


Aanderaa Currents (August – September 2011)

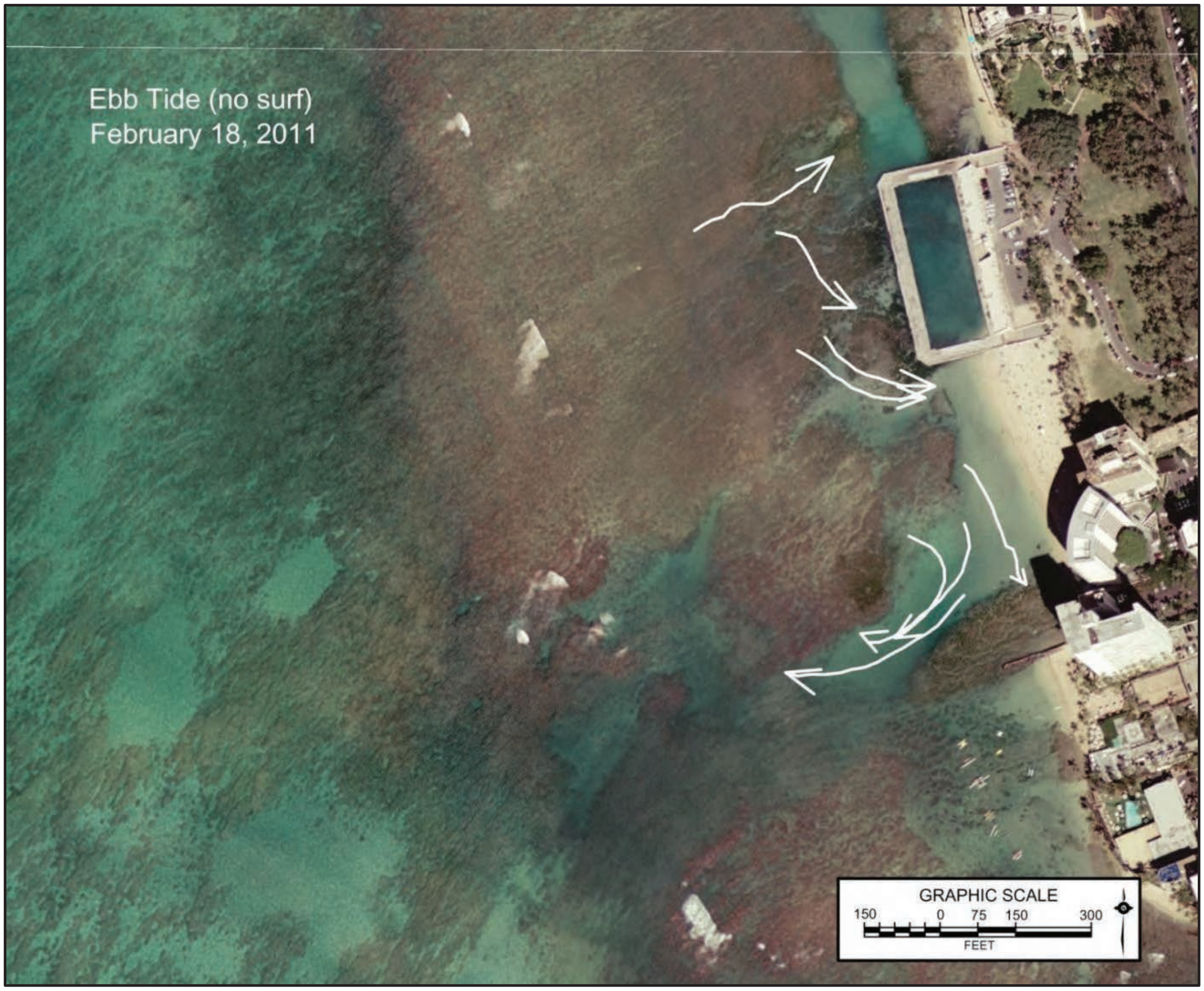


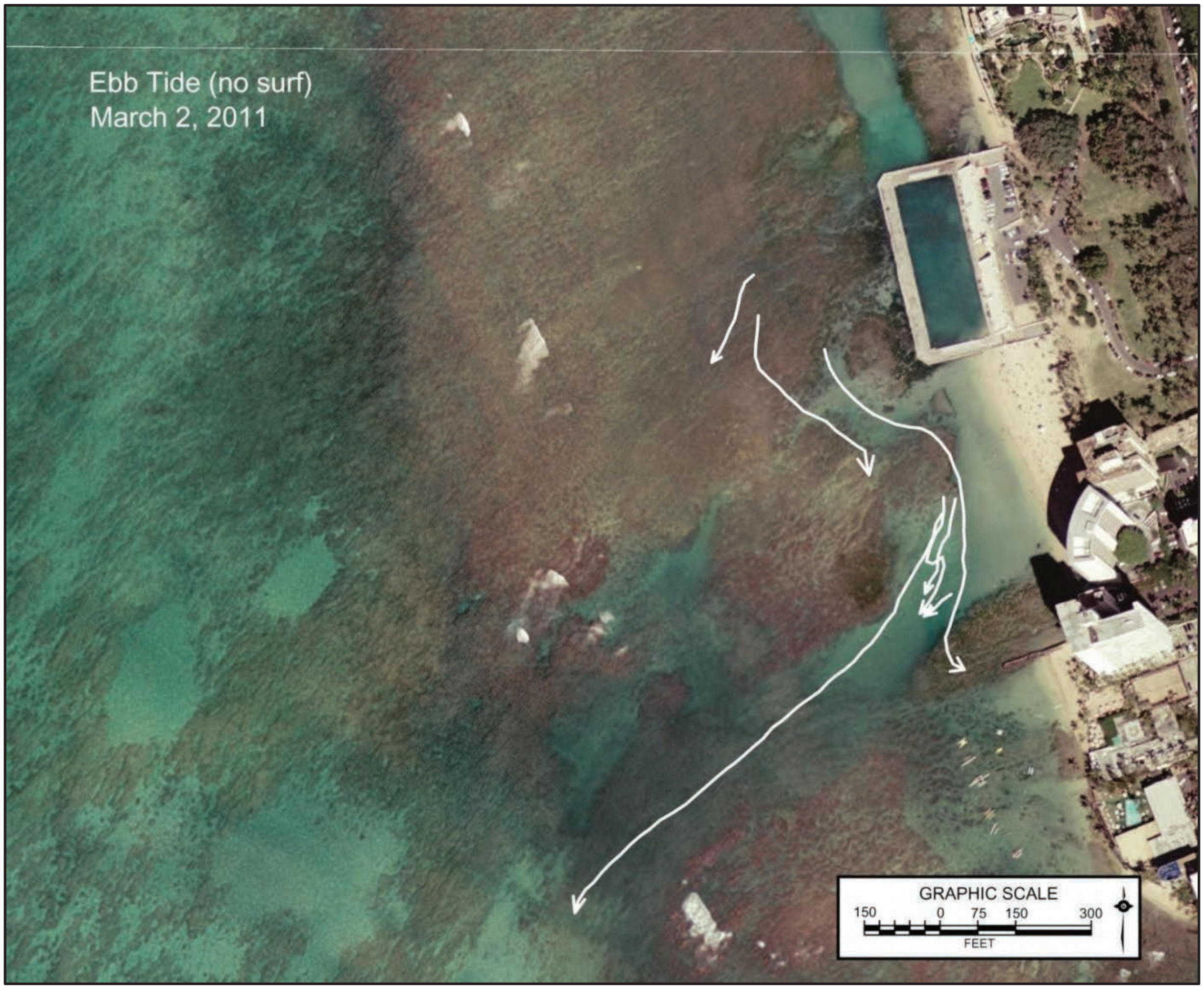


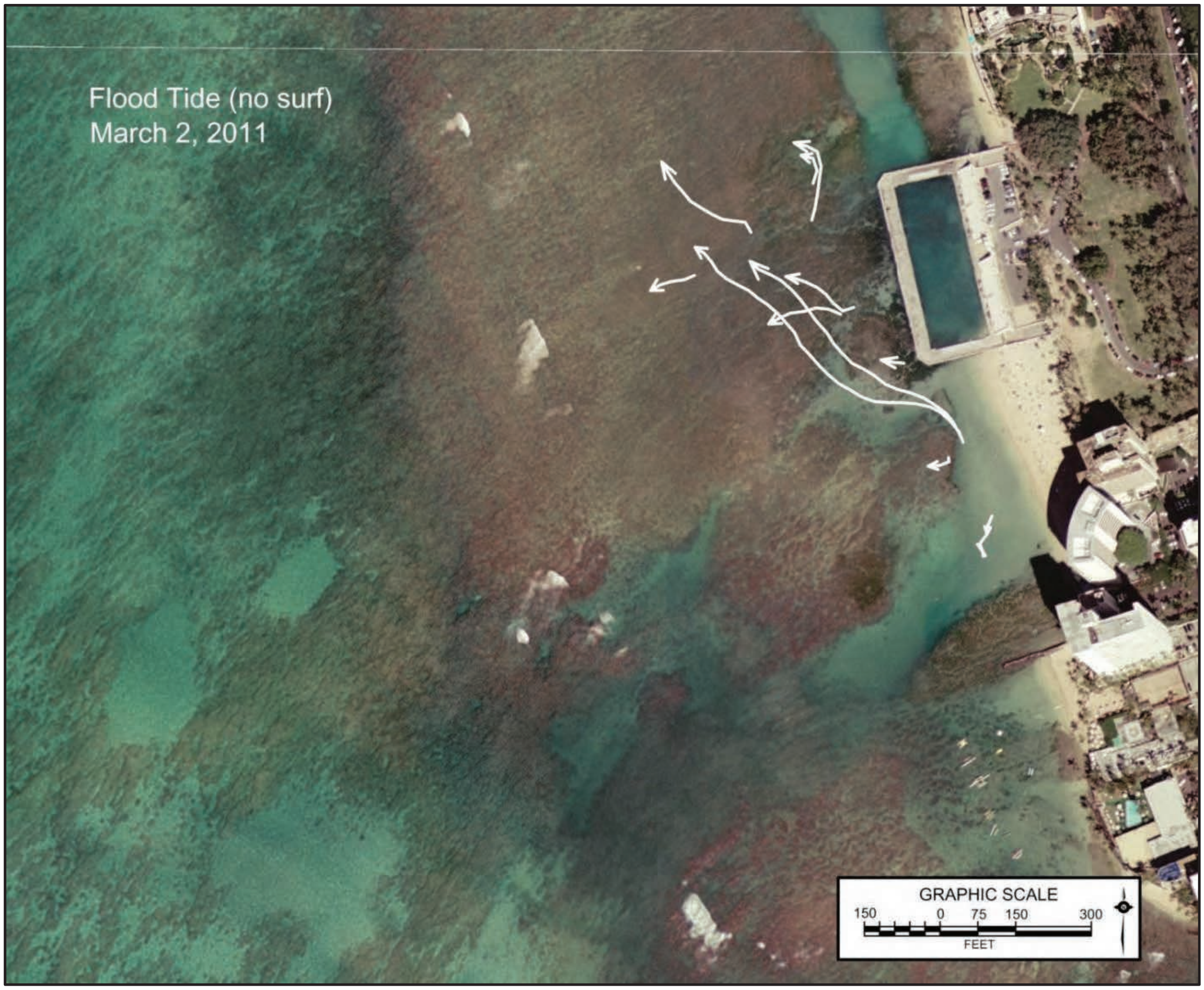


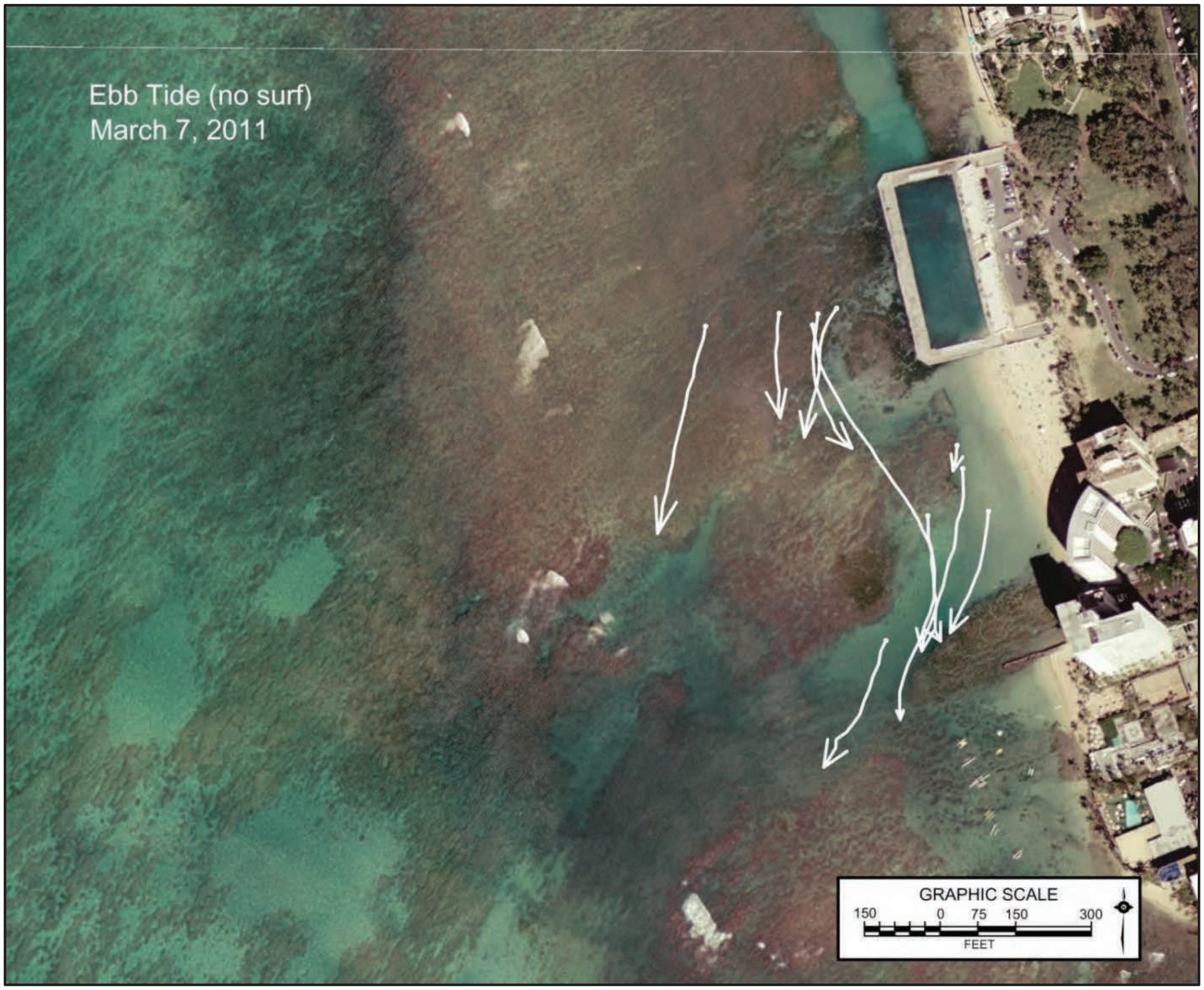


APPENDIX C.
DROGUE PATHS.
WINTER 2010-2011 AND SUMMER 2011 DEPLOYMENTS.



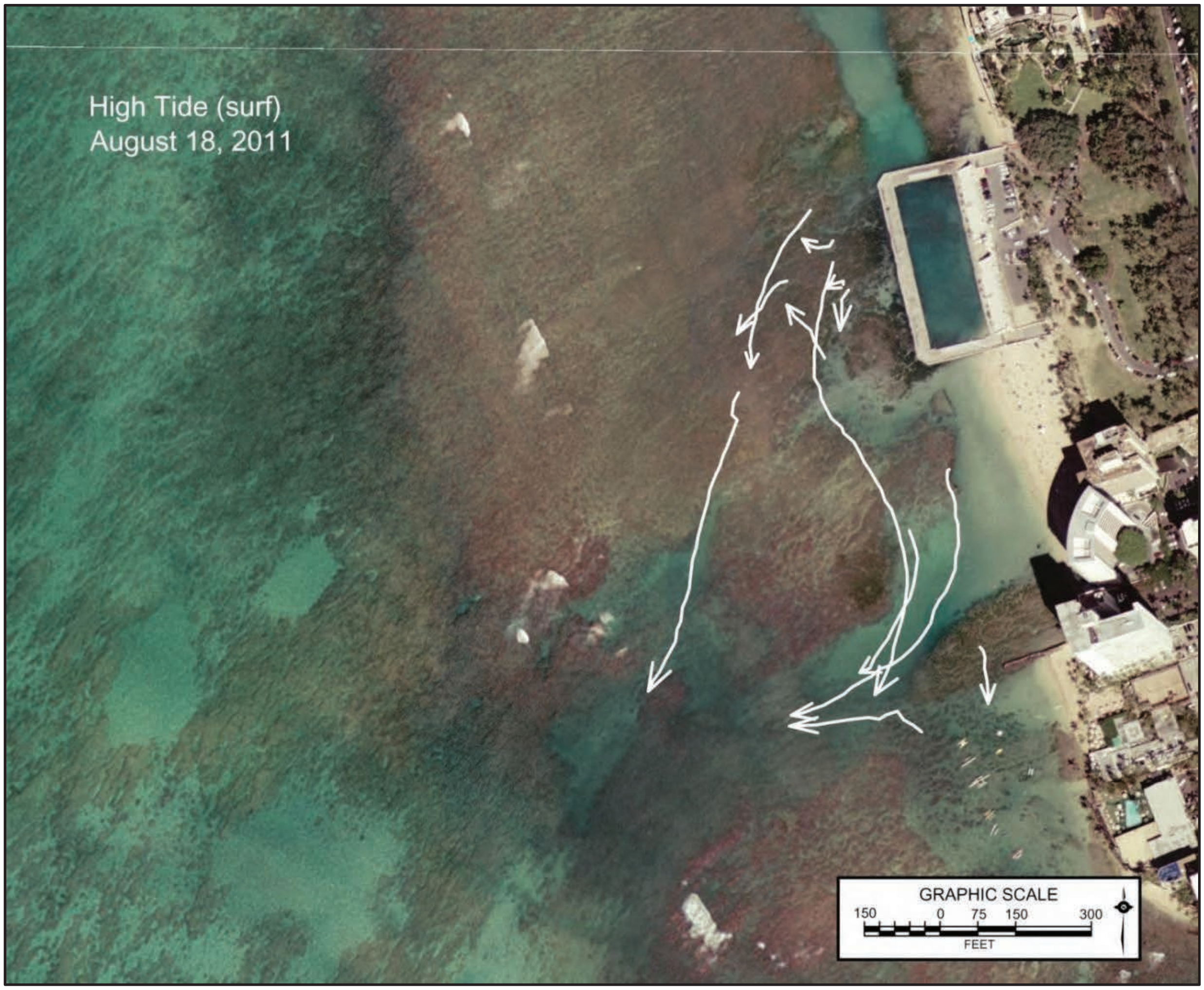

Ebb Tide (no surf)
March 2, 2011
GRAPHIC SCALE
150
0
75
150
300
FEET

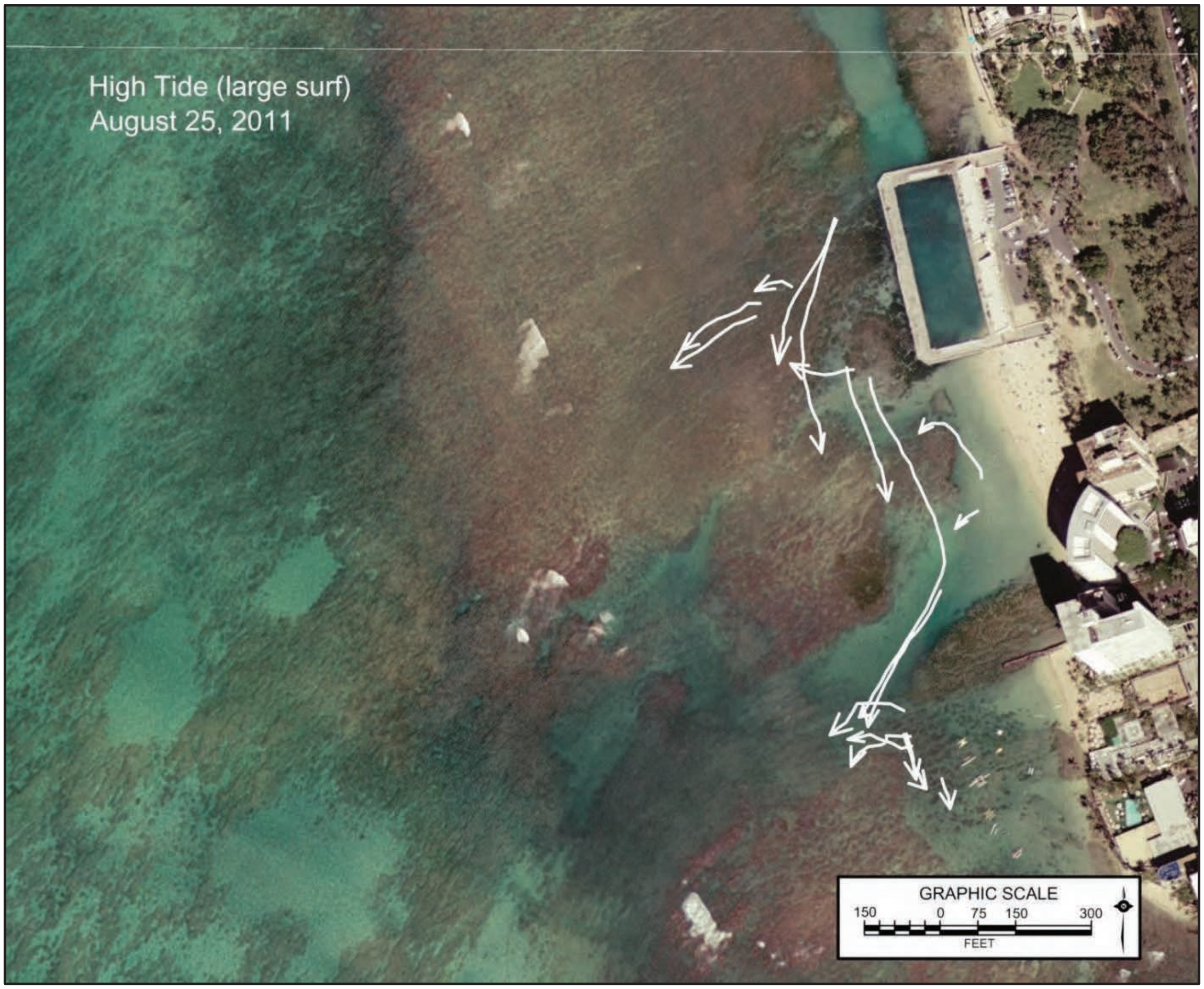

Flood Tide (no surf)
March 2, 2011
GRAPHIC SCALE
150 0 75 150 300
FEET


Ebb Tide (no surf)
March 7, 2011
GRAPHIC SCALE
150
0
75
150
300
FEET


Flood Tide (no surf)
March 7, 2011
GRAPHIC SCALE
150 0 75 150 300
FEET


Flood Tide (surf)
June 23, 2011
GRAPHIC SCALE
150 0 75 150 300
FEET


High Tide (surf)
August 18, 2011
GRAPHIC SCALE
150
0
75
150
300
FEET


High Tide (large surf)
August 25, 2011
GRAPHIC SCALE
150
0
75
150
300
FEET


High Tide (surf)
October 6, 2011
GRAPHIC SCALE
150 0 75 150 300
FEET

APPENDIX D.

GEOTECHNICAL CONSULTATION LETTER REPORT
IN SUPPORT OF BEACH STABILIZATION CONCEPT DEVELOPMENT.
WAIKIKI WAR MEMORIAL COMPLEX AT WAIKIKI BEACH.
HONOLULU, OAHU HAWAII.

YOGI KWONG ENGINEERS, LLC (2015).

FINAL SUBMITTAL

Geotechnical Consultation Letter Report

In Support of Beach Stabilization Concept Development Waikiki War Memorial Complex at Waikiki Beach

Honolulu, Oahu, Hawaii

Prepared for:

WCP, Inc.
99-061 Koaha Way Suite 209
Aiea, Hawaii 96701

July 2015

Prepared by:

YKE

Yogi Kwong Engineers, LLC
677 Ala Moana Blvd., Suite 710
Honolulu, Hawaii 96813

YKE Project No. 10022

July 22, 2015

Mr. Derek Yasaka
WCP Inc.
99-061 Koaha Way, Suite 209
Aiea, Hawaii 96701

Subject: **Final Submittal**
Preliminary Geotechnical Consultation Letter Report
In Support of Beach Stabilization Concept Development
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Dear Mr. Yasaka:

Yogi Kwong Engineers, LLC (YKE) is pleased to submit this preliminary geotechnical consultation letter report in support of the development of beach stabilization concepts for the proposed Waikiki War Memorial Complex project at Waikiki Beach on the Island of Oahu, Hawaii, for your use. Our geotechnical engineering services were performed in general accordance with the Agreement for Professional and Technical Services dated February 17, 2014 approving our fee proposal to Sea Engineering, Inc. dated November 5, 2013.

A draft submittal of the preliminary geotechnical consultation letter report was submitted for review and comment on July 11, 2014 and the project team's review comments have been incorporated into this submittal. We appreciate the opportunity to provide these services to WCP Inc. If you have any questions regarding this letter and the attached Geotechnical Consultation Letter Report, please do not hesitate to contact us.

Yours truly,

Yogi Kwong Engineers, LLC

Reyn Hashiro, P.E.
Associate

James Kwong, Ph.D., P.E.
Principal

Yogi Kwong Engineers, LLC
677 Ala Moana Blvd., Suite 710
Honolulu, Hawaii 96813
Tel: 808.942.0001
Fax: 808.942.0004

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Appendix

This report presents the results of a preliminary geotechnical evaluation performed by Yogi Kwong Engineers, LLC (YKE) in support of the development of beach stabilization concepts for the Waikiki War Memorial Complex Draft Environmental Impact Statement (EIS). The project site is located at Sans Souci Beach Park (the beach was also referred to as Kaimana Beach) in Waikiki on the island of Oahu, Hawaii.

Based on an email dated July 2, 2015 from Sea Engineering, Inc. (SEI), we understand that the two (2) previously proposed beach stabilization concepts have been modified to reduce potential construction difficulties..

The two (2) current beach stabilization concepts, Options 1 and 2, proposed by SEI are illustrated in Figures 5 and 6. Both concepts consist of removing the existing bleachers and boundary walls of the existing salt water swimming pool, and constructing new concrete groin stems approximately in the existing pool area. Beach sand will be placed between the concrete groin stems. Option 1 will include erecting new protective rock rubblemound groin heads at the ocean end of the groin stems. In Option 2, a shorter concrete groin stem will be constructed on the south side without a groin head, resulting in a narrow beach on the south side.

The new sand beach will be created ocean side of the entry arcade structure with a horizontal crest at +6 feet Mean Sea Level (MSL) extending gently downslope towards the ocean to a minimum depth of -4 feet MSL in both options. Please refer to Figures 7 and 8 for typical sections of the two concepts.

The approximate project location and its general vicinity are shown on the Project Location Map, Figure 1, and the Aerial Photograph of Project Location, Figure 2, respectively. Plan and profile views of the two (2) proposed options are shown in Figures 5 through 9.

1.1 PURPOSE AND SCOPE OF WORK

The purpose of this study was to provide preliminary geotechnical consultation for the conceptual beach stabilization scheme to be considered in the draft Environmental Impact Statement for this project by reviewing the existing geotechnical data supplemented by a new geophysical survey.

The following scope of services was performed in general accordance with the Agreement of Professional and Technical Services dated February 17, 2014 approving our proposal to Sea Engineering, Inc. dated November 5, 2013.

- Reviewed the Harding Lawson Associates geotechnical report entitled "Geotechnical Investigation, Waikiki War Memorial and Natatorium, Waikiki, Oahu, Hawaii, dated

December 12, 1991, its addendum dated March 1, 1996, and the pertinent construction design drawing for the reconstruction of the Natatorium dated December 3, 1998. The reconstruction project was awarded and about to begin when the City terminated the project.

- Reviewed the previous geotechnical report entitled "Geotechnical Exploration and Foundation Evaluation Report" by Yogi Kwong Engineers, LLC dated December 2011.
- Performed a brief site reconnaissance with SEI and its sub-consultant, Global Geophysics. Global Geophysics performed a geophysical survey over water along three (3) transect lines outside the existing salt water pool on April 17, 2014. YKE reviewed the interpreted geophysical data provided by Global Geophysics for probable geologic conditions.
- Prepared a draft Geotechnical Report dated July 11, 2014 for review and comment by the project team, and this final submittal summarizing our preliminary findings from engineering analyses and evaluations of the available geotechnical and geophysical data, and presenting our geotechnical recommendations for beach stabilization concepts evaluation and preliminary foundation support considerations for the proposed concrete groin / seawalls.
- Conducted an in-house quality assurance review of the geotechnical recommendations and preliminary evaluation findings by a principal engineer of our firm.

2.1 GENERAL SITE SURFACE CONDITIONS

The project site is located to the west of the existing WWI War Memorial in the Waikiki Natatorium in Kapiolani Park on Sans Souci Beach Park (the beach was also known as Kaimana Beach) on the island of Oahu, as shown in Figure 1. The beach park is bounded on the south by the New Otani Kaimana Beach Hotel and on the north by the Waikiki Aquarium. The beach park is currently provided with several shower stations, several bathrooms within the existing War Memorial Natatorium complex, and shoulder parking areas along an existing narrow access road and in a lower paved lot along the Natatorium wall .

Historically the area north of the ocean was part of Kapiolani Park where a horse racing track was located. The beach front and sandy beach was owned privately by descendants of the Alii. A portion of the 1912 Map of Waikiki is shown in Figure 4. The 1912 map indicated that there was a shallow reef flat along the shoreline and a remnant stream channel through the reef at the present Sans Souci Beach Park.

The Waikiki Natatorium was a salt water swimming pool with bleachers located on the north side. The bleachers, deck and the boundary walls surrounding the existing pool were constructed over the shallow reef flats and elevated above the water by pile foundations. The deck elevation was set at approximately +4 feet MSL and the top of the outer sea walls were at approximately +6.6 feet MSL. The bleachers are located on the north side of the pool and vary in height from 4 feet to 19 feet. A portion of the east and west walls of the pool were dredged to -10 feet MSL to install pipes for water circulation. A rubble rock wall was constructed around the pipes to construct the east and west walls. The pool area was dredged from -7 feet MSL to a maximum of -20 feet MSL. Over the years much of these facilities become corroded and deteriorated to an unusable condition.

The surface topography of the park area is generally flat at an average ground surface elevation of +7 feet MSL. An approximately 3.5-foot high retaining wall separates the road shoulder from the Natatorium. A volleyball court and a parking lot are located between the short retaining wall and the boundary wall on the north side of the Natatorium. The existing ground elevations at the volleyball court and the parking lot vary from approximately +4 feet to +3.2 feet MSL.

Presently the concrete structure of the Natatorium is spalling and portions of the deck surrounding the pool have collapsed. It appears that spalling was mostly caused by corrosion of the steel reinforcement bars within the concrete structure.

2.2 REGIONAL GEOLOGY

The island of Oahu was built by two (2) shield volcanoes, the Waianae volcano and the Koolau volcano. The older Waianae volcano was built in the west, and the younger Koolau volcano was built in the east. Each volcano has been truncated by massive submarine landslides, the Waianae Slump to the southwest and the Nuuanu Slide to the northeast. The Waianae volcano and Koolau volcano have ages dated from about 4.0 million years (Ma, Mega annum) to as young as about 2.9 Ma and from about 3.0 Ma to 1.78 Ma respectively (Sherrod et al, 2007).

A vast amount of the Waianae and Koolau volcanoes was removed by fluvial and marine erosion during the Pleistocene that created deep valleys. After these erosion cycles, the island was submerged more than 1,200 feet, and the valleys were drowned and alluviated. Scattered sporadically above the Koolau basalt are lava flows and vent deposits of the rejuvenated stage of Hawaiian volcanism, the Honolulu Volcanics. About 40 Honolulu Volcanic vents have been identified and are concentrated within the southeastern portion of the elongated Koolau edifice. Some of the best known vents include Diamond Head, Punchbowl Crater, Salt Lake Crater, and Koko Head.

During the last several hundred thousand years, regressions and transgressions of sea level occurred, which resulted in renewed erosion of the higher deposits and growth of coral farther offshore. The fluctuations of the sea level that took place at the same time that the Honolulu Volcanic Series were deposited (about 50,000 years ago to present) resulted in migrating shorelines, and the formation of deep erosion channels from Manoa and Palolo Valleys. These erosion channels dissected upland or deeper basaltic lava flows and earlier coral and alluvial deposits. During periods of low sea level, these alluvial channels (valleys) and erosion surfaces developed well below the current mean sea level. Sea level fluctuations also contributed to the consolidation or over-consolidation of some alluvial silts and clays, resulting in very stiff to hard consistency.

The project area is located in lower Waikiki on the island of Oahu adjacent to Mount Leahi (Diamond Head Crater). Mount Leahi is a volcanic tuff crater that was active during the period known as the Honolulu Series Volcanics. The crater formation changed the stream flows. Most of these erosion channels in the project area were later filled in by the alluvial and tuffaceous deposits. The remnant of a stream channel can be seen in the reef at Kaimana beach adjacent to the Natatorium.

Ancient back-reef sedimentation basins in the area were infilled by very soft and loose lagoonal and estuarine deposits and swamps while the sea level rose and fell during glacial and interglacial periods. Substantial man-made fills were placed to raise the ground surface of much of the lower Waikiki when the area was originally developed. Due to the past complex depositional environment in the area, variations in stratigraphy, complex interbedding and intercalations of the above deposits within short distances, in both vertical and horizontal directions, should be expected.

Coralline deposits were formed primarily as a result of wave actions on coralline reefs during different stands of the sea level. Wave actions caused breakage of reef formation to form rubblestone to coralline detritus. Subsequent re-cementation of coralline debris by algal coral and influx of brackish water organisms through the beach sand deposits formed cemented calcareous sandstone to "beach rock" limestone ledges. Rises in sea level introduced an influx of fine sediments in a matrix with coarse coralline detritus. Due to the wave actions dominating the depositional environment, coralline deposits and coral reef limestone are often highly variable in all directions.

The regional geology map of the project area and its vicinity is presented in Figure 3. The geology of the project site consists of beach deposits (Qbd) that were formed by the erosion of paleo coral reefs which have been re-worked by waves and deposited as beach deposits. To the east of the project area lies alluvium (Qa) and Honolulu Volcanics tuff cone deposits (Qot).

2.3 SUBSURFACE CONDITIONS

The subsurface conditions presented in this preliminary geotechnical consultation letter report are based on our interpretation of the historical subsoil data in the geotechnical report entitled "Geotechnical Investigation, Waikiki War Memorial and Natatorium, Waikiki, Oahu, Hawaii, by Harding Lawson Associates, dated December 12, 1991; its addendum dated March 1, 1996; and the geotechnical report entitled "Geotechnical Exploration and Foundation Evaluation Report, Waikiki War Memorial Complex at Waikiki Beach, Honolulu, Oahu Hawaii," by YKE, dated December 2011; which are supplemented by the geophysical data from Global Geophysics taken on April 17, 2014 and YKE's general experience in this area. These reports by others are included in Appendices B and C.

The project site is located inland of Kapua Channel, a possible ancient alluvial channel cutting through the coral reef limestone during the Malama Low Stand of sea level. The channel was infilled on the shore by lagoonal and estuarine deposits. The area surrounding Kapua Channel is mantled by shallow reef flats that are exposed during extreme low tides. The borings drilled by Harding Lawson Associates within the Natatorium indicated that a well cemented reef flat crust did not exist at their boring locations. The borings indicated that at some locations, only a relatively thin medium dense crust of coral sand and gravel detritus existed in the top portions of the borings. No substantial coral reef formation was encountered within the existing pool.

The on land boring data from YKE's Borings B-1 and B-2 indicated that the two (2) onshore borings were located over relatively shallow and well cemented coral reef limestone. The data from Boring B-3 is similar to the Harding Lawson borings with no indication of a reef flat formation over the lagoonal deposits.

The 1996 HLA borings within the Natatorium in general encountered lagoonal deposits consisting of loose to very loose gray silty beach sand and coral fragments. At approximately 17 to 24 feet below the top of the borings, very soft gray sandy silt was encountered down to approximately 40 to 43 feet depth. At 40 to 43 feet bgs, a reef formation consisting of light brown to brown coral limestone was encountered.

The subsoil conditions can therefore be generalized into four (4) predominant soil or geologic units which, however, were not all encountered within the same boring as discussed below.

- FILL. Variable on land fill materials were encountered in YKE's Borings B-1 and B-3 to approximately 1.5 to 2.5 feet below ground surface (bgs) respectively and consisted of medium stiff to stiff brown elastic silt with sand and roots. Thicker fill materials were encountered within the pool and generally consisted of basalt and coral sand and gravels.
- BEACH and REEF DEPOSITS. Beach and reef deposits appear to primarily consist of very loose to medium dense, tan to off-white coralline sand and silty coralline sand and occasional coral gravel.
- LAGOONAL DEPOSITS. Lagoonal deposits appear to generally consist of very loose gray silty beach sand and very soft gray slightly sandy silt with shells.
- CORAL REEF LIMESTONE / CORALLINE DEPOSITS – Off-white to tan, moderately to strongly cemented hard coral reef limestone was encountered on land in YKE Boring B-1 approximately from 7 feet to the end of the boring at approximately 17 feet bgs. Coralline deposits, possibly very weakly cemented, were encountered in Boring B-2 approximately from 7 feet to the end of the on land boring at approximately 30 feet bgs. The coralline reef formation was encountered in the 1996 Harding Lawson Associate borings at approximately 40 to 45 feet below the surface and consisted of dense, light brown to brown silty coralline gravel with sand or well cemented coral limestone.

The over water geophysical survey was performed on April 17, 2014 by Global Geophysics, under subcontract to Sea Engineering Inc. The data was obtained by using resistivity methods. The survey location and the results coded data are shown in Appendix B. In general, the higher the resistivity in ohm-meter, the higher the density of the material surveyed. At this time, the geophysical interpretation of possible subsurface conditions along the transect line may include the possible presence of a void or sink hole (lowest resistivity, violet color zone on the profile), and the possible presence of very soft or very porous lagoonal materials (blue color zone on profile). Possible coral reef formation may be present depicted in light green to dark red colored zone on the profile.

3.1 BEACH STABILIZATION CONCNEPTS

Based on our preliminary evaluation using pertinent geotechnical data from the available references, we believe that both Options 1 and 2 developed by the study team to create a protected beach at the war memorial complex site appear to be feasible from a foundation support standpoint. The geotechnical aspects of various design concepts for filling the existing pool and construction of the proposed rock rubblemound groin heads and sea wall foundations discussed with the project team during the course of this study are summarized below.

3.2 DEMOLITION AND FILLING OF THE POOL

It is our understanding that the existing pool deck, bleachers, front and side walls would be demolished prior to filling of the "pool" in both schemes; however, the back wall forming the pool adjacent to the existing bleachers on the east side would be retained. It is our opinion that filling of the pool could be performed by placing boulders to small rock or coarse gravel on the bottom of the existing pool up to an elevation of -5.5 feet MSL and topping it with beach sand to the currently proposed finish beach depth at -4 feet MSL. However the cobbles and boulders will sink into the compressible soils, to a certain extent. The weight of the new fills will include short and long term ground settlement or subsidence.

To reduce potential ground settlement and to support the new beach sand over boulder or gravel fill, the soft sediments below the pool bottom could be improved by installation of stone columns, soil mixing with grout, and possibly other ground improvement techniques. To reduce loss of the rock or gravel fill into the underlying soft soils, if practical, geotextile such as filter fabric and geogrid could be placed over the soft sediments on the bottom of the pool, otherwise a properly designed aggregate filter layer must be designed and placed between the new fills and the highly compressible lagoonal soils. The rock or gravel fill could also be reinforced with geogrid to create a stiffer fill layer to be spread over the underlying highly compressible subsoils. On top of the rock or gravel fill at -5.5 feet MSL, geotextile (if practical) and/or an aggregate choking layer could be used to minimize loss of the overlying beach sand into voids of the underlying rock or gravel fill.

The new fills in the swimming pool is anticipated to settle substantially due to compression and consolidation of the underlying highly compressible soils. Based on previous settlement estimates in the Harding Lawson reports, it appears prudent to assume that the initial pool filling may settle several feet or more. Even with ground improvement, a substantial amount of additional beach sand may therefore need to be imported and placed above the rock or gravel fill to achieve the desired finished beach depth.

A project specific geotechnical investigation should be performed to explore the site conditions and to provide soil samples for testing and settlement and ground stability analysis.

3.3 ROCK RUBBLEMOUND GROIN HEADS AND SEA WALL FOUNDATIONS

The proposed groin steams / sea walls and rock rubblemound groin heads at the end of the new sea walls would be located on the northern and southern sides of the exiting swimming pool to protect the new beach. The available topographic information in the 1991 construction plans indicated that the depth to firmer subsoils could be relatively shallow in general. The topographic map and available data also indicate that the depth to a firm bearing stratum below the proposed new sea walls or groins under the revised concepts appears to be deeper at approximately -7 to -16 feet MSL. Dredging or removing the soft sediments to these depths and filling without impacting the adjacent areas and structures will be very difficult if not impossible. The differential settlements of the new sea walls or groins may also be substantial.

Therefore, we recommend that the new sea walls or groins be constructed on a concrete structural base mat that is supported on pile foundations. However, handling and driving long and heavy pre-stressed concrete pile will be a significant challenge as large cranes operating over water and heavy pile driving hammer will be required. We believe that lighter and sufficiently thick steel pipe piles could be used to support the new sea walls as the pipe piles could be driven to the underlying coral limestone formation using a light weight hammer mounted on a small crane or fork lift that generally can be readily launched onto a suitable water craft. The use of the pipe piles and a relatively smaller driving hammer would also reduce potential ground vibration generated during pile driving that may adversely impact the adjacent Honolulu Aquarium and other structures.

For preliminary planning purposes, we believe that the pipe piles can be designed for a nominal vertical capacity of 25 tons per pile if driven to a sufficient depth. The geophysical data indicates that coral formation may not be substantially present or exist in a local area. Therefore the pipe piles supporting the north seawall may have to be driven to greater depths in this area. A detailed geotechnical investigation should be performed in the design phase to explore the depth and conditions of a suitable bearing stratum, to develop the anticipated pile driving details. and to evaluate if the pipe piles should be closed or open ended.

The rock rubblemound groin heads could be constructed as a boulder and rock revetment with sufficiently large rubble stones on the outer shell and progressively smaller stones in its core and base layers. The design of the rock rubblemound should be performed by the Ocean Engineer. Based on the geophysical data, firmer subsoils may be present at relatively shallow depths at the proposed rubblemound areas. Soft sediments below the mudline and overlies the firmer subsoils should be substantially removed prior to construction of the groin heads from a geotechnical standpoint. Similar to the pool filling method, geosynthetic reinforced rock or gravel fill could be used to backfill below the bottom of the groin heads. The purpose of the reinforced fill layers is to spread the weight of the groin heads to reduce potential fill induced differential settlements. The reinforced fill details and requirements should be evaluated during the design phase of the project, when project specific subsurface and laboratory testing data can be obtained.

3.4 LIQUEFACTION POTENTIAL AND SEISMIC DESIGN CONSIDERATIONS

Liquefaction is a phenomenon in which a soil loses a substantial amount of shear strength due to the build-up of excess pore-water pressure, which is most commonly generated by strong earthquake ground shaking. Liquefaction can also occur as a result of cyclic loading conditions generated by vibratory construction equipment. In general, soils most susceptible to liquefaction are saturated, loose, uniformly graded, fine-grained sands containing little or no fines. The HCA 1996 report indicated the site may be susceptible to soil liquefaction in a significant earthquake. Based on the currently available data, we take no exception to this opinion.

A detailed analysis of the liquefaction potential of the project site would have required a more elaborate field exploration program including the drilling and sampling of deep borings to about 100 feet below the existing grade. Such an analysis is beyond the current scope of work for this preliminary geotechnical evaluation and consultation.

3.5 FUTURE GEOTECHNICAL INVESTIGATION

This report was prepared using existing data for the purpose of preparing an EIS report. It is important that project specific additional geotechnical investigations be performed during the design phase to support the design of the pile foundations and the reinforced rock or gravel fills below the proposed beach and new sea walls or rock revetments. Additional boring data is also needed in the areas where the geophysical survey did not detect any probable coral reef formation, such as along the proposed northern sea wall.

The preliminary geotechnical opinions presented in this report are for planning purposes only. They are based on the assumption that the scope of the project design, as described, does not change appreciably and that significant variations in soil properties from those encountered by the previous field exploration and the subsurface conditions discussed in this report do not occur. The descriptions and discussions of anticipated subsurface conditions presented in this report are intended to assist WCP Inc. (WCP), SEI and the City & County of Honolulu, Department of Design and Construction (DDC) study team in the preliminary evaluation of possible beach stabilization concepts only. A more detailed geotechnical evaluation and investigation will be necessary to support the design of the beach stabilization concepts, when the concept(s) are further developed.

This report was prepared for use by WCP, SEI and DDC's study team in accordance with generally accepted geotechnical engineering principles and practices. The geotechnical opinions and recommendations given in this report are based on our analysis of the data collected for this conceptual project. Any additional conclusions and/or recommendations made from the data by others are solely their own responsibility.

No warranty is included, either expressed or implied, that the actual conditions encountered will conform exactly to the conditions described herein. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended or implied.

Note that the scope of service associated with this report was designed solely to achieve the objectives, schedule, budget, and risk-management preferences WCP, SEI and DDC's study team established for this project. Except WCP, SEI and the DDC's study team, no one should use or rely on this report. No one, not even WCP, SEI and the DDC's study team, should use or rely on this report for any extension of this project, for any other project, or for any other purpose. Unless YKE verifies in writing that it has reviewed the report and that the proposed use, reuse or reliance is acceptable, any such use, reuse, or reliance is prohibited and shall be at the user's, reuser's, or relier's sole risks.

It is our assumption that a more detail geotechnical study will be performed in the future if the beach stabilization concepts discussed herein proceed to the design phase.

Barker, R. M., et al., 1991. Manuals for the Design of Bridge Foundations. National Cooperative Highway Research Program NCHRP Report 343

DAS, Braja M., 2006. *Principles of Geotechnical Engineering, Sixth Edition.* Thomson Canada Limited.

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MacDonald, G.A., Abbott, A.T., and Peterson. F.L., 1983. *Volcanoes in the Sea: The Geology of Hawaii*, 2nd Edition, University of Hawaii Press, Honolulu, Hawaii.

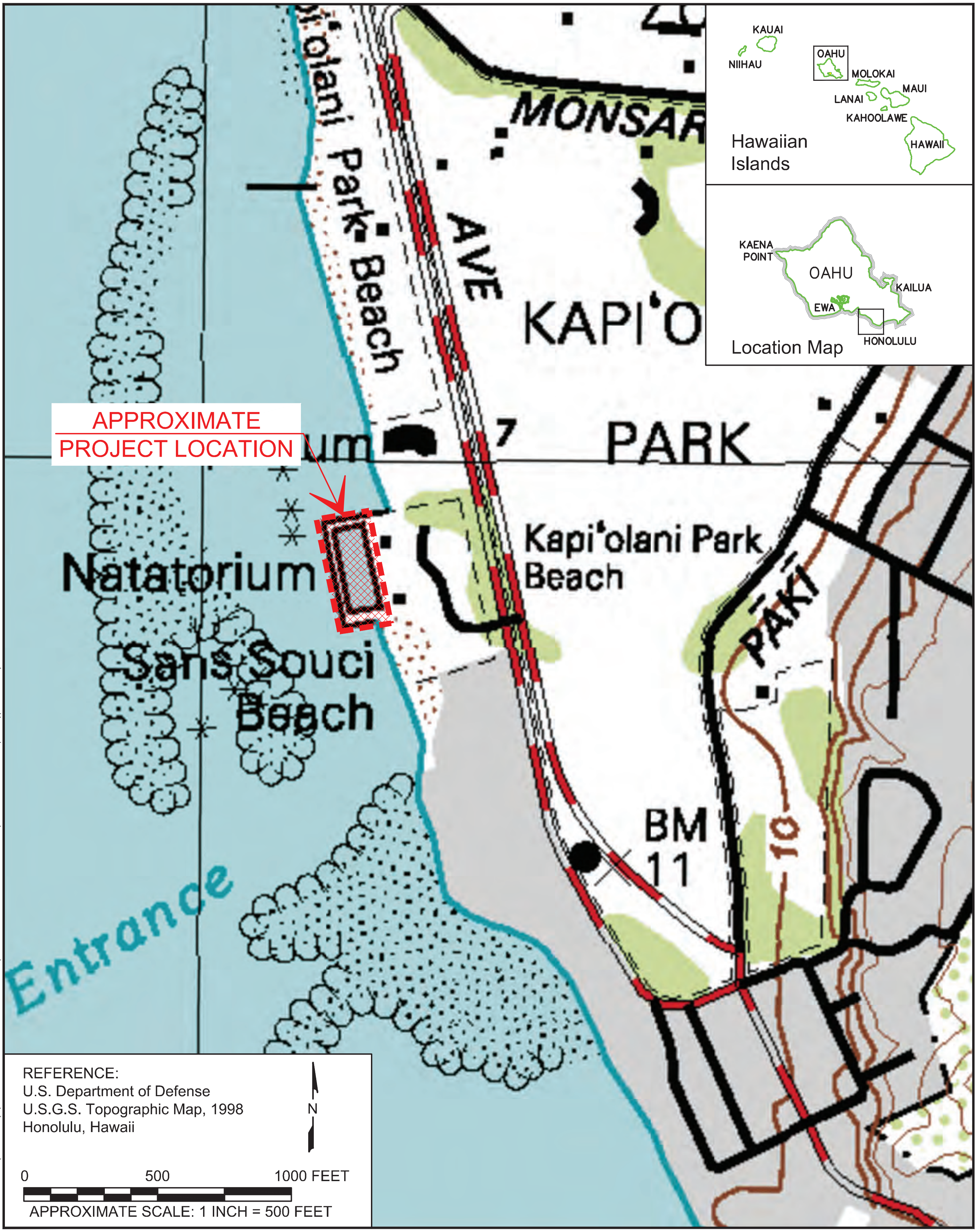
Sherrod, David R., Sinton, John M., Watkins, Sarah E., & Brunt, Kelly M., 2007. *Geologic Map of the State of Hawai`i: U.S. Geological Survey Open-File Report 2007-1089*.

Sowers, G. F., Hedges, C. S., 1966. "*Dynamic Cone for Shallow In-Situ Penetration Testing", Vane Shear and Cone Penetration Resistance Testing of In-Situ Soils.* ASTM Special Technical Publication #399.

Stern, H.T. and Vaksvik, K.N., 1935. *Geology and Groundwater Resources of the Island of Oahu, Hawaii*. Division of Hydrography Bulletin 1.

U.S. Geologic Survey Topographic Map, 1998. *Honolulu Quadrangle*. U.S. Department of Defense.

FIGURES



PROJECT LOCATION MAP

Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022.01

YKE
YOGI KWONG ENGINEERS, LLC

FIGURE 1

P:\10022.01 WAIKIKI NATATORIUM EIS (ANNEX A)\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\(10022.01) FIGURES 1 TO 3 & 5 – PROJECT LOCATION, AERIAL PHOTO, REGIONAL GEOLOGY.DWG

AERIAL PHOTOGRAPH OF PROJECT LOCATION

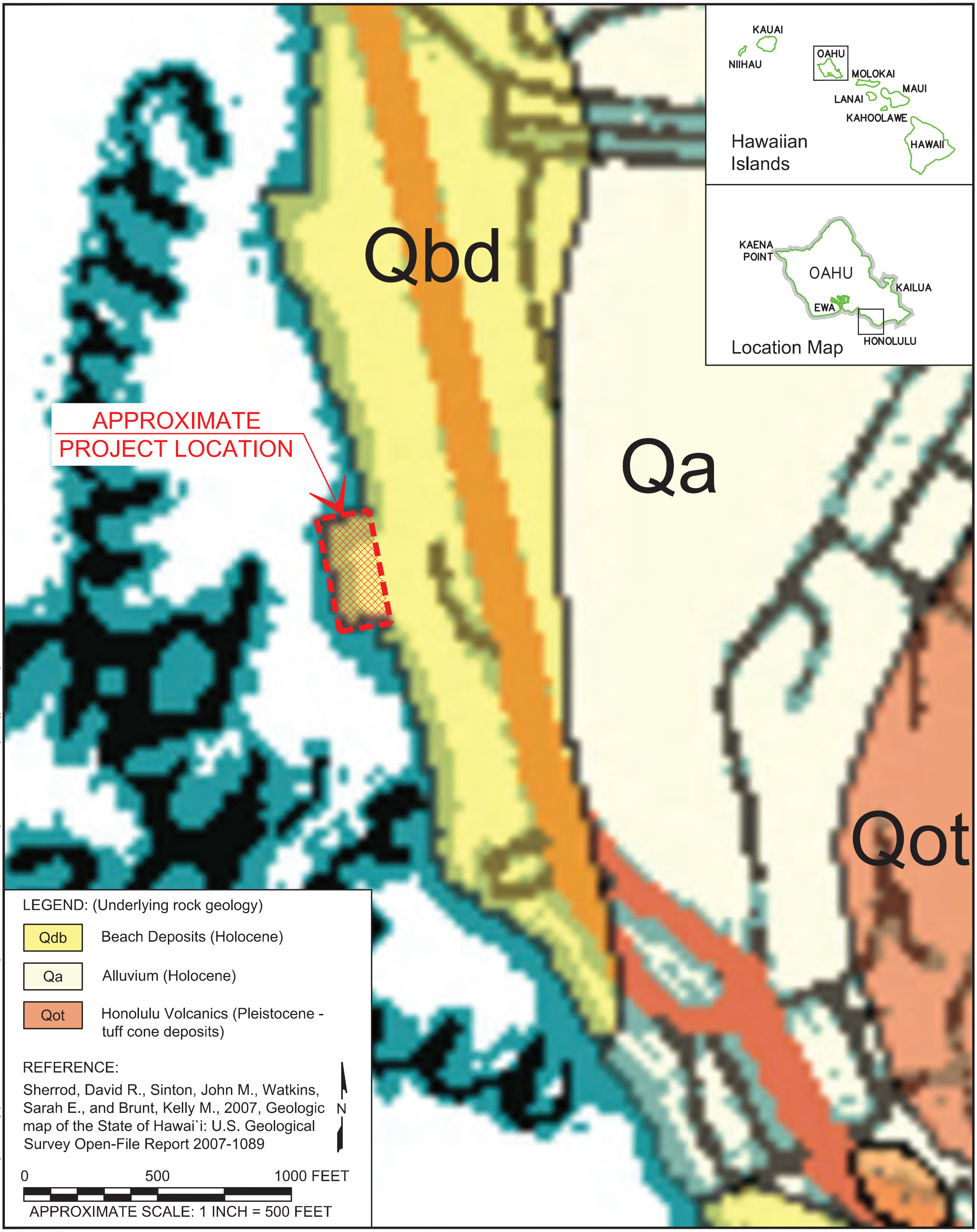
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022.01

YOGI KWONG ENGINEERS, LLC

FIGURE 2

P:\10022.01 WAIKIKI NATATORIUM EIS (ANNEX A)\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\(10022.01) FIGURES 1 TO 3 & 5 – PROJECT LOCATION, AERIAL PHOTO, REGIONAL GEOLOGY.DWG



REGIONAL GEOLOGY MAP

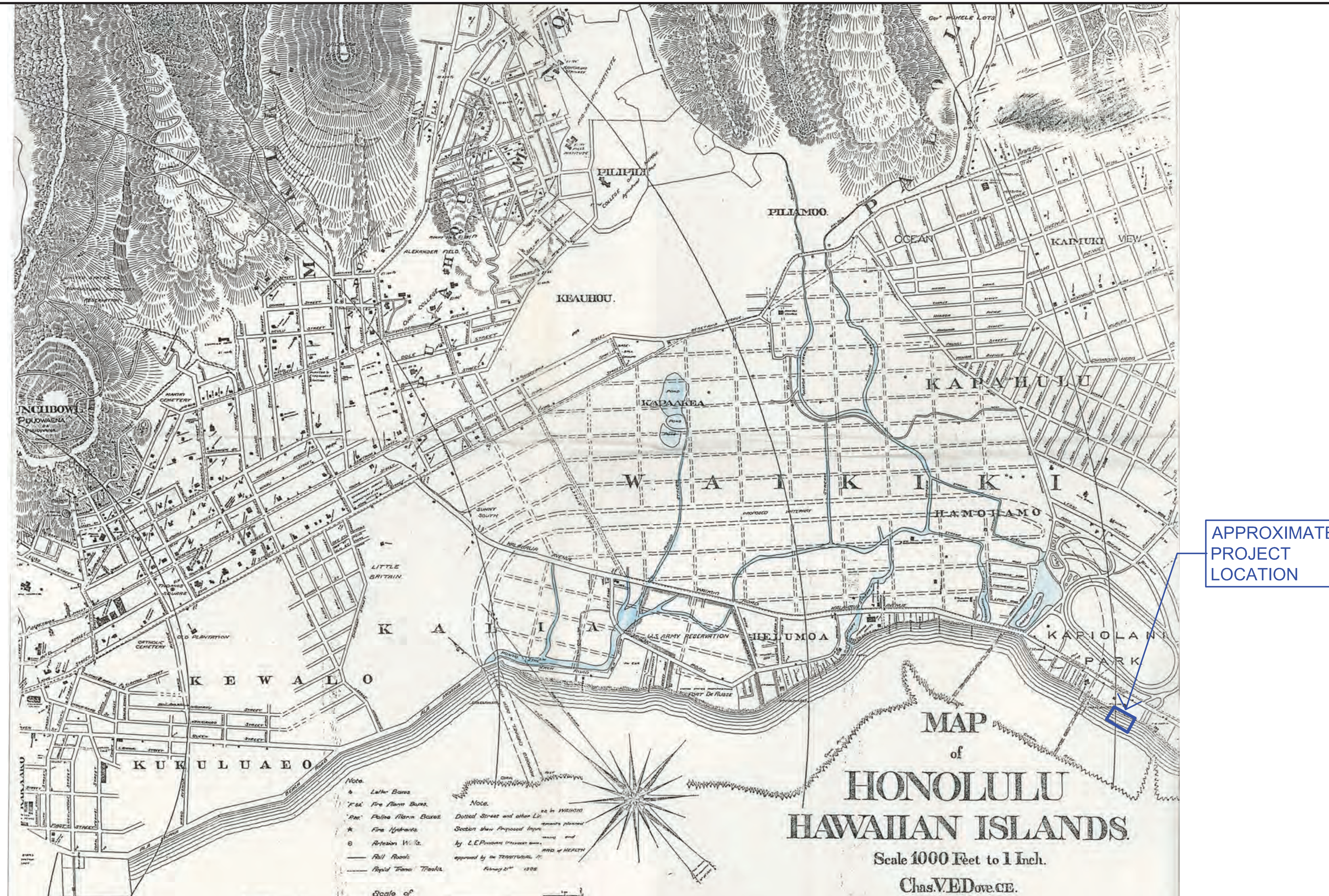
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022.01

YOGI KWONG ENGINEERS, LLC

FIGURE 3

P:\10022.01 WAIKIKI NATATORIUM EIS (ANNEX A)\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\(10022.01) FIGURES 1 TO 3 & 5 – PROJECT LOCATION, AERIAL PHOTO, REGIONAL GEOLOGY.DWG



P:\10022.01 WAIKIKI NATATORIUM EIS (ANNEX A)\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\(10022.01) FIGURE 4 - 1912 MAP OF WAIKIKI.DWG

1912 MAP OF WAIKIKI

Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022.01

REFERENCE:
- Map of Honolulu Hawaiian Islands by Chas. V. E. Dove., Dated 1912.

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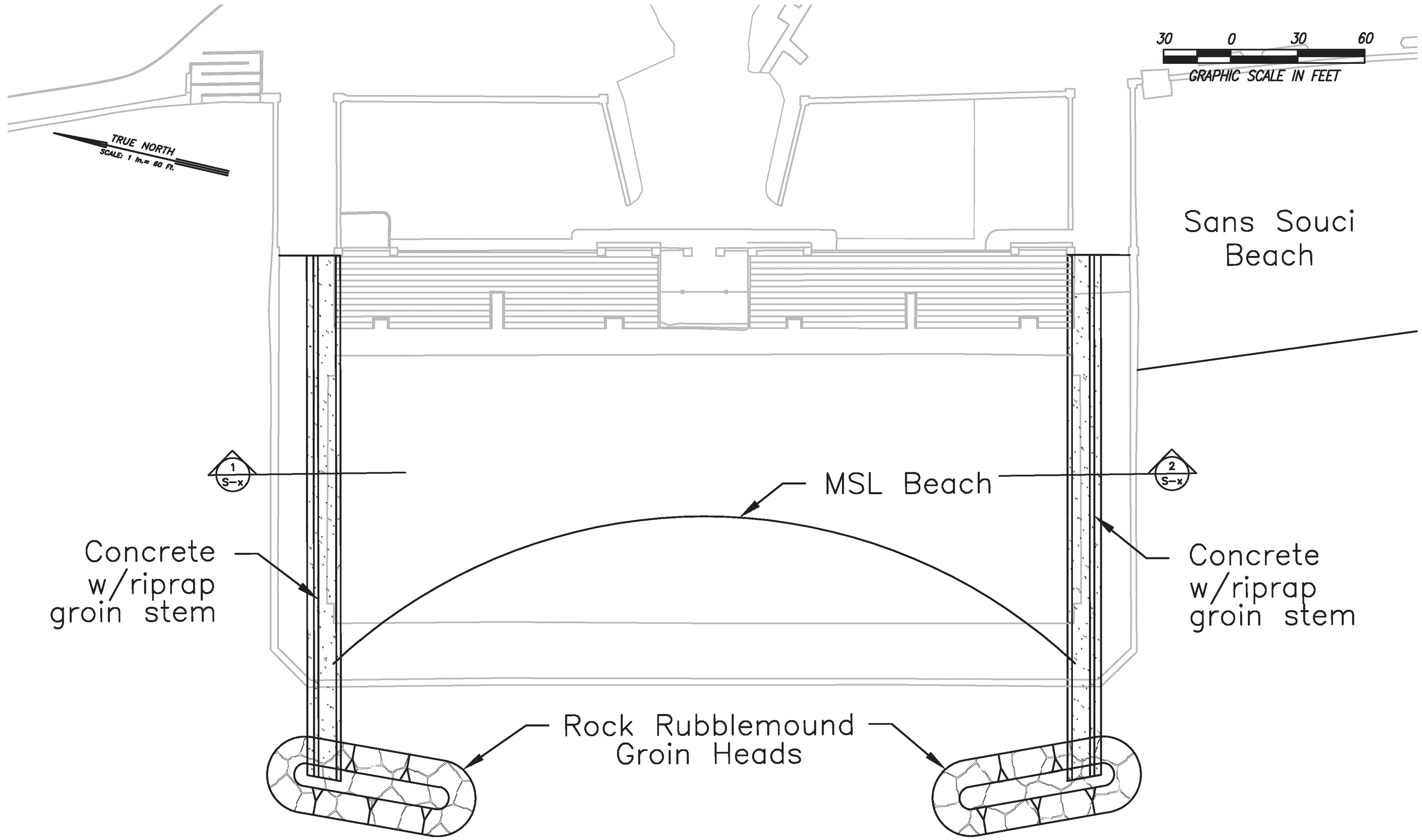
YOGI KWONG ENGINEERS, LLC

FIGURE 4



OPTION 1

SEA ENGINEERING, INC. OPTION 1
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022.01

REFERENCE:
- Concept Drawings from Sea Engineering, Inc. provided on July 6, 2015.

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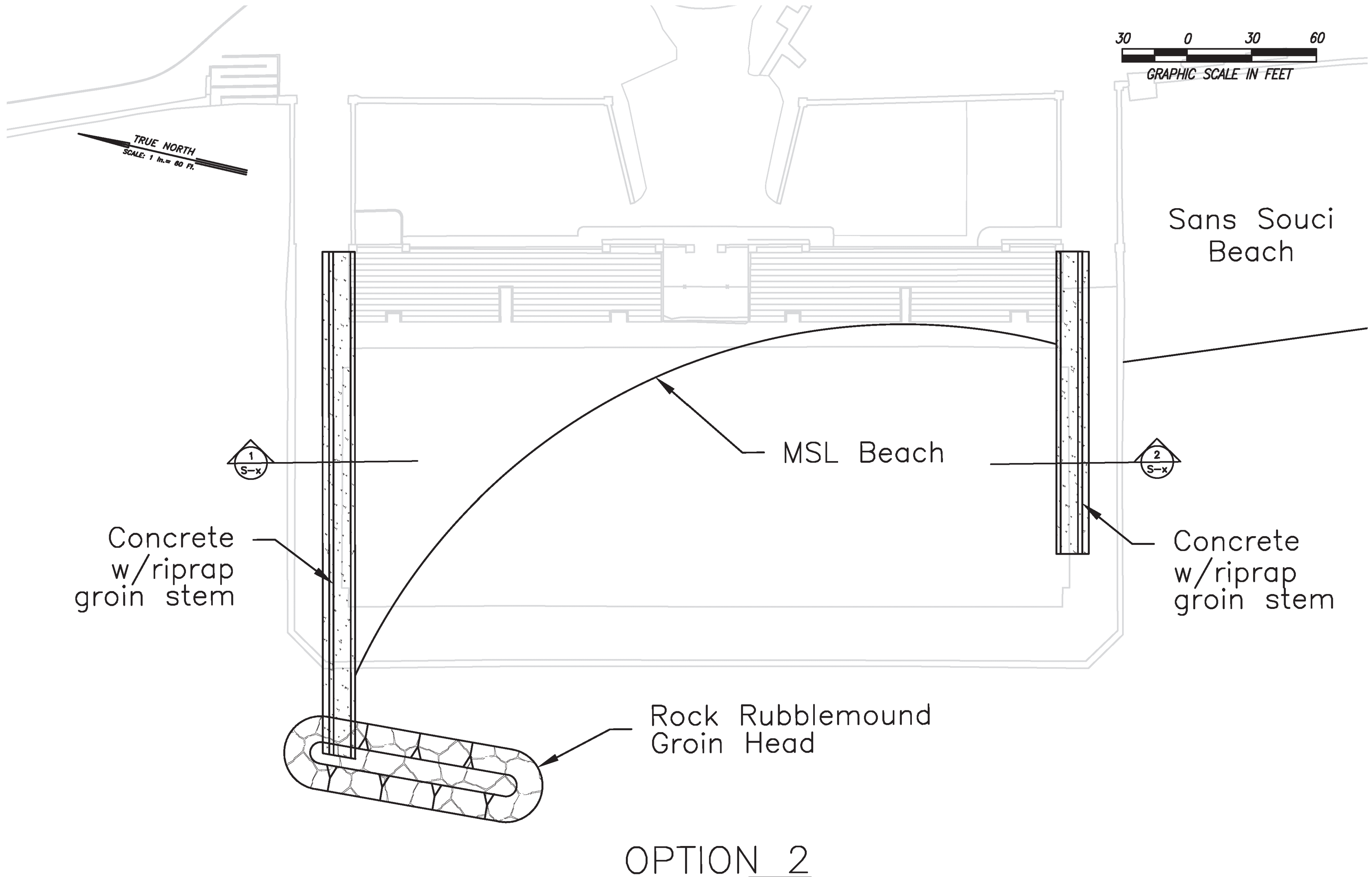
YOGI KWONG ENGINEERS, LLC

FIGURE 5



P:\10022.01 WAIKIKI NATATORIUM EIS (ANNEX A)\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\(10022.01) FIGURE 5 TO 9 - SEA ENGINEERING.DWG

SEA ENGINEERING, INC. OPTION 2
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022.01

REFERENCE:
- Concept Drawings from Sea Engineering, Inc. provided on July 6, 2015.

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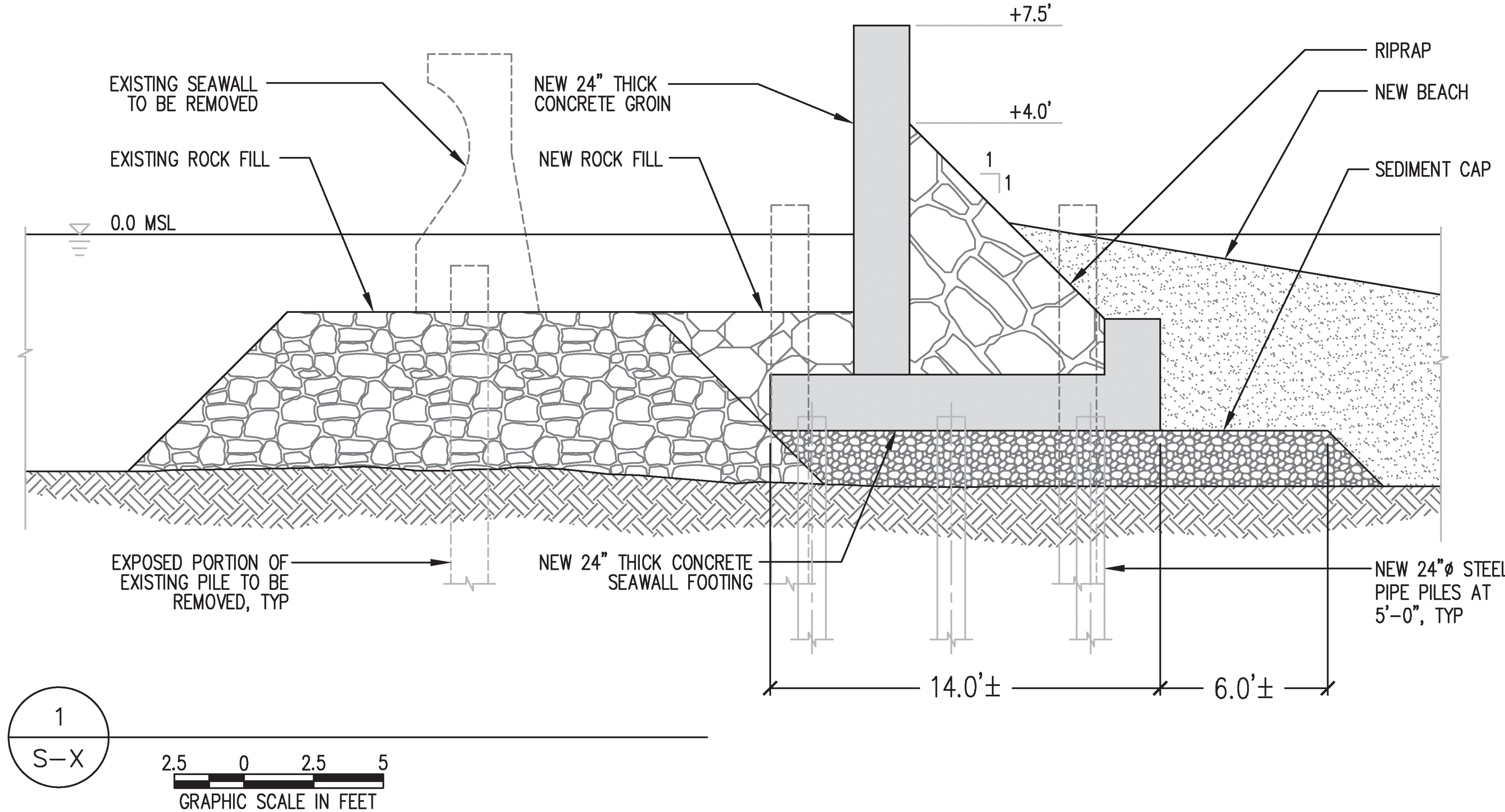
YOGI KWONG ENGINEERS, LLC

FIGURE 6



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SEA ENGINEERING, INC. SECTION 1
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022.01

REFERENCE:
- Concept Drawings from Sea Engineering, Inc. provided on July 6, 2015.

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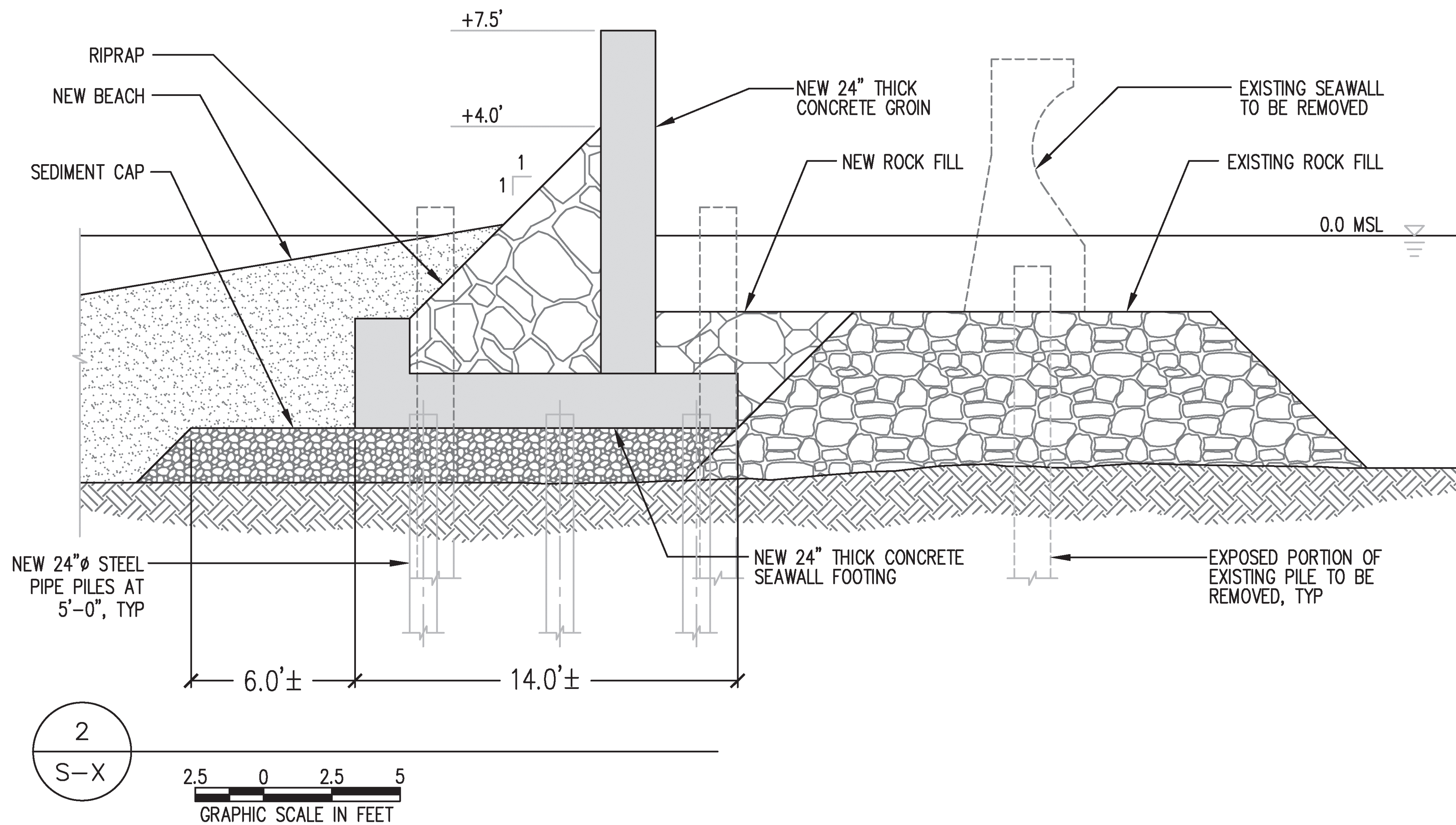
YOGI KWONG ENGINEERS, LLC

FIGURE 7



SEA ENGINEERING, INC. SECTION 2

Waikiki War Memorial Complex at Waikiki Beach

Honolulu, Oahu, Hawaii

Project No. 10022.01

REFERENCE:

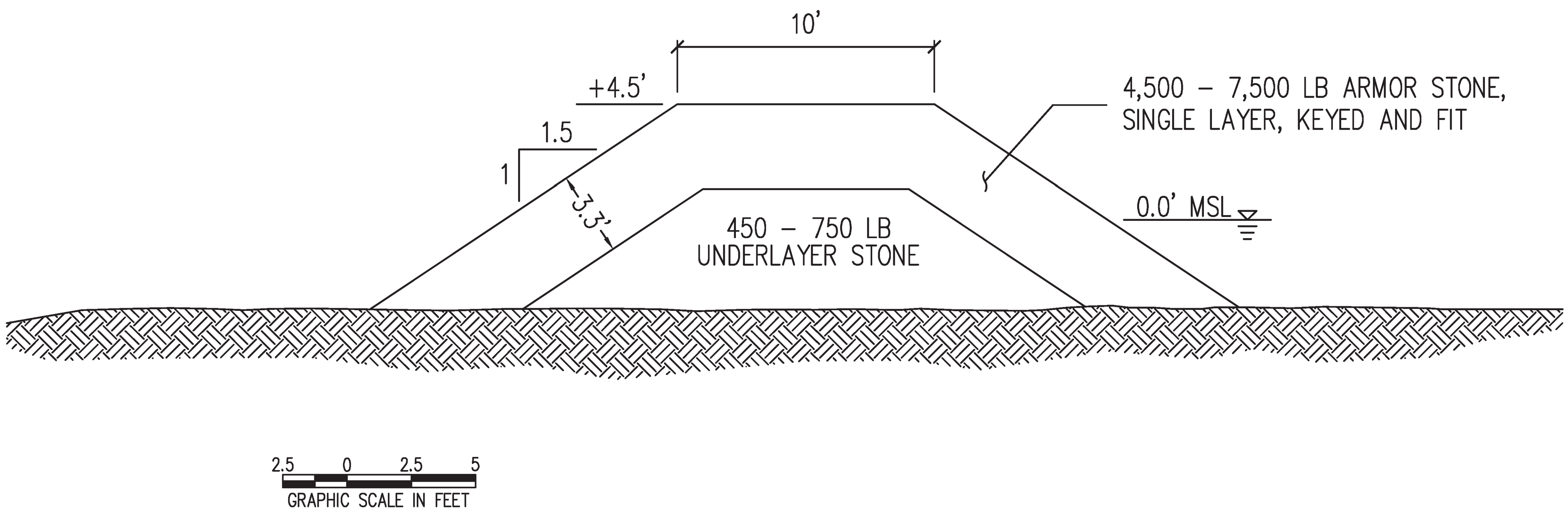
- Concept Drawings from Sea Engineering, Inc. provided on July 6, 2015.

NOT TO SCALE

YOGI KWONG ENGINEERS, LLC

FIGURE 8

P:\10022.01 WAIKIKI NATATORIUM EIS (ANNEX A)\500.00 ENGINEERING ANALYSIS\505.01 AUTOCAD DRAWINGS\REPORT FIGURES\DWG\(10022.01) FIGURE 5 TO 9 - SEA ENGINEERING.DWG



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SEA ENGINEERING, INC. ROCK RUBBLE MOUND GROIN HEAD SECTION
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii
Project No. 10022.01

REFERENCE:
- Concept Drawings from Sea Engineering, Inc. provided on July 6, 2015.

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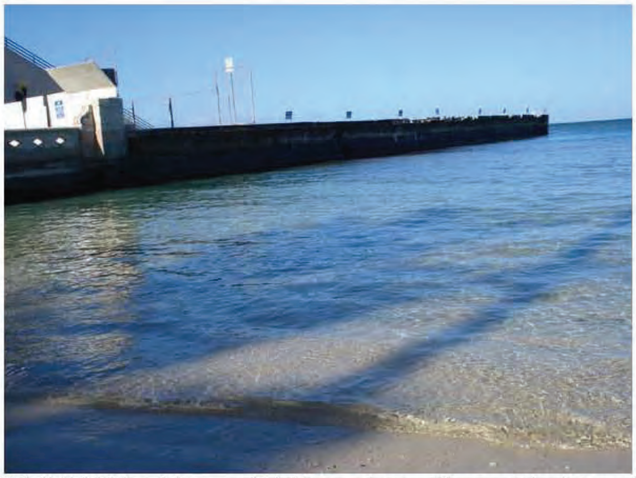
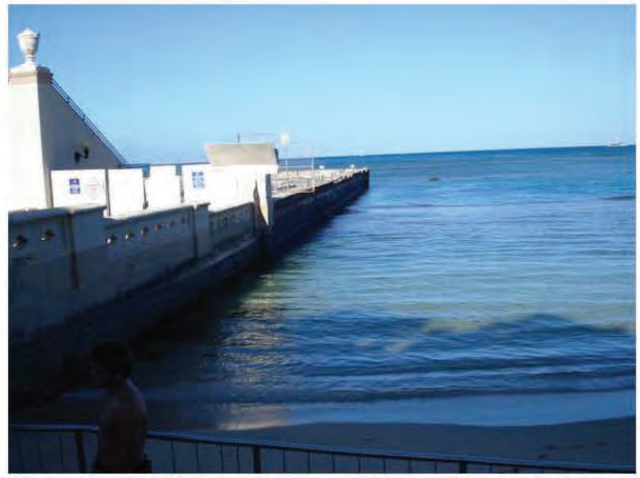
YOGI KWONG ENGINEERS, LLC

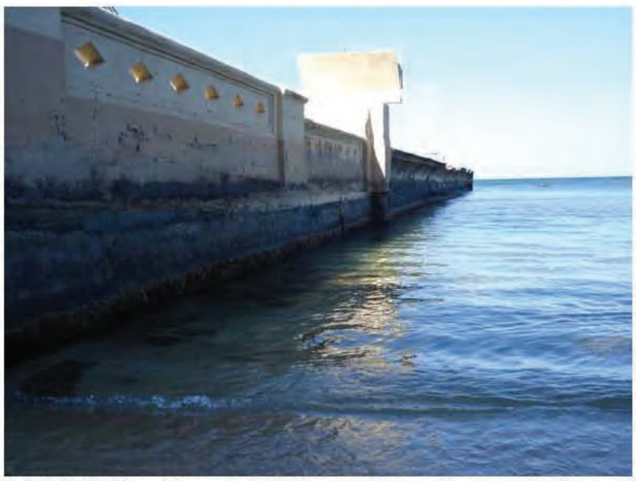
FIGURE 9

APPENDIX A

Selected Site Photographs


Waikiki War Memorial Complex - General view of North wall


Waikiki War Memorial Complex - General view of North wall


Waikiki War Memorial Complex - General view of North wall


Waikiki War Memorial Complex - General view of North wall


Waikiki War Memorial Complex - General view of North wall


Waikiki War Memorial Complex - General view of North wall

SELECTED SITE CONDITION PHOTOGRAPHS
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE A-1

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

SELECTED SITE CONDITION PHOTOGRAPHS
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE A-2

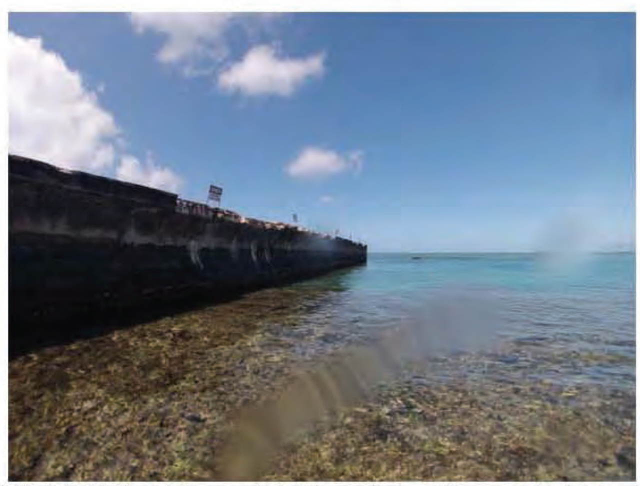
Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall



Waikiki War Memorial Complex - General view of North wall

SELECTED SITE CONDITION PHOTOGRAPHS
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE A-3

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of North wall

Waikiki War Memorial Complex - General view of Wall: NW corner

SELECTED SITE CONDITION PHOTOGRAPHS

Waikiki War Memorial Complex at Waikiki Beach

Honolulu, Oahu, Hawaii

Project No. 10022

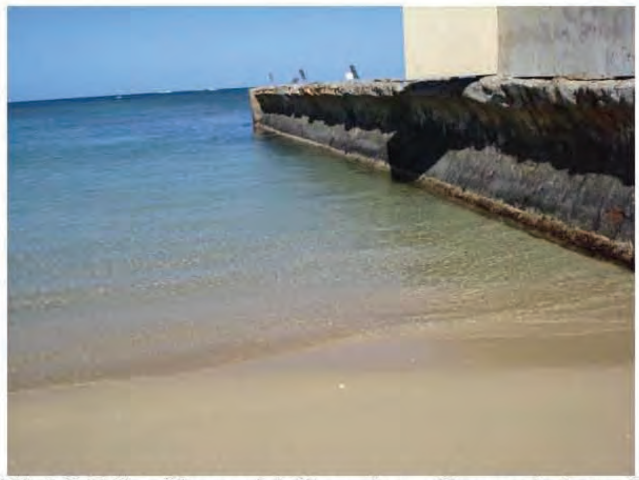
YOGI KWONG ENGINEERS, LLC.

FIGURE A-4

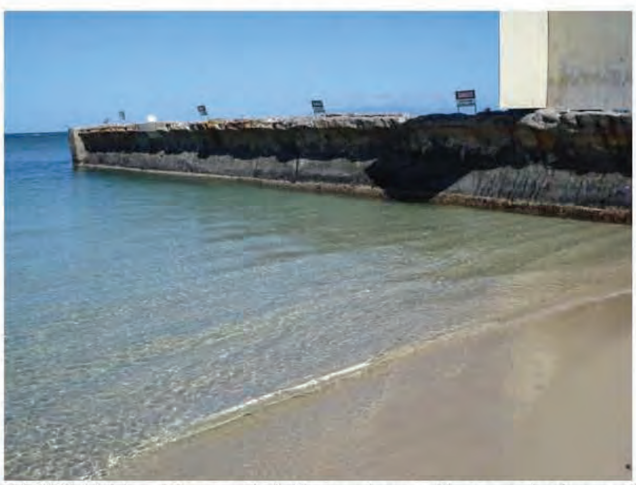
Waikiki War Memorial Complex - General view of Wall: NW corner

Waikiki War Memorial Complex - General view of Wall: NW corner

Waikiki War Memorial Complex - General view of Wall: NW corner



Waikiki War Memorial Complex - General view of South wall



Waikiki War Memorial Complex - General view of South wall

Waikiki War Memorial Complex - General view of South wall

SELECTED SITE CONDITION PHOTOGRAPHS

Waikiki War Memorial Complex at Waikiki Beach

Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE A-5

Waikiki War Memorial Complex - General view of South wall

Waikiki War Memorial Complex - General view of South wall

View of Sans Souci Beach

View of Sans Souci Beach

Waikiki War Memorial Complex - General view of east face

Waikiki War Memorial Complex - General view of east face

SELECTED SITE CONDITION PHOTOGRAPHS

Waikiki War Memorial Complex at Waikiki Beach

Honolulu, Oahu, Hawaii

Project No. 10022

YOGI KWONG ENGINEERS, LLC.

FIGURE A-6


View of coral reef remains along shoreline


View of coral reef remains along shoreline


View of coral reef remains along shoreline


View of coral reef remains along shoreline


View of coral reef remains along shoreline


View of coral reef remains along shoreline

SELECTED SITE CONDITION PHOTOGRAPHS
Waikiki War Memorial Complex at Waikiki Beach
Honolulu, Oahu, Hawaii

Project No. 10022

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YOGI KWONG ENGINEERS, LLC.

FIGURE A-7

APPENDIX B

Geophysical Data (by Global Geophysics)

Global Geophysics

P.O. Box 2229
Redmond, WA 98073-2229
Tel: 425-890-4321
Fax: 360-805-0259

August 21, 2013 Our Ref.: 103-0918.000

Sea Engineering, Inc.
863 N Nimitz Hwy
Honolulu, HI

Attention: Mr. Scott Sullivan

RE: REPORT ON THE GEOPHYSICAL SURVEY AT THE WAIKIKI WAR MEMORIAL, HONOLULU, HAWAII

Dear Mr. Sullivan:

Global Geophysics conducted electrical resistivity tomography (ERT) on April 17th, 2014 at the Waikiki War Memorial Natatorium, Honolulu, Hawaii. The proposed objective of the geophysical investigation is to assist in studying the subsurface conditions.

METHODOLOGY AND INSTRUMENTATION

Electrical resistivity tomography was used for this study. The following paragraphs describe the method and field procedure.

Electrical Resistivity Tomography (ERT)

The electrical resistivity tomography technique maps differences in the electrical properties of geologic materials. These differences can result from variations in lithology, water content, and pore-water chemistry. The method involves transmitting an electric current into the ground between two electrodes and measuring the voltage between two other electrodes. The direct measurement is an apparent resistivity of the area beneath the electrodes that includes deeper layers as the electrode spacing is increased. Recent advances in technology permit rapid collection of multiple soundings, using up to 56 electrodes for each spread. The data are modeled to create a 2-D geo-electric cross-section that is useful for mapping both vertical and horizontal variations of the subsurface strata.

The data were acquired with an AGI SuperSting R8 using up to 56 electrodes spaced at a 7 foot interval. Once the electrode array was installed in the ground, multiple soundings were automatically carried out by the control unit. Downloading and routine modeling of the data was done on-site to provide preliminary analysis and QA/QC of the data. These results were displayed on a color monitor as cross-section that highlight changes in resistivity with depths along the transects.

RESULTS

The ERT data was collected along 3 transects. The locations of these lines are shown in Figure 1. The interpreted resistivity profiles are shown in Figure 2. The borehole logs were used to calibrate the interpretation.

Four units were interpreted:

- Lagoon deposit (above the dashed red line)
- Coral/gravel (between the dashed red and orange lines)
- Silty/clayey soil (between the dashed orange and purple lines)
- Limestone (below the dashed purple line).

Karst features are interpreted on all three lines.

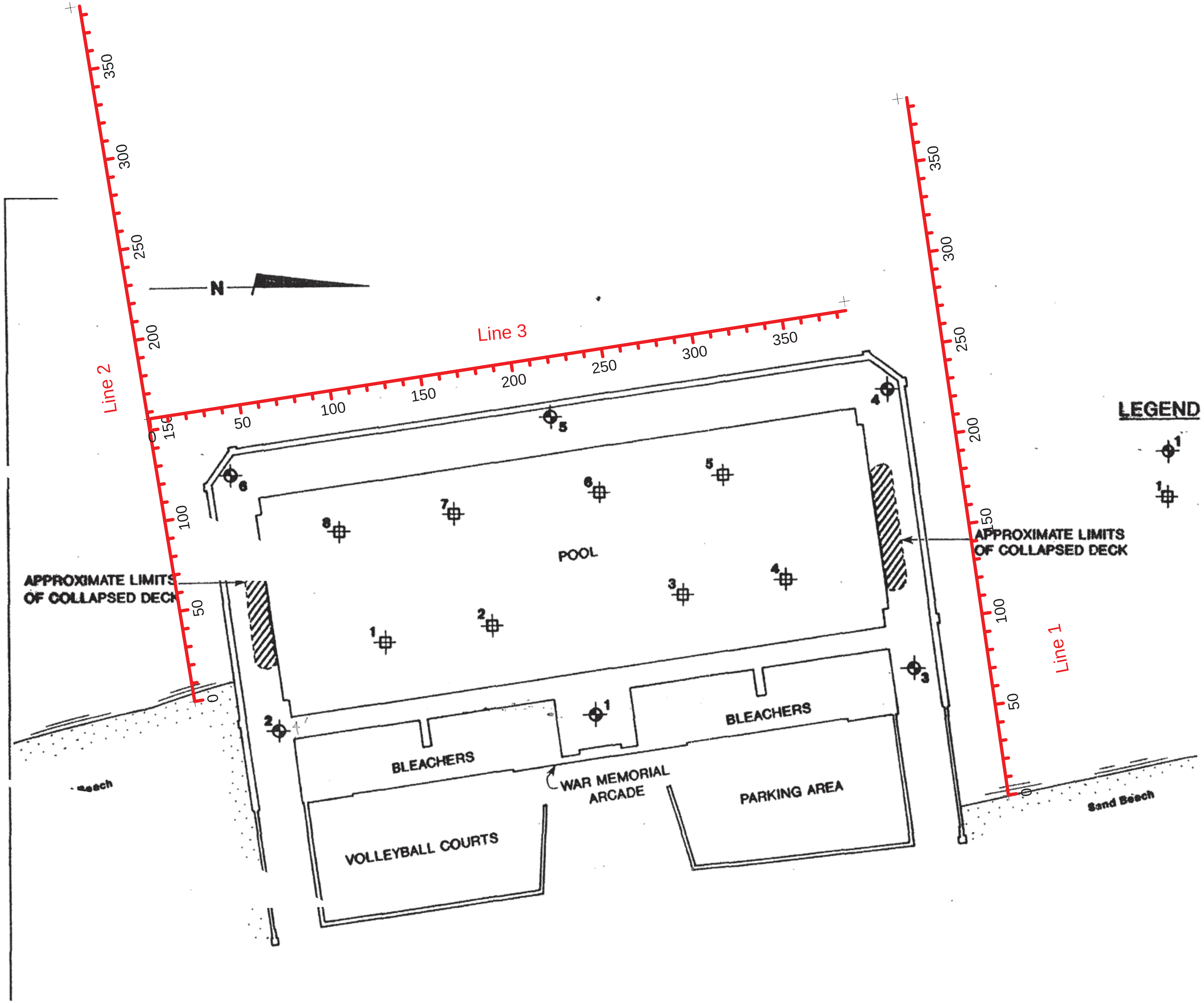
LIMITATIONS OF THE GEOPHYSICAL METHOD

Global geophysics services are conducted in a manner consistent with the level of care and skill ordinarily exercised by other members of the geophysical community currently practicing under similar conditions subject to the time limits and financial and physical constraints applicable to the services. ERT is a remote sensing geophysical method that may not detect all subsurface conditions due to the limitations of the methods and soil conditions. In general, the errors in the interpreted depths, dependent on the resolution of the technique, are estimated to be approximately ±10 % of the true depths.

Sincerely,

Global Geophysics

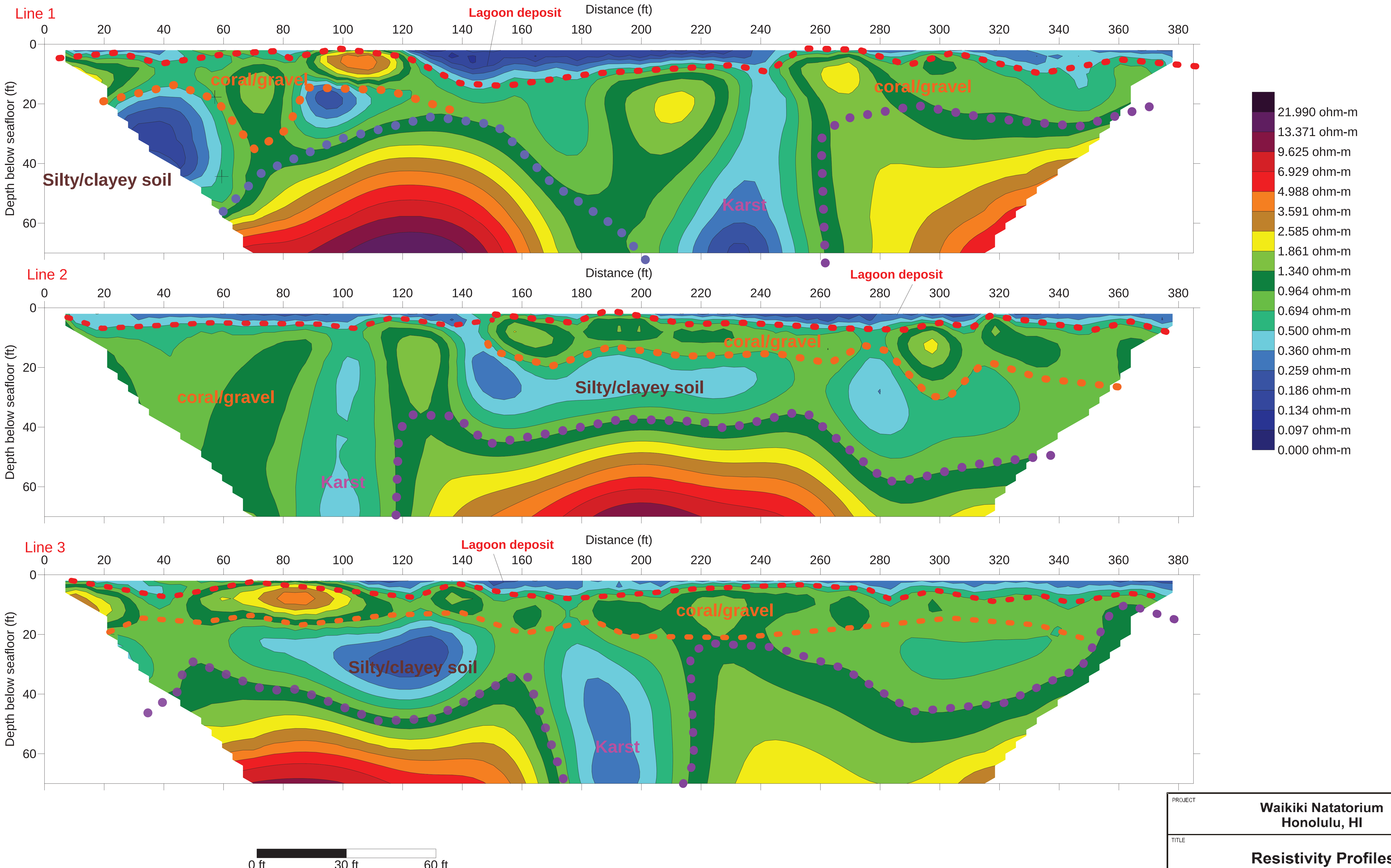
John Liu, Ph.D., R.G.
Principal Geophysicist



LEGEND

- Boring Location and Designation
- Test Pit Location and Designation

PROJECT	Waikiki Natatorium Honolulu, HI		
TITLE	Site Plan		
Global Geophysics P.O.BOX 2229 REDMOND, WA 98073-2229 Tel: 425-890-4321	PROJECT NO.: 103-0918.000 DESIGN -- CADD JL CHECK JL REVIEW --	FILE No. SCALE AS SHOWN	REV.
		FIGURE 1	



PROJECT	**Waikiki Natatorium Honolulu, HI**		
TITLE	**Resistivity Profiles**		
Global Geophysics P.O.BOX 2229 REDMOND, WA 98073-2229 Tel: 425-890-4321	PROJECT NO.: 103-0918.000	FILE No.	
	DESIGN --	SCALE AS SHOWN	REV.
	CADD JL	**FIGURE 2**	
	CHECK JL		
	REVIEW --		

APPENDIX E.

HARDING LAWSON ASSOCIATES
GEOTECHNICAL REPORT AND ADDENDA
(1991-1996)

Waikiki Natatorium

Harding Lawson Associates

March 1, 1996

10372.034
4654MI

Mr. Eric G. Crispin
Leo A. Daly
Bank of America Building, Suite 1000
1357 Kapiolani Boulevard
Honolulu, Hawaii 96814

Addendum to Geotechnical Report
Waikiki Natatorium
Waikiki, Honolulu, Hawaii

Dear Mr. Crispin:

This letter presents Harding Lawson Associates' (HLA's) addendum to our geotechnical report dated December 12, 1991, for the Waikiki Natatorium. This addendum supersedes our recommendations presented in a facsimile dated December 16, 1992, and a letter dated February 22, 1995. As discussed during our meeting on February 29, 1996, revisions to our original recommendations presented in our geotechnical report are based on changes to the project design which include the following:

- The existing pile foundations supporting the existing deck were evaluated by Wiss, Janney, Elstner Associates, Inc., and determined to be in usable condition and, therefore, will be utilized to support a portion of the new pool deck. We understand that the new deck will be designed to impose loads that will not exceed the current loads carried by the existing piles.

- Large concrete wall units (CWUs) will be used to support the pool deck on both ends. The precast wall units would have dimensions of approximately 5 feet by 4 feet by 8 to 12 feet. The CWUs are envisioned to be supported on shallow footings. The spaces between the CWUs and below the pool deck are not anticipated to be backfilled.

- The exterior sea wall will have a new protective revetment to protect against scouring and to reduce wave energy forces.

- The deep portion of the existing pool will be filled to raise grades. In addition, portions of the existing pool along Grid Line B are currently below the proposed wall footing elevation at -10 feet mean lower low water (MLLW). Surveys indicate that firm bottom elevations in these areas range from approximately -9 to -17 feet MLLW. Underwater fills would be needed to raise grades beneath the new footing and adjacent to the new footing.

- The bleacher slabs and foundations for non-load-bearing walls will be demolished and reconstructed.

DISCUSSION AND CONCLUSIONS

We believe the new concept of using footings to support the new CWUs is geotechnically feasible. However, we have the following geotechnical concerns which are discussed below:

- New Fill
- Soil Improvement
- Protection Stone and Existing Piles
- Scour Beneath Footings
- Seismic Effects
- Non-load-bearing Foundations

New Fill

New fill will be used to raise existing grades within the deep areas of the existing pool area and near the new footings along the pool's west inboard side. The deep portion of the existing pool was surveyed by SEA Engineering. Their survey data indicate portions of the pool bottom to be approximately -20 feet with respect to MLLW, and describe firm bottom as approximately -23 feet MLLW. We estimate approximately 3 to 6 inches of settlement would occur from filling the deep area.

The new fills should be placed prior to soil improvement below new footings. This will allow settlements to occur sooner. As soil improvement is accomplished, the nearby surrounding soils will tend to densify and result in additional settlements beyond the footing edge and soil improvement area. In these areas additional new fill will be needed to raise grades.

Soil Improvement

As previously discussed with Leo A. Daly personnel, we believe the large CWUs used to support the pool deck can be supported using shallow foundations supported on lagoonal soils which have been improved by densification. Because some of the lagoonal deposits consist of silty sands with fines content greater than 15 percent passing the No. 200 sieve size, densification by vibroflotation may not be effective. Our discussions with a specialty foundation contractor, Hayward Baker, indicate that the vibroreplacement method may be more effective for granular soils with high fines contents. Vibroreplacement involves use of the vibrocompaction probe which applies vibration energy at the required depth. The surrounding soils are densified. In addition, a stone backfill is added to the hole created by the probe. The stone backfill is compacted as the probe is withdrawn, stone added, and the probe reinserted into the probe hole. The compacted stone backfill behaves like a structural reinforcing element which increases bearing capacity and reduces settlement. The probe spacing and depth of soil improvement will influence the allowable bearing capacity and settlements.

Our discussions with Hayward Baker indicate that preliminary estimates for the depth of soil improvement beneath the footing vary from at least 3 times the footing width to the underlying coral (about Elevations -38 to -41 feet, MLLW). The lateral extent of soil improvement would be directly beneath the new footings and include one to two rows of probe holes on either side of the new footings. Specialty contractors should be contacted to determine if a barge is necessary to accomplish the soil improvement, the depth and lateral extent of soil improvement, and frictional resistance along the base of the footing. The specifications should be adjusted to specify that the specialty contractor be responsible for the design of the soil improvement. The specialty contractor should communicate with the general contractor to determine the construction schedule because soil improvement may densify adjacent areas such as the bleacher stands and slabs-on-grade.

Some specialty contractors who have performed soil improvement by vibroreplacement methods include:

- Hayward Baker, Inc.
  P. O. Box 7690
  Ventura, California 93006
  Phone number: 805-933-1331

- Nicholson Construction Company
  P. O. Box 1702
  Tacoma, Washington 98401
  Phone number: 206-433-6111

Protection Stone and Existing Piles

The existing protection stone will need to be removed because the stone will prevent the probe from advancing. The existing piles need not be removed but may be incorporated into the new footing. The additional capacity provided by the piles should not be relied upon.

Scour Beneath Footings

The bottom of the footings should be located beneath the anticipated scour depth, and the subgrade beneath the footings should be protected from scour. Scour beneath footings would lower or remove frictional resistance at the footing bottom. Scour on the footing edges would lower or remove passive resistance on the footing sides. Your project ocean engineer may have suggestions in protecting the subgrade.

Seismic Effects

The underlying compressible lagoon deposits may be susceptible to liquefaction. Preliminary findings from the 1994 Guam earthquake indicate coralline lagoon deposits may be susceptible to liquefaction. Use of the vibroreplacement method would densify the surrounding soils and may mitigate the risk of liquefaction within the soil improvement zone.

Non-load-bearing Foundations

Existing bleacher slab-on-grade and non-load-bearing wall foundations will be removed and reconstructed. For footings that are designed with an allowable bearing of 2,500 pounds per square foot (psf), we estimate total settlement of approximately 1 inch and differential settlements between footings of approximately 3/4 inch.

RECOMMENDATIONS

Site Preparation

After removal of the floor slab and structural elements in the arcade and bleacher areas, the exposed subgrade soils should be proofrolled with a smooth-drum roller having a static weight of at least 10 tons to provide a dense, unyielding surface. Soft areas should be excavated until hard material is encountered or to a depth of 3 feet, whichever is less. Excavated areas should be backfilled with approved fill material (discussed below) compacted to at least 95 percent relative compaction.* Our field engineer should observe the proofrolling to check whether overexcavation is indicated.

Subsequent to the removal of the pool deck and supporting elements, spalled concrete and debris on the pool bottom should be removed. Within the pools, sand, sediment and debris

*Relative compaction refers to the dry density of the compacted material expressed as a percentage of the maximum dry density of the same material as determined by ASTM D1557.

should be dredged from the floor to allow placement of the gravel and sand-lining materials. The silt layer in the center-makai area of the pool, estimated to be 5 feet thick, should be removed completely.

Fill Materials, Placement and Compaction

Fill Material Above Water. In areas such as the bleacher area, fill should be a soil or soil/rock mixture free of debris, organics, and other deleterious materials. Maximum particle size should be 4 inches. Fill should have less than 10 percent passing a No. 200 sieve. Onsite soils are not suitable for use as fill. Fill materials should be approved by our engineer prior to use. For areas above water levels, fill should be placed in level layers approximately 8 inches thick and compacted with vibratory equipment to at least 95 percent relative compaction. Heavy compaction equipment should not be used to compact fill behind retaining walls within a horizontal distance equal to the height of the wall or 8 feet, whichever is greater.

Fill Material Below Water. New fill will be used to raise existing grades within the deep areas of the existing pool area and near the new footings along the pool's west inboard side. We previously recommended in our 1991 report that the silt encountered in this deep area be removed prior to raising grades. We still continue to recommend that the silts be removed.

The new fills should be placed prior to soil improvement below new footings. This will allow settlements to occur sooner. As soil improvement is accomplished, the nearby surrounding soils will tend to densify and produce additional settlements beyond the footing edge and soil improvement area. In these areas, additional new fill will be needed to raise grades. Overfilling prior to soil improvement is also feasible; however, the specialty contractor should be consulted regarding estimates of settlements near the new footing edge caused by soil improvement.

We recommend coarse, clean gravels be used to raise grades beneath sea water. Basalt gravel meeting gradations for ASTM C33 No. 67 would be suitable as fill material. The basalt gravels should be densified using vibroreplacement methods. If sands are placed over this material, migration of the beach sand into the voids and gradual lowering of the sand bottom should be expected. If this is a concern, a geotextile can be placed over the densified gravel to reduce the migration of the overlying sand into the gravel.

Soil Improvement

We recommend that a specialty foundation contractor with a minimum of eight years of experience with vibroreplacement methods be used to improve the underlying soils. The specialty foundation contractor should have design experience in similar soil conditions. The drawings and specifications should be adjusted to specify that the specialty foundation contractor shall improve the subsurface soil properties to an allowable bearing capacity of 1,800 pounds per square feet (factor of safety = 3) and limit the total settlements to less than 1 inch and differential settlements to less than 1/2 inch.

The existing sea wall is constructed with boulders placed adjacent to the existing pile foundations. In addition, piles should be anticipated in both CWU footing alignments. The specialty contractor should be prepared to encounter boulders beneath the proposed footing location and within the depth of soil improvements. Boulders may need to be removed to allow the probe access to the underlying soils. Prior to footing construction, standard penetration tests (SPT) should be used to reconfirm soil improvement to achieve the specified allowable bearing capacity, and total and differential settlements. The specialty contractor should be responsible to perform the SPTs. These results should be submitted for HLA's review.

Shallow Foundations

Pool deck foundations can be supported on spread footings bearing on in situ soils which have undergone soil improvement. Non-load-bearing bleacher wall footings can be supported on new compacted fill or on in situ soils which have been proofrolled. Spread footings should be designed using the following criteria:

Allowable Bearing Pressures

	Non-load-bearing Foundations	**Pool Deck Foundations**
Allowable Bearing Pressure		
Dead plus long-term live loads	2,500 psf	1,800 psf
Total loads (including wind or seismic)	3,300 psf	2,400 psf
Ultimate Resistance to Lateral Loads (no factor of safety included)		
Friction factor (mass concrete on sand)	0.35	0.35
Passive soil resistance (above water)	360 pcf	360 pcf
Passive soil resistance (below water)	150 pcf	150 pcf

psf = pounds per square foot.
pcf = pounds per cubic foot.

Friction resistance along the base of footings can be computed by multiplying the friction factor by the vertical sustained load. Passive resistance is expressed above as equivalent fluid unit weight on the face of structural elements. The passive pressure and friction factor shown on the table do not include a safety factor; we recommend a safety factor of 2 for design purposes. Passive resistance should be neglected in the upper 1 foot unless the soil is confined by a pavement or slab-on-grade. The pool deck footings should be embedded below the predicted scour depth from ocean engineering studies.

Slab-on-Grade Floors

Prior to construction of slab-on-grade floors, subgrade soils should be compacted to form a dense, unyielding surface. Slab-on-grade floors should be underlain by at least 4 inches of clean, crushed rock to provide uniform support and a capillary moisture break. Gravel meeting ASTM C33 No. 67 gradation will be suitable. The crushed rock should be compacted to provide a dense, unyielding surface. Where penetration of moisture through the slab would be objectionable, a vapor barrier can be placed over the crushed rock before pouring is done for the slab. Two inches of sand placed over the vapor barrier can aid in curing the slab and protect the barrier during construction. The need for a vapor barrier and sand should be governed by architectural and structural factors.

This document was prepared for the sole use of Leo A. Daly and the State of Hawaii, the only intended beneficiaries of our work. No other party should rely on the information contained herein without prior written consent of HLA.

Please call me if you have any questions.

Sincerely yours,

HARDING LAWSON ASSOCIATES

Keith K. Hayashi

Keith K. Hayashi
Civil Engineer - 7043

QC: CPM

KKH/rmf

FACSIMILE TRANSMITTAL

To:	Mr. Fred Matsuda / Leo A. Daly Company
Fax Number:	520-3757
From:	Russell C.H. Leong
Date:	February 22, 1995
Subject:	Waikiki Natatorium - Revised Recommendations
Project Number:	10372.1

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Number of pages (including this cover sheet):

Remarks:

Transmitted herewith are revised recommendations for the Waikiki Natatorium project. Please call me if you have any questions.

cc:

Transmitted by: Helen Fujikawa

If you do not receive all pages, please call Helen Fujikawa at (808) 486-6009.

Harding Lawson Associates
Engineering and Environmental Services
235 Pearlridge Center, Phase 1, 98-1005 Moanalua Road
Aiea, HI 96701 – (808) 486-6009

FAX (808) 486-7184

Harding Lawson Associates

HLA

February 22, 1995

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RECEIVED FEB 2 2 1995

Mr. Fred Matsuda
Leo A. Daly Company
Bank of America Building
1357 Kapiolani Boulevard, Suite 1000
Honolulu, Hawaii 96814-4537

Revised Recommendations
Waikiki Natatorium
Waikiki, Honolulu, Hawaii

Dear Mr. Matsuda:

This letter amends Harding Lawson Associates' (HLA's) original recommendations for the subject project. These revised recommendations should be appended to the front of HLA's original report dated December 12, 1991. We previously provided additional recommendations for the revised project changes in a facsimile dated December 16, 1992. Our revised recommendations are based on the project changes which have included the following:

- The existing pile foundations used to support the existing deck were evaluated by others and determined to be in need of repair, and therefore an alternative foundation was planned to support the new pool deck instead of driving piles.

- Large concrete wall units (CWUs) will be used to support the pool deck on both ends. The precast wall units would have dimensions of 1 to 1.5 feet by 4 feet by 8 to 12 feet. The CWUs are envisioned to be supported on shallow footings. The spaces between the CWUs and below the pool deck are not anticipated to be backfilled.

- The exterior sea wall will have a new protective revetment in order to protect against scouring and to reduce wave energy forces.

- The deep portion of the existing pool will be filled to raise grades. In addition, portions of the oceanside edge of the existing pool are currently below the proposed wall footing elevation at -10 feet mean lower low water (MLLW). Surveys indicate that firm bottom elevations along the oceanside edge range from approximately -9 to -17 feet MLLW. Fills would be needed to raise grades beneath the new footing and adjacent to the new footing.

- The bleacher slabs and foundations for non-load-bearing walls will be demolished and reconstructed.

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DISCUSSION AND CONCLUSIONS

We believe the new concept of using footings to support the new CWUs and pool deck is geotechnically feasible. However, we have the following geotechnical concerns which are subsequently discussed:

- New Fill
- Soil Improvement
- Protection Stone and Existing Piles
- Scour Beneath Footings
- Seismic Effects
- Non-load-bearing Foundations

New Fill

New fill will be used to raise existing grades within the deep areas of the existing pool area and near the new footings along the pool's west inboard side. The deep portion of the existing pool was surveyed by SEA engineering. Their survey data indicate portions of the pool bottom to be approximately -20 feet with respect to MLLW, and describe firm bottom as approximately -23 feet MLLW. We estimate approximately 3 to 6 inches of settlement would occur from filling the deep area.

The new fills should be placed prior to soil improvement below new footings. This will allow settlements to occur sooner. As soil improvement is accomplished, the nearby surrounding soils will tend to densify and result in additional settlements beyond the footing edge and soil improvement area. In these areas additional new fill will be needed to raise grades.

Soil Improvement

As previously discussed with Leo A. Daly personnel, we believe the large CWUs used to support the pool deck can be supported using shallow foundations supported on lagoonal soils which have been improved by densification. Because some of the lagoonal deposits consist of silty sands with fines content greater than 15 percent passing the No. 200 sieve size, densification by vibroflotation may not be as effective. Discussions with a specialty foundation contractor, Hayward Baker, indicate that for granular soils with high fines contents, the vibroreplacement method may be more effective. Vibroreplacement involves use of the vibrocompaction probe which applies vibration energy at the required depth. The surrounding soils are densified. In addition, a stone backfill is added to the hole created by the probe. The stone backfill is compacted as the probe is withdrawn, stone added, and the probe reinserted into the probe hole. The compacted stone backfill behaves like a structural reinforcing element which increases bearing capacity and reduces settlement. The probe spacing and depth of soil improvement will influence the allowable bearing capacity and settlements.

Discussions with Hayward Baker indicate preliminary estimates for the depth of soil improvement beneath the footing to vary from at least 3 times the footing width to the underlying coral (about Elevations -38 to -41 feet, MLLW). The lateral extent of soil improvement would be directly beneath the new footings and include up to one to two rows of probe holes on either side of the new footings. The specialty contractors should be contracted to determine if a barge is necessary to accomplish the soil improvement, the depth and lateral extent of soil improvement, and frictional resistance along the base of the footing. The specifications should be adjusted to specify that the specialty contractor be responsible for the design of the soil improvement. The specialty contractor should communicate with the general contractor to determine the construction schedule because soil improvement may densify adjacent areas such as the bleacher stands and slabs-on-grade.

Specialty contractors who have performed soil improvement by vibroreplacement methods include:

Hayward Baker, Inc.
P.O. Box 7690
Ventura, California 93006
Phone number: 805-933-1331

Nicholson Construction Company
P.O. Box 1702
Tacoma, Washington 98401
Phone number: 206-433-6111

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The existing protection stone will need to be removed, since the stone will prevent the probe from advancing. The existing piles need not be removed but may be incorporated into the new footing. The additional capacity provided by the piles should not be relied upon.

Scour Beneath Footings

The bottom of the footings should be located beneath the anticipated scour depth, and the subgrade beneath the footings should be protected from scour. Scour beneath footings will lower or remove frictional resistance at the footing bottom. Scour on the footing edges will lower or remove passive resistance on the footing sides. Your project ocean engineer may have suggestions in protecting the subgrade.

Seismic Effects

The underlying compressible lagoon deposits may be susceptible to liquefaction. Preliminary findings from the 1994 Guam earthquake indicate coralline lagoon deposits may be susceptible to liquefaction. Use of the vibroreplacement method would densify the surrounding soils and may mitigate the risk of liquefaction within the soil improvement zone.

Non-load-bearing Foundations

Existing bleacher slab-on-grade and non-load-bearing wall foundations will be removed and reconstructed. We estimate for an allowable bearing of 2,500 pounds per square foot (psf), about 1 inch of total settlement and about 3/4 inch of differential settlement would occur.

RECOMMENDATIONS

Site Preparation

After removal of the floor slab and structural elements in the arcade and bleacher areas, the exposed subgrade soils should be proofrolled by a smooth-drum roller with a static weight of at least 10 tons to provide a dense, unyielding surface. Soft areas should be excavated until hard material is encountered to a depth of 3 feet, whichever is less. Excavated areas should be backfilled with approved fill material (discussed below) and compacted to at least 95 percent relative compaction.* Our field engineer should observe the proofrolling to check whether overexcavation is indicated.

After removal of the pool deck and supporting elements, spalled concrete and debris on the pool bottom should be removed. Within the pools, sand, sediment and debris should be dredged from the floor to allow placement of the gravel and sand-lining materials. The silt layer in the center-makai area of the pool, estimated to be 5 feet thick, should be removed completely.

Fill Materials, Placement and Compaction

Fill Material Above Water. In areas such as the bleacher area, fill should be a soil or soil/rock mixture free of debris, organics, and other deleterious materials. Maximum particle size should be 4 inches. Fill should have less than 10 percent passing a No. 200 sieve. Onsite soils are not

---

*Relative compaction refers to the dry density of the compacted material expressed as a percentage of the maximum dry density of the same material as determined by ASTM D1557.

suitable for use as fill. Fill materials should be approved by our engineer prior to use. For areas above water levels, fill should be placed in level layers approximately 8 inches thick and compacted with vibratory equipment to at least 95 percent relative compaction. Heavy compaction equipment should not be used to compact fill behind retaining walls within a horizontal distance equal to the height of the wall or 8 feet, whichever is greater.

Fill Material Below Water. New fill will be used to raise existing grades within the deep areas of the existing pool area and near the new footings along the pool's west inboard side. We previously recommended in our 1991 report that the silt encountered in this deep area be removed prior to raising grades. We still continue to recommend that the silts be removed.

The new fills should be placed prior to soil improvement below new footings. This will allow settlements to occur sooner. As soil improvement is accomplished, the nearby surrounding soils will tend to densify and produce additional settlements beyond the footing edge and soil improvement area. In these areas, additional new fill will be needed to raise grades. Overfilling prior to soil improvement is also feasible; however, the specialty contractor should be consulted regarding estimates of settlements near the footing edge.

New fills will be used to raise grades beneath seawater within the existing pool, and beneath and adjacent to new footings. We recommend the new fill material be placed prior to soil improvement and footing construction.

We recommend coarse clean gravels be used to raise grades beneath seawater. Basalt gravel meeting gradations presented in ASTM C33 #67 coarse would be suitable as fill material. The basalt gravels should be densified using vibroreplacement methods. If sands are placed over this material, migration of the beach sand into the voids and gradual lowering of the sand bottom should be expected.

Soil Improvement

We recommend that a specialty foundation contractor with a minimum of eight years of experience with vibroreplacement methods be used to improve the underlying soils. The specialty foundation contractor should have design experience in similar soil conditions. The drawings and specifications should be adjusted to specify that the specialty foundation contractor shall improve the subsurface soil properties to an allowable bearing capacity of 1,800 pounds per square feet (factor of safety = 3) and limit the total settlements to less than 1 inch and differential settlements to less than 1/2 inch.

Portions of the existing sea wall are indicated to have the seawall base expanded as a footing. The existing sea wall is constructed with boulders placed adjacent to the existing pile foundations. These boulders will need to be removed to allow the probe access to the underlying soils. The specialty contractor should be prepared to encounter boulders beneath the proposed footing location and within the depth of soil improvements. In addition, piles should be anticipated in both CWU footing alignments. Soil Improvement should be reconfirmed to achieve the specified allowable bearing capacity, and total and differential settlements prior to footing construction by the use of standard penetration tests (SPT). The specialty contractor should be responsible to perform the SPT tests. These results should be submitted for HLA's review.

Shallow Foundations

Pool deck foundations can be supported on spread footings bearing on in situ soils which have undergone soil improvement. Non-load-bearing bleacher wall footings can be supported on new compacted fill or on in situ soils which have been proofrolled. Spread footings should be designed using the following criteria:

Allowable Bearing Pressures

	Non-load-bearing Foundations	Pool Deck Foundations
Allowable Bearing Pressure		
Dead plus long-term live loads	2,500 psf[1]	1,800 psf
Total loads (including wind or seismic)	3,300 psf	2,400 psf
Ultimate Resistance to Lateral Loads (no factory or safety included)		
Friction factor (mass concrete on sand)	0.35	0.35
Passive soil resistance (above water)	360 pcf[2]	360 pcf
Passive soil resistance (below water)	150 pcf	150 pcf

1. psf = pounds per square foot.
2. pcf = pounds per cubic foot.

Friction resistance along the base of footings can be computed by multiplying the friction factor by the vertical sustained load. Passive resistance is expressed above as equivalent fluid unit weight on the face of structural elements. The passive pressure and friction factor shown on the table do not include a safety factor; we recommend a safety factor of 2 for design purposes. Passive resistance should be neglected in the upper 1 foot unless the soil is confined by a pavement or slab-on-grade. The pool deck footings should be embedded below the predicted scour depth from ocean engineering studies.

Slab-on-Grade Floors

Prior to construction of slab-on-grade floors, subgrade soils should be compacted to form a dense, unyielding surface. Slab-on-grade floors should be underlain by at least 4 inches of clean, such as ASTM C33 gradation No. 67, to provide uniform support and a capillary moisture break. The crushed rock should be compacted to provide a dense, unyielding surface. Where penetration of moisture through the slab would be objectionable, a vapor barrier can be placed over the crushed rock prior to pouring the slab. Two inches of sand placed over the vapor barrier can aid in curing the slab and protect the barrier during construction. The need for a vapor barrier and sand should be governed by architectural and structural factors.

Please call me if you have any questions.

Sincerely yours,

HARDING LAWSON ASSOCIATES

Russell C.H. Leong
Civil Engineer - 6315

QC: GTSH

RCHL:hkf

811188-02

HARDING LAWSON ASSOCIATES
803 Kamehameha Highway, Room 404
Pearl City, Hawaii 96782
Phone: (808) 455-6551
Fax: (808) 455-1507

RECEIVED DEC 17 1992

FACSIMILE TRANSMITTAL

File
BF
Cliff
Pat

TO: LEO A. DALY

FAX NO.: 521-3757

ATTENTION: MR. CLIFFORD LAU or MR. BENNETT FUNG

FROM: RUSSELL LEONG

DATE: December 16, 1992 TIME: 5:15 pm

HLA JOB NO. 10372.034

SUBJECT: NATATORIUM, OAHU, HAWAII

RECOMMENDATIONS FOR REVISED SCHEME

NO. OF PAGES INCLUDING TRANSMITTAL: 9

ORIGINAL OR COPY TO FOLLOW VIA MAIL: YES: ____ NO: X

IF YOU DO NOT RECEIVE ALL PAGES, PLEASE CALL RUSSELL LEONG AT (808) 455-6551 IMMEDIATELY.

REMARKS:

WALL FOOTINGS AT THE BLEACHER AREA:

1. Wall footings are non-load bearing. Maximum load in this area is 2.12 kips per lineal foot.

2. Qall = 2500 PSF, Estimated Total Settlement = 1" with Differential Settlement of 0.75".

3. Settlements based on Leo A Daly fax dated 12/8/92.

4. Exposed near surface soils should be proofrolled as recommended in our report dated 12/12/91 and any soft compressible areas removed.

DEEP PORTION OF THE POOL (ELEV -20 TO -25):

1. We understand that the deep portion of the pool was previously used as the diving area. Old construction drawings indicate that this area was to be dredged from about elevation -9 to elevation -15 and have plan dimensions of about 39′ by 72′. A recent survey by SEA Engineering indicates that the pool bottom at about -20 with firm bottom at about -23 feet. Our previous soils report for this project indicates that silt was encountered in this diving area.

2. Our report recommended that the silt layer in the diving area (up to 5 feet thick) be removed completely. We still recommend that this silt be removed prior to filling in the deep area. The diving area should be filled with lighter volcanic cinders consisting of coarse clean gravels to reduce the loads applied to the underlying lagoonal deposits.

3. We estimate up to 3-inches of settlement would occur from the filling of the diving area. Cinder gravels need not be densified, future settlement should be anticipated if the submerged gravels are subjected to shaking such as during an earthquake or nearby pile driving.

4. Portions of the oceanside edge of the pool is currently below the bottom of the proposed wall footing at elevation -10 feet. Fills would be necessary along portions the wall footing alignment to raise the grade to elevation -10 feet. We recommend that clean volcanic cinder gravels be used to fill this area and the fill be densified using submersible vibrators. Densification limits should extend at least 1/2 the footing width beyond the footing edge. Fill settlement should be monitored as recommended in our soils report and should be essentially complete prior to constructing the wall footing.

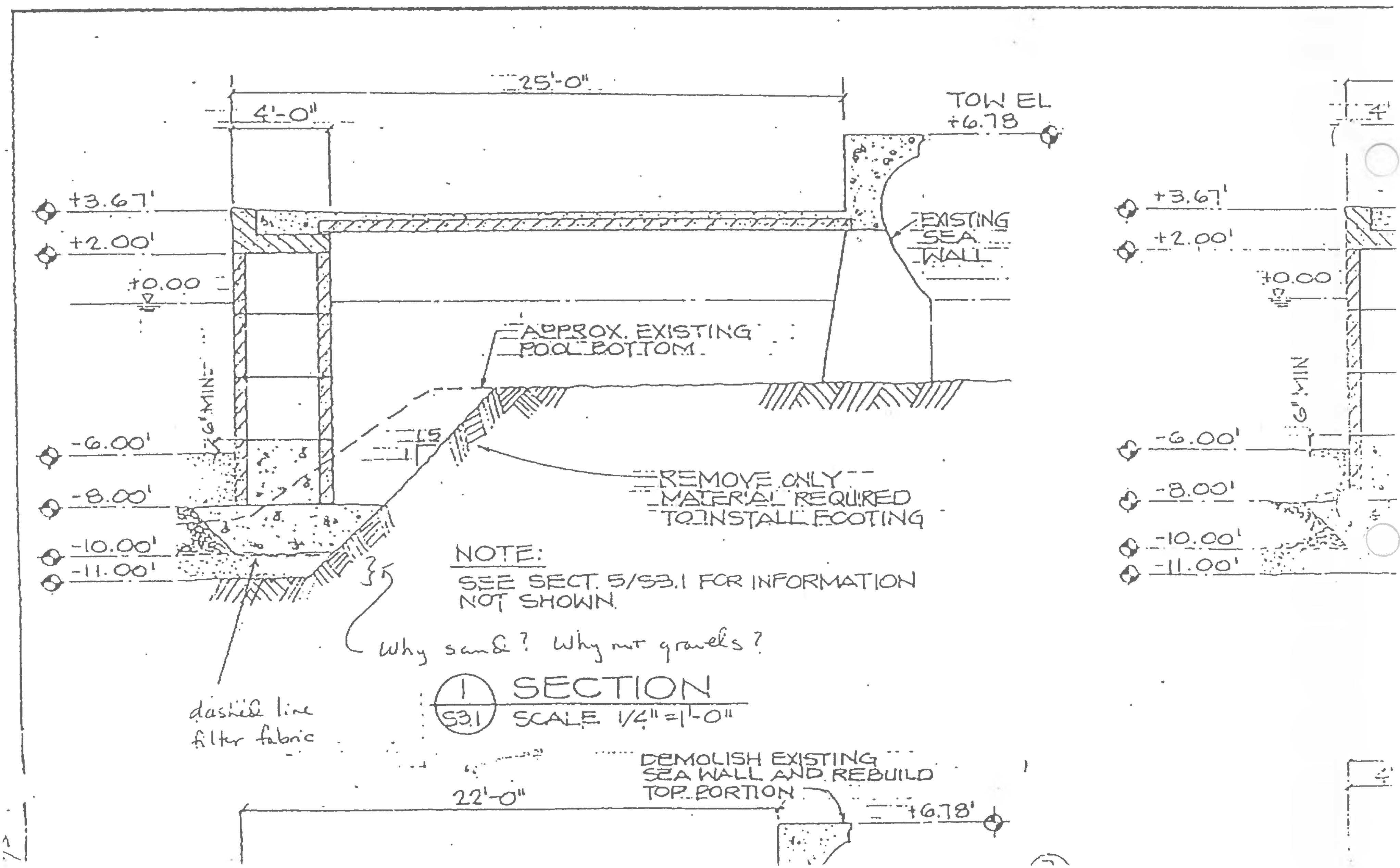
WALL FOOTINGS:

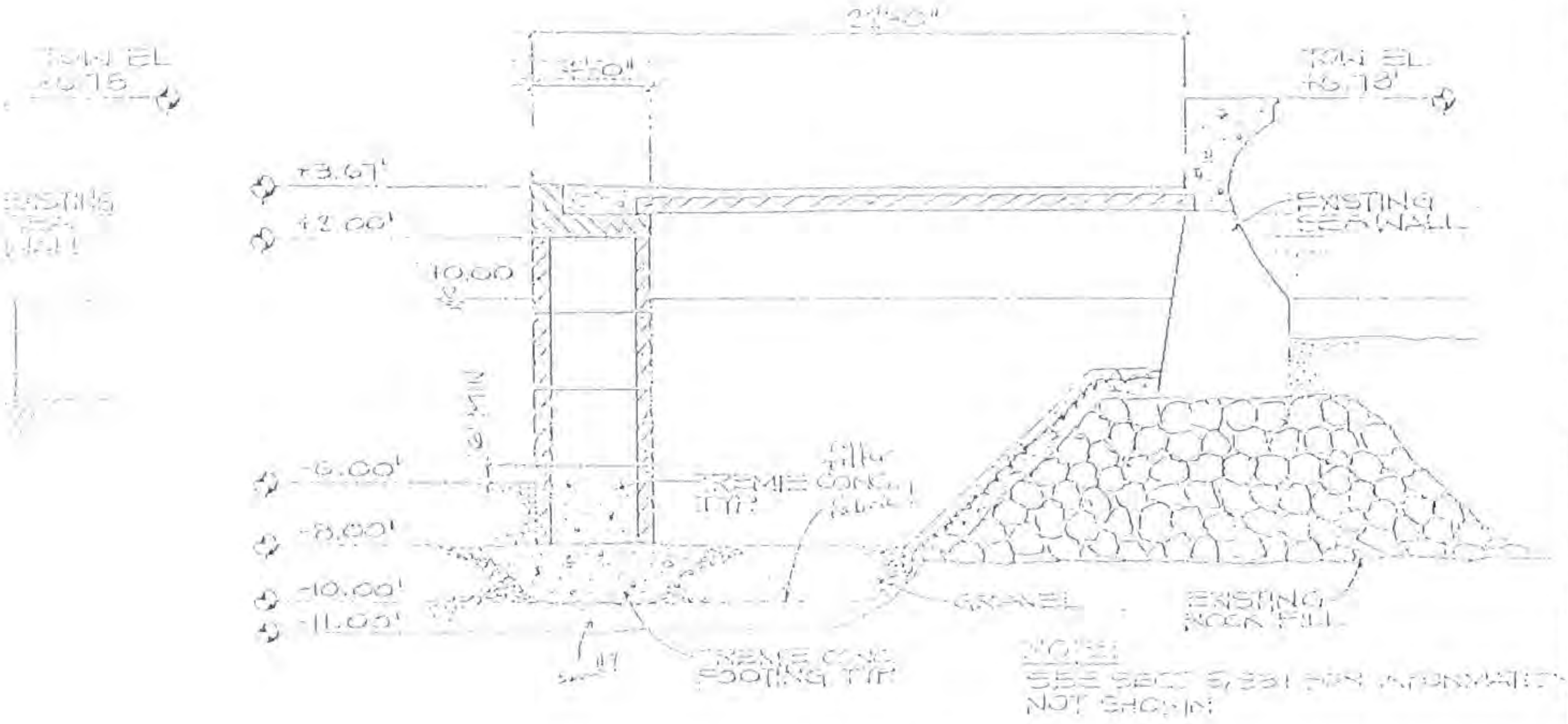
1. Hollow precast units approximately 4 feet wide, 8 to 12 feet long, and 1 to 1.5 feet high would be stacked to build the wall surrounding the pool. These units would have 4-inch diameter holes in which epoxy coated rebars could be insert and grouted. The wall would be used to support a precast deck panel on one end and the other end would use the existing sea wall to support the ocean side end of the deck panel. Loads from the wall and deck panel are 7.1 kips per lineal foot for the dead load and 1.3 kips per lineal foot for the short term live load. That portion of the dead load is from the precast deck is 1.25 kips per lineal foot.

2. We recommend an allowable bearing of 1800 psf be used to size the wall footing provided the bottom of footing does not go below elevation -10 feet. We estimate total settlements to be about 1-inch with differential settlements of 3/4-inch; however, subsurface conditions may vary between borings and settlements would be more in softer areas. We recommend that the plans and specifications allow for the realignment of the precast blocks should there be more settlement in localized areas.

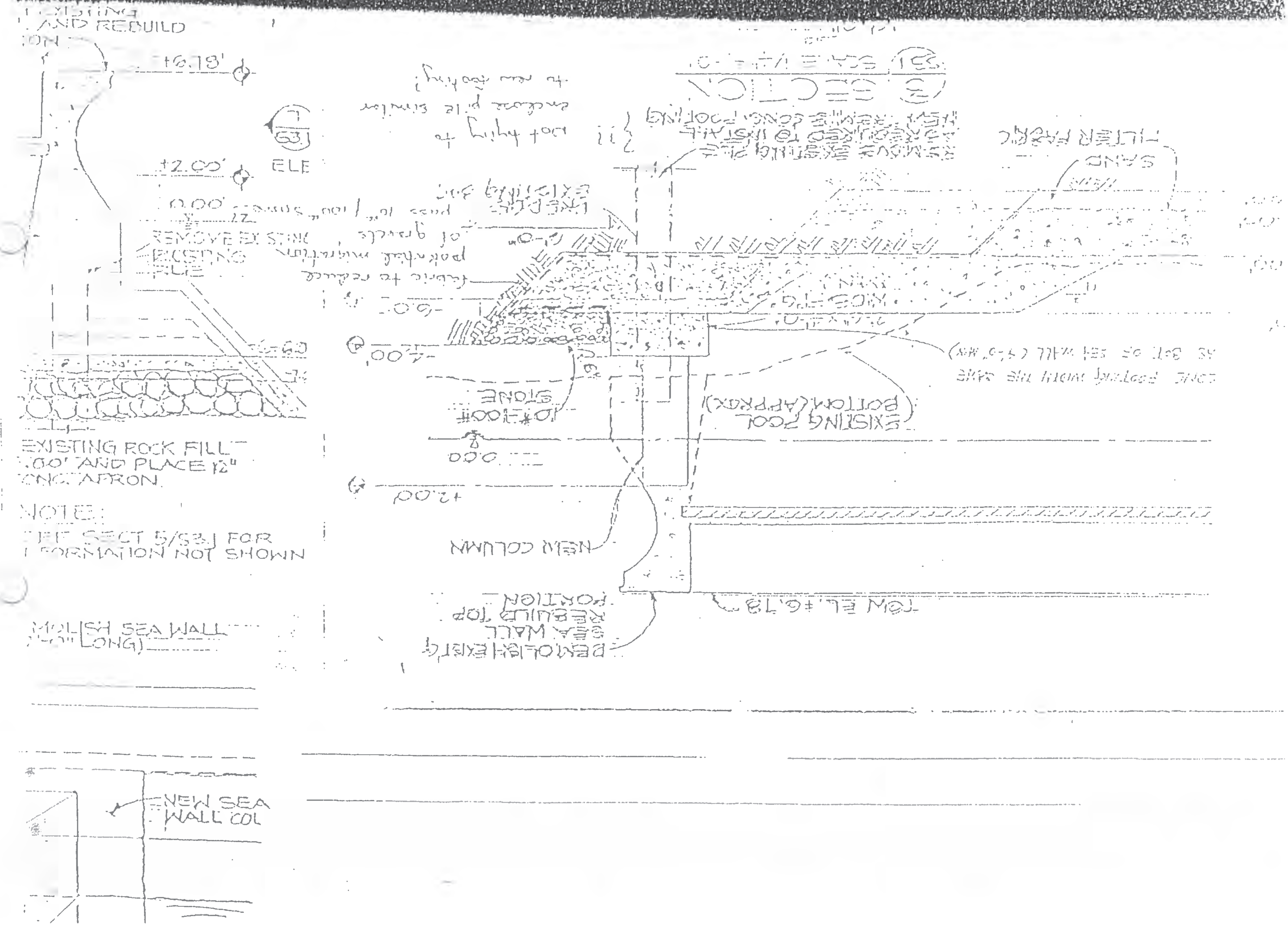
3. If fill is needed to raise the existing grade to finish subgrade elevation beneath the footing, we recommend a clean cinder gravel be used and the gravels densified with a submersible vibrator. In cut areas, the subgrade should be densified. Densified gravels should be used to raised grade if settlement should occur.

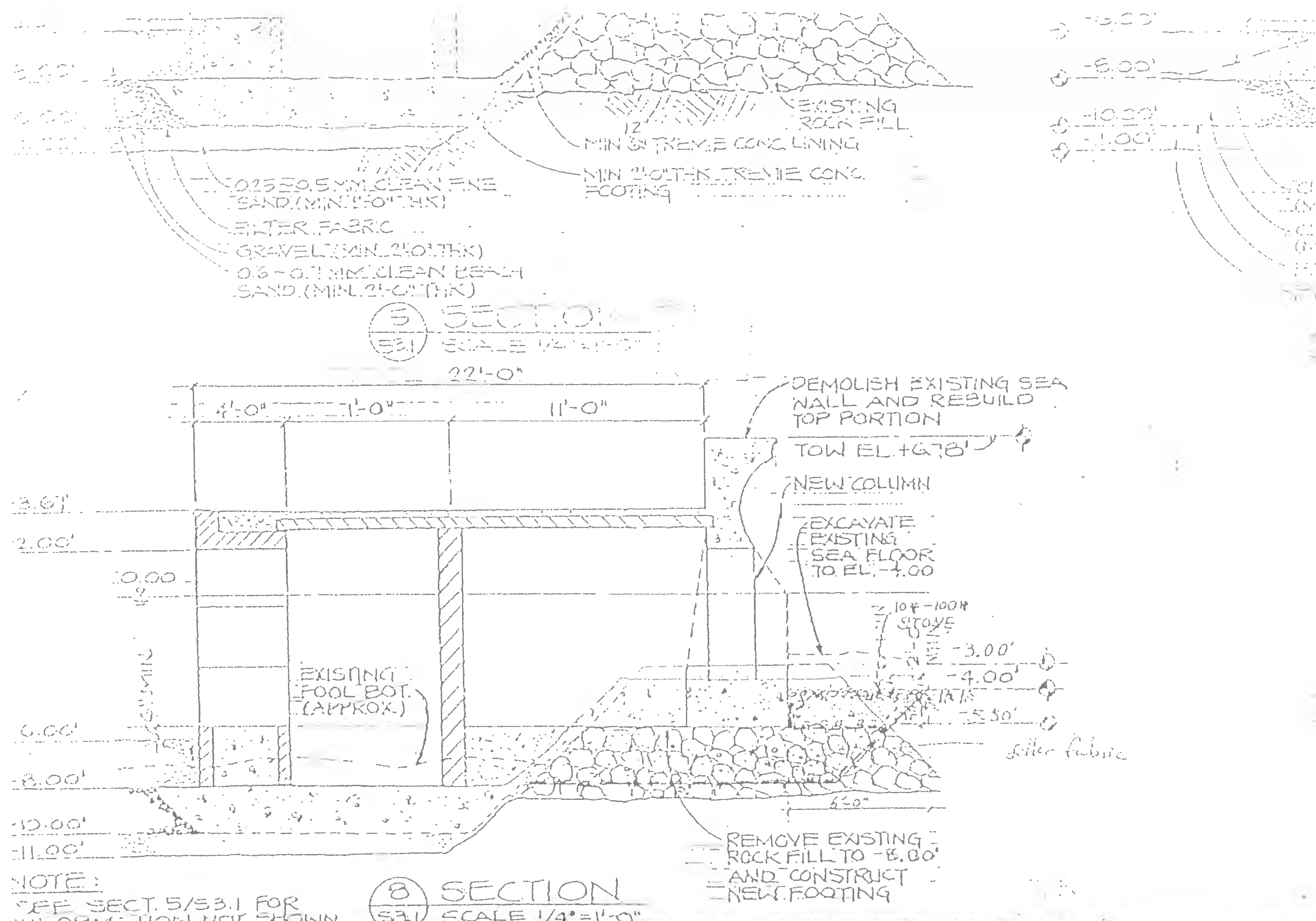
4. If possible, the precast deck panels should should also be placed on to subject the subsurface soils to the full dead loads. Settlement should be monitored. After settlement has occured, the precast blocks should be realigned and then grouted.

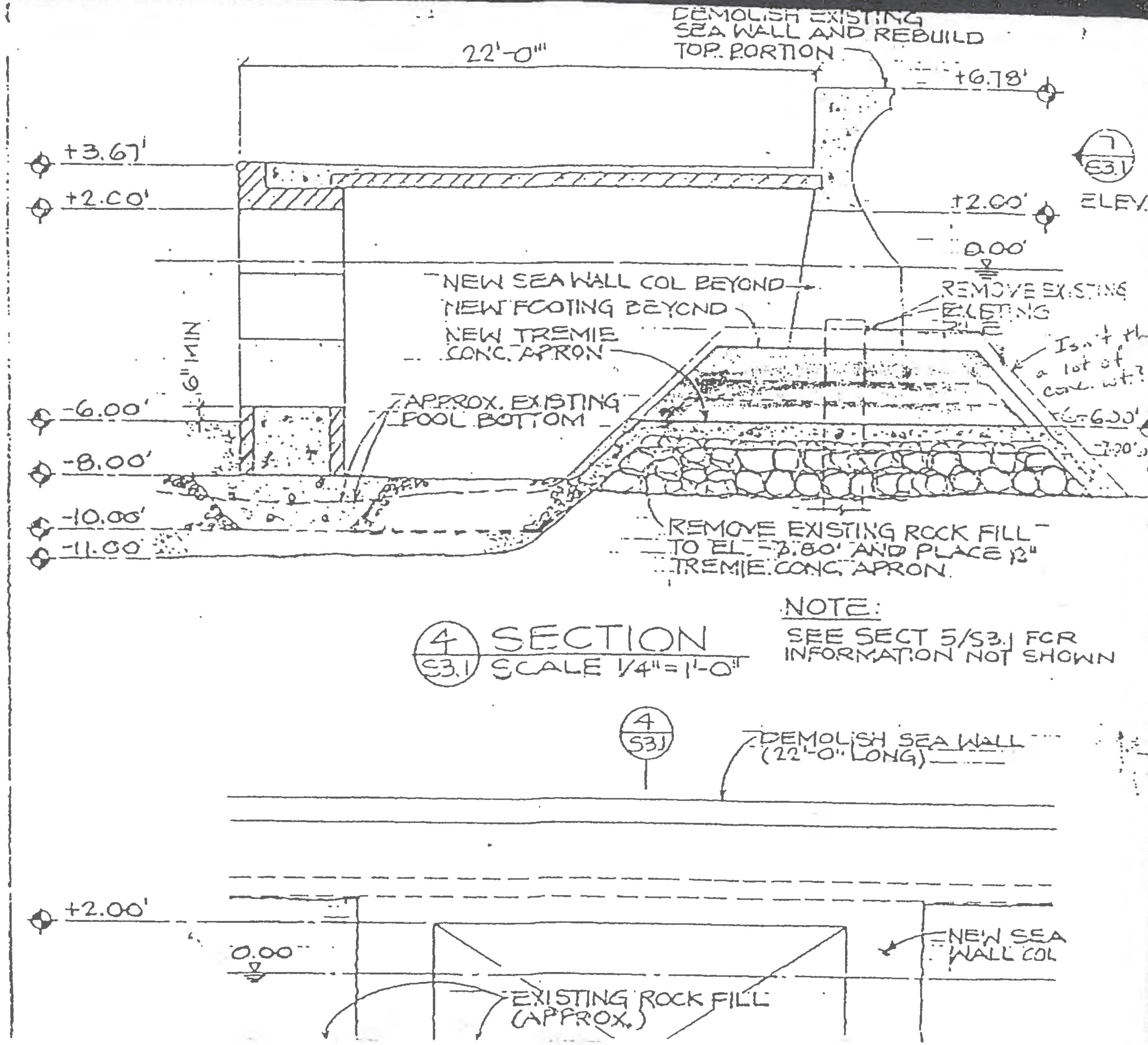

25'-0"
4'-0"
TOW EL +6.78
+3.67'
+2.00'
+0.00
EXISTING SEA WALL
APPROX. EXISTING POOL BOTTOM
6" MIN
-6.00'
-8.00'
-10.00'
-11.00'
1.5
1
REMOVE ONLY MATERIAL REQUIRED TO INSTALL FOOTING
NOTE:
SEE SECT. 5/S3.1 FOR INFORMATION NOT SHOWN
Why sand? Why not gravels?
dashed line filter fabric
1
S3.1
SECTION
SCALE 1/4"=1'-0"
DEMOLISH EXISTING SEA WALL AND REBUILD TOP PORTION
22'-0"
+6.78'



2 SECTION
S3.1


EXISTING
AND REBUILD
+6.18'
+2.00'
ELE
0.00'
REMOVE EXISTING
EXISTING PILE
EXISTING ROCK FILL
.00' AND PLACE 12"
CONC APRON.
NOTE:
SEE SECT 5/S3.1 FOR
INFORMATION NOT SHOWN
MOLISH SEA WALL
LONG)
NEW SEA
WALL COL
SECTION
SAND
FILTER FABRIC
REMOVE EXISTING PILE AS REQUIRED TO INSTALL NEW FOOTING
not trying to enclose pile similar to new footing
fabric to reduce potential migration of gravels
-4.00'
+2.00
0.00
10#-100# STONE
NEW COLUMN
DEMOLISH EXIST'G SEA WALL REBUILD TOP PORTION
EXISTING POOL BOTTOM (APPROX)
TOW EL +6.78


EXISTING ROCK FILL
12" MIN @ TREMIE CONC LINING
MIN 2'-0" THK TREMIE CONC FOOTING
0.25-0.5 MM CLEAN FINE SAND (MIN 1'-0" THK)
FILTER FABRIC
GRAVEL (MIN 2'-0" THK)
0.6-0.7 MM CLEAN BEACH SAND (MIN 2'-0" THK)
-6.00'
-10.00'
-11.00'
5 / S3.1 SECTION
22'-0"
4'-0"
11'-0"
11'-0"
DEMOLISH EXISTING SEA WALL AND REBUILD TOP PORTION
TOW EL +6.78'
NEW COLUMN
EXCAVATE EXISTING SEA FLOOR TO EL -4.00
10#-100# STONE
-3.00'
-4.00'
-5.50'
filter fabric
EXISTING POOL BOT. (APPROX.)
3.61'
2.00'
0.00
6.00'
-8.00'
-10.00'
-11.00'
6'-0"
REMOVE EXISTING ROCK FILL TO -8.00' AND CONSTRUCT NEW FOOTING
8 / S3.1 SECTION
SCALE 1/4"=1'-0"
NOTE:
SEE SECT. 5/S3.1 FOR INFORMATION NOT SHOWN



DEMOLISH EXISTING SEA WALL AND REBUILD TOP PORTION
22'-0"
+6.78'
+3.67'
+2.00'
ELEV.
7/S3.1
0.00'
NEW SEA WALL COL BEYOND
NEW FOOTING BEYOND
NEW TREMIE CONC. APRON
REMOVE EXISTING EXISTING PILE
Isn't this a lot of conc. wt?
6" MIN
-6.00'
APPROX. EXISTING POOL BOTTOM
-8.00'
-10.00'
-11.00'
REMOVE EXISTING ROCK FILL TO EL -7.80' AND PLACE 12" TREMIE CONC. APRON
NOTE:
SEE SECT 5/S3.1 FOR INFORMATION NOT SHOWN
4/S3.1 SECTION
SCALE 1/4"=1'-0"
4/S3.1
DEMOLISH SEA WALL (22'-0" LONG)
+2.00'
0.00
NEW SEA WALL COL
EXISTING ROCK FILL (APPROX.)

Harding Lawson Associates

A Report Prepared for

Leo A. Daly, Alfred A. Yee Division
Honfed Tower
1357 Kapiolani Boulevard, Suite 1000
Honolulu, Hawaii 96814

GEOTECHNICAL INVESTIGATION
WAIKIKI WAR MEMORIAL AND NATATORIUM
WAIKIKI, OAHU, HAWAII

HLA Job No. 03712,034.06

by

Joseph C. Light bycom
Joseph C. Light
Project Engineer

Christian P. Muller
Christian P. Muller
Civil Engineer - 5748

Harding Lawson Associates
803 Kamehameha Highway, Room 404
Pearl City, Hawaii 96782

December 12, 1991

0303R

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LIST OF ILLUSTRATIONS

I INTRODUCTION

This report presents the results of our geotechnical investigation for the Waikiki War Memorial and Natatorium in Waikiki, Oahu, Hawaii. The project is located on the Waikiki shoreline between Kaimana Beach Hotel and the Waikiki Aquarium. The project location is shown on Plate 1.

A. Project Description

The Natatorium is a saltwater swimming pool structure built out into the ocean from near the original shoreline. The pool is surrounded by a sea wall, and an adjacent concrete deck supported on beams and piles. Flushing channels are provided on the Diamond Head and Ewa sides to allow sea water circulation within the pool. An entry archway, the War Memorial arcade, is flanked on both sides by spectator bleachers built over locker rooms. Plan area of the project is approximately 73,000 square feet.

At this time, the Natatorium is in a state of considerable disrepair. The concrete deck has collapsed into the pool on the Diamond Head and Ewa sides, and portions of the sea wall are damaged. The bleachers and their supporting concrete beams and walls have suffered significant deterioration.

The current reconstruction plan includes the following:

1. Sea Wall

All portions of the sea wall that are above the top of the existing pool deck will be removed. The upper portions of the sea wall will be reconstructed and tied to the new slab-on-grade deck. Additional inlets will be constructed to allow for improved sea water circulation. Groins will be constructed adjacent to the inlets to reduce sand and sediment movement into the pool.

Appendix F:
Marine Biological and Water Quality Surveys

AECOS No. 1241B

Marine biological and water quality surveys at the Waikīkī War Memorial Natatorium Honolulu, Oʻahu

Prepared by:

AECOS, Inc.
45-939 Kamehameha Hwy, Suite 104
Kāneʻohe, Hawaiʻi 96744-3221

June 4, 2012

Marine biological and water quality surveys at the Waikīkī Beach War Memorial Natatorium Honolulu, Oʻahu[1]

June 4, 2012 | **_FINAL DRAFT_** | _AECOS_ No. 1241B

Stacey Kilarski, Susan Burr, and Chad Linebaugh
AECOS, Inc.
45-939 Kamehameha Hwy, Suite 104
Kāneʻohe, Hawaiʻi 96744
Phone: (808) 234-7770 Fax: (808) 234-7775 Email: aecos@aecos.com

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[1] Report prepared for Wil Chee-Planning for use in the preparation of the master plan and will be included in an environmental impact statement.

Introduction

The Waikīkī War Memorial Natatorium was built in 1927 along the shore of Waikīkī (Fig. 1) as part of the Waikīkī War Memorial Park in memoriam to members of the military services from Hawaiʻi killed in World War I. The current condition of the Natatorium is a health and safety hazard and has been closed since 1979. The City and County of Honolulu considered various alternative uses for the Natatorium and is preparing an Environmental Impact Statement. The preferred alternative includes removal of the entire structure and creation of a beach between groins and construction of a replica memorial arch (the "Project"). Implementation of the preferred alternative has the potential to impact marine resources and water quality in the project area.

This report updates an interim report (*AECOS*, 2010a) and describes marine biological resources and water quality in and around the waters of the Natatorium based on surveys conducted in October 2010, February 2011, and April 2012. Potential impacts of alternatives for the Natatorium site and creating a sand beach are assessed.

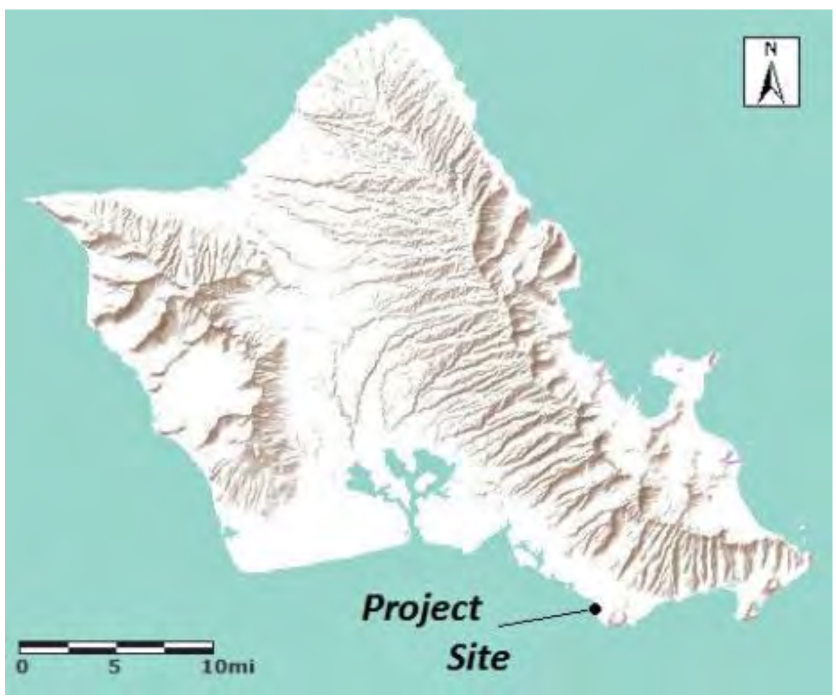


Figure 1. Waikīkī War Memorial Natatorium location on the Island of Oʻahu.

Site Description

The Natatorium is located on the south coast of the Island of Oʻahu (see Fig. 1), toward the southeastern end of Waikīkī between the Waikīkī Aquarium and the New Otani Kaimana Beach Hotel (Fig. 2). On the south side of the Natatorium is Sans Souci or Kaimana Beach. A dredged channel, approximately 15 m (50 ft) wide and 3 m (10 ft) deep fronts the Waikīkī Aquarium and abuts the north side of the Natatorium.

The Natatorium walls are constructed of reinforced concrete placed on the inshore reef. The main features include an entrance archway, bleachers, and a 100 m by 36 m (330 ft by 120 ft) saltwater swimming pool. Despite repair attempts—in 1949 and in 2000 when improvements were made mainly to the bleachers and the entrance archway—the facility is failing structurally. Large sections of the concrete decking have collapsed and rusting rebar is exposed (Figs. 3a and 3b).

Figure 2. Location of the Natatorium.

Figure 3a (left). Collapsed decking on south wall.
Figure 3b (right). Collapsed decking on land-side (east) fronting bleachers.

The entire Waikīkī Beach shoreline from Kahanamoku Beach on the west to Sans Souci Beach on the southeast is highly altered by seawalls, groins, and jetties, all placed in an effort to stabilize the shoreline. Over 382,278 m^3 (500,000 yd^3) of sand have been placed on the beach at Waikīkī since 1928 (Fletcher and Miller, 2003). The nearshore waters in the vicinity of the Natatorium have been impacted by land-based activities since the early 1900's. In particular, dredging of the channel on the northern side of the Natatorium and sand placement on the beach south of the Natatorium in the 1950's impacted shallow marine communities in the area (SEA, 1992).

Area Description

The fringing reef off Waikīkī is an eroded limestone platform influenced by sand suspension and scour caused by impinging waves. Sand-filled pockets are abundant and support diverse assemblages of sediment-dwelling invertebrates (Bailey-Brock and Krause, 2008); exposed limestone outcrops support mostly turf-forming algae (*AECOS*, 1979, 2009). Live coral is sparse in the nearshore waters off Waikīkī, accounting for less than one percent of the bottom (OI, 1991; MRC, 2007; *AECOS*, 2007, 2008, 2009, 2010b). Other reef macro-invertebrates, such as sea urchins and sea cucumbers, are conspicuous but relatively uncommon (OI, 1991; MRC, 2007; *AECOS*, 2009).

Two biotopes in the vicinity of the Waikīkī Natatorium have been previously defined: high energy reef flat biotope and the biotope of sand (SEA, 1992). The biotope of sand is located south of the Natatorium. Sand is not a stable substratum, and with the impingement of wave energy, sand particles are moved around and scour adjacent hard bottom and benthic communities. The high energy reef flat biotope dominates the shallow areas offshore and to the north (except the dredged channel) of the Natatorium. The dominate substratum in this zone is limestone with patches of sand and rubble. Sand and rubble are found on the bottom of the dredged channel to the north of the Natatorium and in shallow wave-cut channels that are generally orientated perpendicular to shore (Fig 4). These channels are 1 to 10 m (3 to 33 ft) in width, 5 to 35 m (16 to 115 ft) in length, and up to 50 cm (20 in) in depth (SEA, 1992).

The Waikīkī Marine Life Conservation District (MLCD) encompasses the area north of the Natatorium to the groin at the end of Kapahulu Avenue from the mean higher high water (MHHW) mark to the edge of the reef or 457 m (500 yd) offshore, whichever is greater. Within the MLCD, taking of any marine life (i.e., fish, algae, coral, 'live rock') is prohibited. The Waikīkī-Diamond Head Shoreline Fisheries Management Area (FMA) extends from the Ewa wall of the Natatorium to the Diamond Head Lighthouse, from the highwater mark out to a minimum seaward distance of 500 yards (457 m), or to the seaward edge of the fringing reef if one occurs beyond 500 yards (457 m; HAR §13-48). Fishing in the FMA is allowed during even-numbered years. Despite restrictions on fishing, fish biomass and diversity are low in nearshore areas of low relief bottom (Williams et al., 2006; MRC, 2007; *AECOS*, 2009).

Figure 4. Limestone with patches of sand and rubble are dominant substrata off the Natatorium. Wave cut channels run perpendicular to shore.

Green sea turtles or *honu* (*Chelonia mydas*) are regularly observed over the shallow reef platform off Waikīkī, as many of their preferred algal food species are abundant or common on the reef flat (*AECOS*, 2009, 2010a, 2010b). In general, water quality off Waikīkī is good, although waves and the shallow bottom often produce elevated turbidity as sediments are continuously resuspended (*AECOS*, 2009; USEPA, 2009). Water quality in the Natatorium pool has historically been degraded due to poor circulation of sea water between the pool and ocean (SEA, 1992). Deteriorated and potentially dangerous water quality conditions forced closing of the Natatorium (Leo A. Daly, 1995).

Project Description

Alternatives for the use of the site include replacement of the existing structure with a memorial beach. Coastal engineers developed seven conceptual designs to determine feasible groin configurations to create a memorial beach (SEI, 2008). The conceptual designs were restricted to the existing structure's footprint. The project goal is to provide a stable beach within the present Natatorium site while leaving Sans Souci beach unaffected. Each conceptual design includes beach nourishment (recovery of sand from offshore and placement of this sand on the beach via a pipeline) though the volume of sand fill varies among the conceptual designs. The seven conceptual designs are as follows (SEI, 2008), and were used to guide the survey design described in this report:

- Conceptual Design 1 includes an L-groin situated at the Ewa west end of the study site, extending 250 ft from shore, with a 60-foot head. An 80-foot detached breakwater is located toward the Diamond Head end along the line of the offshore wall.
- Conceptual Design 2a includes a 250-foot long L-groin at the Ewa end, as in Conceptual Design 1. A 110-foot long groin at the Diamond Head end separates the new beach area from Sans Souci Beach.
- Conceptual Design 2b includes two L-groins at the lateral extents of the Natatorium. The L-groin on the Diamond Head side follows the existing Natatorium walls and has a 65-foot head. The trunk of the Ewa groin is 310 ft long and the 90-foot head is angled by 25 degrees from the offshore Natatorium wall to orient the gap between the groins with the incident wave angle.
- Conceptual Designs 3a and 3b include 260-foot long groins at the lateral extents of the Natatorium. Conceptual Design 3a includes complete removal of the Natatorium and a crescent-shaped beach between the groins, while Conceptual Design 3b retains the bleachers and has no beach.
- Conceptual Design 4 was developed based on the "Partial Restoration Alternative" presented in a 1990 planning report and the 1995 final environmental impact statement (SEA, 1992). The Diamond Head wall and half of the offshore wall are replaced with a 265-foot long by 215-foot wide L-groin. The Ewa wall is replaced with a 185-foot groin and an 85-foot detached breakwater is placed 80 ft offshore of the end of the groin. A 180-foot detached breakwater is placed on the reef 85 ft offshore of the 130-foot outer gap. The concept design shows the beach extending fully to the L-groin.
- Conceptual Design 5 includes a T-head groin that extends 285 ft from shore on the Ewa end and an 85-foot detached breakwater is shown at

the offshore Diamond Head corner of the project site. The head of the Ewa L-groin is angled to orient the gap between the groins with the incident wave angle.

Since our 2010 surveys, a preferred design alternative has been selected, which is a modification of Alternative 2b; to demolish the existing structure; construct two groins within the existing footprint of the Natatorium pool and build a replica memorial arch located slightly inland. Sand is proposed to be reclaimed from an offshore deposit and placed along the shoreline between the two groins (WCP, 2012). The reclaimed sand is proposed to be loaded on a barge anchored offshore the Natatorium and placed between the two groins via an underwater pipeline.

Survey Methods

Water Quality

To characterize the water quality within and around the Waikīkī Natatorium and to contribute to the baseline water quality characterization, five sampling stations were established (Fig. 5). Station "Pool" is located inside the Natatorium pool at the midpoint along the eastern side. Station "Sans Souci" is located just off the Sans Souci beach shoreline, approximately 3 m (10 ft) south of the Natatorium. Station "Circ Culvert" is located along the northern face of the Natatorium near a circulation culvert. Station "Off Ewa Corner" is located 84 m (275 ft) seaward of the northwest corner of the Natatorium. Station "Offshore" is located in the outer Kapua Channel, 450 m (1500 ft) offshore of the revetment extending from the beach fronting the Colony Surf Hotel.

Latitude and longitude coordinates for water quality monitoring stations were recorded during the first sampling event using a Garmin GPSMap 60CSx receiver. The same unit was used to navigate to stations during subsequent monitoring events.

Field measurements for temperature, salinity, pH, and dissolved oxygen (DO) were taken *in situ* at each monitoring station. At each station, water samples were collected in appropriate containers from just below the surface, preserved on ice, and taken to *AECOS* laboratory in Kāneʻohe, Oʻahu (Log Nos. 26726, 27076 and 27204) for analyses. Collected samples were analyzed for turbidity, total suspended solids (TSS), nitrate+nitrite (NO_3+NO_2), ammonia (NH_4), total nitrogen (TN), total phosphorus (TP), and chlorophyll α (Chl α). Table 1 lists the field instruments and analytical methods used to evaluate these samples.

Figure 5. Waikīkī Natatorium Restoration Project, water quality sampling stations in yellow.

Table 1. Analytical methods and instruments used for analysis of water quality for the Waikīkī Natatorium project.

Analysis	**Method**	**Reference**
Temperature	EPA 170.1	USEPA (1983)
Salinity	bench salinometer	Grasshoff et al. (1999)
pH	EPA 150.1	USEPA (1983)
Dissolved Oxygen	EPA 360.1	USEPA (1983)
Turbidity	EPA 180.1, Rev. 2.0	USEPA (1993)
Total Suspended Solids	SM 2540D	SM (1998)
Nitrate+Nitrite nitrogen	EPA 353.2 Rev. 2.0	USEPA (1993)
Ammonia nitrogen	SM 4500-NH3 B/C	Grasshoff et al. (1999)
Total Nitrogen	persulfate digestion EPA 353.2	Grasshoff et al. (1999)
Total Phosphorus	EPA 365.1 Rev. 2.0	USEPA (1993)
Chlorophyll α	SM 10200 H	SM (1998)

Biology

Based on the conceptual designs, *AECOS* marine biologists surveyed three marine areas associated with the Project: 1) Natatorium interior including the pool bottom and walls; 2) Natatorium exterior including the walls and surrounding reef flat and dredged channel and; 3) the sand supply pipeline corridor. In each area, divers collected data on percent benthic composition, macro-invertebrate density, coral abundance and size-class distribution, and density and biomass of fishes, as described below.

Reconnaissance Survey

AECOS biologists surveyed the marine community of the interior pool, including sea floor and concrete walls on October 20, 2010. This initial reconnaissance survey was done by snorkeling the perimeter and making several crossings of the pool. The intent of this initial survey was to assemble a taxonomic list with abundance categories for macro-invertebrates, algae, and fishes; note any biological resources of special concern; and measure all coral colonies encountered. The hazardous conditions of the concrete decking made snorkeling under the decking dangerous. Therefore, a small underwater video camera (GoPro® HERO) was utilized to capture images of biota under the partially collapsed concrete decking. The GoPro® HERO camera was attached to the end of a 1.8 m (6 ft) pole, which was extended under the decking. Video images were viewed to assess community composition and organisms on and under the decking.

Benthic Community Composition

Natatorium Interior— *AECOS* biologists surveyed the pool bottom and walls to obtain quantitative data on substrate type and macro-invertebrates (Fig. 6). Prior to the survey, the biologists selected two random points within each of two delineated segments on the west and shore side walls, resulting in four stratified random survey stations. From each point, 10-m transect lines were extended along the pool bottom to the north, parallel to the shore. A 0.5 x 0.5 m^2 polyvinyl chloride (PVC) quadrat frame was centered over the transect line at 1-m intervals and biologists identified substrate type and estimated area of substratum (limited to macroalgae or sand) to the nearest five percent within each 0.25-m^2 quadrat.

Five transects were used to quantitatively assess the pool walls: one each on the north and south walls, two on the seaward wall, and one on the shore side wall (see Fig. 6). The locations of the transect lines were determined by available wall surface area, as large sections of the walls and/or decking have collapsed. Transects (10-m length) were extended along the walls and a 0.25-m^2 quadrat was centered over a transect line at 1-m intervals, 0.5m up from the bottom of the pool. Within each 0.25-m^2 quadrat, biologists identified substrate type and estimated the area of substratum (macroalgae/turf, encrusting algae, or bare concrete) to the nearest five percent.

Figure 6. Approximate locations of October 2010 Natatorium interior wall and pool bottom transects locations.

Natatorium Exterior — In February 2011, *AECOS* biologists surveyed the exterior pool wall and adjacent reef flat for substrate type, coral colony size and species, and macro-invertebrates. To evaluate all conceptual Project alternatives, transect locations were grouped into five "impact areas" (Fig. 7). The location and configuration of the impact areas were designed to assess potential impacts from the implementation of the conceptual designs: 1) Area C included the entire exterior concrete pool wall; 2) Area D encompassed a 5-m (16-ft) wide perimeter around the exterior pool wall; 3) Area E extended 32 m (105 ft) offshore from the northwest corner of the outer wall and 55 m (180 ft) to the south; 4) Area F was 5 m (15 ft) wide and extended 26 m (85 ft) to the north from the northwest corner, and included the edge of the dredged channel; and 5) Area G was 5 m (15 ft) wide and extended 8 m (25 ft) from the shore parallel to the north wall and also included an edge of the dredged channel.

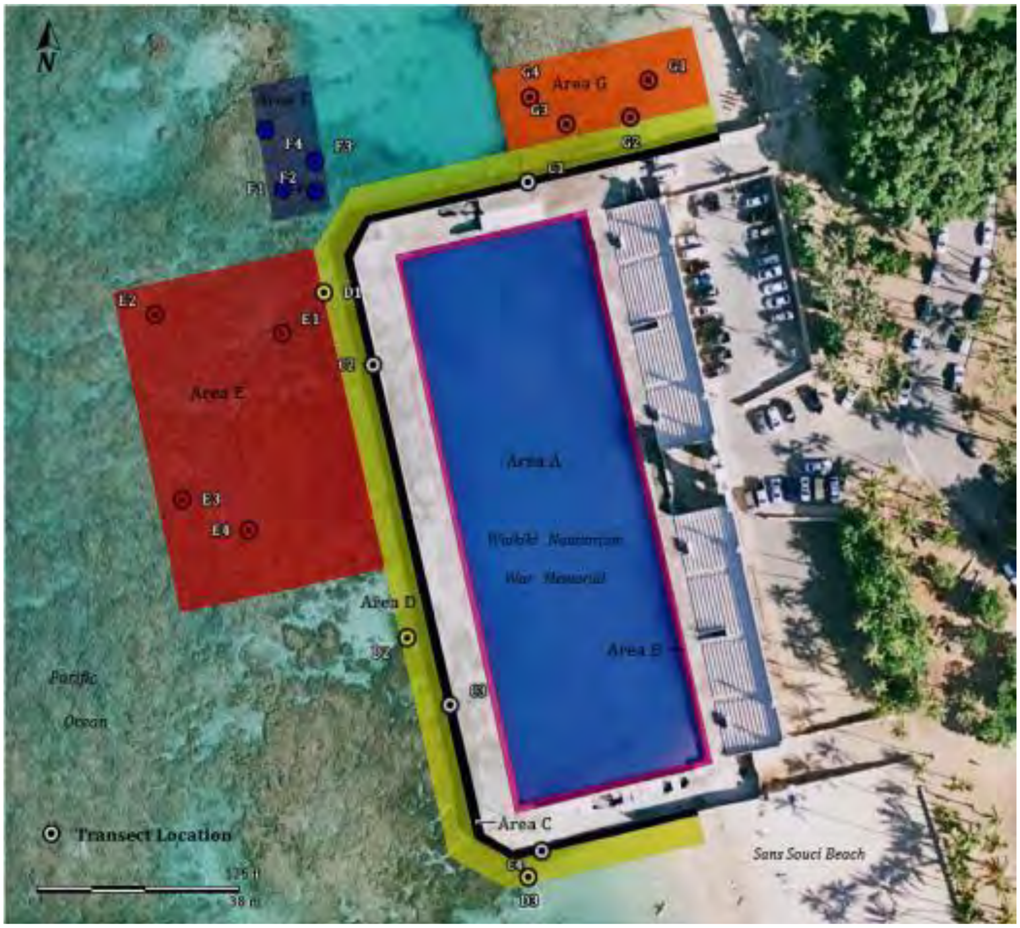


Figure 7. Five Natatorium exterior areas surveyed shown with locations of February 2011 benthic community survey points.

Prior to entering the field, biologists selected the start location of four transects within each impact area by using a random number generator to identify x- and y-coordinates on an aerial image of the area. At each location a 10-m long transect was extended along the pool bottom to the south, parallel to the shore, and a 1-m^2 quadrat frame centered over the transect line at 1-m intervals. Within each 1-m^2 quadrat, the biologists identified substrate type and estimated area of substratum to the nearest five percent. Additionally, biologists noted the presence of the following algal species: *Acanthophora spicifera, Avrainvillea* *amadelpha, Amansia glomerata, Codium* spp., *Gracilaria coronopifolia, G. salicornia, Gelidium* sp., *Hypnea* sp., *Pterocladiella* sp., *Sargassum obtusifolium, S. echinocarpum, S. polyphyllum,* and *Ulva* sp. These algae are of particular interest in Hawaiʻi because they are either invasive, important for cultural harvest, or utilized by sea turtles (Preskitt et al. 2011; Russell and Balazs, 2000; NMFS-USFWS, 1998; Russell et al., 2003; Arthur and Balazs, 2008).

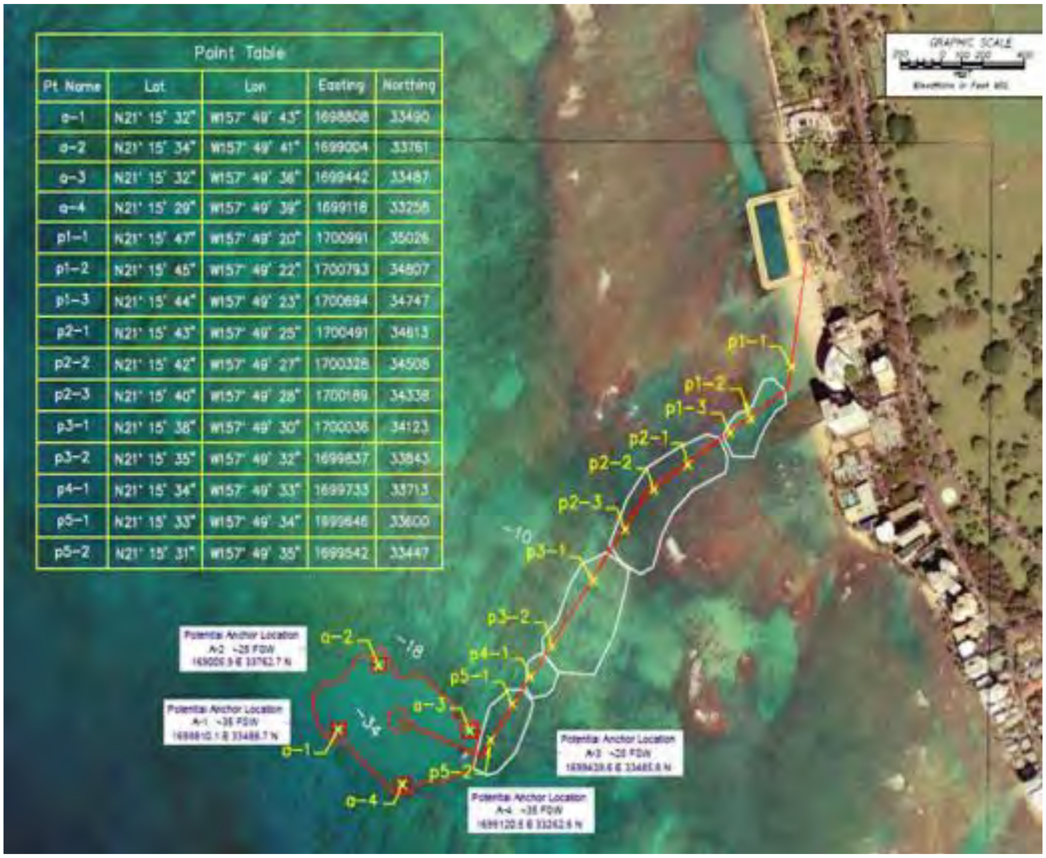
Pipeline Corridor and Barge Anchor Points — In April 2012, *AECOS* biologists surveyed the proposed pipeline corridor for substrate type, coral colony size and species, and macro-invertebrate species. The approximately 600-m (2000-ft) long corridor was delineated into five segments (P1 through P5; Fig. 8) by SEI on an aerial image. Prior to entering the field, biologists selected start location for transects using a random number generator to identify x- and y-coordinates within the five segments: three transects in P1 and P2; two transects in P3 and P5; and one transect in P4, resulting in 11 stratified random survey stations.

At each survey station, a 10-m transect was extended perpendicular to the course of the corridor and a 1-m^2 quadrat frame was placed over the center of the transect at 1-m intervals. Within each 1-m^2 quadrat, the biologists identified substrate type and all coral colonies and other macro-invertebrates present. Estimates of the area of substratum were made to the nearest five percent, for a total 10-m^2 survey area per transect.

Potential barge anchor point coordinates were provided by SEI prior to entering the field. At each of the four proposed anchor locations (A1-A4; Fig. 8), biologists conducted a reconnaissance survey to assess the bottom type (sand or hardbottom) and to determine if any coral colonies are present. Biologists assessed the area approximately 5m from the center point of the proposed barge anchor locations.

Coral Assemblages

All coral colonies within the Natatorium interior, Natatorium exterior, and pipeline corridor impact areas were identified and individually measured for maximum diameter (see NOAA, 2008). Transects (10-m) used for benthic community composition were also used for coral assessments. Coral colony diameters were recorded by size class in 5 cm increments (1 to 5 cm, >5 to 10 cm, etc.). Coral colony area estimates were derived by calculating the area of a circle from the diameter recorded for each individual coral colony. Area estimates were used to assess coral percent cover.



Point Table

Pt Name	Lat	Lon	Easting	Northing
a-1	N21° 15' 32"	W157° 49' 43"	1698808	33490
a-2	N21° 15' 34"	W157° 49' 41"	1699004	33761
a-3	N21° 15' 32"	W157° 49' 36"	1699442	33487
a-4	N21° 15' 29"	W157° 49' 39"	1699118	33256
p1-1	N21° 15' 47"	W157° 49' 20"	1700991	35026
p1-2	N21° 15' 45"	W157° 49' 22"	1700793	34807
p1-3	N21° 15' 44"	W157° 49' 23"	1700694	34747
p2-1	N21° 15' 43"	W157° 49' 25"	1700491	34613
p2-2	N21° 15' 42"	W157° 49' 27"	1700328	34506
p2-3	N21° 15' 40"	W157° 49' 28"	1700189	34338
p3-1	N21° 15' 38"	W157° 49' 30"	1700036	34123
p3-2	N21° 15' 35"	W157° 49' 32"	1699837	33843
p4-1	N21° 15' 34"	W157° 49' 33"	1699733	33713
p5-1	N21° 15' 33"	W157° 49' 34"	1699646	33600
p5-2	N21° 15' 31"	W157° 49' 35"	1699542	33447

Figure 8. Pipeline corridor and barge anchor points shown with locations of April 2012 benthic community survey points.

Fish Assemblages

Natatorium Interior—Due to poor underwater visibility, fish surveys were not conducted in the Natatorium pool.

Natatorium Exterior — Fish surveys were conducted in each of the five exterior impact areas, as well as one additional area: Area H, located adjacent to Area E, extended 32 m (105 ft) offshore of the west wall and 55 m (180 ft) to the south (Fig. 9). Area H was added to capture the mobile fish community on the reef flat off the Natatorium. Two types of quantitative fish surveys, generally similar to those employed by NOAA's Coral Reef Ecosystem Division (see NOAA, 2011), were conducted in each impact area.

One biologist conducted a belt transect survey to quantify relatively small-bodied (<25 cm) and abundant fishes. That biologist swam along a 25-m long transect line recording counts of all small fishes encountered to species level, if possible, within a visually estimated width of 1 m on either side of the transect (50 m^2 area). Fish length (total length or TL) was estimated to the nearest 5 cm for all fishes encountered. A second biologist conducted a stationary point count (SPC) to quantify relatively larger (>25 cm) fishes. During a five minute count, all fishes >25 cm in length within a visually estimated distance of 5 m were recorded. TL was estimated to the nearest 5 cm for all large fishes encountered.

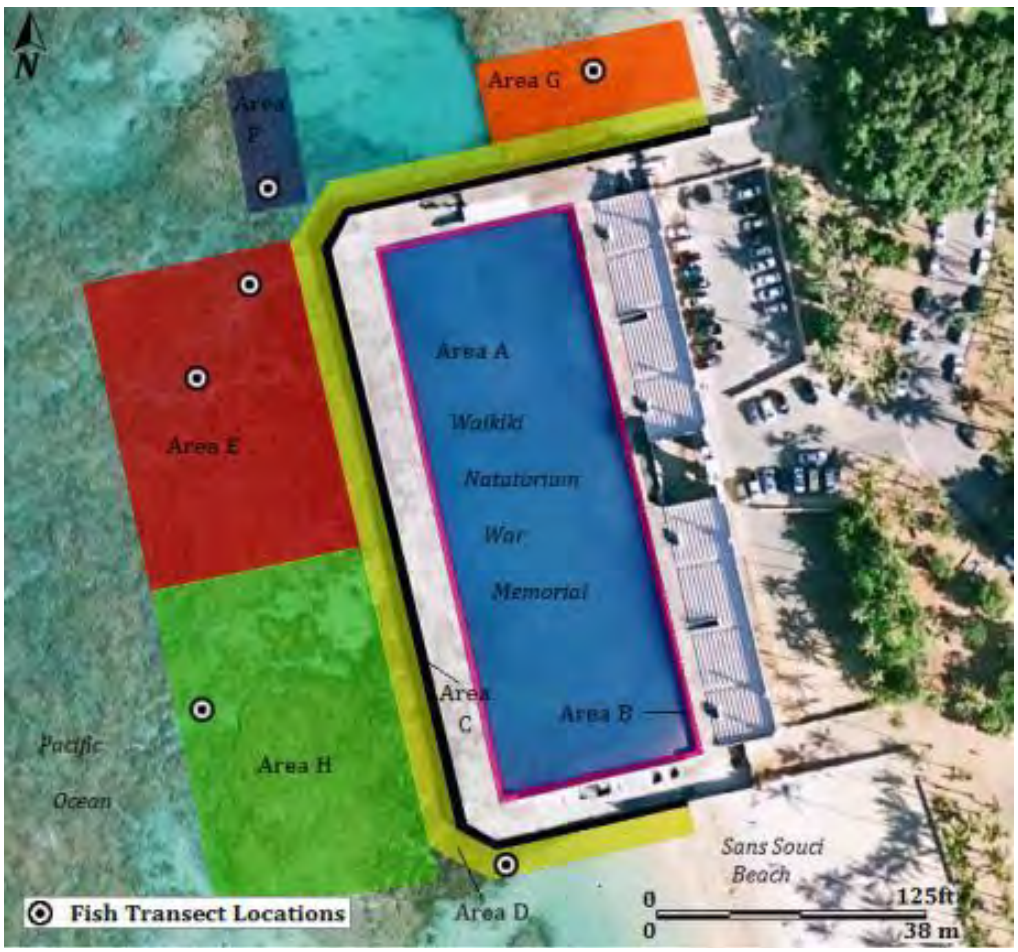


Figure 9. Natatorium exterior survey areas shown with locations of February 2011 fish survey points and transect lines

The biomass of each individual fish was calculated using an allometric length-weight conversion: $W = aTL^b$, where parameters a and b are species-specific constants, TL is total length in mm, and W is weight in grams. Length-weight fitting parameters were obtained from FishBase (Froese and Pauly, 2011). Fish species were also grouped into one of seven trophic guilds based on their primary food source: piscivore (feed on other fish), herbivore (feed on algae), zooplankton feeder, mobile invertebrates feeder, sessile invertebrates feeder, detritivore (feed on detritus or non-living organic matter), or obligate corallivore (feed on live coral). Primary food source data were ascertained from several published sources (Hoover, 2008; Froese and Pauly, 2012). Trophic guild data were analyzed for trends in fish biomass and distribution within the survey area.

Pipeline Corridor — Fish surveys were conducted at four stations in the pipeline corridor survey areas: P1-1, P2-1, P3-1, and P5-1 (see Fig. 8). Two types of quantitative fish surveys, as described above, were conducted at each station.

Results

Water Quality

A summary of water quality results are presented in Tables 2 and 3. Mean (based upon 3 samples) temperatures, salinities, and pH were similar across all 5 stations. Mean temperatures ranged from 25.2 to 25.8°C, mean salinities ranged from 35.6 to 35.8 ppt, and mean pH ranged from 8.07 to 8.19. Mean dissolved oxygen (DO) saturation levels showed more variability with a low of 82% at Sta. Pool station to a high of 107% at Sta. Off Ewa Corner.

Turbidity and total suspended solids (TSS) were slightly elevated at all stations. Mean turbidity ranged from a low of 1.56 NTU at Sta. Offshore to a high of 2.32 NTU at Sta. Sans Souci. Mean TSS ranged from a low of 8.4 mg/L at Sta. Pool to a high of 10.0 mg/L at Sta. Circ. Culvert. TSS values are higher than expected for the turbidities recorded, a result that comes from the way these two parameters measure suspended matter. TSS is sensitive to fine sand in the water column because it is a dry weight of all solid matter collected in a water sample. Turbidity, on the other hand, is a measure of the light-scattering property of particles finer than sand; sand particles settle out of the light beam before a stable reading can be taken. Field conditions that resuspend sand off the bottom will result in high TSS without a corresponding increase in turbidity.

The results for the nutrient and biological water quality parameters are given in Table 3. Geometric mean ammonia (NH_3) concentrations were elevated across all 5 stations, with the highest concentration of 35.6 µg N/L found at Sta. Pool. NO_3+NO_2 concentrations were quite variable, ranging from a low of <1 µg N/L at Sta. Offshore and Sta. Off Ewa Corner to a high of 13.3 µg N/L at Sta. Pool. NO_3+NO_2 are the forms of inorganic nitrogen most commonly utilized in benthic algal and phytoplankton production in marine waters.

Table 2. Summary of physical water quality measurements made between October 2010 and April 2011, at five stations off the Waikīkī Natatorium.

Station		**Temp.** (°C)	**Salinity** (ppt)	**DO sat.** (%)	**pH**	**Turbidity** (NTU)	**TSS** (mg/L)
Pool							
	mean	**25.7**	**35.6**	**82**	**8.07**	**2.09**†	**8.4**†
	range	25.0 - 26.2	35.1 – 36.1	61 - 114	7.96 - 8.14	1.77 – 2.62	1.77 – 2.62
	count	*3*	*3*	*3*	*3*	*3*	*3*
Circ. Culvert							
	mean	**25.7**	**35.8**	**83**	**8.10**	**2.29**†	**10.0**†
	range	24.4 – 26.8	35.4 - 36.1	65- 116	8.05 - 8.14	1.62 – 2.86	7.7 – 16.0
	count	*3*	*3*	*3*	*3*	*3*	*3*
Off Ewa Corner							
	mean	**25.5**	**35.8**	**107**	**8.16**	**2.07†**	**9.6**†
	range	24.1 - 26.9	35.4 - 36.2	90 - 126	8.02 - 8.27	1.36 – 3.31	8.0 – 13.0
	count	*3*	*3*	*3*	*3*	*3*	*3*
Offshore							
	mean	**25.2**	**35.8**	**91**	**8.19**	**1.56**†	**8.4**†
	range	23.9 – 26.1	35.6 - 36.2	78 - 107	8.12 - 8.30	1.04 – 2.02	4.4 – 18.0
	count	*3*	*3*	*3*	*3*	*3*	*3*
Sans Souci							
	mean	**25.8**	**35.8**	**90**	**8.14**	**2.32**†	**8.7**†
	range	24.1-27.1	35.4-36.1	66 - 129	8.04-8.20	1.26 – 3.66	6.7 – 13.0
	count	*3*	*3*	*3*	*3*	*3*	*3*

† geometric mean

Most of the total nitrogen (Total N) measured at all five stations is organic nitrogen, rather than inorganic moities. Geometric mean total N concentrations ranged from a low of 173 µg N/L at Sta. Off Ewa Corner to a high of 222 µg N/L at Sta. Pool. Total nitrogen represents the total reservoir of nitrogen that theoretically can be used in benthic algal and phytoplankton productivity. Total nitrogen consists of both particulate and soluble components, each containing refractile portions that are not available as a nutrient source.

Table 3. Summary of selected water quality measurements made between October 2010 and April 201 at five stations off Waikīkī Natatorium.

Station	**Ammonia** (µg N/L)	**Nitrate + Nitrite** (µg N/L)	**Total N** (µg N/L)	**Total P** (µg P/L)	**Chl. α** (µg/L)
Pool					
Geometric mean	**35.6**	**13.3**	**221.9**	**5.0**	**0.39**
range	5 - 143	9 – 26	188 – 257	4 – 8	0.24 – 0.50
count	*3*	*3*	*3*	*3*	*3*
Circ. Culvert					
Geometric mean	**17.7**	**3.6**	**191.3**	**5.4**	**0.33**
range	3 – 116	1 - 9	156 – 255	4 – 31	0.28 – 0.36
count	*3*	*3*	*3*	*3*	*3*
Off Ewa Corner					
Geometric mean	**19.6**	**<1**	**173.2**	**5.4**	**0.30**
range	7 - 108	<1	138 – 224	4 - 12	0.20 – 0.41
count	*3*	*3*	*3*	*3*	*3*
Offshore					
Geometric mean	**18.9**	**<1**	**174.1**	**4.0**	**0.26**
range	3 – 118	<1	138 - 255	4	0.20 – 0.44
count	*3*	*3*	*3*	*3*	*3*
Sans Souci					
Geometric mean	**19.8**	**3.6**	**201.3**	**5.6**	**0.32**
range	<3 – 137	3 – 5	172 – 242	4 – 11	0.27 – 0.40
count	*3*	*3*	*3*	*3*	*3*

Geometric mean total phosphorus (Total P) concentrations ranged from a low of 4.0 µg P/L at Sta. Offshore to a high of 5.6 µg P/L at Sta. Sans Souci . Total P, like Total N, represents the total reservoir of phosphorus available for primary productivity in these coastal waters. It also has refractile components that will not be oxidized to soluble organic phosphorus forms that can be utilized in algal metabolism.

Geometric mean chlorophyll α concentrations were similarly low across all five stations, ranging from 0.26 µg/L at Sta. Offshore to 0.39 µg/L at Sta. Pool. Chlorophyll α in the water column gives an indication of the amount of phytoplankton biomass present.

Previous Biological Studies

The dominant benthic organisms on the reef platform off the Waikīkī Natatorium are marine macro-algae or *limu*, which cover virtually all exposed hard surfaces that are not scoured or buried by shifting sand (Fig 10). The growth form of these algae is usually low-growing or turf-like. Up to 87 different species have been reported from the Waikīkī reef since 1969 (Doty, 1969; Chave et al., 1973; OI, 1991; Huisman et al., 2007; MRC, 2007; and *AECOS*, 2007, 2008, 2009). Two invasive red algae (Rhodophyta)—*Acanthophora spicifera* and *Gracilaria salicornia*—dominate the benthic flora on the Waikīkī reef, and both are abundant in the vicinity of the Natatorium (Smith et al., 2004; Huisman et al., 2007; MRC, 2007; *AECOS*, 2007, 2008, 2009; SEA, 1992). Algal species observed on the walls of the Natatorium and in adjacent areas include *Dictyosphaeria reticulata*, *Bryopsis* sp., *Halimeda discoidea*, *Neomeris annulata*, *Ulva reticulata*, *Lyngbya majuscule*, *Dictyota sandvicensis*, *Sargassum polyphyllum*, *Lobophora variegata*, *Padina* sp., *Ralfsia pangoensis*, *Sphacelaria furcigera*, *Amansia glomerata*, *Centroceras clavulatum*, *Grateloupia filicina*, *Halymenia Formosa*, *Plocamium sandvicense*, *Poroloithon onkodes*, and *Spyridia filamentosa* (SEA, 1992).

Macro-invertebrates seen in the general vicinity of the Natatorium, as well as on the pool walls, include *Grapsus grapsus* (*aʻama* crab), snails (*Nerita picea*, *Gonodactylus* sp., and *Stenopus hispidus*), and urchins (*Echinometra mathaei*, *E. oblongata*, and *Tripneustes gratilla*; SEA, 1992). Macro-invertebrates observed in various surveys on the reef flat off Waikīkī include *Holothuria atra*, *H. nobilis*, *Echinothrix diadema*, *Tripneustes gratilla*, *Echinometra mathaei*, *Echinostrephus aciculatus*, and various sponges (OI, 1991); *E. mathaei*, *E. aciculatus*, and *H. atra* (MRC, 2007); and an unidentified stomatopod, *E. diadema*, *E. mathaei*, *T. gratilla*, *Actinopyga mauritiana*, *H. atra*, and *H. cinerascens* (*AECOS*, 2007, 2008, 2009).

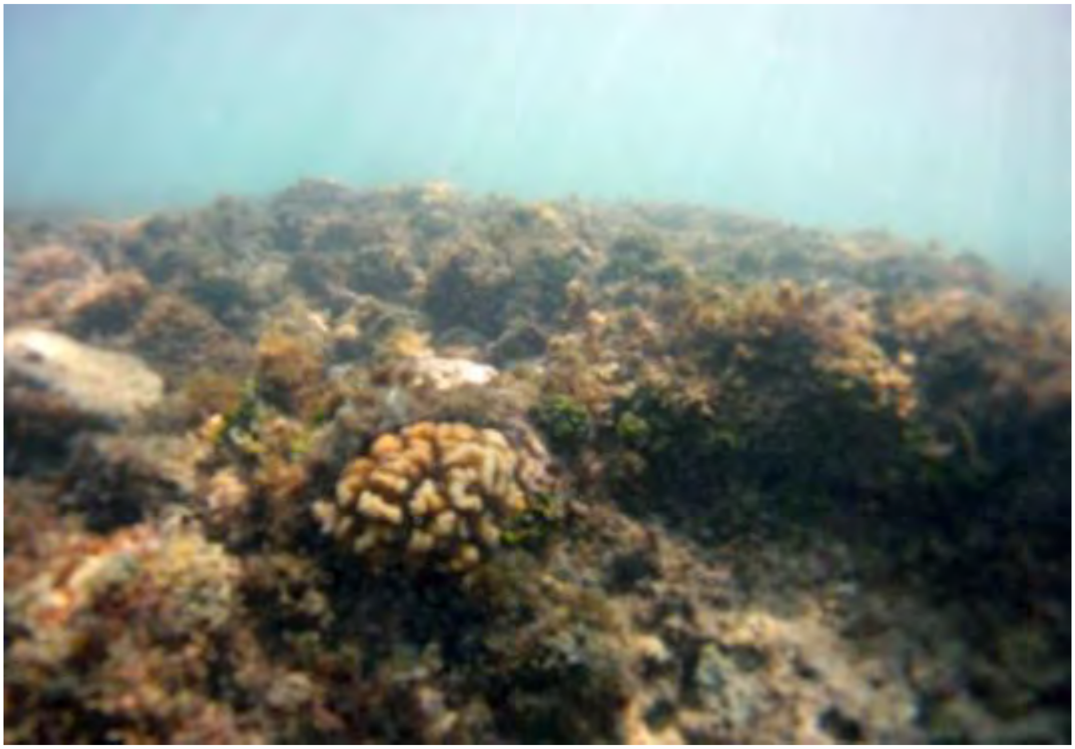


Figure 10. Typical nearshore reef platform area offshore the Natatorium.

Infaunal mollusks occur within the sand patches on the reef flat off the Natatorium. The auger shell (*Terebra inconstans*) has been recorded in the vicinity (SEA, 1992). Two endemic species known to live in the sand habitat of the general Waikīkī area are *Terebra gouldi* (Family Terebridae or auger shells) and *Conus abbreviates* (Family Conidae or cone shells). *T. gouldi* (white spotted auger) occurs off central Waikīkī Beach, just under the surface of the sand (Fletcher and Miller, 2003). All augers prey on specific organisms, usually polychaete worms. *Conus abbreviates* (abbreviated cone) also occurs in sand patches offshore central Waikīkī Beach. Cone snails are nocturnal predators, and withdraw completely into their shells or bury under sand during daylight hours

The most common (although total cover comprising less than one percent of the bottom) hermatypic corals found in the vicinity of the Natatorium are *Pocillopora meandrina* and *Porites lobata* (SEA, 1992). In addition, *P. compressa* has been recorded. Surveys of the general Waikīkī reef flat have recorded the presence of all the following coral species: *Cyphastrea ocellina* (MRC, 2007; *AECOS,* 2007, 2008, 2009), *Montipora capitata*, *M. patula*, *P. evermanni*, *Psammocora stellata*, *Leptastrea purpurea* (*AECOS,* 2007, 2008, 2009, 2010), and *L. bewickensis* (*AECOS*, 2009, 2010).

The fish community in the nearshore waters off Waikīkī is largely structured by the local topography and bottom composition on the reef flat; however, fishes are uncommon. Surveys in the vicinity of the Natatorium (SEA, 1992) found the most common species to be wrasses (*Thalassoma duperrey*, *T. trilobatum*, *Stethojulis balteata*), *Acanthurus triostegus* (*manini*), and *Abudefduf abdominalis* (*mamo*). The surveys also found several species of small juvenile fishes inhabiting small holes and spaces in the reef structure.

Reconnaissance Survey General Observations

The interior pool area consists of a dredged remnant reef in water ranging in depth from 0 to 3.7 m (0 to 12 ft), with a substratum of fine sand and macroalgae with minimal substrate complexity. Along the perimeter of the pool walls, the bottom consists of collapsed concrete piles and decking material. A listing of marine algae and animals identified, and their relative abundances encountered during the survey, is presented as Appendices A through C. Of the species identified in the Natatorium pool, none is listed as threatened or endangered (USFWS, 2012).

Gracilaria salicornia, and invasive alga species, is dominant on the pool walls and is abundant, though with a patchy distribution, on the bottom. The invasive red algae, *Acanthophora spicifera* and *Dichotomeria marginata,* are also abundant on pool walls and bottom. The encrusting coralline red algal species, *Hydrolithon reinboldii*, is common on the pool walls. *Peyssonnelia rubra* is occasional on the pool walls and other hard surfaces on the pool bottom. Other red algae, such as *Amanisa glomerata* and *Tricleocarpa cylindrica*, are common on the pool walls. Present in low abundance are the red algae *Peyssonnelia rubra* and *Cryptonemia yendoi*, green algae *Caulerpa nummularia*, *Avrainvillea amadelpha*, and *Halimeda discoidea,* and brown alga, *Lobophora variegata.*

Corals are uncommon on the pool walls and bottom and none was encountered in the transects. A total of 16 coral colonies were observed throughout the interior of the Natatorium in October 2010 (See Table 11, following).

Boring urchins (*Echinometra mathaei* and *E. oblonga*) are the most commonly seen macro-invertebrate on the pool walls. Other invertebrates observed occasionally on the pool walls include sea frost (*Salmacina dysteri*), false *ʻopihi* (*Siphonaria normalis*), and barnacles (*Amphibalanus amphitrite*). The dotted periwinkle (*Littorina pintado*), nerite snail (*Nerita picea*), parchment worm (*Chaetopterus* sp.), and black purse shells (*Isognomon californicum*) are uncommon in the area. Macro-invertebrates are uncommon on the pool bottom. Species observed include the black sea cucumber (*Holothuria atra*), Keferstein's sea cucumber (*Polyplectana kefersteini*), and spaghetti worm (*Loimia medusa*).

Twenty species of fishes were indentified in the pool interior (See Appendix C). On the pool bottom, *Mulloidichthys flavolineatus* (square-spot goatfish), *Dascyllus albisella* (Hawaiian dascyllus), and *Psilogobius mainland* (Hawaiian shrimp goby) are seen. *Acanthurus triostegus* (*Manini*), *Fistualria commersonii* (bluespotted cornetfish), *Ostracion meleagris* (spotted boxfish), *Kuhlia xenura* (*āholehole*), *Canthigaster jactator* (Hawaiian whitespotted toby), *Arothron hispidus* (stripebelly puffer), and *Sarotherodon melanotheron* (blackchin tilapia) are uncommon around pool walls and under collapsed pool decking. Three adult and several juvenile whitetip reef sharks (*Triaenodon obesus*) occur under the decking of the pool walls.

Benthic Community Composition

Natatorium Interior — Data collected from 50 quadrats on 5 transects were used to calculate benthic community composition (limited to macro and turf algae, encrusting algae, and bare concrete) of the pool walls (Table 4). The concrete pool walls of the Natatorium are covered with fleshy and turf algae, with an average of 72% coverage on the four walls. On the east wall, encrusting algae makes up over half of the substratum. No coral colonies were encountered in the 50 m^2 of pool wall surveyed on 5 transects.

Table 4. Percent benthic cover on Natatorium interior pool walls, surveyed October 2010 (50 0.25 m^2 quads).

	Macro & turf algae	**Encrusting algae**	**Bare concrete**
Mean	72	15	12
Median	80	5	2
Range	0 – 100	0 - 90	0 - 70
Std. dev	±27	±23	±19

Data collected from 40 quadrats on 4 transects were used to calculate benthic community composition (limited to sand and algae) of the pool bottom (Table 5). Over half (62%) of the substratum is sand. Species encountered on the floor of the pool include holes created by alpheid shrimp and commensal gobies, and other burrows possibly created by polychaetes, holothurians, and crustaceans. No coral colonies were observed in the 40 m^2 of pool bottom surveyed on 4 transects.

Table 5. Percent benthic cover on Natatorium interior pool bottom, surveyed October 2010 (40 0.25 m^2 quads).

	Macro & turf algae	**Sand**
Mean	38	62
Median	10	90
Range	0 – 100	0 – 100
Std. dev	±42	±42

<u>Natatorium Exterior</u> — Twenty transects, with a total of 200 quadrats, were used to calculate benthic community composition of the reef flat surrounding the Natatorium. Table 6 and Fig. 11 present the results of the benthic survey. Over half of the substratum in areas D, E, and F, and nearly half in Area C is covered with macroalgae. A moderate amount of coralline algae and algal turf is present in each survey area. Coral cover is very low (<1%) in all surveyed areas.

Photos in Fig. 6 show the topographical complexity and benthic cover at 4 of the survey areas. The exterior walls of Area C have high macroalgal cover and minimal habitat complexity. The reef flat of Area D is scoured with vertical complexity with high macroalgal cover, interspersed with sand bottom. Area E is similar to Area D, with high vertical relief, but has more shallow rubble pits. The reef flat of Area F has greater vertical complexity than Areas D and E and higher macroalgal cover. The channel margin on the edge of Area G has great vertical relief with minimal macroalge cover, while the nearshore shallow reef flat of Area G hosts a diverse macroalgal assemblage. Representative photos of each seascape in the Exterior surveyed area is provided in Figure 12

<u>Pipeline Corridor and Barge Anchor Points</u> —Eleven transects, with a total of 110 quadrats, were used to calculate benthic community composition of the proposed pipeline corridor. Table 7 and Fig. 13 present the results of the benthic survey. Limestone and sand are the dominant benthic types along the proposed pipeline corridor. Over half of the substratum in areas P1 (inshore)

and P4 (offshore), and nearly half in P3 (mid channel) is sand. Over half of the substratum in areas P2 and P5, and nearly half in P3 is limestone. Sustratum at area P4 is composed of only limestone and sand. A small (~10%) amount of macroalgae is present in each survey area except P4, which is almost all sand bottom. When present, coral, coralline algae, and turf algae coverage is low in the surveyed areas.

Table 6. Percent benthic cover on Natatorium exterior, surveyed February 2011.

	Macro algae	**Coralline algae**	**Sand**	**Limestone***	**Turf algae**	**Coral**	**Other**
Area C							
Mean	45	19	0	0	27	<1	6† 2‡
St dev	±27	±18	---	---	±25	±1	±9† ±7‡
Range	0-95	0-72	---	---	0-90	0-5	0-40† 0-25‡
Area D							
Mean	55	7	30	7	1	<1	0
St dev	±36	±8	±42	±15	±4	±0.4	---
Range	0-100	0-25	0-100	0-86	0-20	0-2	---
Area E							
Mean	60	5	7	19	9	<1	0
St dev	±26	±4	±18	±21	±10	±1	---
Range	0-95	0-20	0-80	0-70	0-50	0-3	---
Area F							
Mean	68	15	0.1	12	5	<1	0
St dev	±20	±13	±0.6	±12	±6	±1	---
Range	0-96	0-50	0-3	0-44	0-25	0-4	---
Area G							
Mean	37	4	32	18	8	<1	0
St dev	±34	±8	±42	±24	±10	±0.3	---
Range	0-100	0-25	0-100	0-70	0-30	0-2	---

† Bare concrete pool wall.
‡ Hole in concrete pool wall.
* Includes consolidated limestone and limestone rubble.

The substratum at, and within a 5–m radius, of barge anchor points A-1 through A-4 is sand. Hard bottom and coral growth was not observed within 5 m from the proposed barge anchor points.

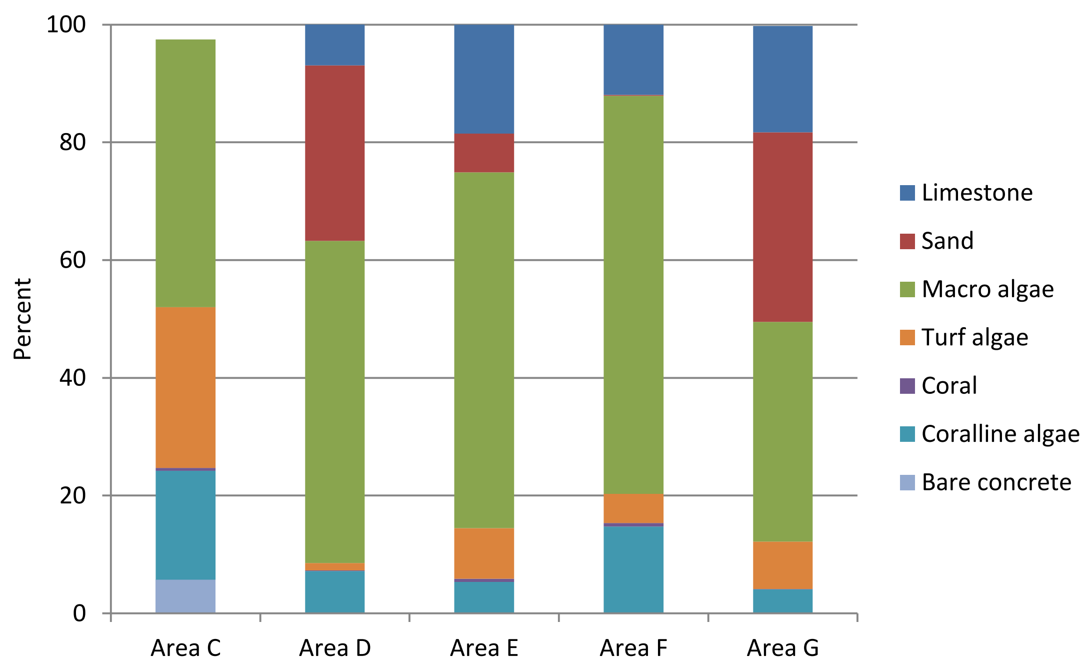


Figure. 11 Percent benthic cover on Natatorium exterior, surveyed February 2011.

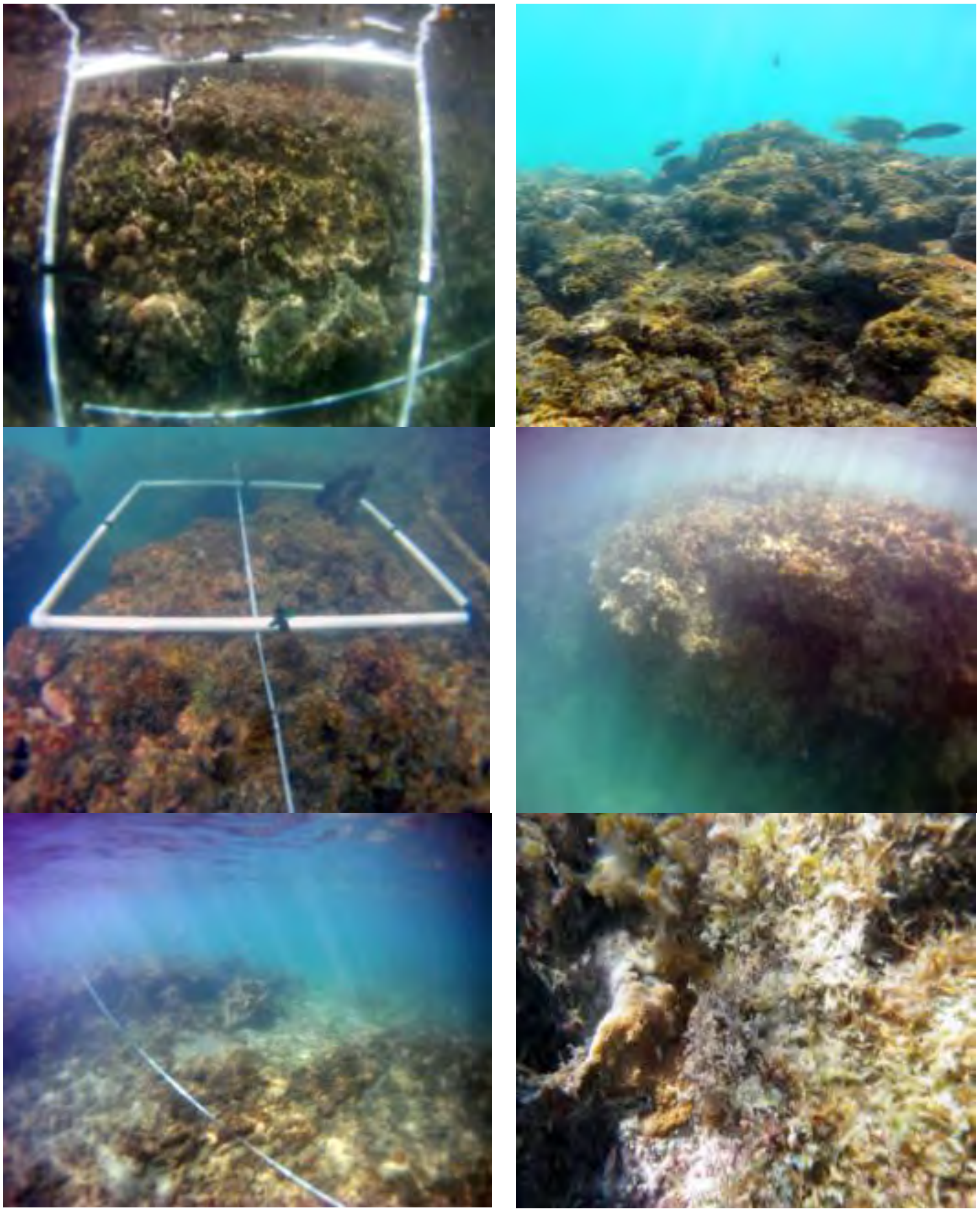


Figure 12. Representative seascapes on the exterior walls (Area C; left, top) close permimeter of exterior walls (Area D; left, mid) and the reef flat offshore from the west corner of the seaward wall (Area E; left, bottom); reef flat west from the corner of western wall (Area F; top right); edge of channel margin off western wall(Area G; right, mid) and reef flat shoreline parallel to western wall (Area G; right, bottom)

Table 7. Percent benthic cover on pipeline corridor, surveyed April 2012.

	Limestone*	Sand	Macro algae	Coral	Coralline algae	Turf algae
Area P1						
Mean	17	69	11	1	<1	2
St dev	±24	±42	±18	±3	±2	±6
Range	0-70	0-100	0-70	0-10	0-5	0-30
Area P2						
Mean	72	5	9	4	6	5
St dev	±19	±10	±14	±6	±5	±7
Range	20-95	0-30	0-70	0-20	0-20	0-25
Area P3						
Mean	41	49	10	<1	0	0
St dev	±39	±46	±12	±2	--	--
Range	0-100	0-100	0-830	0-10	--	--
Area P4						
Mean	5	95	0	0	0	0
St dev	±16	±16	--	--	--	--
Range	0-50	50-100	--	--	--	--
Area P5						
Mean	71	15	9	4	<1	1
St dev	±25	±28	±12	±5	±1	±3
Range	0-100	0-100	0-50	0-15	0-5	0-10

* Includes consolidated limestone and limestone rubble.

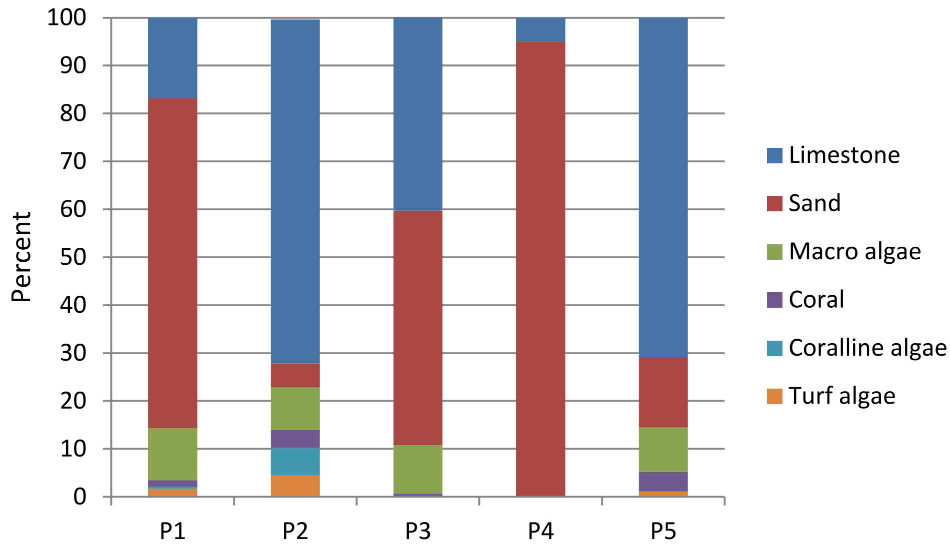


Figure. 13. Percent benthic cover on pipeline corridor, surveyed April, 2012.

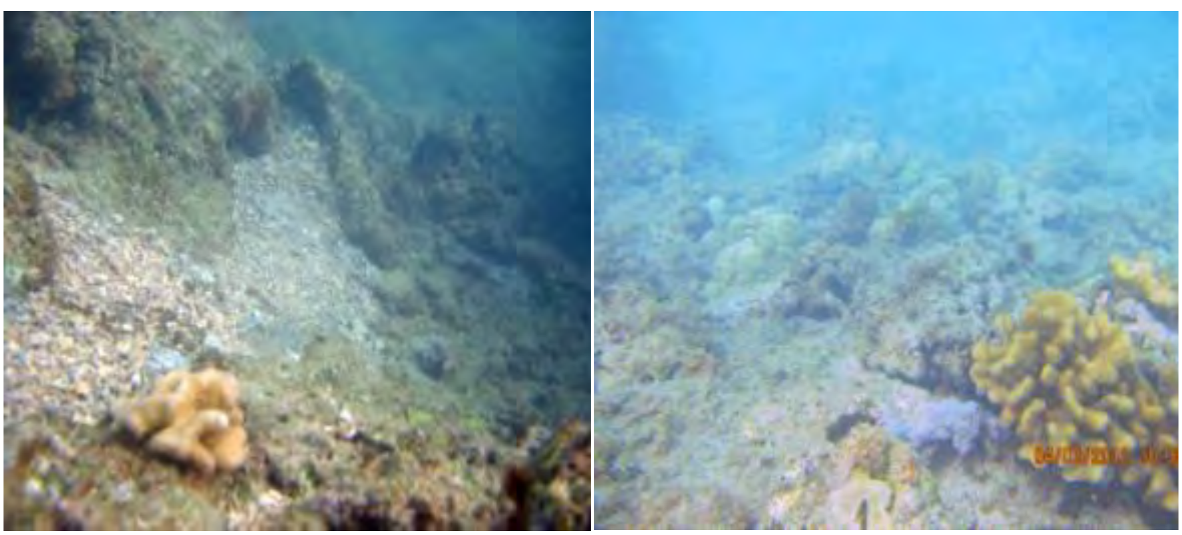


Figure. 14a.(left) Sand bottom and small coral colonies present in pipeline corridor segement 1 (P1). Figure 14b (right) Mostly limestone bottom with small coral colonies in pipeline corridor segement 2 (P2).

Algal Assemblages

Natatorium Interior — Table 8 presents the relative abundance of algal species of particular importance in Hawaiʻi (see Methods, above) found in the Natatorium interior. *G. salicornia* and *A. spicifera* are abundant throughout the surveyed areas and found growing on the walls and pool bottom. *G. salicornia* was found in each of the 50 quads surveyed on the pool walls, and in each of the 40 quads surveyed on the pool bottom. *A. amadelpha* and *G. coronopifolia* was uncommon on both the pool walls and bottom, and *A. glomerata* was common on the pool bottom. *Hypnea* sp. *Ulva* sp. *Pterocladiella* sp. *Sargassum* spp., *Gelidium* sp., were not observed in the Natatorium interior survey areas.

Table 8. Relative abundance of selected algal species considered important (culturally harvested, turtle diet, or for tracking of nonindigenous invasive species) in Natatorium interior (50 quadrats on pool walls; 40 quadrats in pool bottom).

Species	Importance	Pool Walls	Pool Bottom
Acanthophora spicifera	T, I	Abundant	Abundant
Avrainvillea amadelpha	I	Uncommon	Uncommon
Amansia glomerata	T	Common	Absent
Codium spp.	T	Absent	Absent
Gracilaria coronopifolia	I	Abundant	Uncommon
G. salicornia	I	Abundant	Abundant
Gelidium sp.	C	Absent	Absent
Hypnea sp.	T,I	Absent	Absent
Pterocladiella sp.	T	Absent	Absent
Sargassum obtusifolium	C	Absent	Absent
S. echinocarpum	C	Absent	Absent
S. polyphyllum	C	Absent	Absent
Ulva sp.	T	Absent	Absent

KEY TO SYMBOLS USED:
Algae importance:
T – Turtle diet.
I – Non-Indigenous Invasive.
C –Culturally harvested

Natatorium Exterior — Table 9 presents the relative abundance of algal species of particular importance in Hawaiʻi (see Methods, above). *G. salicornia* and *A. spicifera* are abundant throughout the five surveyed areas and found growing on flat limestone and loose rubble in channels. *G. salicornia* was found in each of the 40 quads surveyed in Area E, 39 of 40 quads in Area F, and 33 of 40 of the quads surveyed in Area G. Species observed throughout the survey areas include *A. amadelpha*, *A. glomerata*, *Codium* spp. and *Hypnea* sp. *Ulva* sp. and *Pterocladiella* sp. were seen only rarely. *G. coronopifolia* and *Gelidium* sp. were uncommon in Areas D and G. *A. glomerata, S. obtusifolium S. polyphyllum* and *Pterocladiella* were found on the exterior walls of the natatorium. *Ulva* was common in Area G, at a likely spot of fresh or brackish water discharge, and in a few isolated places on the Natatorium wall.

Table 9. Relative abundance of selected algal species considered important in Natatorium exterior (40 quadrats per survey area).

Species	Importance	Area C	Area D	Area E	Area F	Area G
Acanthophora spicifera	T, I	Abundant	Rare	Abundant	Abundant	Common
Avrainvillea amadelpha	I	Absent	Rare	Abundant	Common	Common
Amansia glomerata	T	Abundant	Common	Absent	Absent	Common
Codium spp.	T	Rare	Absent	Uncomm.	Uncomm.	Common
Gracilaria coronopifolia	I	Absent	Uncomm.	Absent	Absent	Uncomm.
G. salicornia	I	Common	Abundant	Abundant	Abundant	Abundant
Gelidium sp.	C	Absent	Absent	Absent	Absent	Uncomm.
Hypnea sp.	T, I	Common	Rare	Common	Rare	Common
Pterocladiella sp.	T	Abundant	Rare	Rare	Absent	Absent
Sargassum obtusifolium	C	Absent	Absent	Absent	Absent	Absent
S. echinocarpum	C	Common	Absent	Absent	Absent	Absent
S. polyphyllum	C	Rare	Absent	Absent	Absent	Absent
Ulva sp.	T	Rare	Absent	Absent	Absent	Common

KEY TO SYMBOLS USED:
Algae importance:
C –Culturally harvested
T – Turtle diet.
I – Non-Indigenous Invasive.

Natatorium pipeline — Table 10 presents the relative abundance of Invasive algal species *G. salicornia* and *A. spicifera* are abundant in the nearshore segements (P1 and P2) of the Natatorium pipeline corridor. *A. amadelpha* was encountered in the nearshore segment of the pipeline corridor, but rarely. Algal species preferred by *honu* (*Chelonia mydas* or green sea turtle;) in the pipeline corridor include *A. spicifera*, *A. glomerata*, *Codium* spp., *Hypnea* sp., *Pterocladiella*, and *Ulva* sp. The endemic seagrass, *Halophila hawaiiana*, was observed growing in the sand of the nearshore segment (P1) of the pipeline corridor. *G. coronopifolia*, *Sargassum* spp. and *Gelidium* sp., were not observed in the pipeline corridor survey areas.

Table 10. Relative abundance of selected algal species considered important (culturally harvested, turtle diet, or for tracking of nonindigenous invasive species) in Natatorium pipeline corridor (110 quads total)

Species	Importance	P1	P2	P3	P4	P5
Acanthophora spicifera	T, I	Abundant	Common	Rare	Absent	Rare
Avrainvillea amadelpha	I	Rare	Absent	Absent	Absent	Absent
Amansia glomerata	T	Absent	Rare	Absent	Absent	Common
Codium spp.	T	Absent	Uncomm.	Uncomm.	Absent	Absent
Gracilaria coronopifolia	I	Absent	Absent	Absent	Absent	Absent
G. salicornia	I	Abundant	Common	Rare	Absent	Common
Gelidium sp.	C	Absent	Absent	Absent	Absent	Uncomm.
Hypnea sp.	T, I	Absent	Rare	Rare	Absent	Rare
Pterocladiella sp.	T	Rare	Rare	Absent	Absent	Absent
Sargassum obtusifolium	C	Absent	Absent	Absent	Absent	Absent
S. echinocarpum	C	Absent	Absent	Absent	Absent	Absent
S. polyphyllum	C	Absent	Absent	Absent	Absent	Absent
Ulva sp.	T	Absent	Absent	Absent	Absent	Absent

KEY TO SYMBOLS USED:
Algae importance:
C –Culturally harvested
T – Turtle diet.
I – Non-Indigenous Invasive.

Coral Assemblage

Natatorium Interior— The locations and sizes of corals observed on the Natatorium interior surveyed areas are provided in Table 11. A total of 16 coral colonies (3 colonies of *Porites lobata*, 12 colonies of *Pocillopora damicornis*, and 1 colony of *Leptastrea bewickensis*) were observed in the interior of the Natatorium. Figure 15 presents the size class distribution for all coral species observed in the Natatorium pool. Three large colonies (diameter >40 cm) of *P. lobata* are established on the western side of the pool bottom. *Poc. damicornis* colonies were most frequently encountered species in the pool (12 colonies; Fig. 15). Most colonies are diameter sizes >5 to 10 cm or >10 to 20 cm and found growing on the western wall. One small colony (diameter 1 to 5 cm) of *L. bewickensis* was observed growing on the eastern wall.

Table 11. Locations and size classes of corals observed in the pool interior, surveyed October 2010.

Species	General location	Size class (cm)	Number of colonies
Porites lobata	Pool bottom, north side	>40	3
Poc. damicornis	Seaward wall	<5	2
Poc. damicornis	Seaward wall	>5-10	1
Poc. damicornis	Seaward wall	>10-20	1
Poc. damicornis	Northern wall	<5	1
Poc. damicornis	Northern wall	>5-10	2
Poc. damicornis	Northern wall	>10-20	3
Poc. damicornis	Shoreline wall	>5-10	1
Poc. damicornis	Shoreline wall	>20-40	1
Leptastrea bewickensis	Southern wall	<5	1

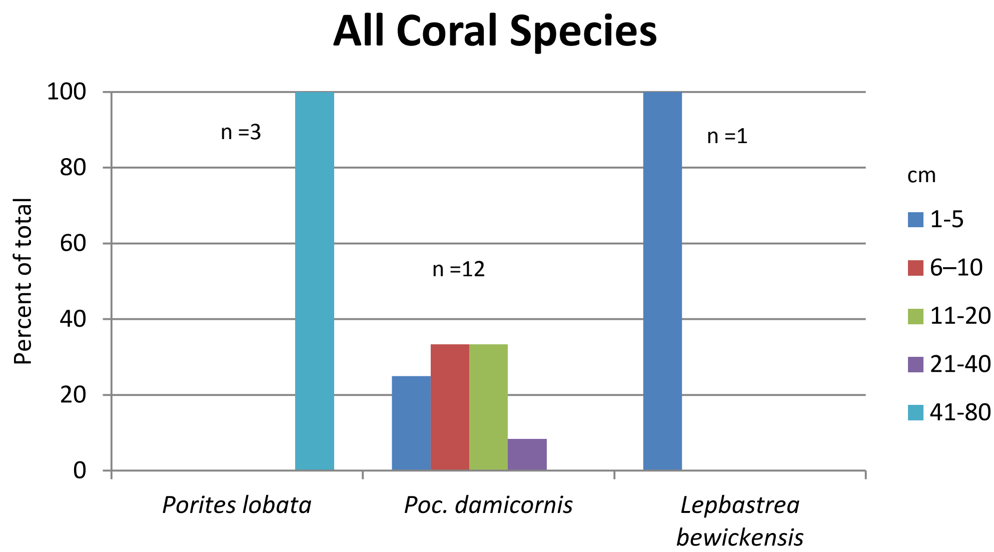


Figure 15. All coral species size class distribution for Natatorium interior.

<u>Natatorium Exterior</u>— The quantitative coral survey of the exterior pool walls and reef flat off the Natatorium found 53 coral colonies from 3 genera (*Porites, Pocillopora*, and *Cyphastrea;* see Appendix B for species list) in a 200 m^2 survey area. Coral cover is low in all surveyed areas, with an average of 0.09 colonies per m^2. Table 12 presents coral density and percent cover in each of the Natatorium exterior survey areas. Overall, mean coral coverage at the five survey areas of the Natatorium exterior was less than 0.1%. The transects surveyed in Area C (vertical exterior pool walls) support the greatest coral growth, with average coral cover of 0.2%. Coral cover within Areas E and F is low (0.1%). Area G and D have an average coral cover of <0.1%.

Detailed coral colony size distribution and count data for the Natatorium exterior surveyed areas are provided in Appendix D. *P. lobata* is the most frequently encountered coral species in the Natatorium exterior (43% of total) and observed in each of the five survey areas (Tables 12 and 13). The size class distribution for all coral species combined is presented in Fig. 16. Most colonies in the Natatorium exterior surveyed areas are small: 93% are between 1 and 10 cm in diameter). Corals with diameter >10 to 20 cm are only found in survey Areas C and E, and make up 7% of the total. No corals with diameter >20 cm were encountered in the Natatorium exterior survey areas.

Table 12. Number of coral colonies and percent coral cover in Natatorium exterior project areas, surveyed February 2011.

	Number of Coral Colonies (individuals per 10m^2)				Coral Cover
	P. lobata	*Poc. meandrina*	*Poc. damicornis*	*Cyphastrea ocellina*	
Area C					
Mean	0.75	1.5	0.75	4	0.2%
St dev	±0.96	±3	±1.0	±7.3	±0.3%
Range	0 -2	0 -6	0 – 2	0 – 15	0-0.6%
n	4	4	4	4	
Area D					
Mean	0.3	0	0	0.3	<0.1%
St dev	±0.6	---	---	±0.6	±<0.01%
Range	0-1	---	---	0-1	0-0.01%
n	4	4	4	4	
Area E					
Mean	2.3	0	0.3	0	0.1%
St dev	±2.6	---	±0.5	---	±0.1%
Range	0 -6	---	0-1	---	0.01-
n	4	4	4	4	
Area F					
Mean	2	0	0.5	0.3	0.1%
St dev	±2.2	---	±0.6	±0.5	±0.1%
Range	0-5	---	0-1	0-1	0.007-
n	4	4	4	4	
Area G					
Mean	0.5	0	0	0	<0.1%
St dev	±0.6	---	---	---	±0.02%
Range	0-1	---	---	---	0-0.04%
n	4	4	4	4	

Table 13. Number of colonies in each size class for each coral taxon observed in Natatorium exterior surveyed areas.

	Size Class (cm)				
Taxon	**1 to 5**	**>5 to 10**	**>10 to 20**	***Total***	***Percent of Total***
Cyphastrea ocellina	10	8	0	*18*	*34*
Porites lobata	12	10	1	*23*	*43*
Poc. meandrina	4	0	3	*7*	*13*
Poc. damicornis	4	1	0	*5*	*9*
Total Count	*30*	*19*	*4*	*53*	
Percent of Total	*57*	*36*	*7*		

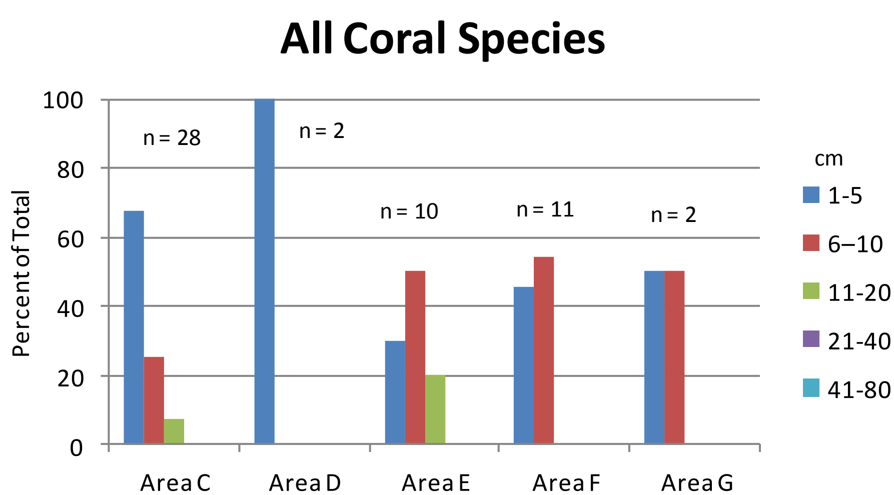


Figure 16. All coral species size class distribution for Natatorium exterior surveyed area.

Pipeline Corridor — The quantitative coral survey of the pipeline corridor areas found 87 coral colonies from 5 genera (*Porites, Pocillopora*, *Montipora, Psammocora*, and *Cyphastrea;* see Appendix B for species list) in a 110 m^2 survey area, for an average of 0.6 colonies per m^2. Table 14 presents coral density and percent cover in each of the pipeline corridor surveyed areas. The mean coral coverage along the pipeline corridor is 0.9%. The transects surveyed in P5 (furtherset offshore segment) support the greatest coral growth of the surveyed areas, with average coral cover at 2%. No coral colonies were observed in P4. Average coral cover within P1 and P3 is low (0.5%). The midchannel pipeline corridor area (P2) has an average coral cover of 1.3%.

Data presented by coral taxon for the pipeline corridor surveyed areas are provided in Appendix D. *P. lobata* is the most frequently encountered coral species in the pipeline corridor surveyed area (46%; Table 14). The size class distribution for all coral species combined is presented in Fig. 17. Most colonies are in the two smallest size classes (1 to 5 cm and >5 to 10 cm). Overall, there is an inverse relationship between size and number of colonies, with the smallest size class being most represented, and the largest size class being represented by only a few colonies (1 to 5 cm, 51%; >5 to 10 cm, 22%; >10 to 20, 20%; >20 to 40 cm, 7% and >40 to 80 cm, 1%). Several corals (*P. lobata*, *Poc. meandrina*, and *M. capitata*) with diameter >20 to 40 cm were encountered in the pipeline corridor, and one colony (*Poc. meandrina*) with diameter >40 to 80 cm was observed. No corals with diameter >80 cm were encountered in the pipeline survey areas.

Table 14. Number of coral colonies and percent coral cover in Natatorium pipeline corridor areas, surveyed April, 2012.

	Number of Coral Colonies (individuals per 10m^2)						**Coral Cover**
	P. lobata	*Poc. meandrina*	*Poc. damicornis*	*C. ocellina*	*M. capitata*	*P. stellata*	
P1							
Mean	3	0	0.3	0	0	0.3	0.5%
St dev	±5.2	--	±0.6	--	--	±0.6	±0.9%
Range	0 -9	--	0 – 1	--	--	0-1	0-01.6%
n	3	3	3	3	--	3	3
P2							
Mean	8.7	0.7	1.3	1	1	0	1.3%
St dev	±3.5	±0.6	±1.5	±1.7	±1.7	--	±1.2%
Range	0-12	0-1	0-3	0-3	0-3	--	0.1-2.6%
n	3	3	3	3	3	3	3
P3							
Mean	0.5	0.5	3	0	0	0	0.5%
St dev	±0.7	±0.7	±4.2	--	--	--	±0.7
Range	0-1	0-1	0-6	--	--	--	0-1
n	2	2	2	2	2	2	2

Table 14 (continued)

	Number of Coral Colonies (individuals per 10m^2)						
	P. lobata	*Poc. meandrina*	*Poc. damicornis*	*C. ocellina*	*M. capitata*	*P. stellata*	**Coral Cover**
P4							
Mean	0	0	0	0	0	0	0%
St dev	--	--	--	--	--	--	--
Range	--	--	--	--	--	--	--
n	1	1	1	1	1	1	1
P5							
Mean	5.5	6	2	0	1.5	0	2%
St dev	±6.4	±7.1	±2.8	--	±2.1	--	±2.8%
Range	1-10	1-11	0-4	--	0-3	--	X-X
n	2	2	2	2	2	2	2

Table 15. Number of colonies in each size class for each coral taxon observed in the pipeline corridor surveyed areas.

	Size Class (cm)						
Taxon	**1 to 5**	**>5 to 10**	**>10 to 20**	**>20 to 40**	**>40-80**	***Total***	***Percent of Total***
Porites lobata	22	9	11	4	--	*46*	*46*
Poc. damicornis	8	2	--	--	--	*10*	*10*
Poc. meandrina	8	7	4	1	1	*21*	*21*
Cyphastrea ocellina	3	0	0	0	0	*3*	*3*
M. capitata	3	0	2	1	0	*6*	*6*
Psammocora stellata	0	1	0	0	0	*1*	*1*
Total Count	*44*	*19*	*17*	*6*	*1*	*87*	
Percent of Total	*51*	*22*	*20*	*7*	*1*		

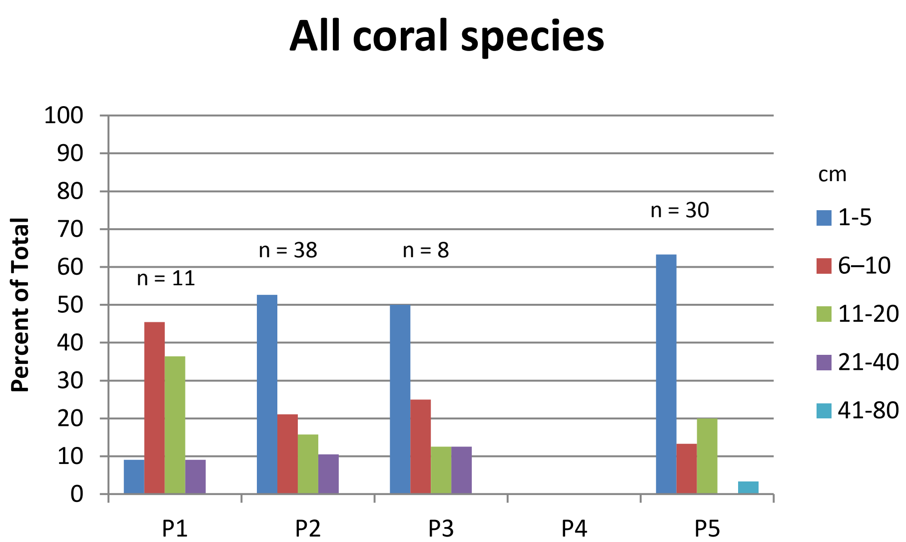


Figure 17. All coral species size class distribution for Pipeline corridor surveyed area.

Macro-Invertebrate Assemblages

<u>Natatorium Exterior</u>—Results of macro-invertebrate surveys in the Natatorium exterior is presented in Table 16. Refer to Appendix C for a species list. Quantitative data from the individual transects within the survey areas are provided in Appendix D.

Mean macro-invertebrate density is 5.9/m^2, composed primarily of urchins (*Echinometra mathaei* and *E. oblonga*). Area C (on the exterior pool walls) hosts a high macro-invertebrate density, totaling 22.8/m^2 (see Appendix D) comprised mostly of rock boring urchins (*E. mathaei*).

<u>Pipeline corridor</u> — Results of macro-invertebrate surveys in pipeline corridor is presented in Table 17. Refer to Appendix C for a species list. Quantitative data from the individual transects within the survey areas are provided in Appendix D.

Macro-invertebrate density in the pipeline corridor surveyed areas is low, with a mean density of 0.6/m^2, composed mostly of urchins (*E. mathaei*). All other invertebrates were rarely encountered.

Table 16. Macro-invertebrate densities (number per m^2) of the Natatorium exterior surveyed areas (20 transects).

	Shelled gastropods	Bivalves	Decapods	Urchins	Other	Total
mean	<0.1	0.7	<0.1	5.0	<0.1	5.9
std. dev	±0.06	±0.7	±0.03	±8.8	±0.03	±10
min	0	0	0	0	0	0.8
max	0.2	2	0.08	23	0.1	23

Taxa observed:
- Shelled gastropods: *Cyprea mauritiana*, *Siphonaira normalis*, *Morula* sp.
- Bivalves: Pteriidae, *Brachidontes crebristriatus, Isognomon perna*
- Decapods: Diogenidae, *Percnon affine*, *Corallianassa borradaiei*
- Urchins: *Echinometra mathaei*, *E. oblonga, Echinothrix calamaris*
- Other: Holothuridae, Zooanthids, Annelida, Ophiuroidea

Table 17. Macro-invertebrate densities (number per m^2) of the pipeline corridor surveyed areas (11 transects).

	Shelled gastropods	Urchins	Decapods	Other	Total
mean	<0.1	0.5	<0.1	<0.1	0.6
std. dev	±0.06	±0.6	±0.03	±0.1	±0.7
min	0	0	0	0	0
max	0.1	1	0.07	0.2	1.5

Taxa observed:
- Shelled gastropods: *Conus* spp. *Morula* sp.
- Decapods: Diogenidae, *Corallianassa borradaiei*
- Urchins: *Echinometra mathaei*, *Echinothrix calamaris*
- Other: Zooanthidae, Annelida, Ophiuroidea, *Holothuria atra*

Fish Assemblages

Natatorium Interior—Fish surveys were not conducted in the Natatorium Interior because visibility was too low. A total of 15 fish species were encountered in the reconnaissance survey of the Natatorium interior. See Appendix C for a list of all species encountered.

Natatorium Exterior—A total of 54 fish species were encountered in the Natatorium Exterior (see Appendix C). Fish data by surveyed area is provided in Appendix D. Table 18 summarizes the fish survey data for the Natatorium Exterior. The average species richness is 9 species. The mean biomass for small fishes (<25 cm) is 86 kg/ha and 57 kg/ha for large fishes (>25 cm). Average total biomass throughout the Natatorium exterior surveyed areas was 143 kg/ha.

Table 18. Mean number of species and mean fish biomass in Natatorium Exterior areas surveyed.

Surveyed Area	Number of Species	Fish Biomass (<25cm; kg/ha)	Fish Biomass (>25cm; kg/ha)	Total Fish Biomass (kg/ha)
Natatorium Exterior				
Mean	9	86	57	143
Total	54			

Pipeline Corridor—A total of 25 fish species were encountered in the Pipeline Corridor (see Appendix C). Fish data by surveyed area is provided in Appendix D. Table 19 summarizes the fish survey data for Pipeline Corridor. The average species richness is low (6 species). The mean biomass for small fishes (<25 cm) is 24 kg/ha, and 6 kg/ha for larger fishes (>25 cm).

Table 19. Mean number of species and mean fish biomass in Pipeline corridor areas surveyed.

Surveyed Area	Number of Species*	Fish Biomass (<25cm; kg/ha)	Fish Biomass (>25cm; kg/ha)	Total Fish Biomass (kg/ha)
Pipeline Corridor				
Mean	6	24	6	30
Total	27			

Fish Trophic Guilds

Natatorium Interior— A grouping into trophic guilds of fishes from our reconnaissance survey reveals five trophic guilds present. Fish are not frequently encountered in the Natatorium interior, but of those seen, sessile invertebrate feeders (e.g. *Canthigaster jactator*) and zooplankton feeders (e.g. *Kuhlia xenura*) are the most common. Piscivores (e.g. *Triaenodon obesus*) were also encountered occasionally.

Natatorium Exterior – A grouping into trophic guilds of fishes from our transect data reveals five trophic guilds present, which is also consistent with previous surveys of nearby areas (*AECOS,* 2009). Herbivores (e.g., *Acanthurus blochii* and *A. triostegus*) account for the greatest overall fish biomass present (62% of the community). Mobile invertebrate feeders, most of which are wrasses (e.g., *Thalassoma duperrey* and *Stethojulis balteata*), were the most frequently encountered trophic guild, making up 35 percent of the community biomass. Piscivores (e.g. *Echnidna nebulosa*), sessile invertebrate feeders (e.g. *Ostracion meleagris* and *Canthigaster jactator*), and zooplankton feeders (e.g. *Abudefdef abdominalis*) combined account for less than 3% of the fish biomass. Table 20 summarizes the trophic guild results.

Table 20. Biomass distribution by trophic guild of fishes in Natatorium Exterior, surveyed February 2011.

Trophic Guild	Number of Fishes	Biomass (kg/ha)	Percent of community
Mobile invertebrate feeder	60	183	35
Herbivore	58	321	62
Sessile invertebrate feeder	6	6	1
Zooplankton feeder	8	5	1
Piscivore	2	3	0.6
TOTAL	134	516	

Pipeline Corridor — Mobile invertebrate feeders, mostly wrasses (e.g. *Thalassoma duperrey*, *Stethojulis balteata*) account for more than half the number of fishes observed and half the biomass estimated in the pipeline corridor surveyed areas. Zooplankton feeders (e.g. *Chromis vanderbilti*) account for nearly one quarter of the fish observed, but for only 3% of the biomass. Herbivores (e.g. *Acanthurus nigrofuscus*) account for 34% of the biomass. Piscivores (e.g. *Carcanthus typicus*) and sessile invertebrate feeders (e.g.

Ostracion meleagris), combined, account for only 13% of the fish biomass within the project vicinity. Table 21 summarizes the trophic guild results.

Table 21. Biomass distribution by trophic guild of fishes in the pipeline corridor surveyed areas off the Natatorium, April, 2012.

Trophic Guild	Number of Fishes	Biomass (kg/ha)	Percent of community biomass
Mobile invertebrate feeder	34	12	50.0
Herbivore	11	8	34.3
Sessile invertebrate feeder	2	2	8.8
Piscivore	3	2	8.9
Zooplankton feeder	16	1	2.8
TOTAL	66	24	100

Discussion

Water Quality

The waters (and bottom) offshore of the Waikīkī Natatorium are classified in Hawaiʻi water quality standards (HDOH, 2009) as: (a) marine waters, (b) open coastal, (c) reef flat, (d) Class A, and (e) Class II marine bottom ecosystem. It is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Other uses are permitted so long as they are compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation. Class A waters are not to act as receiving waters for any discharge which has not received the best treatment or control practicable.

Applicable area-specific state water quality criteria for the Project vicinity are shown in Table 22. The waters surrounding the Natatorium receive less than three million gallons per day of freshwater discharge per shoreline mile, therefore the "dry" criteria are applicable.

Physical water quality measurements during the present survey met state criteria for temperature, salinity, DO saturation and pH. Geometric mean turbidity levels did not meet the state criterion of 0.50 NTU at any of the 5 stations, probably because of mixing with sediments in these shallow nearshore waters. There are no state criteria for TSS in coastal waters.

Table 22. State of Hawaiʻi water quality criteria for Class A, marine open coastal waters (HAR §11-54-6).

Parameter units	**Turbidity** (NTU)	**Total Nitrogen** (µg N/l)	**Nitrate-Nitrite** (µg N/l)	**Ammonia** (µg N/l)	**Total Phosphorus** (µg P/l)	**Chl. α** (µg/l)
Geometric mean not to exceed given value	0.50	150.00	5.00	3.50	20.00	0.30
Value not to be exceeded more than 10% of the time	1.25	250.00	14.00	8.50	40.00	0.90
Value not to be exceeded more than 2% of the time	2.00	350.00	25.00	15.00	60.00	1.75

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

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

Ammonia concentrations did not meet the state geometric mean criterion at any of the 5 stations. Nitrate-Nitrite concentrations during the survey met the state geometric mean criterion at all stations, except at Sta. Pool. The geometric means for Total N did not meet the state geometric mean criterion at any station. The Total P geometric mean state criterion was met at all 5 stations. The chlorophyll α state geometric mean concentration was met at Sta. Off Ewa Corner and Sta. Offshore. Elevated nutrient and chlorophyll concentrations in nearshore coastal waters are usually the result of groundwater intrusions, surface discharges and/or other land-related discharges.

In general, water quality conditions in the Project area were good and met state criteria. Ammonia and Total N levels were elevated at all stations, including the offshore station (Sta. Offshore), suggesting that these increased levels were not specific to the Project site. Similarly, turbidity levels were slightly higher at the nearshore stations, compared with Sta. Offshore, but this is to be expected due to interaction with the shallow bottom sediments.

Under Section 303(d) of the Clean Water Act, states, territories and tribes are required to develop lists of impaired water that do not meet state water quality requirements. None of the coastal waters in the Waikīkī area, including the coastal waters off the Natatorium, have been listed as impaired by the HDOH (USEPA, 2012).

Marine Biota

In general, the community structure of the benthos in the area within and surrounding the Waikīkī Natatorium is dominated by macroalgae. The daily use by large numbers of waders and swimmers in nearshore areas also influences the biotic community. Areas with little or no vertical relief are affected by constantly shifting sands and tend to have little algal or macro-invertebrate diversity, with few coral colonies present. These hard bottom areas may be regularly covered and uncovered by shifting sands and loose rubble. The corals that occur in the area are mostly small and are species that commonly recruit to disturbed areas. The richest biotic assemblages occur in the areas where vertical relief of the limestone affords some protection from wave-driven sand particles and longevity of exposure.

<u>Fishes</u> — Table 23 compares numbers of fish species and biomass results from the present survey with various other surveys on Oʻahu, including the Natatorium vicinity. In a 1992 study of the Natatorium area, the average number of species per transect was 14 and average fish biomass was 620 kg/ha. In the present survey, the average number of species per transect was 9, however fish biomass was over 4 times less, with an average of 143 kg/ha.

Surveys of the Waikīkī MLCD and the FMA found an average number of species per transect to be 11 (MLCD) and 12 (FMA) and fish biomass to be 373 kg/ha (MLCD) and 200 kg/ha (FMA). In general, the number of fish species in the present study is similar to other studies, but fish biomass is less.

Table 23. Mean number of species and fish biomass from various locations in Hawaiʻi compared to Natatorium area.

Location	**Source**	**No. of Species**	**Fish Biomass (kg/ha)**
Oʻahu Island	Friedlander et al., 2005	--	209
Waikīkī, Oʻahu	CRAMP, 2009	9	154
Waikīkī, FMA*, Oʻahu	Williams *et al*., 2006	--	200
Waikīkī MLCD, Oʻahu	Friedlander & Cesar, 2004	11	373
Ala Wai, Oʻahu	CRAMP, 2009	12	145
Gray's Beach, Waikīkī, Oʻahu	*AECOS*, 2009	6	39
Natatorium	SEA, 1992	14	620
Natatorium	**Present survey**	9	143

* Waikīkī -Diamond Head Fishery Management Area (FMA) extends along approximately 2.5 km of shoreline at the southeastern corner of Oʻahu, from the high-water mark to 500 yards (457 m) offshore, or to the seaward edge of the fringing reef.

Protected Species

One protected species was observed in the Project vicinity: green sea turtle or *honu* (*Chelonia mydas*). The green sea turtle is common on the shallow reefs of Waikīkī, and was one was seen during the April 2012 surveys of the offshore pipeline corridor. Also known to occasion the marine environment off the Project is Hawaiian monk seal (*Monachus schauinslandi*; PIFSC unpublished data) and humback whale *or kohola* (*Megaptera novaeangliae*) occurs in deeper waters offshore.

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

The green sea turtle diet consists primarily of benthic macroalgae, which the shallow reefs of Oʻahu provide in abundance. Red macroalgae make up 78% of the turtle diet and green macroalgae make up 12%. The three most common nonnative species consumed are *A. spicifera, Hypnea musciformis*, and *G.*

salicornia. These three abundant and nutritious food sources are now an important part of the turtle diet (Arthur and Balazs, 2008). The shallow reefs found along the south shore of Oʻahu are primarily made up of ancient limestone platforms covered by algae with very little coral cover. Recent surveys of the shallow reefs off Waikīkī and our survey of the area around the Natatorium noted *A. spicifera* as the most abundant macroalgal species present. Numerous other macroalgal species consumed by green turtles also occur off Waikīkī (*AECOS*, 2008, 2010), including several other preferred food species (Table 24). Thus, substantial foraging resources are available for sea turtles off Waikīkī.

Green sea turtle nesting is primarily limited to a few beaches of the Northwestern Hawaiian Islands with 90 percent of nesting occurring at French Frigate Shoals (Balazs et al., 1992). None of the Hawaiian sea turtles is known to nest in the Project vicinity (NOAA-PIFSC, 2010).

Table 24. Macroalgae most preferred by green sea turtles (Russell and Balazs, 2000) and abundance off Waikīkī Natatorium.

Scientific name	Abundance
Acanthophora spicifera	Abundant
Gracilaria salicornia	Abundant
Codium sp.	Common
Melanamansia sp.	Rare
Ulva sp.	Common
Pterocladiella sp.	Occasional
Gelidium sp.	Occasional
Hypnea musciformis	Common

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

Threats to green sea turtles in Hawaiʻi, listed in order of greatest to least, include: disease and parasites, accidental fishing take, and boat collisions.

Lessor threats include: entanglement in marine debris, loss of foraging habitat to development, and ingestion of marine debris (NMFS-USFWS, 1998). Turbidity (murky water) does not appear to deter green sea turtles from foraging and resting areas. Construction projects on the south shore of Oʻahu, at Hawaii Kai and off of Kapolei, have found sea turtles adaptable and tolerant of construction-related disturbances (Brock, 1998a,b).

Coral — State law prohibits the taking, breaking or damaging, with any implement, any stony coral from the waters of Hawaiʻi, including any reef or mushroom coral (HAR §13-95-70). It is also unlawful to take, break or damage, with any implement, any rock or coral to which marine life of any type is visibly attached (HAR §13-95-71). In February 2010, 82 species of corals were petitioned to be listed as threatened or endangered under the Endangered Species Act (NOAA-NMFS, 2010). NOAA has initiated a status review of the proposed species to determine if listing under the ESA is warranted and results of this review are anticipated in late 2012 (K. Graham, Pers. Comm., 2011). Of the petitioned species, two were observed in the Project vicinity: *Cyphastrea ocellina* (occasional), and *Psammocora. stellata* (rare).

Monk Seal — The endangered Hawaiian monk seal (*Monachus schauinslandi*) is known to occur in the waters in the Waikīkī area between Queen's Beach and Sans Souci Beach. The majority of monk seal sighting information collected in the main Hawaiian Islands is reported by the general public and is highly biased by location and reporting effort. Systematic monk seal count data come from aerial surveys conducted by the Pacific Islands Fisheries Science Center (PIFSC) in 2000-2001 and 2008. Aerial surveys of all the main Hawaiian Islands were conducted in 2000-2001 and in 2008 (Baker and Johanos 2004, PIFSC unpublished data). One complete survey of Oʻahu was conducted for each of these years. The 2000 survey was conducted from an airplane and the 2001 and 2008 surveys were both conducted by helicopter. No Hawaiian monk seals were sighted in Waikīkī during any of the three surveys.

Reports by the general public, which are non-systematic and not representative of overall seal use of main Hawaiian Islands shorelines, have been collected in the main Hawaiian Islands since the early 1980s. In total, seventy-six Hawaiian monk seal sightings have been reported in Waikīkī between Queen's Beach and Sans Souci Beach from 2002 to 2011 (Table 25). A sighting is defined as a calendar day during which an individual seal was documented as present at a given location. Sightings were divided into three areas based upon reported location and include Queens Beach, Sans Souci Beach and Waikīkī (unspecified general location; Table 25). No seal sightings have been reported at or offshore of the Natatorium. It should be noted that the majority of monk seal sightings are reported when seals are sighted on-shore. Fifty-three of the reported sightings can be attributed to seven uniquely identifiable seals (Table 26). No births have been documented in the area.

Table 25. Number of reported Hawaiian monk seal sightings in Waikīkī, between Queen's Beach and Sans Souci Beach (2002-2011)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	**Total**
Queen's Beach		1		1	2	8	9	8	6	4	**39**
Sans Souci Beach		1		1		1		2	1		**5**
Waikīkī				4	1	5	2				**32**
Total	**0**	**1**	**0**	**6**	**3**	**14**	**11**	**19**	**7**	**15**	**76**

Table 26. Number of sightings of uniquely identifiable Hawaiian monk seals in Waikīkī, between Queen's Beach and Sans Souci Beach (2002-2011)

Seal ID	**Size**	**Sex**	**Sightings**
RO10	Adult	Female	20
Ro12	Adult	Male	13
R4DF	Adult	Female	2
RE74	Adult	Male	3
RH44	Adult	Female	1
RH58	Adult	Female	12
TK23	Adult	Male	2
Total			**53**

Currently, only the remote Northwestern Hawaiian Islands are considered critical habitat for monk seals (50 CFR 226.201). However, the waters surrounding the Main Hawaiian Islands have been proposed as monk seal critical habitat (50 CFR 226, June 2, 2011; NOAA-NMFS, 2011). The shoreline and marine environment extending seaward to the 500-m depth contour of the Project area are included in the proposed monk seal critical habitat designation.

<u>Humpback Whale</u> — The humpback whale or *kohola* (*Megaptera novaeangliae*) was listed as endangered in 1970 under the Endangered Species Act (USFWS, 1970). Prior to protection, the Pacific humpback whale population was estimated at under 1,000 individuals (Rice, 1978). Today, there are over 7,000; of these, 5,000 are estimated to migrate to Hawaiian waters (HIHWNMS, 2004).

To the east of the Natatorium, the waters of Maunalua Bay are within the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS). Humpback whales normally occur in Hawaiian waters annually from November to May with the peak between January and March (HIHWNMS, 2010). The Project will not directly affect humpback whales, and sounds generated from dredging activities is not anticipated to be substantial enough to cause an acoustic disturbance to protected species in nearshore waters. The following in-water acoustic impact thresholds are currently used by NMFS to assess potential impacts to marine mammals (NOAA, 2005; Don Hubner, Pers. Comm., 2011): Onset of Injury (also known as the Permanent Threshold Shift) is 180 dB for cetaceans and 190 dB for pinnipeds. The Onset of Behavioral Disturbance (also known as the Temporary Threshold Shift / Areal Avoidance) is 160 dB when impulsive sound and 120 dB when continuous, non-impulsive sound.

Conclusions

Impacts

The proposed reconfiguration of the Natatorium into a recreational beach area will result in the loss of marine resources that are within the footprint of the present structure. These communities are dominated by a number of algal species and few corals that exist there despite poor water quality. The corals that occur in the area are mostly small and are species that commonly recruit to disturbed areas. Communities residing in the present Natatorium pool and on the walls of the structure will be impacted, but it is expected that similar communities will recolonize any newly placed solid structures. Recruitment of biota to the new groin structures will likely include marine species established nearby, including corals. The increased vertical relief provided by such structures creates topographic complexity that will benefit fish populations in the harbor by providing habitat and food resources. However, an Essential Fish Habitat (EFH) assessment could be required by regulatory agencies due to the loss of an unknown amount of marine fishes and fish habitat.

Both direct and indirect impacts to the biological community and water quality of Waikīkī reef are likely to be fairly minimal, but construction best management practices (BMPs) must be implemented, particularly during beach nourishment and reconstruction of the interior pool, groin construction, laying of a pipeline, and dewatering. Afternoon winds and waves increase the suspended sediment in the nearshore waters. A water quality monitoring plan should be developed to ensure project activities do not degrade water quality.

We also suggest biological monitoring programs be developed that focus on the specific components of particular interest to the resource and permitting agencies, including, changes in densities and distribution of macro-invertebrates (including changes in condition of corals) on (a) the existing pool walls and pool bottom), (b) proposed groin footprint, and (c) area surrounding the pipeline corridor.

Mitigation

The Clean Water Act states that compensatory mitigation is required to offset environmental losses resulting from unavoidable impacts to waters of the U.S. authorized by U.S. Army Corps permits, and that the mitigation must be commensurate with the amount and type of impact (40 CFR 230, Final Rule; see USACE & EPA, 2008). To calculate the amount of compensatory mitigation required, additional surveys may be required to quantify adverse impacts to coral reef resources and EFH. USFWS has developed a "Phase 2" survey protocol to quantify coral resources that will be directly and indirectly impacted by project alternatives (USFWS and NMFS, 2011). The protocol includes methods to: (1) quantify coral colony size-frequency (size, diversity, new recruits, large colonies, health); (2) quantify diversity, size, density, and biomass of fishes; (3) identify and quantify (percent cover) algae and seagrass; (4) identify and quantify non-coral macro-invertebrate (target cnidarians, echinoderms, mollusks, and crustaceans); (5) quantify percent cover of all benthic species and substrate type. Data collected from the Phase 2 survey will be used to quantify unavoidable coral resource impact and to develop a mitigation and monitoring plan. Possible mitigation strategies that could be implemented include: 1) coral transplantation and 2) invasive algae species removal, briefly discussed below.

<u>Coral transplanting</u> – Impacts to corals could be minimized by relocating larger coral heads in the Project footprint. Head and mound-forming coral colonies occurring in the pool are candidates for transplanting. Transplantation of coral heads is a recommended mitigation measure to reduce losses from direct impacts (USFWS, 2006). There are approximately 16 coral heads (*Pocillopora* spp. and *Porites* spp.) in the Natatorium pool that would be suitable for transplantation. Techniques for the transplantation of corals have been developed and vetted around the world (Edwards, A.J. (ed), 2010).

<u>Invasive algae species removal</u> – The benthic community in the Natatorium pool and exterior reef flat is dominated by a number of invasive algal species (*G. salicornia*, *A. spiciferia*, etc.). Another possible mitigation measure is the removal of these species prior to project construction. Currently, various invasive algae removal efforts on Oʻahu are underway (See TNC, 2012).

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Appendix A

Checklist of algae observed in surveys of Natatorium interior pool bottom and walls (October 2010); of Natatorium exterior walls and surrounding areas (February 2011); and within proposed pipeline corridor (April 2012).

List of algae observed in surveys of Natatorium interior pool bottom and walls (October 2010); of Natatorium exterior walls and surrounding areas (February 2011); and within proposed pipeline corridor (April 2012).

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name & *Hawaiian name*	Status	Abundance by location: Interior pool bottom	Interior pool walls	Exterior pool walls and surrounding areas	Pipeline corridor
	ALGAE					
CHLOROPHYTA	GREEN ALGAE					
Avrainvillea amadelpha		Nat.	U			U
Boodlea composita		Ind.			R	
Caulerpa nummularia		Ind.		U		
Caulerpa racemosa		Ind.			O	
Chlorodesmis caepitosa		Ind.			R	
Codium edule	*wāwae`iole*	Ind.			R	O
Dictyosphaeria versluysii		Ind.			U	O
Halimeda discoidea		Ind.	U			
Halimeda sp.					O	O
Microdictyon umbilicatum					R	A
Neomeris sp.		Ind.			U	C
Ulva fasciata	sea lettuce *pālahalaha*	Ind.			A	
RHODOPHYTA	RED ALGAE					
Acanthophora spicifera		Nat.	C	A	A	A
Amansia glomerata		Ind.		C	A	U
Asparagopsis taxiformis	*kohu*	Ind.			O	C
Centroceras clavulatum		Ind.			O	
Cryptonemia yendoi		Ind.		U		
Dichotomeria marginata		Ind.	A	A	U	O
Galaxaura sp.		Ind.			O	O
Gelidiella acerosa		Ind.				U
Gelidium pluma		Ind.			R	O
Gibsmithia hawaiiensis		Ind.				R
Gracilaria coronopifolia	*manauea*	Ind.			R	
Gracilaria salicornia		Nat.	A	A	A	A
Hydrolithon onkodes		Ind.			O	O
Hydrolithon reinboldii		Ind.			U	
Hypnea chordacea		Ind.			U	
Hypnea musciformis		Ind.			C	U
Jania micrarthrodia		Ind.			C	
Martensia flabelliformis		Ind.				R

Peyssonnelia rubra		Ind.	O	O		
Portieria hornemannii		Ind.			O	O
Pterocladilla capillacea		Ind.			C	
Pterocladiella caerulescens		Ind,			O	U
Sporolithon erythraeum		Ind.			U	
Spyridia filamentosa		Ind.			U	
Tolypiocladiag glomerulata		Ind.			U	
Tricleocarpa cylindrica		Ind.		C	O	U
Trichogloea sp.		Ind.			R	U
OCHROPHYTA	BROWN ALGAE	.				
Colpomenia sinuosa		Ind.			R	
Dictyota acutiloba	*alani*	Ind.			C	
Dictyota sandvicensis	*alani*	End.			C	O
Dictyopteris plagiogramma		Ind.			R	A
Laurencia succisa	*lipe`epe`e*	Ind.			U	
Lobophora variegata		Ind.		U	O	
Padina sanctae-crucis		Ind.			O	U
Ralfsia expansa		Ind.			O	
Sargassum echinocarpum	*kala*	Ind.			C	
Sargassum polyphyllum	*kala*	Ind.			U	
Stypopodium flabelliforme		Ind.				U
Turbinaria ornata		Ind.			C	U
CYANOBACTERIA						
Lyngbya majuscule					A	C
MAGNOLIOPHYTA	Flowering plants					
Halophila hawaiiana	Hawaiian seagrass	End.				O

KEY TO SYMBOLS USED:

Abundance categories:

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

Status categories:

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

Appendix B

Checklist of macro-invertebrates (including corals) observed in surveys of Natatorium interior pool bottom and walls (October 2010); of Natatorium exterior walls and surrounding areas (February 2011); and within proposed pipeline corridor (April 2012).

List of macro-invertebrates (including corals) observed in surveys of Natatorium interior pool bottom and walls (October 2010); of Natatorium exterior walls and surrounding areas (February 2011); and within proposed pipeline corridor (April 2012).

PHYLUM, CLASS, ORDER, FAMILY			Abundance by location			
Genus species	Common name & *Hawaiian name*	Status	Interior pool bottom	Interior pool walls	Exterior pool walls and surrounding areas	Pipeline corridor
	INVERTEBRATES					
PORIFERA, DEMOSPONGIAE, DYSIDEIDAE	Sponges					
Unid.			R			
Sigmadocia sp.				R		
CNIDARIA, ANTHOZOA, SCELRACTINIA						
POCILLOPORIDAE						
Pocillopora damicornis	lace coral	Ind.		U	U	
Pocillopora meandrina		Ind.			U	
PORITIDAE						
Porites lobata	lobe coral, *pohaku puna*	Ind.	U			
Porites lutea		Ind.			U	
ACROPORIDAE						
Montipora capitata	rice coral	Ind.			U	
FAVIIDAE						
Leptastrea bewickensis	bewick coral	Ind.		R		
Cyphastrea ocellina				U		
ANNELIDA, POLYCHAETA SERPULIDAE	WORMS					
Salmacina dysteri	sea frost	Ind.		O		
TEREBELLIDAE						
Loimia medusa	medusa spaghetti worm	Ind.	O	O		
CHAETOPTERIDAE						
Chaetopterus sp.	parchment worm	Ind.		U		
AMPHINOMIDAE						
Eurythoe complanata	fire worm				U	
MOLLUSCA, GASTROPODA PATELLIDAE						
Siphonaria normalis	false ʻopihi *ʻopihi-ʻawa*	Nat.		O		

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name & *Hawaiian name*	Status	Abundance by location Interior pool bottom	Interior pool walls	Exterior pool walls and surrounding areas	Pipeline corridor
NERITIDAE						
Nerita picea	black nerite *pipipi*	Nat.		U		
CYPRADIDAE						
Cyprae mauritiana	humpback cowry *leho ahi*					
CONIDAE						
Conus imperialis	imperial cone	Ind.			U	
THAIDADAE						
Morula uva	grape drupe	Ind.			R	
Morula sp.	drupe	Ind.			R	
LITTORINIDAE						
Littoraria pintado	dotted periwinkle *pipipi kolea*	Ind.		U	U	
VERMETIDAE						
Serpulorbis variabilis	worm snail *kauna`oa*	Ind.			U	
MOLLUSCA, ANASIPIDAE, APLYSIDAE						
Aplysia parvula	small sea hare *kualakai*	Ind.			O	
MOLLUSCA,BIVALVIA, MYTILIDAE						
Brachiodontes crebristriatus	Hawaiian mussel	Ind.			C	
PTERIIDAE						
Unid					C	
ISOGNOMONIDAE						
Isognomon californicum	black purse shell	Ind.		R		
Isognomon perna	brown purse shell *nahawele*	Ind.			R	
ARCIDAE						
Arca ventricosa	*`olepe-papaua*	Ind.			R	
ARTHROPODA, CIRRIPEDIA, BALANIDAE						
Amphibalanus amphitrite	Amphitrite's rock barnacle	Nat.		O		
ARTHROPODA, MALACOSTRACA, DECAPODA, HIPPOLYTIDAE						
Saron marmoratus	marbled shrimp	Ind.			R	
CALLIANASSIDAE						

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name & *Hawaiian name*	Status	Interior pool bottom	Interior pool walls	Exterior pool walls and surrounding areas	Pipeline corridor
			Abundance by location			
Callianassa borradailei	ghost shrimp				U	
DIOGENIDAE						
Unid.	hermit crab				U	
GRAPSIDAE						
Percnon affine	blue-eyed crab	Ind.			R	
Grapsus tenuicrustatus	thin shelled rock crab;*ʻaʻama*	Ind.		C	R	
MAJIDAE						
unid.	spider crab	Ind.		U		
ECHINODERMATA, OPHIUROIDEA, OPHIOCOMIDAE	BRITTLE STARS					
Ophiocoma erinaceus					U	
ECHINODERMATA, ECHNOIDEA, ECHINOMETRIDAE	SEA URCHINS					
Echinometra mathaei	rock boring urchin *ʻina kea*	Ind.		O	A	
Echinometra oblonga	oblong boring urchin; *ʻina*	Ind.		O	A	
DIADEMATIDAE						
Echinothrix diadema	blue-black urchin, *wana*	Ind.			R	
Echinothrix calamaris	double spined urchin	Ind.			R	
	SEA CUCUMBERS					
ECHINODERMATA, HOLOTHUROIDEA						
HOLOTHURIDAE		Ind.			R	
Holothuria atra	black sea cucumber *loli okuhi kuhi*	Ind.	U		R	
Holothuria pervicax	stubborn sea cucumber	Ind.				

KEY TO SYMBOLS USED:

Abundance categories:

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

Status categories:

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

Appendix C

Checklist of fish observed in surveys of Natatorium interior pool bottom and walls (October 2010); of Natatorium exterior walls and surrounding areas (February 2011); and within proposed pipeline corridor (April 2012).

List of fish observed in surveys of Natatorium interior pool bottom and walls (October 2010); of Natatorium exterior walls and surrounding areas (February 2011); and within proposed pipeline corridor (April 2012).

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name & *Hawaiian name*	Status	Abundance by location Interior pool bottom	Interior pool walls	Exterior pool walls and surrounding areas	Pipeline corridor
VERTEGRATA, ACTINOPTERYGII	BONY FISHES					
MURAENIDAE						
Echnidna nebulosa	snowflake moray *puki kāpā*	Ind.			R	
Gymnothorax eurostus	stout moray	Ind.				U
CHANIDAE						
Chanos chanos	milkfish *awa*	Ind.			R	
ACANTHURIDAE						
Acanthurus triostegus	convict tang *manini*	Ind.		U	A	O
Acanthurus nigrofuscus	brown surgeonfish *māʻiʻiʻi*	Ind.			O	O
Acanthurus blochii	ringtail surgeonfish *pualu*	Ind.			O	O
Naso unicornis	bluespine unicornfish *kala*	Ind.			R	
CARACANTHIDAE						
Caracanthus typicus	Hawaiian coral croucher	End.				R
MONACANTHIDAE						
Cantherhines sandwichiensis	squaretail filefish	Ind.				R
LUTJANIDAE						
Lutjanus fulvus	blacktail snapper *toʻau*	Ind.	R			
FISTULARIIDAE						
Fistualria commersonii	bluespotted cornetfish; *nūnū*	Ind.	R			
SCORPAENIDAE						
Dendrochirus barberi	Hawaiian green lionfish	End.	R			R
Sebastapistes contorta	speckled scorpionfish	End.				R
APOGONIDAE						

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name & *Hawaiian name*	Status	Abundance by location Interior pool bottom	Interior pool walls	Exterior pool walls and surrounding areas	Pipeline corridor
Unid.	juv. cardinalfish *ʻupāpalu*	--		U		
SPHYRAENIDAE						
Sphyraena barracuda (juv)	great barracuda *kākū*	Ind.		U		
PLEURONECTIFORMES						
Bothus mancus	flowery flounder	Ind.				R
MULLIDAE						
Mulloidichthys flavolineatus	square-spot goatfish *wekeʻā*	Ind.	O		O	
Upeneus arge	bandtail goatfish *weke pueo*	Ind.			U	
Parupeneus multifasciatus	manybar goatfish *moano*	Ind.			U	U
POMACENTRIDAE						
Abudefduf abdominalis	Hawaiian sergeant *mamo*	End.		U	C	
Abudefduf sordidus	black spot sergeant *kūpīpī*	Ind.		U	C	
Dascyllus albisella	Hawaiian dascyllus; *ʻāloʻiloʻi*	End.	U		R	
Stegastes fasciolatus	Pacific gregory	Ind.			U	U
Plectroglyphidodon imparipennis	bright-eye damselfish	Ind.				O
Chromis vanderbilti	blackfin chromis	Ind.				U
LABRIDAE						
Unid.	juv.				O	
Cheilio inermis	cigar wrasse *kūpou*	Ind.			O	
Gomphosus varius	Bird wrasse *Hīnālea “ iwi*	Ind.			U	U
Thalassoma duperrey	saddle wrasse *hinalea lauwili*	End.			A	C
Thalassoma trilobatum	Christmas wrasse *ʻawela*	Ind.			O	C
Stethojulius balteata	belted wrasse *ʻomaka*	End.			O	O
Labroides phthirophagus	Hawaiian cleaner wrasse	End.		R		
Coris gaimard	yellowtail coris	Ind.				U
Coris ventusa	Elegant coris	End.			R	
ZANCLIDAE						

PHYLUM, CLASS, ORDER, FAMILY			Abundance by location			
Genus species	Common name & *Hawaiian name*	Status	Interior pool bottom	Interior pool walls	Exterior pool walls and surrounding areas	Pipeline corridor
Zanclus cornutus	morrish idol *kihikihi*	Ind.			O	O
AULOSTOMIDAE						
Aulostomus chinensis	trumpetfish *nunu*	Ind.			R	
SYNODONTIDAE						
Synodus ulae	Hawaiian lizardfish *ulae*	Ind.			R	
SCARIDAE						
Unid.	juv. parrotfish	--		O	A	
Scarus psittacus	juv. palenose parrotfish *uhu*	Ind.			U	
Calotomus carolinus	Carolines parrotfish *Ponuhunuhu*	Ind.			U	
GOBIDAE						
Psilogobius mainland	Hawaiian shrimp goby	End.	U			
CARANGIDAE						
Selar crumenophthalmus	bigeye scad *akule*	Ind.			U	
Scomberoides lysan	leatherback	Ind				U
CHAETODONIDAE						
Chaetodon lunula	raccoon butterflyfish *kikakapu*	Ind.			U	
BALISTIDAE						
Rhinecanthus rectangulus	reef triggerfish, *humuhumu nukunuku ahupuaʻa*	Ind.			O	O
KUHLIIDAE						
Kuhlia sandvicensis	zebra-head flagtail *āholehole*	Ind.			U	
Kuhlia xenura	Hawaiian flagtail *āholehole*	End.	O	O		
BELONIDAE						
Tylosurus acus	needlefish					U
OSTRACIIDAE						
Ostracion meleagris	spotted boxfish: *moa*	End.		U	O	O

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name & *Hawaiian name*	Status	Abundance by location Interior pool bottom	Interior pool walls	Exterior pool walls and surrounding areas	Pipeline corridor
TETRAODONTIDAE						
Canthigaster amboinensis	ambon toby	Ind.				U
Canthigaster jactator	Hawaiian whitespotted toby	End.		U	C	O
Arothron hispidus	stripebelly puffer	Ind.		U		
CICHLIDAE						
Sarotherodon melanotheron	blackchin tilapia	Nat.		U		
ELASMOBRANCHII, CARCHARIHINIFORMES, CARCHARHINIDAE						
Triaenodon obesus	White tip reef shark	Ind.	U	U		

KEY TO SYMBOLS USED:

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Appendix D

Detailed results for individual surveys areas

Coral Assemblages

Natatorium Exterior — Coral colonies are generally small (1 to 10 cm in diameter) and mostly found in areas E and F. One colony with diameter in the 11 to 20 cm class was observed in Area E. No *P. lobata* colonies >20 cm in diameter were found in the surveyed areas and no corals were recorded in Areas D, E, or G. Colonies of *Cyphastrea ocellina* within the survey areas are small (1 to 10 cm) and mostly found in Area C (Fig. 2). One colony (diameter 1 to 5 cm) was observed in Area D, and one colony (diameter 6 to 10 cm) was observed in Area F.

A total of seven colonies of *Poc. meandrina* (diameters 1 to 20 cm) were encountered in the survey areas (Fig. 3). Most are small colonies (1 to 5 cm) and occur in Area C; one colony (diameter 11 to 20 cm) was observed in Area E. No *Poc. meandrina* colonies were observed in Areas D, F, or G. *Poc. damicornis* colonies within the survey areas are small (1 to 5 cm, and one colony in 6 to 10 cm class; Fig. 4). Mechanical damage to *Poc. meandrina* and *Poc. damicornis* colonies was particularly evident in Area C.

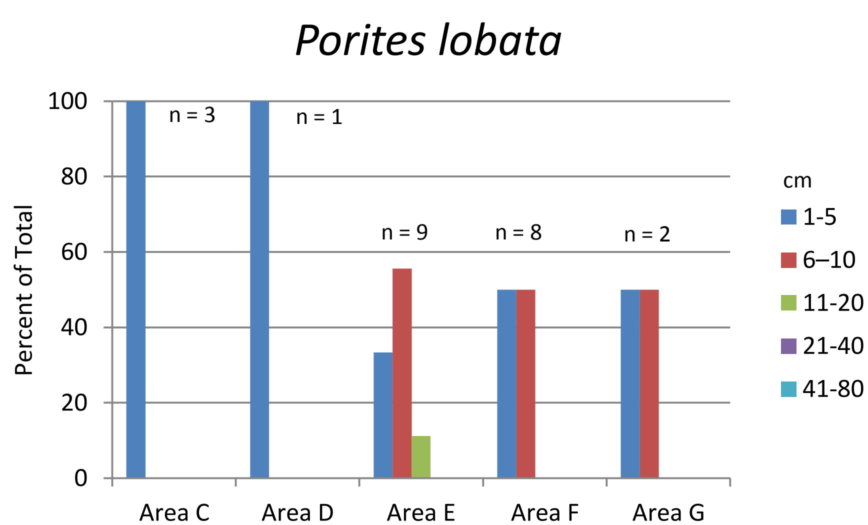

Figure 1. *Porites lobata* size class distribution for Natatorium exterior surveyed areas.

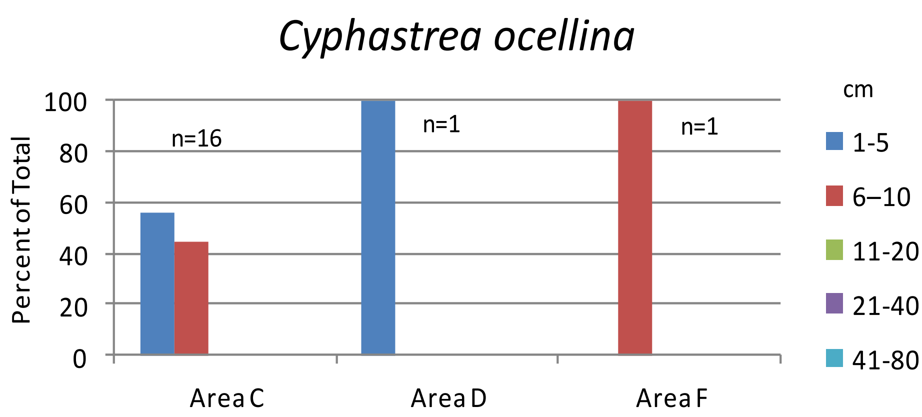

Figure 2. *Cyphastrea ocellina* size class distribution for Natatorium exterior surveyed areas.

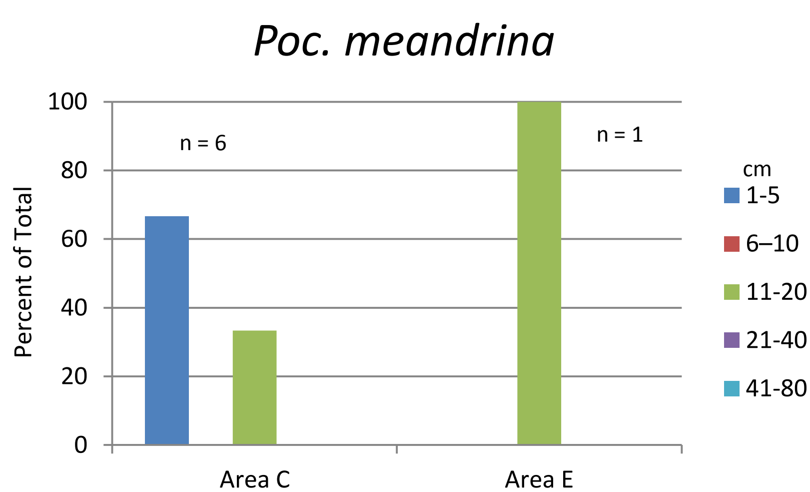

Figure 3. *Poc. meandrina* size class distribution for Natatorium exterior surveyed areas.

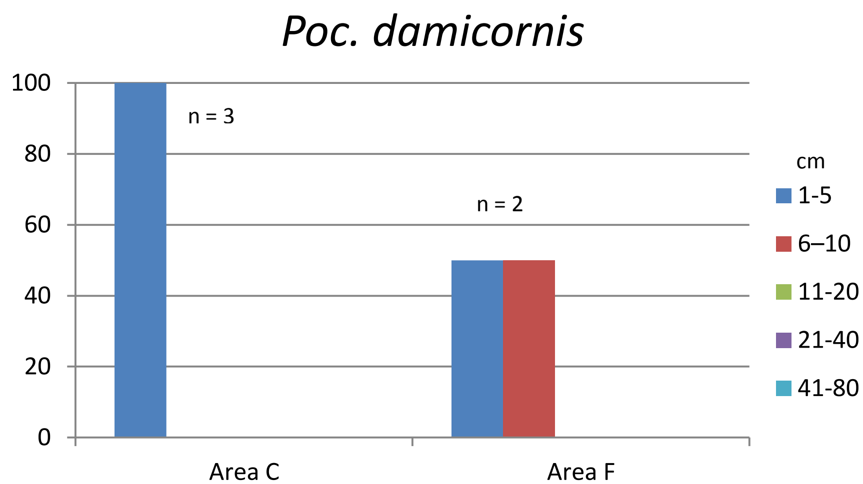

Figure 4. *Poc. damicornis* size class distribution for Natatorium exterior surveyed areas.

<u>Pipeline Corridor</u> — *P. lobata* is the most common coral species encountered in the pipeline corridor, with a total of 46 colonies observed. Figure 5 presents size class distribution for *P. lobata* in the pipeline corridor. Most are small colonies (1 to 5 cm in diameter) and found in segment P2 (mid-channel). Colonies in this segment, and in segment P1, have a broad range of sizes. No *P. lobata* colonies >40 cm in diameter were found in the surveyed areas. A total of 22 colonies of *Poc. meandrina* was encountered in the survey areas. Most are of the two smallest (1 to 5 cm and 6 to 11 cm) size classes and found in P5 (furthest offshore: Fig. 6). None were found in the P1 (nearshore segment). Once colony (diameter 41 to 80 cm) was found in P5. A total of ten small (diameters 1 to 10 cm) colonies of *Poc. damicornis* were encountered in the survey areas (Fig. 7). Figure 8 presents sixe class distribution for *M. capitata* in the pipeline corridor. Three colonies were found in P2; two colonies (diameter 11 to 20 cm) and three small (diameters 1 to 5 cm) were found in P5. One colony (diameters 6 to 10 cm) was observed in P1 (Fig. 9).

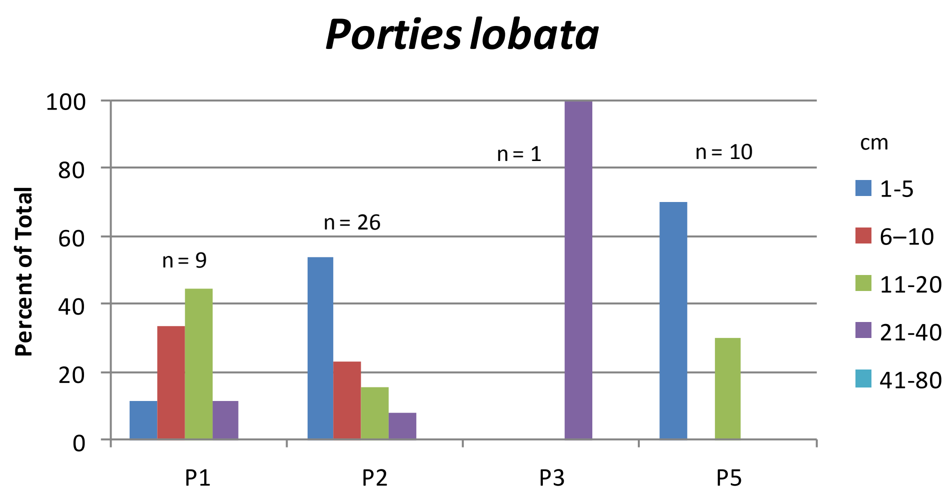

Figure 5. *Porites lobata* size class distribution for Pipeline corridor surveyed areas.

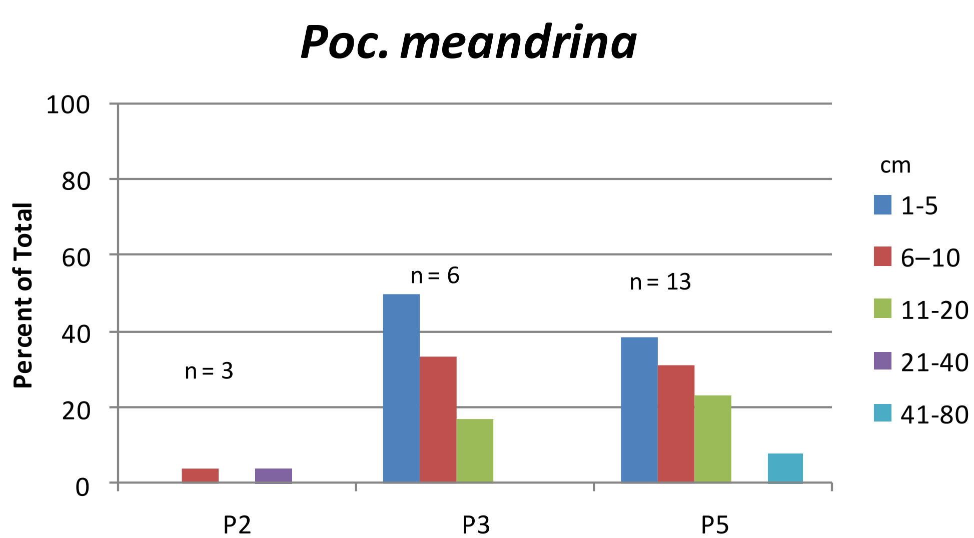

Figure 6. *Pocillopora meandrina* size class distribution for Pipeline corridor surveyed areas.

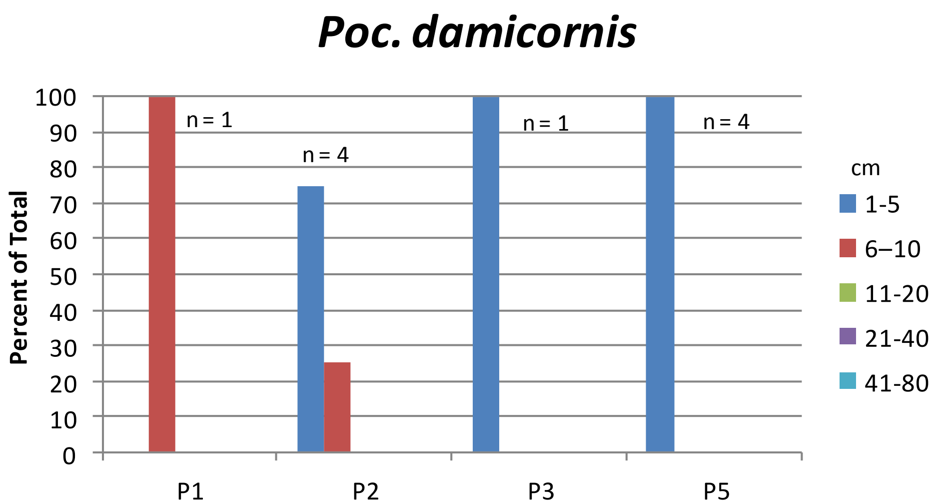

Figure 7. *Pocillopora damicornis a* size class distribution for Pipeline corridor surveyed areas.

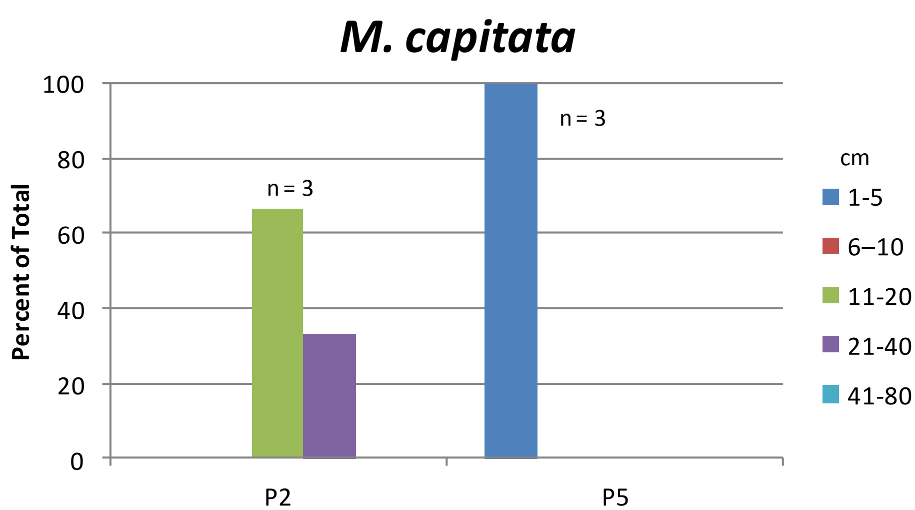

Figure 8. *Montipora capitata* size class distribution for Pipeline corridor surveyed areas.

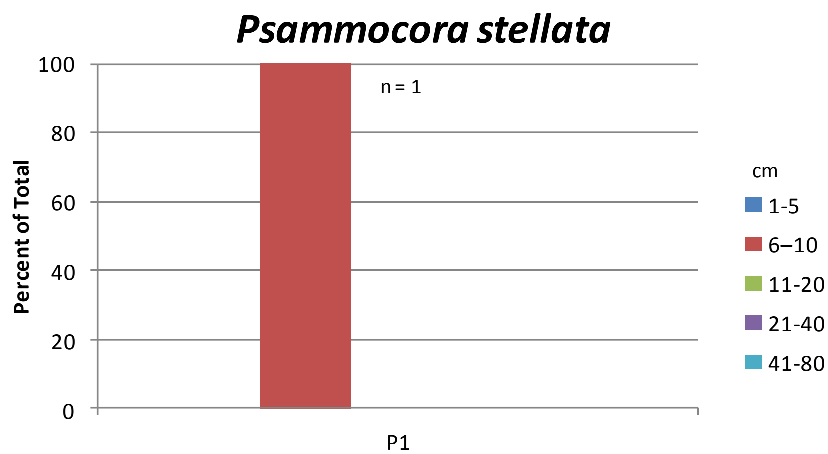

Figure 9. *Psammocora stellata* size class distribution for Pipeline corridor surveyed areas.

Macro-Invertebrate Assemblages

Natatorium Exterior — Tables 1 through 5 present the results of macro-invertebrate density surveys in each of the Natatorium exterior surveyed areas. Macro-invertebrate densities in Area C (on the exterior pool walls) is high, totaling 22.8/m^2 (Table 1) and comprising mostly rock boring urchins (*Echinometra mathaei*). One banded, non-boring urchin (*Echinothrix calamaris*) was encountered in the survey in Area C. Invertebrate composition and density on one transect in Area C varied considerably from the other three transects in the area, especially with respect to urchins. This transect occurred on the east side of the pool and may be sheltered from wave action.

Macro-invertebrates are nearly absent from the area adjacent to the pool walls in Area D; none observed in one of four transects. This transect was over sand bottom, providing much different habitats than the fleshy algae and limestone substratum associated with the other three transects in Area D. A small congregation of Hawaiian mussels (*Brachiodontes crebristriatus*) was encountered in one transect, resulting in average densities of 0.6/m^2 for Area D. Similar to Area D, areas E and F have low invertebrate densities. In all three areas, the bottom is covered predominantly by fleshy algae, with minimal limestone substrate visible. Macro-invertebrates observed in Area F are bivalves (*B. crebristriatus*, *Isogonoma perna,* and pteriid oyster) and urchins with average densities of 2.1/m^2 and 1.2/m^2, respectively (Table 4). Area G

(Table 5) had low invertebrate densities, with bivalves (*I. perna* and pteriid oyster) most abundant (average density of 0.6/m^2).

Table 1. Macro-invertebrate densities (per m^2) in 4 transects within Area C.

	Shelled Gastropods	**Bivalves**	**Shrimp,Crab & Hermits**	**Urchins**
	Conus, Morula & *Siphonaria* sp.	Unidentified sp.	Decapoda	(*E. mathaei, E. oblonga* & *Echinothrix calamaris*)
C-1	0.1	0	0.1	13.3
C-2	0.2	0.2	0	12.3
C-3	0	0	0	62.5
C-4	0.5	0.3	0.2	2.0
mean	0.2	0.1	<0.1	22.5
st. dev	±1.1	±0.5	±0.2	±26.8
min	0	0	0	0
max	0.5	0.3	0.1	9.2

Table 2. Macro-invertebrate densities (per m$^{2)}$ in 4 transects within Area D.

	Zoanthidae	**Shelled Gastropods**	**Bivalvia**	**Shrimp, Crab & Hermits**	**Urchins**
	(*Zoanthus* sp.)	(*Morula* & *Conus*)	(*B.crebist.*, Pteriidae, *I. perna*)	(*C.barradaiei*)	(*E. mathaei* & *E. oblonga*)
D-1	0.1	0.3	2.3	0.1	0
D-2	0	0	0.2	0	0.1
D-3	0	0.1	0	0	2.4
D-4	0	0	0	0	0
mean	<0.1	<0.1	0.6	0.1	<0.1
st. dev.	±0.2	±0.2	±2.0	±0.3	±1.6
min	0	0	0	0	0.3
max	0.1	0.1	1.1	0.2	0.1

Table 3. Macro-invertebrate densities (per m^2) in 4 transects within Area E.

	Shelled Gastropods (*Conus* sp.)	**Bivalvia** (*B.crebist.*)	**Shrimp** (*C.borradaiei*)	**Ophiuroidea**	**Urchins** (*E. mathaei*)	**Holothuridae** (*H. atra*)
E-1	0	0	0.1	0.1	0.1	0.1
E-2	0.1	0.1	0	0.1	0.2	0
E-3	0.1	0.1	0	0.1	0.2	0
E-4	0	0.7	0	0.1	1.0	0
mean	<0.1	0.2	0.1	0.1	0.4	<0.1
st. dev.	±0.2	±0.7	±0.4	±0.3	±0.8	±0.2
min	0	0	0	0	0	0
max	0.1	0.3	0.2	0.1	0.4	0.1

Table 4. Macro-invertebrate densities (per m2) in four transects within Area F.

	Porifera	**Bivalvia** (*B.crebist., I. perna* & Pteriidae)	**Shelled Gastropods** (*Conus* sp.)	**Urchins** (*E. mathaei* & *E. oblonga*)	**Holothuridae** (*H. atra*)
F-1	0	3.8	0	0.8	0
F-2	0	2.7	0	0.6	0.1
F-3	0.1	0.2	0.1	0.5	0
F-4	0	2.0	0.1	3.3	0
mean	<0.1	2.1	0.1	1.2	<0.1
st. dev.	±0.2	±3.8	±0.2	±2.1	±0.2
min	0	0	0	0	0
max	0.1	2.0	0.1	0.9	0.1

Table 5. Macro-invertebrate densities (per m^{2}) in four transects within Area G.

	Zoanthidae	Annelida	Bivalvia (*I. perna* & *Pteriidae*)	Shrimp & Hermit crabs (*C. borradaiei*)	Holothuridae (*H. pervicax*)
G-1	0	0	0	0	0.2
G-2	0	0	0	0	0.2
G-3	0	0.3	0	0	0.2
G-4	0.1	0	2.3	0.2	0
mean	<0.1	0.1	0.6	0.1	0.2
st. dev.	±0.2	±0.47	±2.0	±0.2	±0.5
min	0	0	0	0	0
max	0.1	0.3	1.1	0.2	0.2

Pipeline Corridor — Tables 6 through 9 present the results of macro-invertebrate density surveys in each of the pipeline corridor surveyed areas. Macro-invertebrate densities in Area C (on the exterior pool walls) is high, totaling 22.8/m^2 (Table 1) and comprising mostly rock boring urchins (*Echinometra mathaei*). One banded, non-boring urchin (*Echinothrix calamaris*) was encountered in the survey in Area C. Invertebrate composition and density on one transect in Area C varied considerably from the other three transects in the area, especially with respect to urchins. This transect occurred on the east side of the pool and may be sheltered from wave action.

Macro-invertebrates are nearly absent from the area adjacent to the pool walls in Area D; none observed in one of four transects. This transect was over sand bottom, providing much different habitats than the fleshy algae and limestone substratum associated with the other three transects in Area D. A small congregation of Hawaiian mussels (*Brachiodontes crebristriatus*) was encountered in one transect, resulting in average densities of 0.6/m^2 for Area D. Similar to Area D, areas E and F have low invertebrate densities. In all three areas, the bottom is covered predominantly by fleshy algae, with minimal limestone substrate visible. Macro-invertebrates observed in Area F are bivalves (*B. crebristriatus*, *Isogonoma perna,* and pteriid oyster) and urchins with average densities of 2.1/m^2 and 1.2/m^2, respectively (Table 4). Area G

Table 6. Macro-invertebrate densities (per m$^{2)}$ in three transects withinP1.

	Shrimp,Crab & Hermits Decapoda	**Urchins** (*E. mathaei*)
P1-1	0	0
P1-2	<0.1	0
P1-3	<0.10	<0.1
mean	<0.1	<0.1
st. dev	±0.2	±0.2
min	0	0
max	0.1	0.1

Table 7. Macro-invertebrate densities (per m$^{2)}$ in three transects within P2.

	Shelled Gastropods (*Conus* sp. & *Morula* sp.)	**Serpulidae**	**Zooanthidae**	**Ophiuroidea**	**Urchins** (*E. mathaei* & *E. calamari*)	**Holothuridae** (*H. atra*)
P2-1	0.3	0.1	0	0.2	0.3	0.1
P2-2	0.1	0	0	0.1	1.1	0
P2-3	0	0	<0.1	0	1.9	<0.1
mean	0.1	<0.1	,0.1	0.1	1.1	<0.1
st. dev.	±0.3	±0.2	±0.2	±0.3	±1.8	±0.2
min	0	0	0	0	0	0
max	0.1	0.1	0.1	0.1	0.7	0.1

Table 8. Macro-invertebrate densities (per m2) in two transects within P3.

	Shelled Gastropods *Morula* sp.	Urchins (*E. mathaei & E. calamaris*)
P1-1	<0.1	1
P1-2	<0.1	0.6
mean	<0.1	0.9
st. dev	±0.3	±1.1
min	0	0
max	0.1	0.5

Table 9. Macro-invertebrate densities (per m2) in two transects within P5.

	Shrimp,Crab & Hermits Decapoda	Urchins (*E. mathaei, E. calamaris & T. gratilla*)
P5-1	<0.1	0.4
P5-2	0	0
mean	<0.1	0.2
st. dev	±0.2	±0.5
min	0	0
max	0.1	0.2

Fish Assemblages

Natatorium Exterior— A total of 32 species of fishes were identified in the survey areas. *Thalassoma duperrey* (saddle wrasse) is the most abundant species and is nearly ubiquitous on the reef flat. *Acanthurus triostegus* (*manini*) is also abundant in small schools feeding on benthic algae. Schools of juvenile parrotfish (Family Scaridae) are common in areas adjacent to the exterior walls (Area C) and over the shallow reef flat of Area E. *Abudefduf sordidus* (black-spot sergeant), *Abudefdef abdominalis* (*mamo*), and *Canthigaster jactator* (Hawaiian whitespotted toby) are common throughout the survey areas. *Moa*, *Ostracion meleagris* (spotted boxfish), *Mulloidichthys flavolineatus* (bandtail goatfish), *Stethojulis balteata* (belted wrasse), *Thalassoma trilobatum* (Christmas wrasse), *Chelio inermis* (cigar wrasse), *Zanclus cornutus* (Morrish idol), *Acanthurus* *nigrofuscus* (brown surgeonfish), *Acanthurus blochii* (ringtail surgeonfish), and *Rhinecanthus rectangulus* (reef triggerfish) are encountered occasionally throughout the survey areas. Uncommonly seen species include *Upeneus arge* (bandtail goatfish), *Parupeneus multifasciatus* (manybar goatfish), *Stegastes fasciolatus* (Pacific gregory), *Scarus psittacus* (juv. palenose parrotfish), *Selar crumenophthalmus* (*akule*), and *Kuhlia xenura* (*āholehole*). *Echnidna nebulosa* (snowflake moray) *awa* (milkfish), *Aulostomus chinensis* (trumpetfish), and *Synodus ulae* (Hawaiian lizardfish), *Dascyllus albisella* (Hawaiian dascyllus), and *Naso unicornis* (bluespine unicornfish) are all rare fishes in the survey areas.

Pipeline Corridor —A total of 27 species of fishes were identified in the pipeline corridor survey areas. *T. duperrey* (saddle wrasse) is the most abundant species in the pipeline corridor surveyed areas. Aggregations of *Chromis vanderbilti* (blackfin chromis) are often seen hovering above branching coral colonies, feeding upon zooplankton. *Stethojulis balteata* (belted wrasse) and *Acanthurus nigrofuscus* (brown surgeonfish) are encountered occasionally throughout the survey areas. *Acanthurus blochii* (ringtail surgeonfish), *Bothus mancus* (flowery flounder), *Cantherhines sandwichiensis* (squaretail filefish), *Canthigaster amboinensis* (ambon toby), *C. jactator* (Hawaiian whitespotted toby), *Caracanthus typicus* (Hawaiian velvetfish), *Dendrochirus barberi* (Hawaiian lionfish), *Gomphosus varius* (bird wrasse), *Ostracion meleagris* (spotted boxfish), *Parupeneus multifasciatus* (manybar goatfish), *Plectroglyphidodon imparipennis* (brighteye damselfish), *Rhinecanthus rectangulus* (*humuhumunukunukuāpuaʻa*), *Sebastapistes coriorta* (speckled scorpionfish), *Stegastes fasciolatus* (Hawaiian gregory), *Thalassoma trilobatum* (Christmas wrasse), *Tylosurus acus* (crocodile needlefish), *Gymnothorax eurostus* (stout moray eel), *Scomberoides lysan* (*lai*), *Zanculus cornutus* (Moorish idol), *Coris gaimard* (yellowtail coris), are all rare fishes in the survey areas.

Fish Biomass

Natatorium Exterior — Table 13 lists the number of species encountered and biomass estimates for each of the seven survey areas. The mean biomass for small fishes (<25 cm) is 86 kg/ha. Small fish biomass estimates in Area C (134 kg/ha) and Area E (161 kg/ha) are considerably greater than the mean for the other survey areas. These two areas also has a greater number of species (9 and 12 species per transect, respectively) than the mean for all survey areas (8 species per transect). Fish biomass estimates in areas D and H (31 kg/ha and 39 kg/ha, respectively) are nearly 2 times smaller than the mean for the combined areas.

The mean biomass for large fishes (>25 cm) is 62 kg/ha. In Area F, large-fish biomass estimate is 311 kg/ha, over 3 times the mean biomass for all survey areas. In Area G, biomass estimate of 81 kg/ha is almost 1.5 times the mean biomass. The area between Area G and Area F is a dredged channel that runs parallel to the shoreline. Both areas surveyed the reef flat as well as the cross-sectional edge of the channel. The substratum of the channel is a mix of coral rubble from the reef flat, basalt stones and sand. The channel margin is an area of topographic complexity that supports larger fishes. The mean biomass estimates of Area F and G reflect this topographic relief and suitability for large fishes. Only one large fish was observed in Area E and no large fish were encountered in Area D.

The overall total mean biomass for all fishes encountered in the seven survey areas is 149 kg/ha. High total fish biomass is observed in Areas F and G. The vertical relief provided by the narrow channel margin is likely to account for the higher biomass, as this area could encourage the presence of fish populations, as described above.

Table 13. Number of species and fish biomass from areas surveyed in February 2011.

Location	Total No. of Species	Fish Biomass (<25cm; kg/ha)	Fish Biomass (>25cm; kg/ha)	Total Fish Biomass (kg/ha)
Area C	9	135	44	178
Area D	2	31	0	31
Area E	12	161	3	164
Area F	8	94	216	311
Area G	7	58	81	139
Area H	7	39	28	67
Mean	*8*	*86*	*62*	*149*

Pipeline Corridor — Table 14 lists the number of species encountered and biomass estimates for each of the four survey areas. The mean biomass for small fishes (<25 cm) is 58 kg/ha. Small fish biomass estimate at Sta. 2-1 (132 kg/ha) is nearly four times greater than the mean for all other stations combined. Eleven individual wrasses accounted for over half of the small fish biomass at Sta. 2-1. Sta. 5-1 had 41 individuals of 10 different species, though the most common fish was the very small (5 cm) *Chromis vanderbilti.* The entire biomass at Sta. 3-1 was composed of a single mid-sized *Rhinecanthus* *rectangulus*. The mean biomass for large fishes (>25 cm) is 11 kg/ha, composed entirely of a single large fish (*Scomberoides lysan* or *lai*) observed at Sta. 2-1.

The overall total mean biomass for all fishes encountered in the four survey areas is 24 kg/ha. Highest total fish biomass is observed at Sta. 2-1.

Table 14. Number of species and fish biomass from pipeline corridor surveyed areas, April 2012.

Station	**Total No. of Species**	**Fish Biomass (<25cm; kg/ha)**	**Fish Biomass (>25cm; kg/ha)**	**Total Fish Biomass (kg/ha)**
1-1	4	26	0	26
2-1	10	69	23	92
p3-1	1	11	0	11
p5-1	10	15	0	15
Mean	*6*	*30*	*6*	*36*

Appendix G:
Archaeological Inventory Survey

Pacific Legacy

Historic Preservation

DRAFT

**ARCHAEOLOGICAL INVENTORY SURVEY
AT THE
WAIKĪKĪ WAR MEMORIAL COMPLEX,
AHUPUA‘A OF WAIKĪKĪ, KONA DISTRICT,
ISLAND OF O‘AHU, HAWAI‘I**

[TMK (1) 3-1-031]

Pacific Legacy: Exploring the past, informing the present, enriching the future.

CULTURAL RESOURCES CONSULTANTS

Hawai‘i Offices:
Kailua, O‘ahu
Hilo, Hawai‘i

California Offices:
Arnold
Berkeley
El Dorado Hills
Lancaster

DRAFT

ARCHAEOLOGICAL INVENTORY SURVEY AT THE WAIKĪKĪ WAR MEMORIAL COMPLEX, AHUPUAʻA OF WAIKĪKĪ, KONA DISTRICT, ISLAND OF OʻAHU, HAWAIʻI

[TMK (1) 3-1-031]

Prepared by:
James McIntosh, B.A.
and
Paul L. Cleghorn, Ph.D.

Pacific Legacy, Inc.
30 Aulike Street, Suite 301
Kailua, HI 96734
(808) 263-4800

Prepared for:
WCP, Inc.
99-061 Koaha Way,
Aiea, HI 96701

October 2018

ABSTRACT

Pacific Legacy Inc., under contract to WCP Inc., conducted an archaeological inventory survey at the Waikīkī War Memorial Complex in the *ahupua*ʻ*a* of Waikīkī, island of Oʻahu, Hawaiʻi [TMK (1) 3-1-031]. Specifically, the project area is situated within Kapiʻolani Beach Park, in the area of Sans Souci Beach. The archaeological investigations were conducted as part of an Environmental Impact Statement for the Waikīkī War Memorial Complex.

During the course of the project two different archaeological testing episodes were conducted: first in 2011 and again in 2018. The second episode was the result of changes to the Project Area boundary and consultations with the State Historic Preservation Division.

In all, 22 shovel test pits and 12 backhoe trenches were excavated during the course of the project. Seven subsurface features were identified within the trenches and a discontinuous cultural layer was also identified. Several traditional artifacts were recovered along with historic vestiges documented throughout the project area. A single marine shell fishhook was identified in Shovel Test Pit 5 (60 cmbs) and an associated charcoal sample returned a date of AD 1460 to 1650. This layer and associated features have been designated as Site 50-80-14-7211.

Further testing was conducted in 2018 to further clarify the boundaries of Site 7211. During this episode, a coral abrader was recovered within STP 15 along with marine shell midden (50 cmbs). This deposit is attributed to the same cultural deposit identified in 2011. This layer and associated features have been designated as Site 50-80-14-7211. No human remains were observed during the subsurface testing.

It is recommended that preservation be undertaken for Site 50-80-14-7211, a significant cultural deposit within the Project Area. In addition, archaeological monitoring is recommended for any excavations within this portion of Kapiʻolani Park deeper than 50 cm below surface.

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Frontispiece: The arch of the War Memorial Waikīkī (2011).

1.0 INTRODUCTION

Pacific Legacy Inc., under contract to WCP, Inc., conducted an archaeological inventory survey (AIS) at the Waikīkī War Memorial Complex (WWMC) in the *ahupuaʻa* of Waikīkī, island of Oʻahu, Hawaiʻi. (TMK: (1) 3-1-31). Specifically, the project area is situated within Kapiʻolani Beach Park, in the area located *makai* of Kalākaua Avenue often referred to as Sans Souci Beach (Figure 1). The archaeological investigations were conducted as part of an Environmental Impact Statement (EIS) (in prep.) for the WWMC. The boundary of the Project Area is shown in Figure 2.

1.1 BACKGROUND

Officially opened on 24 August 1927, the Waikīkī War Memorial Natatorium was constructed as "a memorial dedicated to the men and women of Hawaiʻi who served in World War I" (NRHP Nomination Form 1980) (Appendix A). The open air salt-water swimming pool measures 100 meters in length and is fed directly from the ocean. A series of concrete bleachers overlook the pool and could seat ca. 2,500 spectators. The main entry into the Natatorium is via a large triumphal arch inscribed with the words "The War Memorial" (see frontispiece). Constructed at a cost of $250,000.00 maintenance was a constant problem at the structure, which has undergone several facelifts over the years. Many of the main decks around the pool have collapsed and have become a danger to the general public. The Natatorium was last opened to the public in 1978 and has been locked and boarded up since, because of its deteriorating condition and danger to the public.

Today, the "War Memorial Natatorium" is on the State of Hawaiʻi as site 50-80-14-9701 and the National Register of Historic Places (NRIS No. 80001283).

1.2 PROJECT HISTORY

In 2009, the City and County of Honolulu looked into proposed changes for the WWMC. During the process, it was determined that the preferred course of action was to:

> *create a war memorial beach between constructed groins, fronted by a replica memorial arch in alignment with the existing Roll of Honor plaque and hau tree arbor. The entire Natatorium structure – everything built seaward of the 1927 shoreline – would be removed. This alternative – removal of the Natatorium and creation of a new beach – was the recommendation made to the City and County of Honolulu by the Task Force in September 2009.*

In support of this proposed action, Pacific Legacy, Inc. conducted archaeological testing in the proposed Project Area for this alternative (the current Alternative 2: War Memorial Beach alternative). Archaeological subsurface testing was conducted on two different occasions. Initial testing was conducted between August 29 and September 2, 2011, 10 shovel test pits (STPs) and 12 backhoe trenches were excavated within the then Project Area.

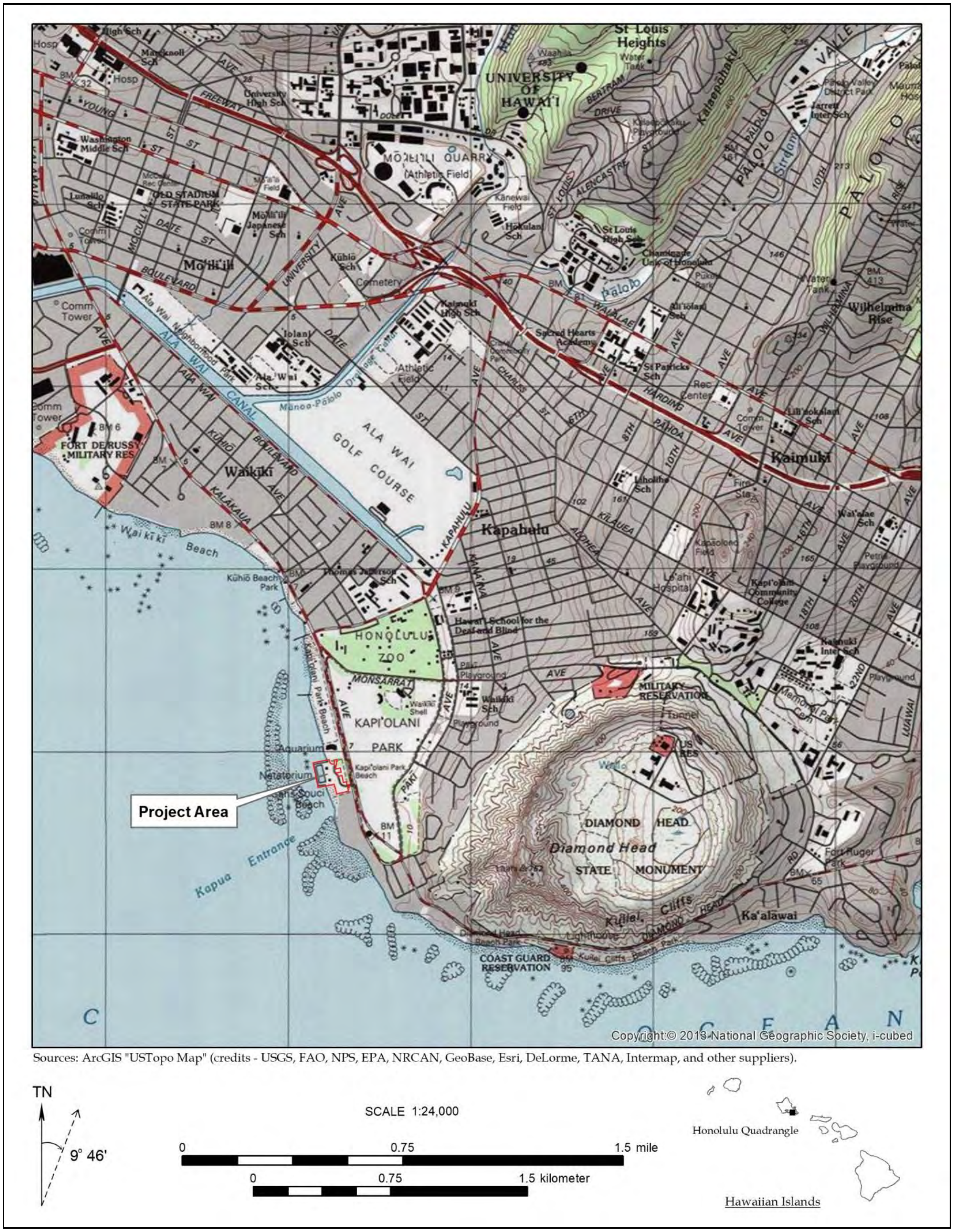


Figure 1 Project location depicted on National Geographic TOPO map.

Figure 2. Project area boundary.

Subsequently, through consultations with the State Historic Preservation Division and changes to the preferred alternative and an adjustment to the Project Area, additional archaeological testing was warranted. As a result, Pacific Legacy, Inc., undertook additional testing within the revised and current Project Area in August 2018. The results of both of the testing episodes are presented within the AIS.

1.3 Environment

The WWMC is located on the south shore within Kapiʻolani Park, on the island of Oʻahu. Located just to the east of Waikīkī proper, the park serves as a major outdoor venue for events, activities and recreational sports.

This area of Waikīkī receives less than 20 inches of rainfall annually (Juvik and Juvik 1998: 56) with the dominant trade winds coming from the northeast. Vegetation within Kapiʻolani Park is ornamental in nature and consists of ironwood trees (*Casuarina equisetifolia*) coconut trees (*Cocos nucifera*), *hau* (*Hibiscus tiliaceus*), *milo* trees (*Thespesia populnea*), banyan trees (*Ficus benghalensis*), shower trees (*Cassia*) and various shrubs and grasses.

Soils within the project area are derived from two sources: Jaucas Series and Beaches.

Jaucas Series

> Jaucas series consists of excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean…They develop in wind- and water deposited sand from coral and seashells (Foote et al 1972: 48).

Beaches

> Beaches occur as sandy, gravelly, or cobbly areas on all islands…They are washed and rewashed by ocean waves. The beaches consist mainly of light-colored sands derived from coral and seashells (Foote et al. 1972: 28).

1.4 Environmental Impact Statement Alternatives

Presented below are four brief summaries of project alternatives from the EIS for the WWMC. The archaeological testing discussed in this report addresses the needs of the alternatives, especially Alternative 1 (Perimeter Deck) and Alternative 2 (War Memorial Beach). For more details or specific information regarding these alternatives, the reader is referred to the EIS for the WWMC.

Alternative 1 - Perimeter Deck

The Perimeter Deck is illustrated in Figure 3. This alternative would retain the bleachers and arches, and rehabilitate the deck around the Natatorium, while removing the less visible submerged structures (such as the makai and ʻEwa seawalls) which block the free flow of water between the swim basin and open ocean. This alternative would expose the entire pool to the coastal waters. The Perimeter Deck would result in the demolition of the makai and ʻEwa side seawalls of the swim basin and reconstruction of the deck on support piles, allowing for the free flow of water between the ocean and a swim basin area. The shape, configuration, and size of the decking would be retained, resulting in the structure's appearance emulating the original facility when seen from above. The Diamond Head groin would remain and be structurally improved to ensure the retention of Kaimana Beach. The bleachers arch, and other existing elements of the Natatorium structure would also remain and be restored to their historic appearance.

The Perimeter Deck proposes minimal land-side improvements. Existing land-side conditions including landscaping, parking, access, and drainage would remain as they currently exist at the site. Construction of a new paved walkway that extends the existing Kapiʻolani Regional Park shoreline promenade to Kaimana Beach. The promenade currently ends near the boundary between the Waikīkī Aquarium and the project site. Restore level surface leading to the Roll of Honor plaque (limited to universal access).

Alternative 2 - War Memorial Beach

The War Memorial Beach is illustrated in Figure 4. This alternative would create a beach between constructed groins, fronted by a replica memorial arch in alignment with the existing Roll of Honor plaque and hau tree arbor. The entire Natatorium structure, i.e., everything built seaward of the 1927 shoreline, would be removed. Various landside improvements would also be undertaken. As noted, this alternative (removal of the Natatorium and creation of a new beach) was the recommendation made to the City by the Task Force in September 2009 and corresponds to the City's "proposed action" at the time of the 2014 FEA-EISPN. The 2011 archaeological investigations were focused on this alternative.

The War Memorial Beach alternative would relocate the memorial arch, demolish other elements of the Complex, and construct a public beach and lagoon in place of the existing saltwater pool. This alternative would use portions of the existing seawall combined with new rock, concrete walls and groins to create a protected beach and swimming area within the Natatorium footprint that would remain stable while still providing for active flushing of the water. The existing hau trees, trellises, coconut trees, and three large trees on site would be maintained, as well as the exceptional and historic trees along Kalākaua Avenue. Additional plantings would conform to a master tree and shrub planting plan. Lawn areas would be rehabilitated and the irrigation systems upgraded and automated.

The War Memorial Beach landside park improvements and changes include:
Construction of a new bathhouse and outdoor shower facility on City park lands mauka of the Complex. Replacement of the internal road/parallel parking that bisects the site with a consolidated lot at the park's south side. The capacity of the new parking lot would be sufficient to retain the same number of stalls (77) currently at the park. The existing curb cut on Kalākaua Avenue would be reused to access the new parking lot.

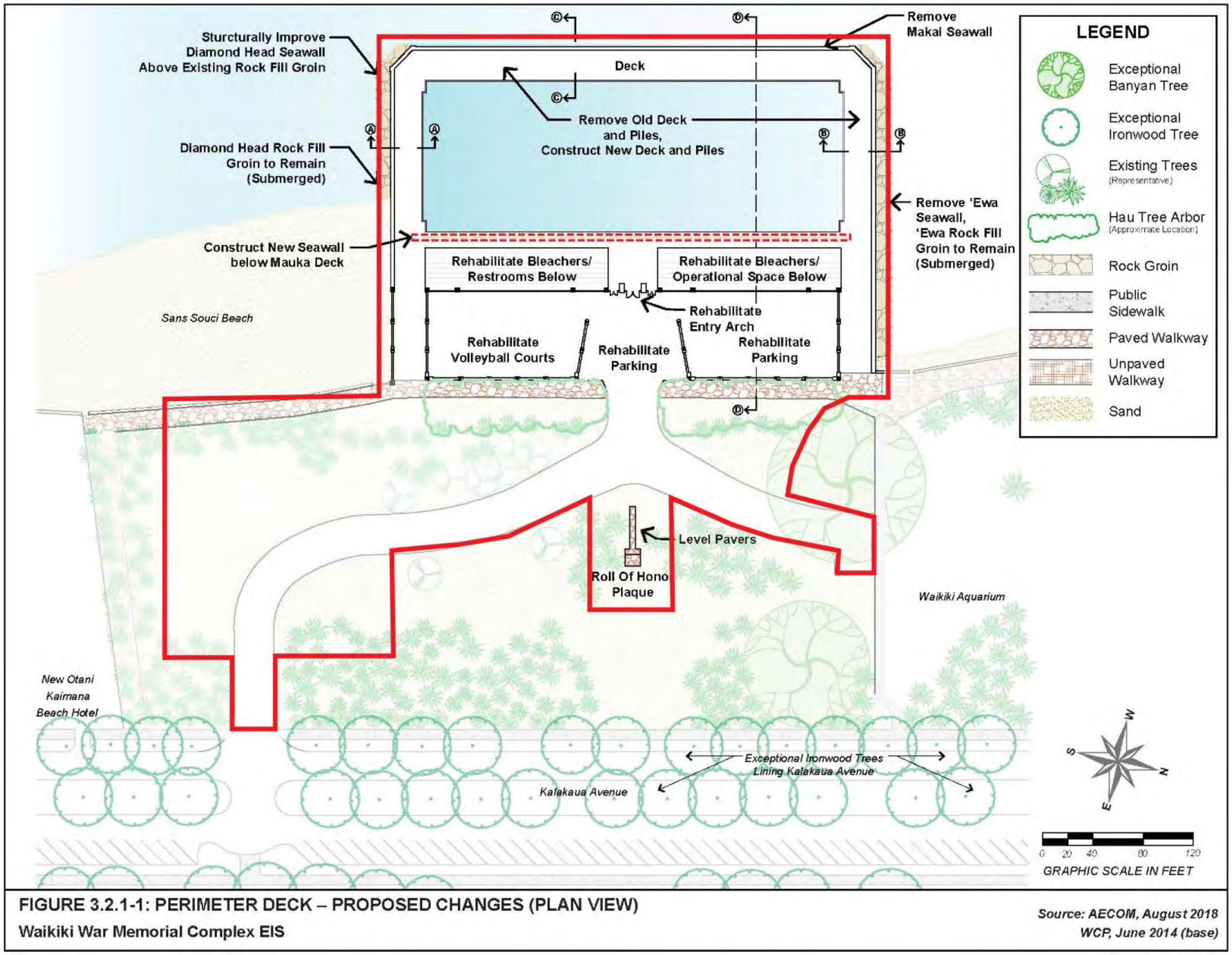


Figure 3. The Perimeter Deck Option.

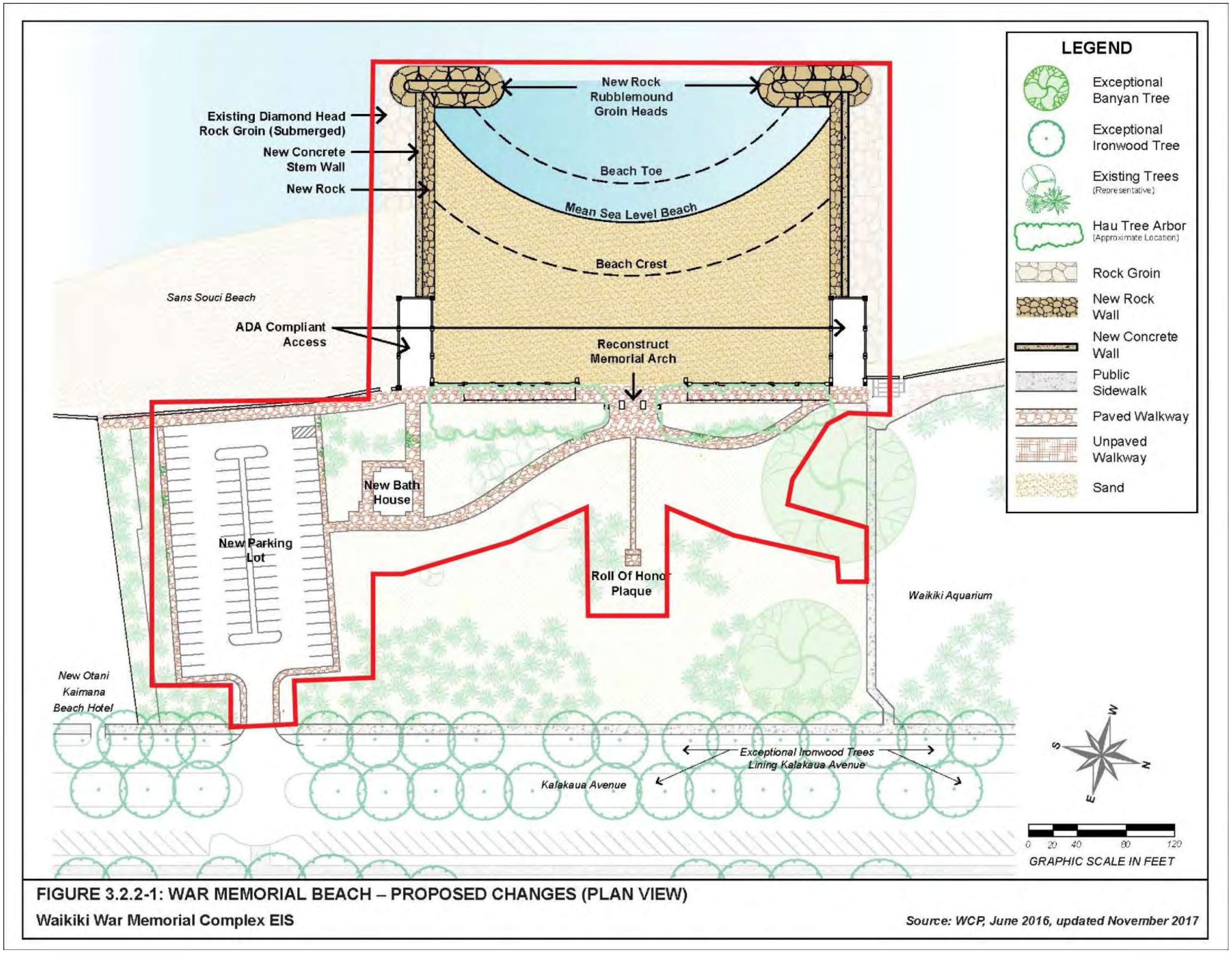


Figure 4. The War Memorial Beach Option.

Alternative 3 - Closed System Pool (previously "Reconstruction and Restoration of the Natatorium")

The intent of the Closed System Pool is to renovate the Complex to its historic character. This alternative involves maintaining the Natatorium structures while constructing a concrete lined fresh water swimming pool in place of the saltwater pool (Figure 5). In addition to the pool, other challenges to the land-side mechanical facilities would need to be considered. The spaces beneath the bleachers may not be able to accommodate the required mechanical equipment, the office space currently used by the Ocean Safety and Lifeguard Services Division office, and the existing restroom facilities. Due to its historic status, and to avoid compromising its historic integrity, a new adjacent building to house the mechanical equipment (e.g., pumps, filters, and surge tanks) would need to be carefully accommodated within the site, likely in the volleyball court area.

Under this alternative, the entire Natatorium structure would be maintained. Presently, the bleacher structure continues to deteriorate, requiring emergency work to remove loose concrete and perform limited patching that allows continued use of the bathroom facilities. A repair project and other improvements would have to be implemented to ensure continued use of the bleacher structure and spaces below. Repair work would include, among other things, waterproofing and new plasterwork for the bleachers, addressing areas that have spalled and cracked, and possible localized reconstruction in targeted areas. Due to the lifecycle costs of continual monitoring and maintenance, the option of reconstructing the bleacher structure, as originally planned, should be explored. This alternative assumes that the bleacher structure would be repaired and would require continual monitoring and maintenance.

The Closed System Pool does not propose any land-side improvements. Existing land-side conditions including landscaping, parking, access, and drainage would remain as they currently exist at the site.

Alternative 4 - No Action

No action represents the baseline conditions for which the action alternatives are evaluated. Under No Action, the WWMC would remain in its current dilapidated condition and the pool and bleachers would remain closed to the public. There would be no change to the land use or facilities that currently exist at the site. This alternative would maintain the status quo and all structures would remain in place and continue to deteriorate.

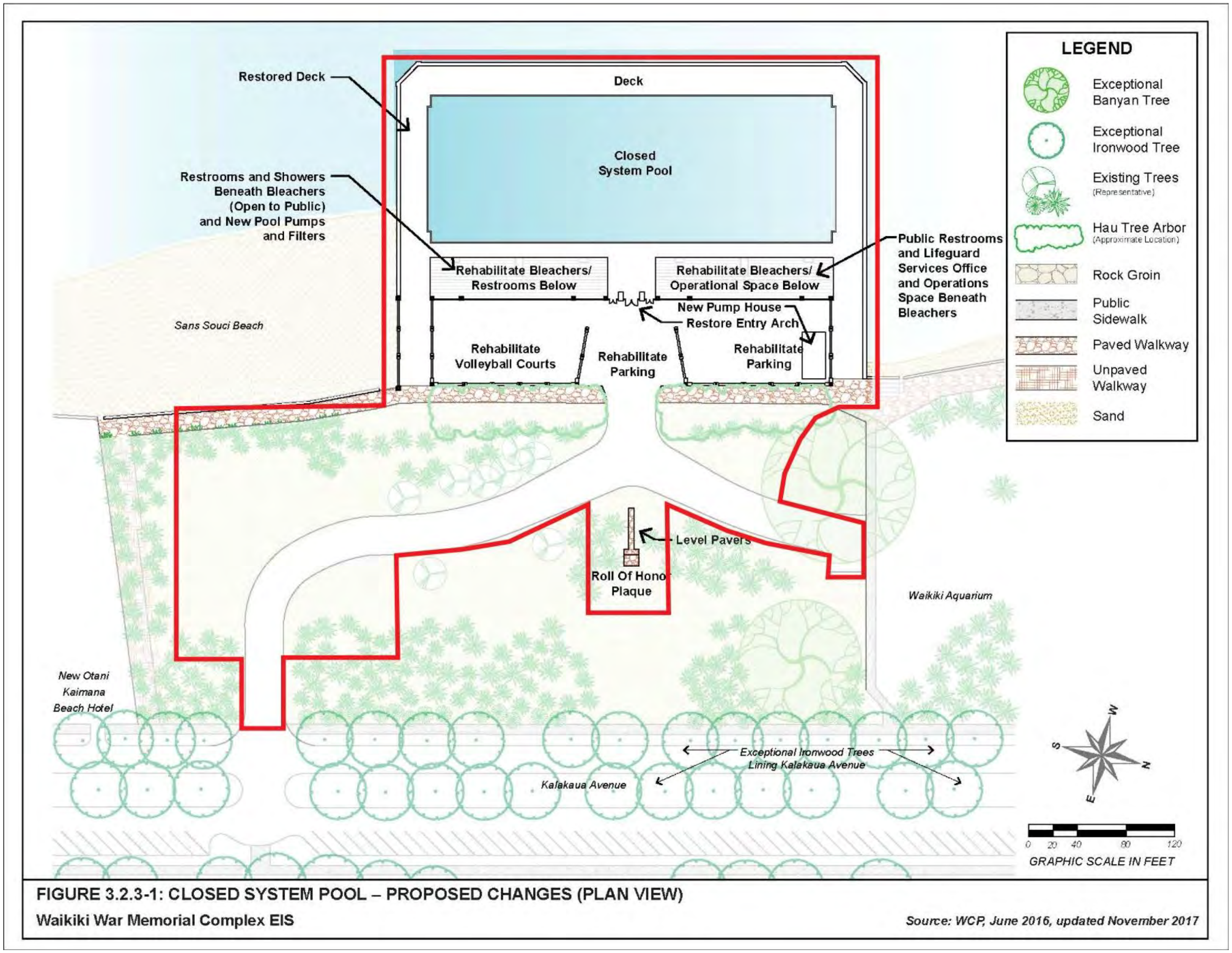


Figure 5. The Closed System Pool Option.

2.0 METHODS

Archaeological subsurface testing was conducted within the Project Area on two different occasions, first in 2011 when a different Project Area was proposed. Subsequently, the Project Area was modified requiring a second period of testing in 2018. The archaeological testing conducted in 2011 consisted of both shovel test pits (STPs) and trench excavations while the 2018 excavations consisted only of STPs. During both testing episodes, the archaeological field investigations were conducted by James McIntosh, B.A. and Caleb C. Fechner, B.A., under the overall direction of Dr. Paul L. Cleghorn, Ph.D.

Archaeological testing was limited to the terrestrial areas of the park and Natatorium. No underwater archaeological investigations were conducted during either testing episode.

2.1 2011 ARCHAEOLOGICAL TESTING

Initial testing was conducted between August 29 and September 2, 2011, 10 STPs and 12 backhoe trenches were excavated within the then Project Area. Prior to trench excavations, the eastern section of the park proposed for new parking stalls and new bath house presented in Alternative #2. This area was first surveyed with Ground Penetrating Radar (GPR) (Figure 6). The GPR was utilized in a large open area of the park to aid in the identification of potentially significant subsurface deposits, specifically human remains and to locate and identify utilities that maybe encountered during trenching. The GPR identified a number of "anomalies" which were interpreted as buried utility lines of miscellaneous metal debris. No "voids" were identified during the GPR. A "void" is interpreted as a feature that might contain human remains.

A total of 12 trenches were excavated using a backhoe. Several factors determined the placement of the trenches: the locations of subsurface utility lines and the request from Kapiʻolani Park personnel to stay a safe distance away from trees to avoid damaging roots. Work areas were secured using moveable barricades and caution tape. Each trench was closely monitored while excavation occurred; soil material was inspected as it was removed from the trenches. Soils were visually screened as they were slowly emptied from the backhoe bucket.

The walls of each trench were cleaned and straightened using a flat nose shovel and trowel in order to better see the soil stratigraphy. The stratigraphy was recorded for each trench. Profiles were drawn of at least one sidewall and all soils were recorded using standard United States Department of Agriculture nomenclature and Munsell Soil Color designations (2000). All trenches were backfilled at the end of each day.

The STPs were placed in two areas within the park where there was a probability of encountering subsurface utility lines or in areas where mechanical excavations would damage trees roots. The STPs were carefully hand excavated with round nosed shovels and all soil was screened through ¼" and ⅛" mesh screen. All soils were recorded using standard United States Department of Agriculture nomenclature and Munsell Soil Color designations (2000).

No profiles were drawn for any of the shovel test units, because the profiles in the STPs were redundant with those recorded in the backhoe trenches.

Figure 6. GPR was used to survey the area prior to the commencement of trenching in 2011.

2.2 2018 Archaeological Testing

After consultations with the State Historic Preservation Division (SHPD) and changes in the Project Area additional subsurface testing was warranted. Further testing was conducted between August 7 and 10, 2018 when an additional 12 STPs were excavated with the purpose of more thoroughly testing within the amended Project Area (Figure 1 and Figure 2). No mechanical testing backhoe testing or GPR was employed during the second series of excavations.

The 12 STPs were excavated by hand and all soil was screened through nested ¼″ and ⅛″ mesh screens. All of the units were excavated to between 85-100 centimeters below surface (cmbs). At that point a hand held auger equipped with a sand head was employed to excavate the remainder of the unit to 160 cmbs. All 12 of the recent STPs were excavated to a total depth 160 cmbs.

All soils were recorded using standard United States Department of Agriculture nomenclature and Munsell Soil Color designations (2000). All STPs were backfilled at the end of the day. No human remains were encountered during testing.

All collected materials (artifacts and midden) were transported to the Pacific Legacy laboratory in Kailua, where they were cleaned, sorted and identified. All material will be curated at this facility. The location of each STP and backhoe trench was recorded with a Trimble GeoXH and processed through ESRI software.

3.0 HISTORIC BACKGROUND

3.1 LAND COMMISSION AWARDS

Private land ownership was introduced into Hawai‘i during the Mahele ‘Āina (the division of Hawaiian lands) of 1848. Crown and *ali‘i* lands were awarded in 1848 and *kuleana* titles were awarded to the general populace in 1850 (Chinen 1958). The awarded lands are called Land Commission Awards (LCA's). In reviewing the LCA's we are also able to determine previous land use within and around the project area. Thus we are able to determine how Native Hawaiians lived and worked in this area of Hawai‘i and possibly indicate how the current project area was traditionally used.

A review of the LCA's for the current project determined that only a single LCA has been awarded in the vicinity of the current project area. LCA 5593:1 was awarded to an individual named Pehu (Figure 7). The land was given to Pehu in 1823 by King Liholiho.

3.2 KAPI‘OLANI PARK

The land comprising Kapi'olani Park was obtained primarily from Crown Lands provided by King David Kalākaua and established the park as a charitable trust in 1896 (Weyeneth 2002: 7). "Kapi‘olani Park was established in Honolulu by a private corporation as a preserve for the few, the rich, and the well-born, but it has developed into a public recreation ground" (Weyenth 1991: 2). The Park was designed by Archibald S. Cleghorn, resident of the nearby family estate of ‘Āinahau and brother-in-law to King Kalākaua and father of Princess Ka'iulani. Cleghorn served as Vice President and later President of the Kapi'olani Park Association.

The appearance and use of the park has undergone many changes throughout its history. The large open space of Kapi'olani Park was used previously as a horse racing track while the ponds and wetlands allowed park goers the opportunity to boat in calm waters.

The Kodak Hula Show began operating on the grass area behind Sans Souci Beach (adjacent to the War Memorial) in 1937. The flat grassy area with the palm trees and ocean background proved to be the perfect location for the hula show that operated on that spot until 1969 when the show was moved to the Waikīkī Shell. In 1992, Kapi‘olani Park was placed on the Hawai‘i Register of Historic Places.

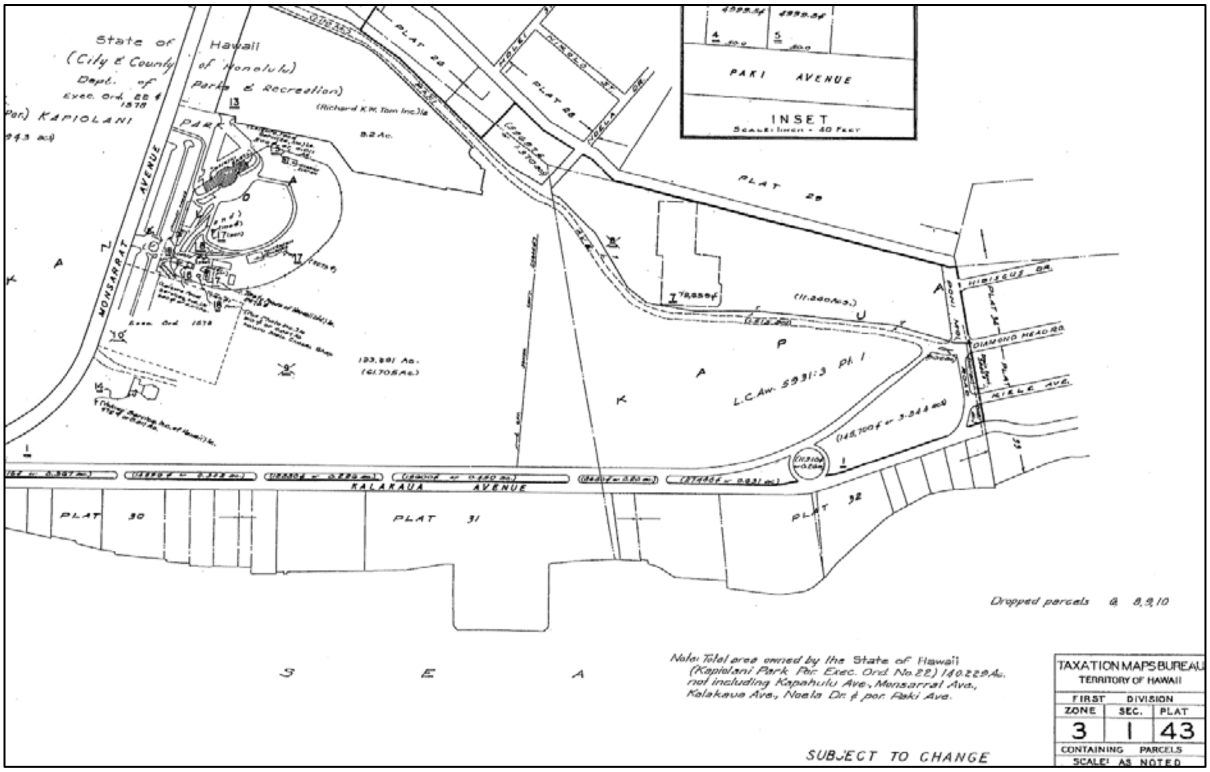
Today the park contains tennis courts, baseball and soccer fields, the Waikīkī Aquarium and much abundant space for the public to enjoy. The significance of Kapi'olani Park was recognized by listing it as a historic property (SIHP No. 50-80-14-9758) in the Hawai‘i Register of Historic Places in 1992.

3.3 WILLIAM G. IRWIN RESIDENCE

In 1899, the renowned architect C. W. Dickey designed a "stately mansion" for the sugar industry magnate William G Irwin (Hibbard and Franzen 1986). The Irwin residence was located on the site of the present War Memorial Natatorium, and was one of the earliest Spanish Mission Revival style house in Hawaiʻi (Figure 8). It featured a verandah that wrapped completely around the house and opened into large airy rooms. The Irwin residence was demolished by 1921 for the construction of the War Memorial Natatorium (War Memorial Natatorium Nation Register of Historic Places nomination form; see Appendix A).

3.4 WAR MEMORIAL NATATORIUM

In 1921, the Hawaiʻi Territorial Legislature authorized the issuance of bonds to raise $250,000 for the construction of a War Memorial Natatorium on the former Irwin property. This memorial was dedicated to the men and women who served in World War I. The Natatorium is a reinforced concrete structure that contains an open air ocean water swimming pool (Figure 9). The pool is surrounded on three sides by 20-foot wide deck, on the *mauka* side, 13 levels of bleachers provide spectator seating. The major architectural feature of the Natatorium is the Beaux-Arts inspired main entry with its triumphal arch flanked by two lesser arches (Frontispiece and Figure 10).



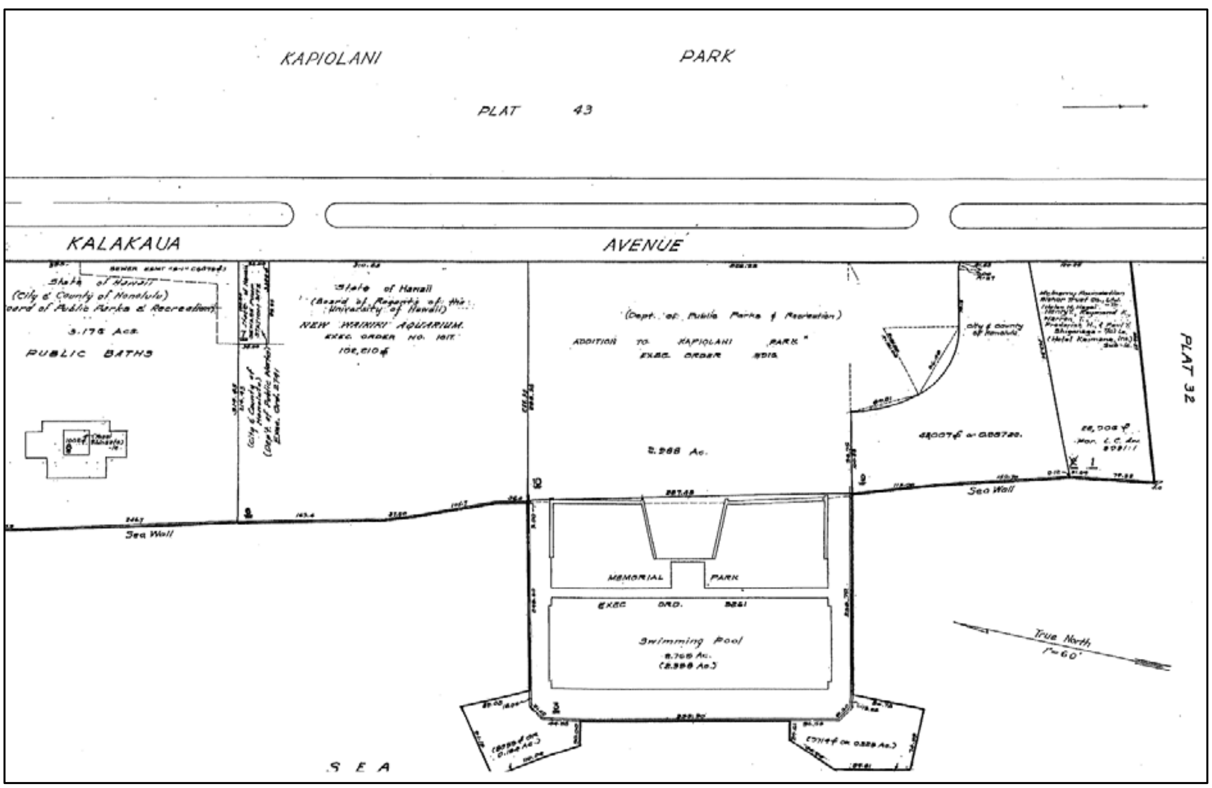


Figure 7. TMK maps showing the project area.

Figure 8. The Irwin Residence (1907) formerly located on the site of the Natatorium (photo from Weyeneth 1991: Plate 16).

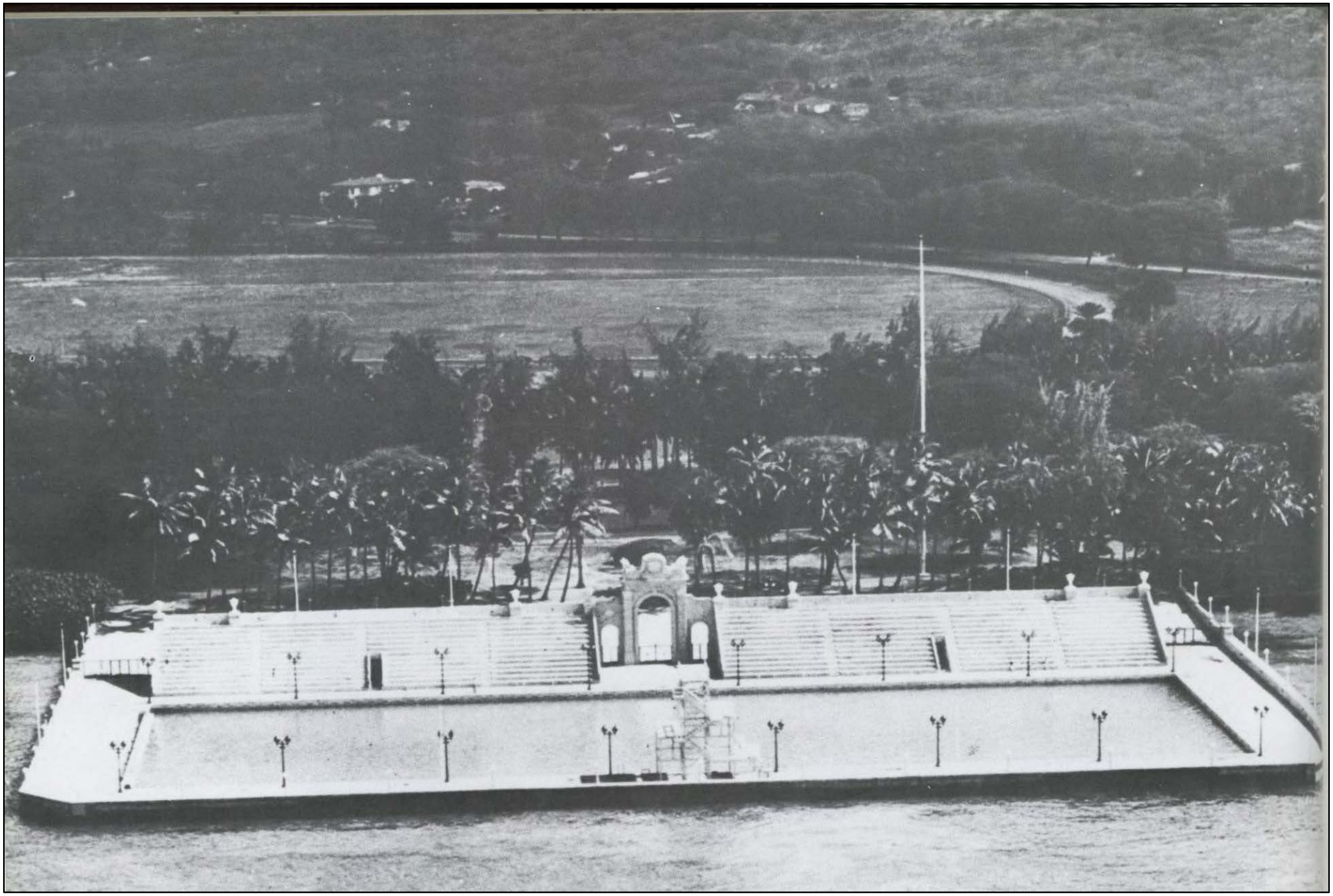


Figure 9. Aerial view of the Natatorium (from Hibbard and Frazen 1986:50).

4.0 PREVIOUS ARCHAEOLOGY

The greater *ahupua*ʻ*a* of Waikīkī has been the location of many archaeological investigations which have resulted in the identification of many buried subsurface archaeological features, sites and human burials (*iwi kūpuna*). The vicinity between the Hilton Hawaiian Village to the west and Kapahulu Avenue to the east contains numerous subsurface features and human burials. According to Mintmier and Collins (2009: 13) "no less than 63 [human burials] were reported between 2000 and 2002 [in Waikiki]."

The Fort DeRussy/Hale Koa Hotel area contains buried fishponds long filled in to reclaim the precious land. Evidence of these ponds has been uncovered during several development projects (Davis 1989, Carlson et al. 1994, Denham and Pantaleo 1997). Also associated with these fishponds are human burials, pits and post holes which is evidence of the intense use of the Waikīkī area in traditional Hawaiʻi.

The current investigations are located on the east end of the Waikīkī *ahupua*ʻ*a* on the far end of Kapiʻolani Park. As a result, the summary of previous archaeological investigations will be focused on the area east of Kapahulu Avenue between the Honolulu Zoo and Diamond Head (see Figure 1).

The first discovery to be treated as an archaeological site is that recorded by N.B. Emerson in 1901. During the 1901 excavation of trenches for the installation of water lines at the home of James B. Castle (near what is today the Elks Club), the remains of at least four individuals were exposed. The individuals were buried in white sands (Jaucus sands). Found with the burials were a variety of goods, including conical whale teeth, large, round, glass beads, and a small *niho-palaoa,* an ornament commonly worn by *ali*ʻ*i*. (Emerson 1902:19).

J.G. McAllister (1933) recorded four *heiau* (temple) in Waikīkī, three in lower Mānoa Valley, and the fourth (*Papa*ʻ*ena*ʻ*ena*) being at the foot of Diamond Head crater.

In April of 2000, Cultural Surveys Hawaiʻi (CSH; Perzinski and Hammatt 2002) conducted archaeological monitoring for excavations associated with the Waikīkī Bandstand and associated ponds. CSH identified a charcoal layer in several areas of the park and recovered a broken basalt stone lamp on the *makai* side of the bandstand.

In early 2001CSH (Perzinski and Hammatt 2001a) conducted archaeological monitoring for a lighting improvement project along Kalākaua Avenue between the Natatorium and Ponimōʻī Road (TMK: [1] 3-1-031, 032 and 043). The monitoring documented a single historic trash pit which yielded glass bottles dating to the early 20th century. Two traditional artifacts (an adze perform and a cowry shell octopus perform) were recovered from a backdirt pile. No traditional cultural deposits or human remains were identified.

Also in April 2001, CSH (Perzinski and Hammatt 2001b) conducted archaeological monitoring for the re-interment facility for the Waikīkī *iwi kūpuna* located on the *mauka* corner of Kalākaua and Kapahulu Avenues fronting the Honolulu Zoo. The excavations did not exceed 60 cm in depth and only a single fragment of bottle glass was identified.

In mid-2001, CSH (Bush et al. 2002) conducted archaeological monitoring for the Queen Surf Promenade improvements located north of the current project area. No traditional or historic artifacts or deposits were uncovered, however, given the presence of burials in the Waikīkī area, archaeological monitoring for any future work was recommended.

Between July 2002 and May 2003, CSH (Bush et al. 2004) conducted archaeological monitoring for the proposed improvements to the Honolulu Zoo located north of the current project area. The monitoring focused on three areas on the west side of the zoo. In most excavations, remnants of previous zoo structures and fill deposits were encountered. Natural sand deposits were observed in on area near the Elephant Exhibit, however no cultural material was encountered. Given the presence of burials in the Waikīkī area, archaeological monitoring for any future work was recommended.

In May 2004, CSH conducted archaeological monitoring (CSH 2004) associated with a new sewer pump station near the Waikīkī Aquarium (TMK [1] 3-1-031:006). The excavations consisted of two electrical trenches totaling ca. 80 meters in length. A single historic trash pit was uncovered (Site 50-80-14-6704). The pit contained items including butchered animal bone, ceramic pieces and glass bottles that dated between 1880 and the 1920s.

In October 2004, Scientific Consulting Services (Tome and Spear 2005) conducted archaeological monitoring associated with the Public Baths Pump Station Modification Improvements Project located adjacent to the Waikīkī Aquarium (TMK: [1] 3-1-31:07), situated just northwest of the current project area. The monitoring identified a single archaeological site (50-80-14-6702) consisting of a single subsurface trash pit containing glass bottles manufactured between the 1870s and the 1920s. The site was assessed as significant under Criteria D with no further work recommended at the site. Archaeological monitoring was suggested for work conducted along the coastal areas.

In 2006, Cultural Surveys Hawaiʻi (Whitman et al. 2008) conducted archaeological monitoring for a 12-inch water installation along Kalākaua Avenue and Ponimōʻī Road, located just to the south of the current project area. The investigations uncovered a single fully articulated human burial (Site 50-80-14-6946) interred in a flexed position. The burial was disinterred and was identified as a young adult of Native Hawaiian ancestry. Archaeological monitoring within the area was recommended for any future work.

In 2008, Archaeological Consultants of the Pacific, Inc. (Liebhardt and Kennedy 2008) conducted archaeological monitoring at the Waikīkī Aquarium (TMK [1] 3-1-31:06) located on the opposite end of the Waikīkī Natatorium from the current project area as part of an electrical system upgrade to the aquarium. The investigations focused on several tranches excavated from Kalākaua Avenue and entering the aquarium property. They excavations uncovered various fill layers overlaying Jaucus sand deposits. No cultural remains were encountered.

4.1 SITE PREDICTABILITY

Based on previous archaeological investigations in the vicinity of the project area and the location of the project area adjacent to ocean resources and inland marshes in the Kapiʻolani Park area, it seems very likely that this area would have been traditionally utilized. We would expect to find habitation features such as living floors, fire hearths and ovens (*imu*), and activity areas where traditional artifacts were made. It also seems that this area has the potential to contain human burials. The area may also contain historic remnant of the Irwin residence and construction of the Natatorium.

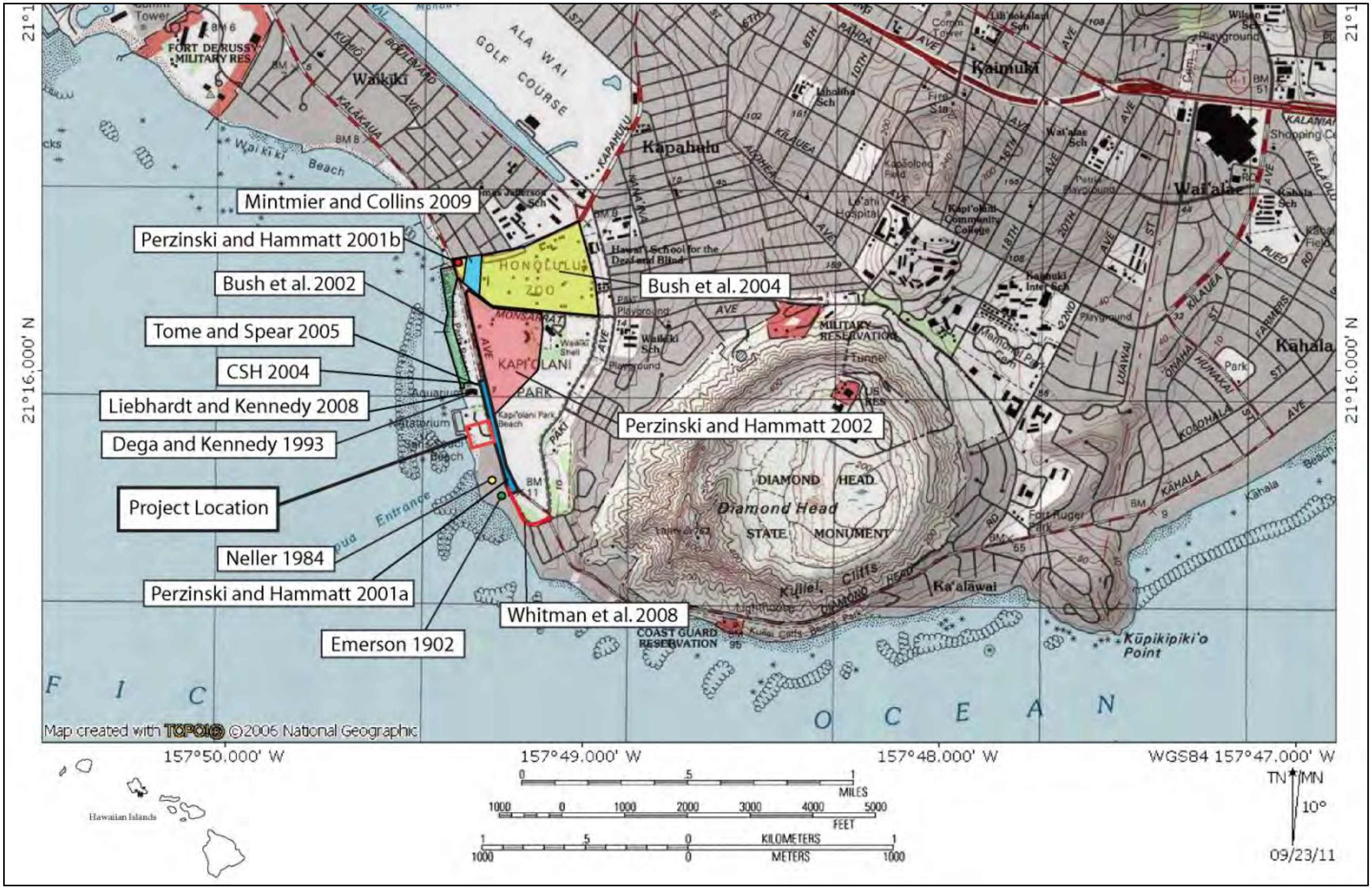


Figure 10. Locations of previous archaeological investigations near the project area.

5.0 FIELD INVESTIGATIONS

The most prominent historic property in the project area is the War Memorial Natatorium (Frontispiece and Figure 9) that was briefly described in Section 3.4. The significance of this property was first recognized by it inclusion in the Hawaii Register of Historic Places in 1973 (SIHP Site No. 50-80-14-9701), followed by its listing in the National Register of Historic Places in 1980. The National Register for Historic Places nomination form for this historic property is presented in Appendix A of the report. The Natatorium was envisioned as a living war memorial. The Natatorium opened on 24 August 1927. Olympic Gold medalist, Duke Kahanamoku, open the pool with the first swim. This was followed by an AAU National championship swimming meet that featured such championship swimmers as Johnny Weissmuller and Clarence "Buster" Crabbe that broke numerous world records

The Natatorium is currently in a very deteriorated condition. Large portions of the decks around the pool have collapsed and plaster has eroded. The Natatorium has become a danger to the public and has been closed to the public since 1978.

5.1 ARCHAEOLOGICAL EXCAVATIONS

A total of 22 shovel test pits (STPs) and 12 backhoe trenches were excavated during the course of the project (Figure 111 through 13). The locations of each were excavation was determined by the locations of existing utilities and vegetation. The intent was to spread out the test excavations as evenly as possible to determine if significant cultural deposits were present within this area of the park.

The excavations within the park identified a fairly even cultural layer throughout the area beginning at approximately 50 cm below the existing ground surface. This cultural layer was overlaid by various fill episodes which were employed undoubtedly by the parks department to raise and level the park grounds. The depth of the cultural layer varies within the park with the shallowest depth being 50 cm below surface and extending to a depth of approximately 110 cm below surface. Tisa cultural layer was assigned the SIHP Site number 50-80-14-7211.

The cultural layer (SIHP No. 7211) was initially identified in STP 5, at 60 cm below surface (Layer III). This layer contained dark gray sand and charcoal. A marine shell fishhook and a charcoal sample was collected from the screen in this layer. The charcoal sample was subsequently identified as to species and then radiocarbon dated (see Section 5.5).

Subsequent testing in the area further demarcated the area of the site. Cultural material was also identified within Layer III (50-75 cmbs) in STP 14 and 15. This material consisted of a coral abrader and midden within STP 14 and midden within STP 15. A possible posthole was also identified within Layer III of STP 14 between 50-75 cmbs.

Seven features were identified during test trenching (Figure 13). Feature 1 was thought to be a tree root- ball, and Feature 6 contained historic materials from the 20th century.

The remaining five features are likely traditional in nature comprising a post hole (Feature 2) and several fire pits. Before providing descriptions of eh subsurface features identified (Section 5.3), descriptions of the 22 shovel test probes (Section 5.1) and the 12 backhoe trenches (Section 5.2) are presented

Figure 11. Backhoe excavations were closely monitored.

Figure 12. Location of shovel test pits and backhoe trenches on ESRI aerial image.

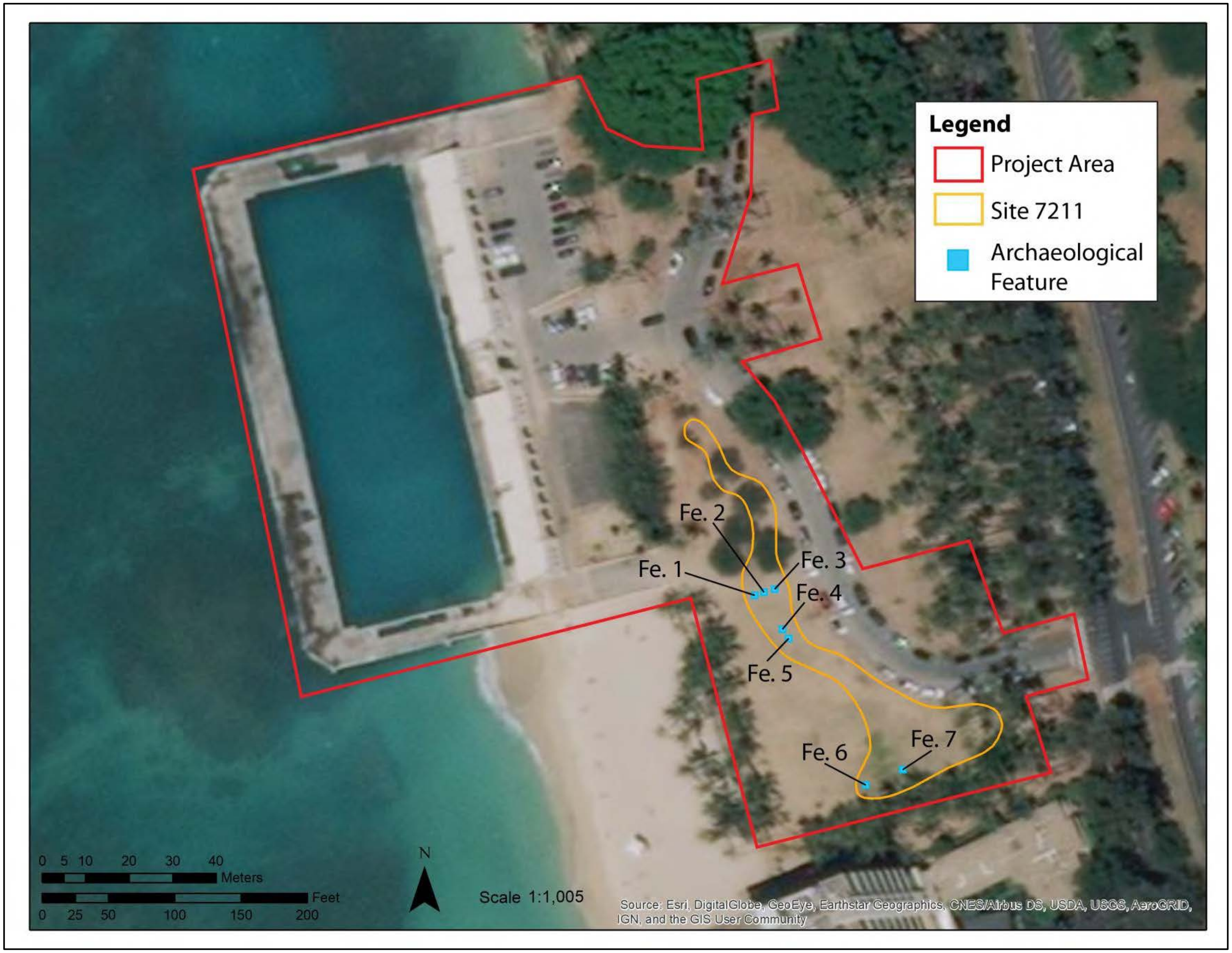


Figure 13. Location of identified subsurface features.

5.2 Shovel Test Pits

Shovel Test 1 (Figure 14)

Layer I	0-40 cmbs	Very dark grayish brown (10YR 3/2) silt; mixed with volcanic cinder, granular structure, slightly sticky, non-plastic; abrupt smooth boundary.
Layer II	40-65 cmbs	Dark yellowish brown (10YR 3/6) loam; platy structure, non sticky, non-plastic; contains glass bottle fragments; abrupt smooth boundary.
Layer III	65-70 cmbs	Light brownish gray (10YR 6/2) sand; sine grain structureless, non-sticky, non-plastic ; abrupt smooth boundary; no charcoal present.
Layer IV	70-100 cmbs	Very pale (10YR 7/4) sand; fine grain; structureless; beach sand.

Figure 14. STP 1 at conclusion of excavation.

Shovel Test 2 (Figure 15)

Layer I	0-6 cmbs	Dark yellowish brown (10YR 3 /4) silty loam; contains cinder; loose, fine grain, non-sticky, non-plastic; "A" Horizon.
Layer II	6-34 cmbs	Strong brown (7.5YR 4/4) silt loam; contains cinder; loose, blocky; non-sticky, non-plastic.
Layer III	34-64 cmbs	Reddish brown (5YR 4/4) clay; platy, sticky, Plastic; contains glass and metal wires.
Layer IV	64-80 cmbs	Light gray (7.5YR 7/1) sand; loose, fine grain, non-sticky, non-plastic. Beach sand.

Figure 15. STP 2 at conclusion of excavations.

Shovel Test 3

Layer I	0-40 cmbs	Very dark brown (10YR 2/2) silty clay; contains cinder, strong, non-sticky, non-plastic; medium granular, abrupt smooth boundary.
Layer II	40-60 cmbs	Dark yellowish brown (10YR 3/ 4) silt loam; platy, slightly sticky, slightly plastic; abrupt smooth boundary; contained fragments of amber glass bottle.
Layer III	60-67 cmbs	Brown (10YR 5/3) sand; structureless, fine grain; non-sticky, non-plastic; abrupt smooth boundary; brown color likely from leaching, no cultural material.
Layer IV	67-100 cmbs	Light yellowish brown (10YR 6/4) sand; structureless, fine grained; non-sticky, non-plastic; abrupt smooth boundary; beach sand containing marine shell and coral.

Shovel Test 4

Layer I	0-6 cmbs	Dark yellow brown (10YR 3/ 4) silt loam; loose; non-sticky, non-plastic; abrupt smooth boundary; contains rootlets.
Layer II	6-40 cmbs	Strong brown (7.5YR 4/4) silt loam; loose blocky, non-sticky, non-plastic; abrupt smooth boundary. Contains pockets of cinder and rootlets.
Layer III	40-75 cmbs	Gray (5YR 6/1) silt; fine grain; non-sticky, non-plastic; gradual boundary; ash-like soil with large concrete chunk, glass and metal.
Layer IV	75-85 cmbs	Light gray (7.5YR 7/1) sand; loose, fine grain; non-sticky, non-plastic; beach sand.

Shovel Test 5 (Figure 166)

Layer I	0-40 cmbs	Dark yellowish brown (10YR 3/ 4) silt; weak, medium grain; non-sticky, non-plastic; abrupt smooth boundary; contains cinder.
Layer II	40-60 cmbs	Dark brown (10YR 3/3) loam; moderate medium, platy; non-sticky, non-plastic; abrupt smooth boundary.
Layer III	60-85 cmbs	Very dark gray (10YR 3/1) sand; structureless, fine grain; non-sticky, non-plastic; gradual, wavy boundary; cultural layer containing charcoal, midden and a marine shell fishhook; charcoal identification and radiocarbon sample submitted from this layer.
Layer IV	85-100 cmbs	Very pale brown (10YR 7/4) sand; structureless, fine granular; non-sticky, non-plastic; beach sand containing marine shell and coral; no cultural material.

Figure 16. STP 5 view to west. Note pit-like feature near photo stick.

Shovel Test 6

Layer I	0-30 cmbs	Dark brown (10YR 3/3) loam; moderate medium granular; slightly sticky, slightly plastic; abrupt smooth boundary. Fill.
Layer II	30-42 cmbs	Very dark gray (10YR 3/1) cinder; structureless, medium, granular; non-sticky, non-plastic; abrupt smooth boundary. Fill.
Layer III	42-57 cmbs	Dark yellowish brown (10YR 3/ 4) loam; moderate, blocky, medium; slightly sticky, slightly plastic; contains gravel; possible base course for old driveway.
Layer IV	57-100 cmbs	Pale brown (10YR 6/3) sand; structureless, fine, granular; non-sticky, non-plastic; beach sand, no cultural material.

Shovel Test 7

Layer I	0-8 cmbs	Dark brown (10YR 3/3) loam; fine granular; non-sticky, non-plastic; abrupt smooth boundary; contains rootlets and modern glass fragments.
Layer II	8-28 cmbs	Yellowish brown (10YR 5/6) cinder; medium crumb; non-sticky, non-plastic; abrupt smooth boundary. Irrigation line in layer; fill.
Layer III	28-37 cmbs	Strong brown (7.5YR 4/6) sandy loam; fine granular, non-sticky, non-plastic; clear boundary; contains glass fragments.
Layer IV	37-60 cmbs	Grayish brown (10YR 5/2) sand; fine granular, non-sticky, non-plastic; gradual boundary; contains some charcoal flecking.
Layer V	60-80 cmbs	Dark gray brown (10YR 4/2) sand; fine granular; non-sticky, non-plastic; gradual boundary; contains midden and charcoal flecking, cultural layer.
Layer VI	80-100 cmbs	Light gray (10YR 7/2) sand; fine granular; non-sticky, non-plastic; beach sand.

Shovel Test 8

Layer I	0-35 cmbs	Very dark grayish brown (10YR 3/2) loam; moderate, medium, granular; slightly sticky, slightly plastic; fill.
Layer II	35-100 cmbs	Very pale brown (10YR 8/2) sand; structureless, fine, granular; non-sticky, non-plastic; beach sand, contains no cultural material.

Shovel Test 9

Layer I	0-40 cmbs	Dark yellowish brown (10YR 4/4) silty clay loam; moderate, medium, granular; non-sticky, non-plastic; abrupt smooth boundary; contains cinder.
Layer II	40-60 cmbs	Dark brown (10YR 3/3) loam; moderate, medium, platy; non-sticky, non-plastic; abrupt, smooth boundary; fill.
Layer III	60-85 cmbs	Dark grayish brown (10YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual, wavy boundary; contains charcoal and marine shell midden.
Layer IV	85-100 cmbs	Very pale brown (10YR 8/3) sand; structureless, fine granular; non-sticky, non-plastic; beach sand, no cultural material.

Shovel Test 10

Layer I	0-9 cmbs	Dark brown (10YR 3/3) loam; fine granular; non-sticky, non-plastic; abrupt smooth boundary; contains rootlets.
Layer II	9-34 cmbs	Yellowish brown (10YR 5/6) cinder; crumb; non-sticky, non-plastic; abrupt smooth boundary; few roots.
Layer III	34-42 cmbs	Dark yellowish brown (10YR 3/ 4) sandy loam; fine granular; non-sticky, non-plastic; clear smooth boundary; compacted hard.
Layer IV	42-90 cmbs	Light gray (10YR 7/2) sand; fine granular; non-sticky, non-plastic; beach sand.

Shovel Test 11

Layer I	0-60 cmbs	Dark brown (10YR 3/3) silt loam; weak fine crumb, mixed with volcanic cinder, friable, non-sticky, non-plastic; abrupt irregular boundary. Contains tree roots.
Layer II	26-55 cmbs	Light brown grey (10YR 6/2) loamy sand; structureless, very fine, granular; loose, non-coherent, non-sticky, non-plastic; abrupt, smooth boundary.
Layer III	60-75 cmbs	Very dark grayish brown (10YR 3/2) loam; moderate fine grain crumb; friable, non-sticky, non-plastic; abrupt smooth boundary.
Layer IV	55-160 cmbs	Very pale (10YR 7/4) sand; structureless, very fine grain; loose, non-coherent, non-sticky, non-plastic; beach sand.

Shovel Test 12

Layer I	0-20 cmbs	Very dark brown (10YR 2/2) silt loam; moderate, fine crumb; friable, non-sticky, non-plastic; abrupt irregular boundary. Contains cinder.
Layer II	20-30 cmbs	Dark brown (10YR 3/3) clay loam; moderate, medium platy; friable, non-sticky, non-plastic; abrupt smooth boundary.
Layer III	30-130 cmbs	Light grey (10YR 7/2) sand; structureless, very fine grain; loose, non-coherent, non-sticky, non-plastic. Beach sand.

Shovel Test 13

Layer I	0-30 cmbs	Very dark brown (10YR 2/2) clay loam; moderate, fine crumb; friable, slightly-sticky, slightly-plastic; abrupt irregular boundary. Contains cinder.
Layer II	30-45 cmbs	Very dark grayish brown (10YR 3/2) loamy sand; structureless, fine granular; loose, non-coherent, non-sticky, non-plastic; abrupt smooth boundary.
Layer III	25-85 cmbs	Dark grayish brown (10YR 4/2) sandy loam; structureless, fine grain; loose, non-coherent, non-sticky, non-plastic; abrupt smooth boundary. Heavily mottled.
Layer IV	55-150 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 14

Layer I	0-40 cmbs	Very dark grayish brown (10YR 3/2) silt loam; moderate, medium crumb; firm, non-sticky, non-plastic; abrupt smooth boundary. Contains cinder.
Layer II	40-50 cmbs	Dark brown (10YR 3/3) sandy clay loam; weak, fine crumb; friable, slightly sticky, slightly plastic; abrupt smooth boundary.
Layer III	50-75 cmbs	Grayish brown (10YR 5/2) loamy sand; structureless, fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt wavy boundary. Contains, marine shell midden, charcoal flecking, coral abrader, and a possible posthole.
Layer IV	75-160 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic. Beach sand.

Shovel Test 15

Layer I	0-25 cmbs	Very dark grayish brown (10YR 3/2) silt loam; moderate, medium crumb; firm, non-sticky, non-plastic; abrupt smooth boundary.
Layer II	25-37 cmbs	Dark yellowish brown (10YR 3/4) loam; weak, fine crumb; firm, non-sticky, non-plastic; abrupt smooth boundary.
Layer III	37-100 cmbs	Grayish brown (10YR 5/2) loamy sand; structureless, fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt wavy boundary. Contains, charcoal flecking, non-human bone and marine shell midden.
Layer IV	70-160 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic. Beach sand.

Shovel Test 16

Layer I	0-25 cmbs	Brown (10YR 4/3) loam; moderate, fine crumb; firm, non-sticky, non-plastic; abrupt smooth boundary. Contains cinder.
Layer II	25-85 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt smooth boundary.
Layer II	85-160 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt smooth boundary. Beach sand.

Shovel Test 17

Layer I	0-6 cmbs	Brown (10YR 4/3) silt loam; weak, fine, subangular blocky; very firm, non-sticky, non-plastic; abrupt smooth boundary.
Layer II	6-16 cmbs	Light grey (10YR 7/2) crushed coral. Abrupt smooth boundary.
Layer III	16-40 cmbs	Very dark grayish brown (10YR 3/3) silt loam; weak, fine crumb; firm, non-sticky, non-plastic; abrupt smooth boundary. Contains cinder metal and fragments.
Layer IV	40-50 cmbs	Very dark brown (10YR 2/2) clay loam; weak fine crumb; firm, slightly sticky, slightly plastic; abrupt smooth boundary. Contains abundant roots, root burn, charcoal flecking, metal and glass.
Layer V	50-70 cmbs	Dark brown (7.5 YR 3/3) clay; weak, medium, platy; friable, sticky, plastic; abrupt smooth boundary.
Layer VI	70-160 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 18

Layer I	0-6 cmbs	Brown (10YR 4/3) silt loam; weak, fine, subangular blocky; very firm, non-sticky, non-plastic; abrupt smooth boundary. Contains bottle glass.
Layer II	6-10 cmbs	Light grey (10YR 7/2) crushed coral. Abrupt smooth boundary.
Layer III	10-30 cmbs	Very dark grayish brown (10YR 3/2) loamy sand; weak, fine granular; friable, non-sticky, non-plastic; abrupt smooth boundary. Contains concrete and tree roots.
Layer IV	30-50 cmbs	Dark yellowish brown (10YR 4/4) loamy sand; structureless, fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt smooth boundary. Contains concrete.
Layer V	50-80 cmbs	Black (10 YR 2/2) sandy clay loam; weak, fine crumb; friable, slightly sticky, slightly plastic; abrupt smooth boundary. Contains metal, glass, ceramic, and concrete. Backfill material.
Layer VI	80-160 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 19

Layer I	0-30 cmbs	Very dark grayish brown (10YR 3/2) silt loam; weak, fine, crumb; firm, non-sticky, non-plastic; abrupt, smooth boundary. Contains cinder.
Layer II	30-60 cmbs	Brown (10 YR 4/3)clay loam; weak, fine crumb; firm, slightly sticky, slightly plastic; abrupt wavy boundary.
Layer III	60-85 cmbs	Light grey (10YR 7/2) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt, smooth boundary. Contains charcoal flecking but no cultural material.
Layer IV	85-160 cmbs	Very pale brown (10YR 8/2) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 20

Layer I	0-3 cmbs	Brown (10YR 3/2) sandy loam; weak, very fine, crumb; firm, non-sticky, non-plastic; abrupt, smooth boundary.
Layer II	3-30 cmbs	light grey (10 YR 7/1) crushed coral. Abrupt, smooth boundary. Contains glass and concrete.
Layer III	30-65 cmbs	Dark brown (10YR 7/2) clay loam; weak, fine crumb; friable, sticky, plastic; abrupt, smooth boundary.
Layer IV	65-160 cmbs	Very pale brown (10YR 8/4) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 21

Layer I	0-6 cmbs	Brown (10YR 4/3) sandy loam; weak, very fine, crumb; firm, non-sticky, non-plastic; abrupt, smooth boundary. Contains glass.
Layer II	6-38 cmbs	White (10 YR 8/1) crushed coral. Abrupt, smooth boundary. Contains concrete and rusted metal.
Layer III	38-53 cmbs	Very pale brown (10YR 7/3) sand; structureless, fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt, smooth boundary. Contains metal, concrete and glass.
Layer IV	42-63 cmbs	Dark grey (10YR 4/1) silt loam; moderate, medium grain; firm, non-sticky, non-plastic; abrupt, smooth boundary.
Layer V	63-75 cmbs	Yellow brown (10YR 5/4) sandy loam; weak, fine granular; loose, non-coherent, non-sticky, non-plastic; abrupt, wavy boundary.
Layer VI	70-160 cmbs	Very pale brown (10YR 7/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 22

Layer I	0-8 cmbs	Dark yellow brown (10YR 3/4) silty clay loam; moderate, fine, sub-angular blocky; firm, slightly sticky, slightly plastic; abrupt, smooth boundary. Contains glass.
Layer II	8-40 cmbs	Dark brown (10 YR 3/3) silt loam; moderate, fine crumb; very firm, slightly sticky, slightly plastic; abrupt, smooth boundary. Contains cinder, a sprinkler head and pipe, bottle glass and red brick fragments.
Layer III	40-70 cmbs	Grayish brown (10YR 5/2) loamy sand; structureless, fine single grain; loose, non-coherent, non-sticky, non-plastic; abrupt wavy. Contains metal, pipe fragments and red brick fragments.
Layer VI	70-160 cmbs	Very pale brown (10YR 8/2) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

5.3 Trenches

Trench 1 (Figure 17)

Layer I	0-10 cmbs	Very dark brown (10YR 2/2) silty loam; moderate medium granular; slightly sticky, slightly plastic; gradual smooth boundary; contains cinder.
Layer II	10-40 cmbs	Very dark brown (10YR 2/2) cinder; structureless, medium granular; non-sticky, non-plastic; abrupt smooth boundary.
Layer III	40-45 cmbs	Very dark brown (10YR 2/2) loam; moderate fine granular; slightly sticky, slightly plastic; abrupt wavy boundary; contains cinder.
Layer IIIA	67-72 cmbs	Very dark brown (10YR 2/2) loam; moderate fine granular; slightly sticky, slightly plastic; abrupt wavy boundary; contains cinder.
Layer IV	45-67 cmbs	Dark grayish brown (10YR 4/2) sandy loam; weak fine granular; slightly sticky, slightly plastic; gradual smooth boundary; contains concrete rubble, fill layer.
Layer V	72-78 cmbs	Very pale brown (10YR 7/4) sand; structureless, fine granular; non-sticky, non-plastic; abrupt wavy boundary; beach sand.
Layer VI	78-109 cmbs	Very dark grayish brown (10YR 3/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual smooth boundary; cultural layer with charcoal and firecracked rock.
Layer VII	109-124 cmbs	Very pale brown (10YR 8/3) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.

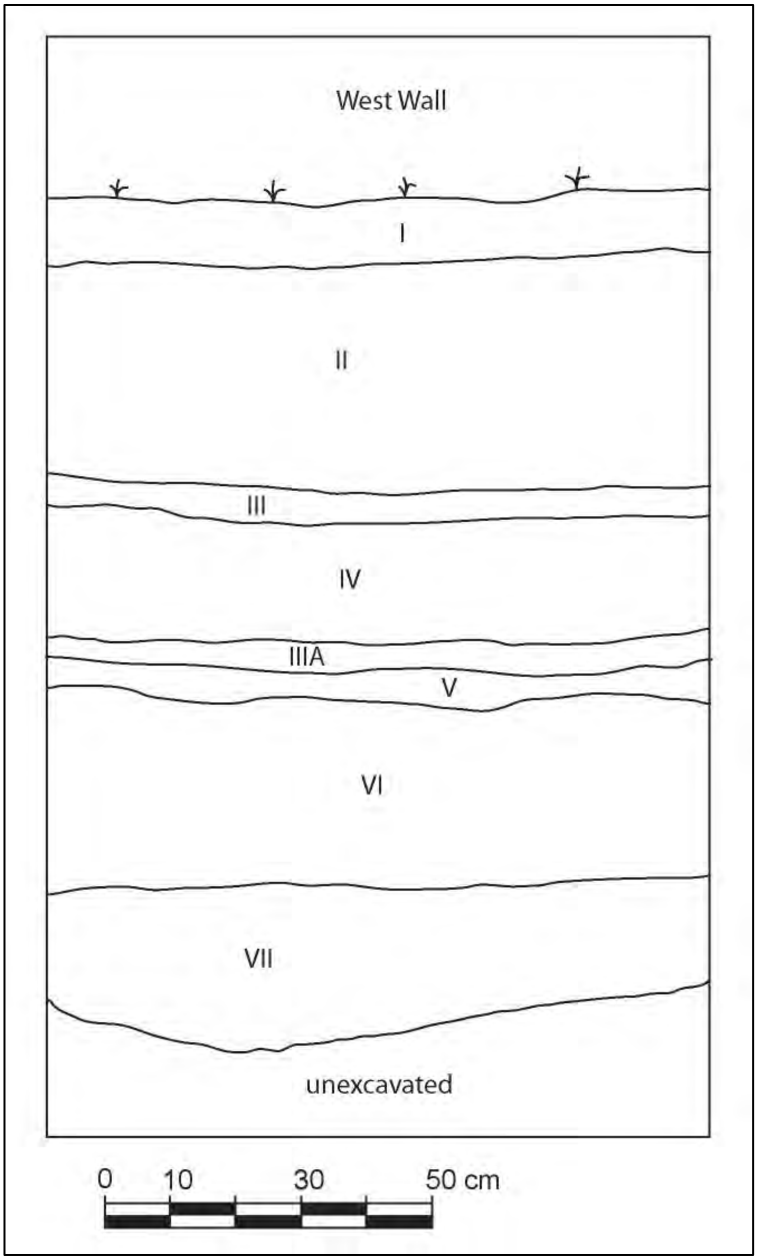


Figure 17. Profile of Trench 1, West Wall.

Trench 2 (Figure 18)

Layer I	0-9 cmbs	Very dark brown (10YR 2/2) loam; moderate medium granular; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer II	9-40 cmbs	Brown (10YR 4/3) silty loam; moderate medium granular; slightly sticky, slightly plastic; gradual smooth boundary.
Layer III	40-55 cmbs	Very dark brown (10YR 2/2) silty clay loam; structureless, medium granular; non-sticky, non-plastic; gradual smooth boundary; contains cinder.
Layer IV	55-67 cmbs	Dark brown (10YR 3/3) silty clay loam; slightly sticky, slightly plastic; moderate, medium platy; abrupt smooth boundary; contains a band of charcoal, fill.
Layer V	67-75 cmbs	Very pale brown (10YR 8/4) sand; structureless, fine granular; non-sticky, non-plastic; gradual, smooth boundary; beach sand.
Layer VI	75-109 cmbs	Very dark grayish brown (10YR 3/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual smooth boundary; contains charcoal, cultural layer.
Layer VII	109-130 cmbs	Very pale brown (10YR8/3) sand; structureless, fine granular, non-sticky, non-plastic; beach sand.

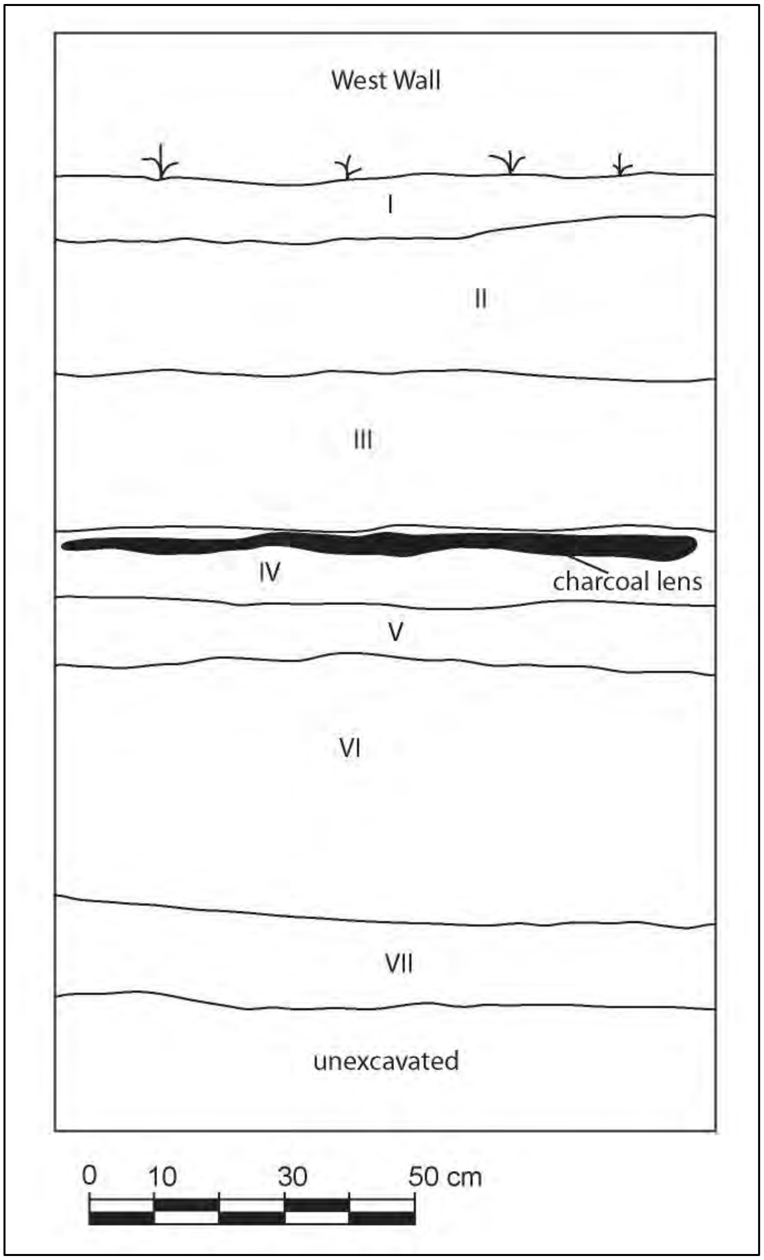


Figure 18. Profile of Trench 2, West Wall.

Trench 3 (Figure 19)

Layer I	0-10 cmbs	Very dark brown (10YR 2/2) loam; Weak medium blocky; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer II	10-35 cmbs	Very dark grayish brown (10YR 3/2) silty clay loam; moderate medium, granular; slightly sticky, slightly plastic; gradual smooth boundary; contains cinder.
Layer III	35-60 cmbs	Dark brown (10YR 3/3) silty clay loam; slightly sticky, slightly plastic; moderate, medium granular; abrupt smooth boundary; contains cinder.
Layer IV	60-69 cmbs	Grayish brown (10YR 5/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt smooth boundary; beach sand.
Layer IVA	60-69 cmbs	Dark reddish brown (2.5YR 2.5/4) clay; moderate medium blocky; sticky, plastic; abrupt, broken boundary; fill.
Layer V	69-81 cmbs	Dark brown (10YR 3/3) clay loam; moderate medium platy; slightly sticky, slightly plastic; abrupt smooth boundary; fill.
Layer VI	81-139 cmbs	Very dark grayish brown (10 YR 3/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual, wavy boundary; cultural layer containing charcoal.
Layer VII	139-150 cmbs	Pale brown (10YR 6/3) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.

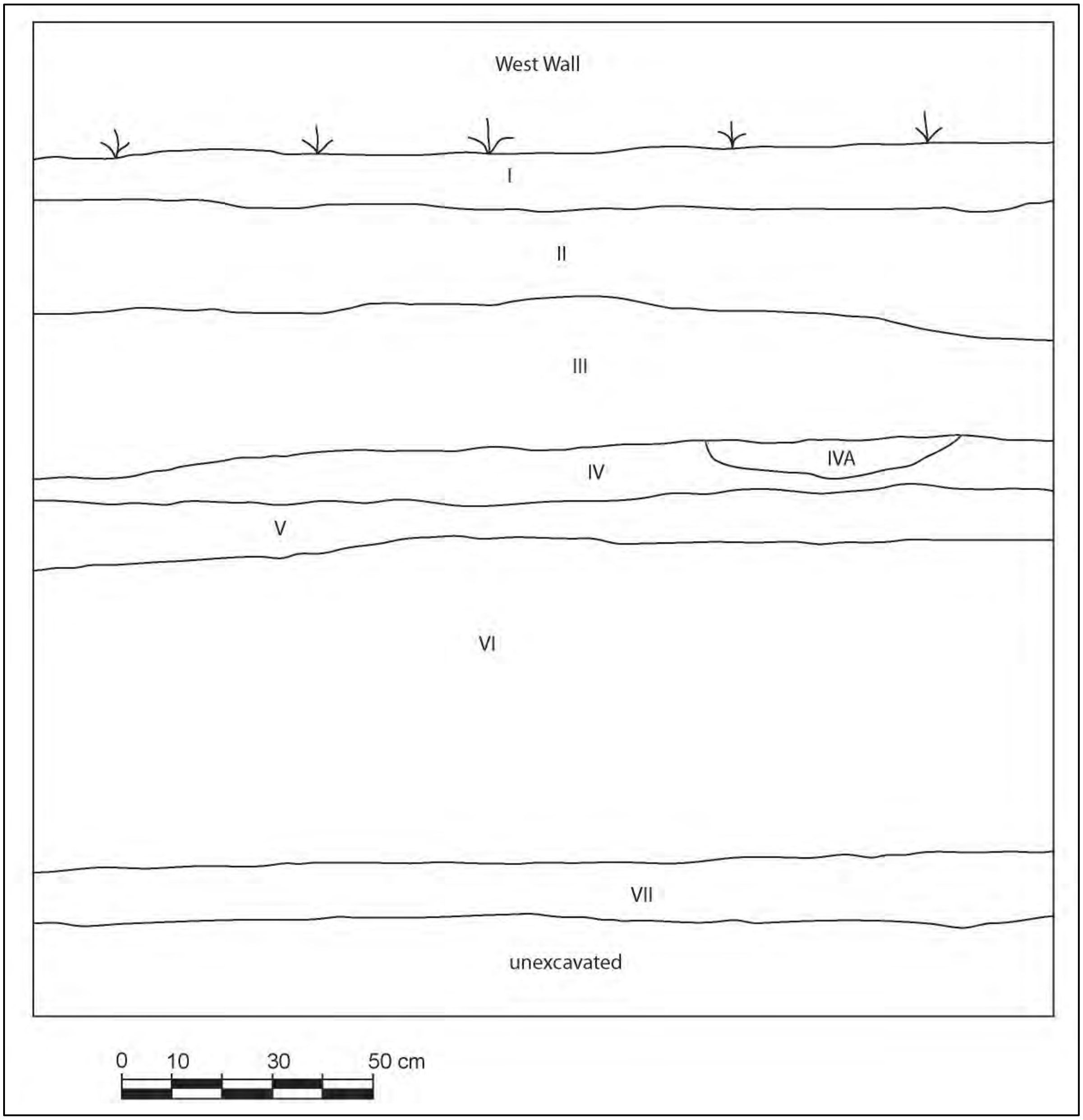


Figure 19. Trench 3, West Wall.

Trench 4 (Figure 20)

Layer I	0-10 cmbs	Very dark brown (10YR 2/2) loam; Weak medium blocky; slightly sticky, slightly plastic; abrupt smooth boundary
Layer II	10-29 cmbs	Very dark grayish brown (10YR 3/2) silty clay loam; moderate medium, granular; slightly sticky, slightly plastic; gradual smooth boundary; contains cinder.
Layer III	29-40 cmbs	Black (10YR 2/1) cinder; structureless, medium granular; non-sticky, non-plastic; abrupt, smooth boundary.
Layer IV	40-63 cmbs	Dark grayish brown (10YR 4/2) sandy loam; moderate medium granular; slightly sticky, slightly plastic; abrupt smooth boundary; contained concentration of ceramic tiles and basalt cobbles.
Layer V	63-74 cmbs	Dark brown (10 YR 3/3) loam; moderate medium platy; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer VI	74-112 cmbs	Very dark grayish brown (10YR3/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt smooth boundary; cultural layer containing charcoal and shell midden.
Layer VII	112-120 cmbs	Very pale brown (10YR 8/2) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.

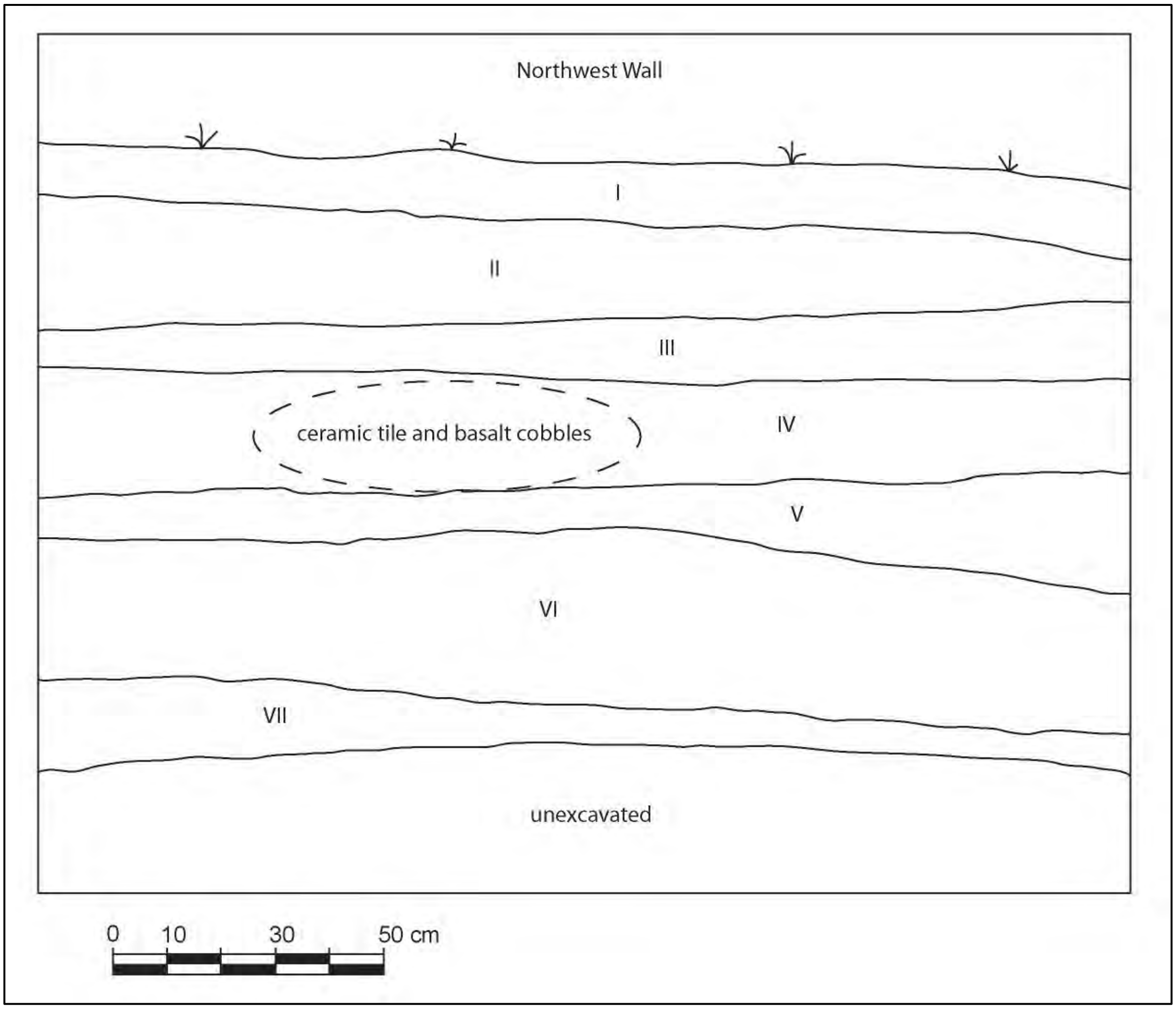


Figure 20. Profile of Trench 4, Northwest Wall.

Trench 5 (Figure 21)

Layer I	0-10 cmbs	Very dark brown (10YR 2/2) loam; weak medium blocky; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer II	10-44 cmbs	Dark brown (10YR 3/3) silt; structureless, medium, granular; non-sticky, non-plastic; abrupt smooth boundary; contains cinder.
Layer III	44-49 cmbs	Light gray (10YR7/1) sandy silt; moderate fine platy; non-sticky, non-plastic; abrupt smooth boundary; contains glass fragments.
Layer IV	49-54 cmbs	Brown (10YR 4/3) silty loam; moderate medium platy; non-sticky, non-plastic; abrupt wavy boundary.

Layer V	54-84 cmbs	Dark grayish brown (10YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual irregular boundary; cultural layer containing features and charcoal staining.
Layer VA	87-97 cmbs	Dark grayish brown (10YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual smooth boundary; cultural layer with charcoal staining.
Layer VI	80-87 cmbs	Vary pale brown (10YR 7/3) sand; structureless, fine granular; non-sticky, non-plastic; gradual smooth boundary; beach sand.
Layer VII	97-130 cmbs	Very pale brown (10YR 8/3) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.
Feature 1	87-120 cmbs	Grayish brown (10 YR 5/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt, irregular boundary; pit containing some charcoal staining, roots; probably a tree root-ball.
Feature 2	60-95 cmbs	Brown (10YR 5/3) sand; structureless, fine granular; non-sticky, non-plastic; possible post hole containing charcoal flecking.
Feature 3	50-65 cmbs	Dark grayish brown (10 YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt smooth boundary; pit containing charcoal and midden.

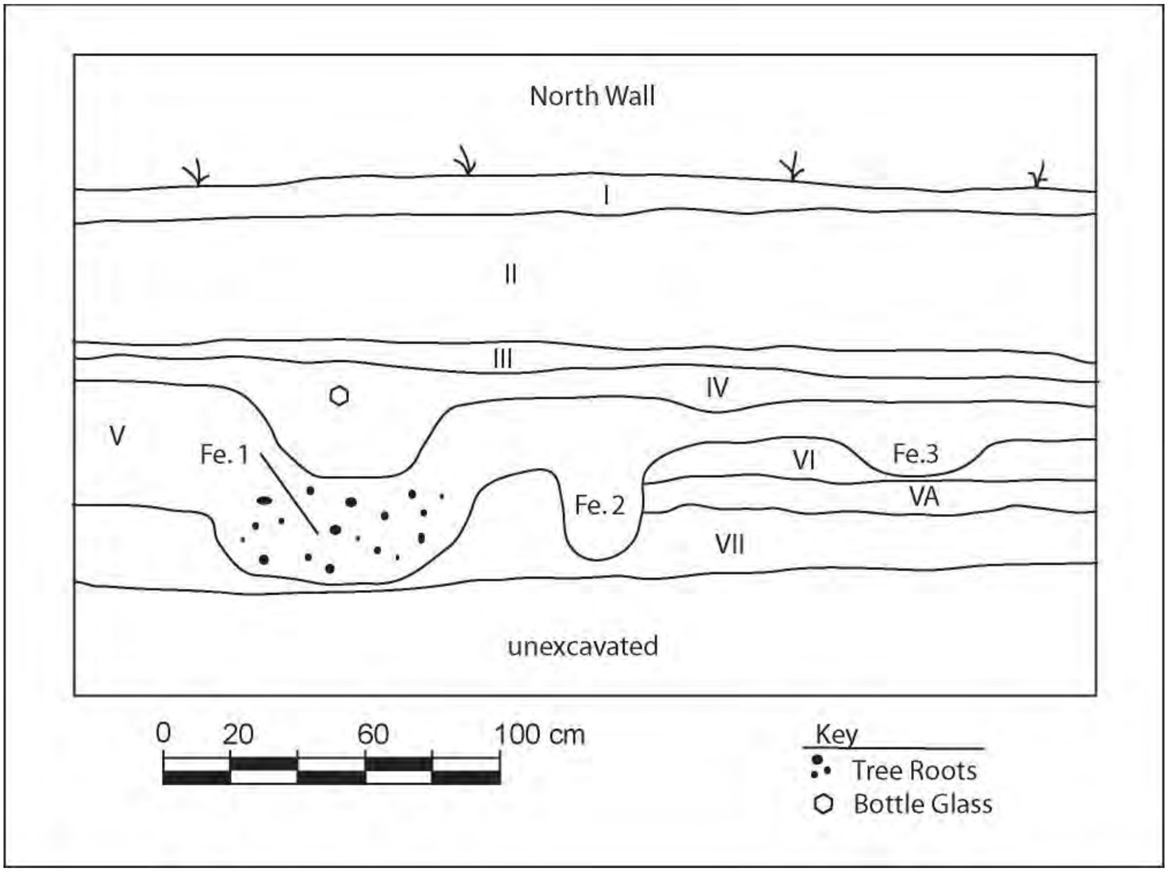


Figure 21. Profile of Trench 5, North Wall.

Trench 6 (Figure 22)

Layer I	0-10 cmbs	Brown (10YR 4/3) sandy loam; weak, fine granular; non-sticky, non-plastic; abrupt, smooth boundary.
Layer II	10-42 cmbs	Dark yellowish brown (10YR 3/ 4) sandy silt; weak medium granular; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer III	42-50 cmbs	Dark yellowish brown (10YR 3/ 4) loam; moderate medium, platy; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer IV	50-80 cmbs	Dark grayish brown (10YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt wavy boundary; cultural layer containing features and charcoal staining.
Layer V	80-107 cmbs	Very pale brown (10YR 8/3) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.
Feature 4	80-95 cmbs	Dark grayish brown (10 YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt irregular boundary; pit containing charcoal staining and flecking.
Feature 5	79-100 cmbs	Grayish brown (10 YR 5/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual irregular boundary; pit containing charcoal staining and flecking.

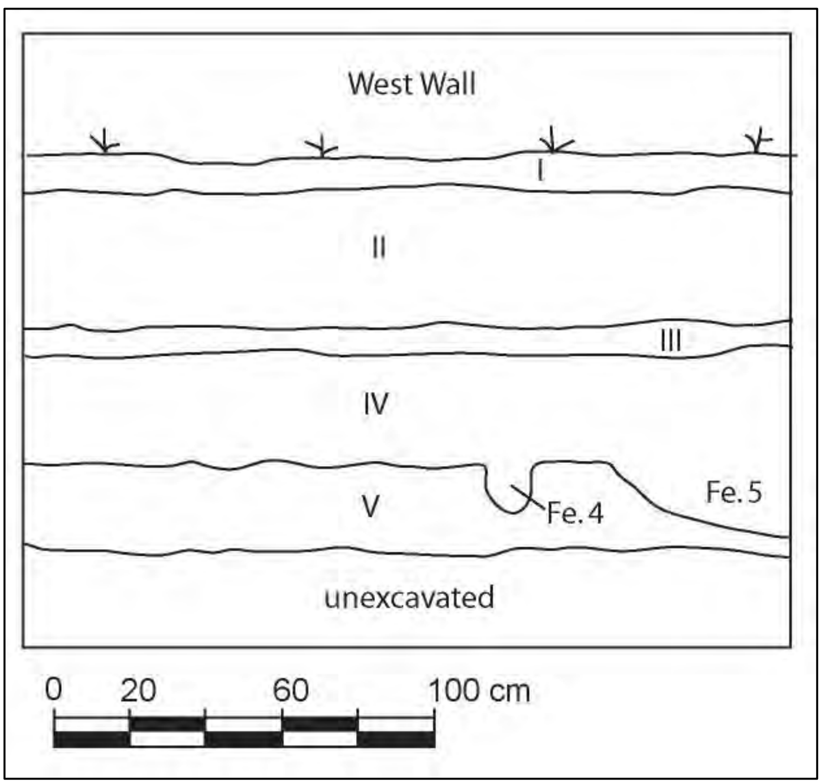


Figure 22. Profile of Trench 6, West Wall.

Trench 7 (Figure 23)

Layer I	0-9 cmbs	Brown (10YR 4/3) sandy loam; weak, fine granular; non-sticky, non-plastic; abrupt, smooth boundary.
Layer II	9-52 cmbs	Very dark grayish brown (10YR 3/2) silty loam, moderate medium, blocky; non-sticky, non-plastic; clear smooth boundary; fill with cinder.
Layer III	52-60 cmbs	Brown (10YR 4/3) clay loam; moderate medium, platy; non-sticky, non-plastic; abrupt smooth boundary.
Layer IV	60-95 cmbs	Very pale brown (10YR 7/4) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.

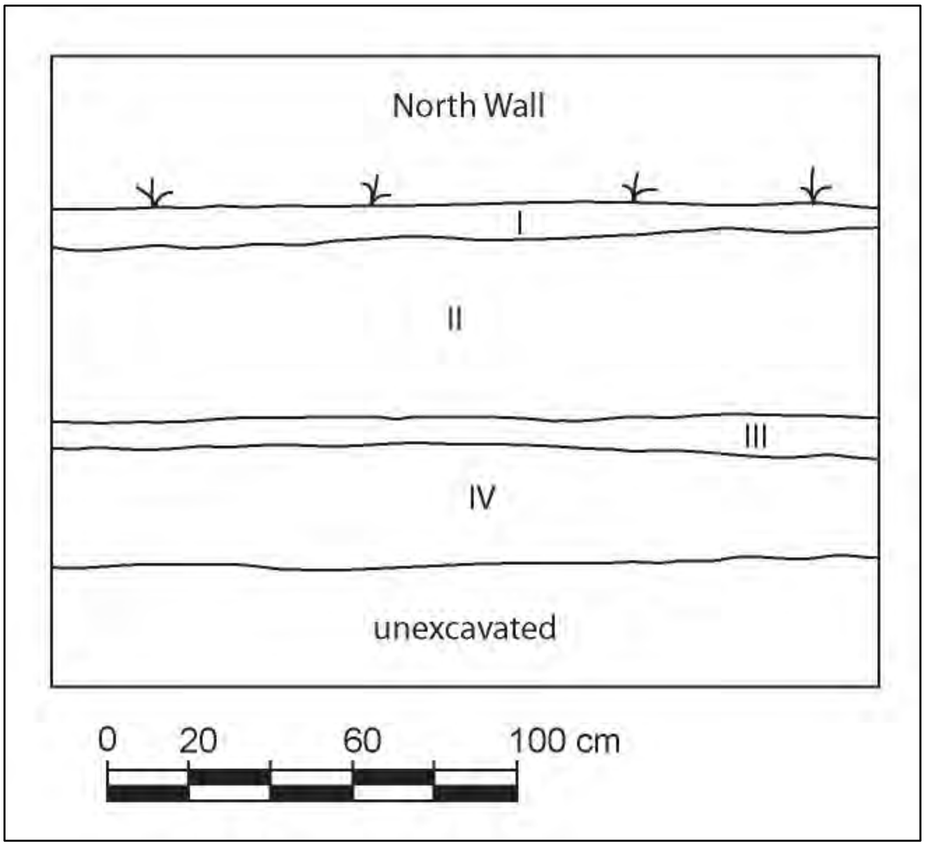


Figure 23. Profile of Trench 7, North Wall.

Trench 8 (Figure 24)

Layer I	0-10 cmbs	Very dark brown (10YR 2/2) sandy loam; structureless, fine granular; non-sticky, non-plastic; abrupt, smooth boundary.
Layer II	10-35 cmbs	Dark brown (10YR 3/3) silty clay; weak medium granular; slightly sticky, slightly plastic; abrupt smooth boundary; contains some cinder.
Layer III	35-58 cmbs	Yellowish brown (10YR 5/4) sandy loam; structureless, fine granular; non-sticky, non-plastic; clear smooth boundary; fill.
Layer IV	58-65 cmbs	Dark yellowish brown (10YR 3/ 4) silty loam; strong, medium, blocky; sticky, plastic; clear smooth boundary; contains some charcoal flecking.
Layer V	65-75 cmbs	Yellowish brown (10YR 5/4) sandy silt; weak, fine granular; non-sticky, non-plastic; abrupt smooth boundary.
Layer VI	75-110 cmbs	Very dark gray (10YR 3/1) sand; structureless, fine granular; non-sticky, non-plastic; gradual, wavy boundary; cultural layer containing charcoal staining and marine shell midden.
Layer VII	100-130 cmbs	Very pale brown (10YR 8/4) sand; structureless, fine granular, non-sticky, non-plastic; beach sand.

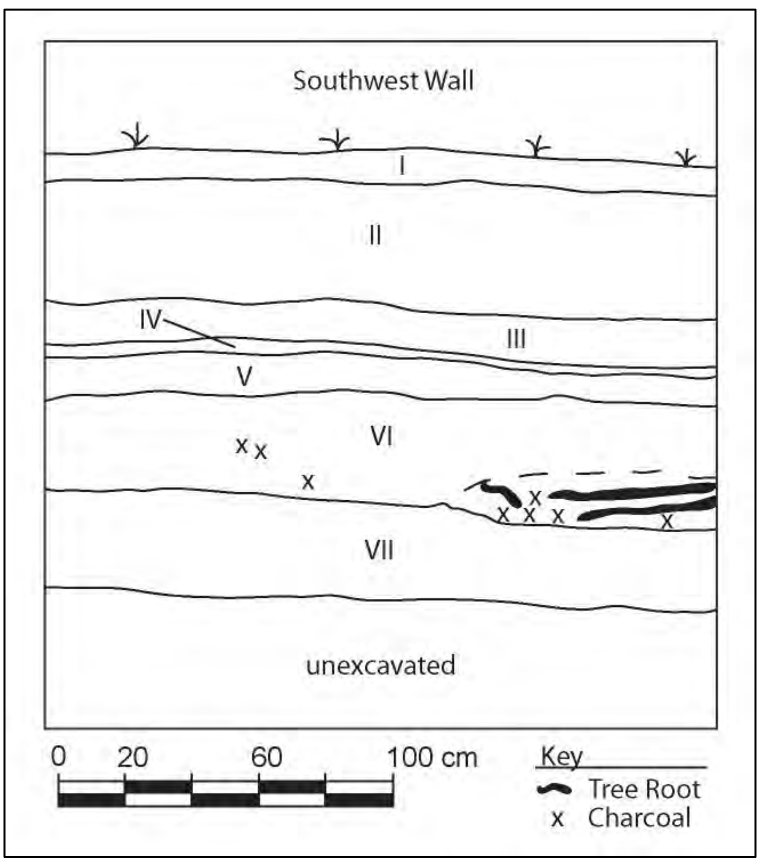


Figure 24. Trench 8 profile.

Trench 9 (Figure 25)

Layer I	0-10 cmbs	Dark yellowish brown (10YR 4/4) silty sand; weak fine granular; non-sticky, non-plastic; clear smooth boundary.
Layer II	10-67 cmbs	Very dark grayish brown (10YR 3/2) sandy silt; structureless, medium granular; non-sticky, non-plastic; clear smooth boundary.
Layer III	36-59 cmbs	Dark yellowish brown (10YR 4/4) silty loam; weak, medium platy; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer IV	53-75 cmbs	Very dark brown (10YR 2/2) sandy silt; structureless, fine granular; non-sticky, non-plastic; abrupt smooth.
Layer V	75-120 cmbs	Very pale brown (10YR 8/2) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.
Feature 6	75-102 cmbs	Very dark brown (10YR 2/2) sandy silt; structureless, fine granular; non-sticky, non-plastic; historic pit feature containing bottle glass, and ceramic earthenware.

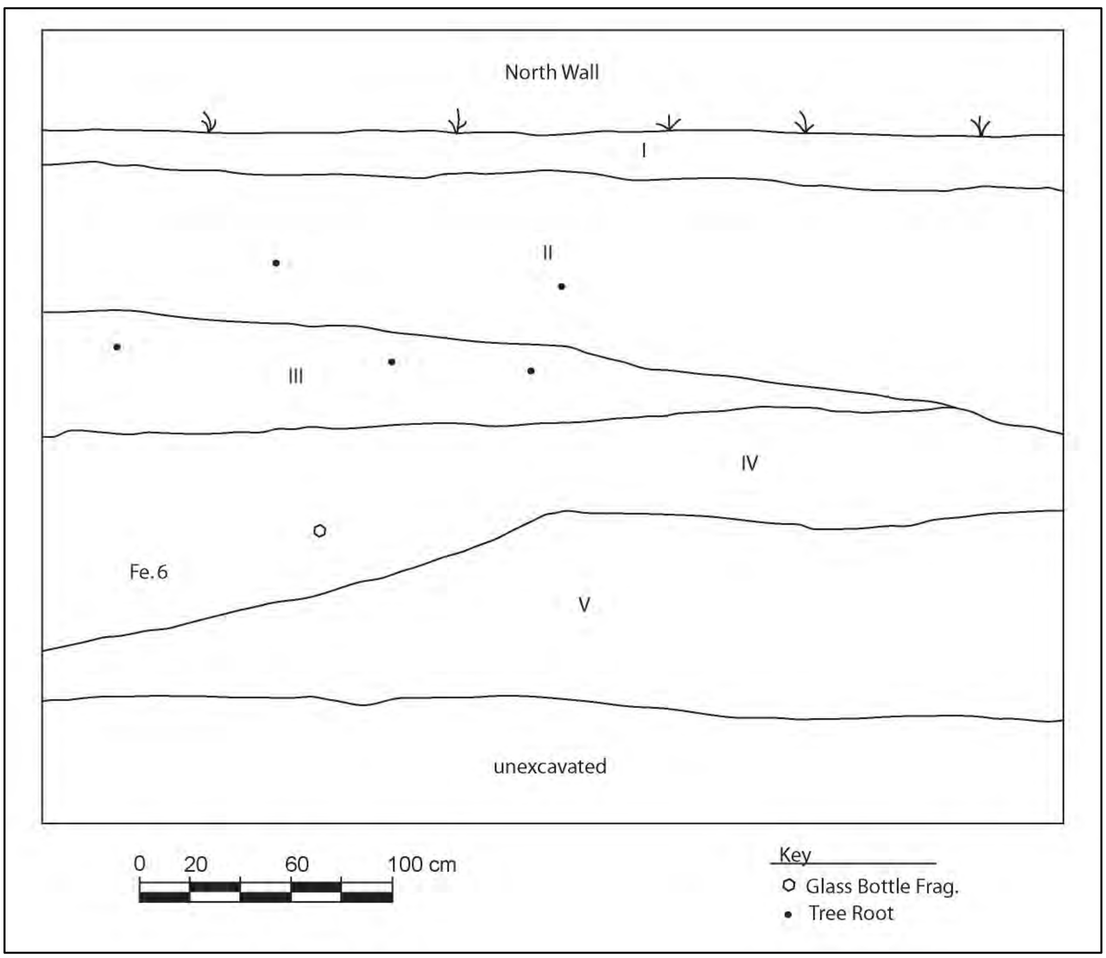


Figure 25. Trench 9 profile.

Trench 10 (Figure 26)

Layer I	0-18 cmbs	Yellowish brown (10 YR5/4) silty sand; structureless, fine granular; non-sticky, non-plastic; clear smooth boundary.
Layer II	18-58 cmbs	Dark brown (10YR 3/3) silty clay loam; weak medium granular; slightly sticky, slightly plastic; clear smooth boundary.
Layer III	58-70 cmbs	Dark yellowish brown (10YR 4/6) silty loam; moderate, medium platy; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer IV	70-90 cmbs	Very pale brown (10YR 8/2) sand; structureless, fine granular; non-sticky, non-plastic; clear smooth boundary; beach sand.
Layer IVA	90-95 cmbs	Very pale brown (10 YR 8/2) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.
Layer V	90-100 cmbs	Light brownish gray (10YR 6/2) sand; structureless, fine granular; non-sticky, non-plastic.

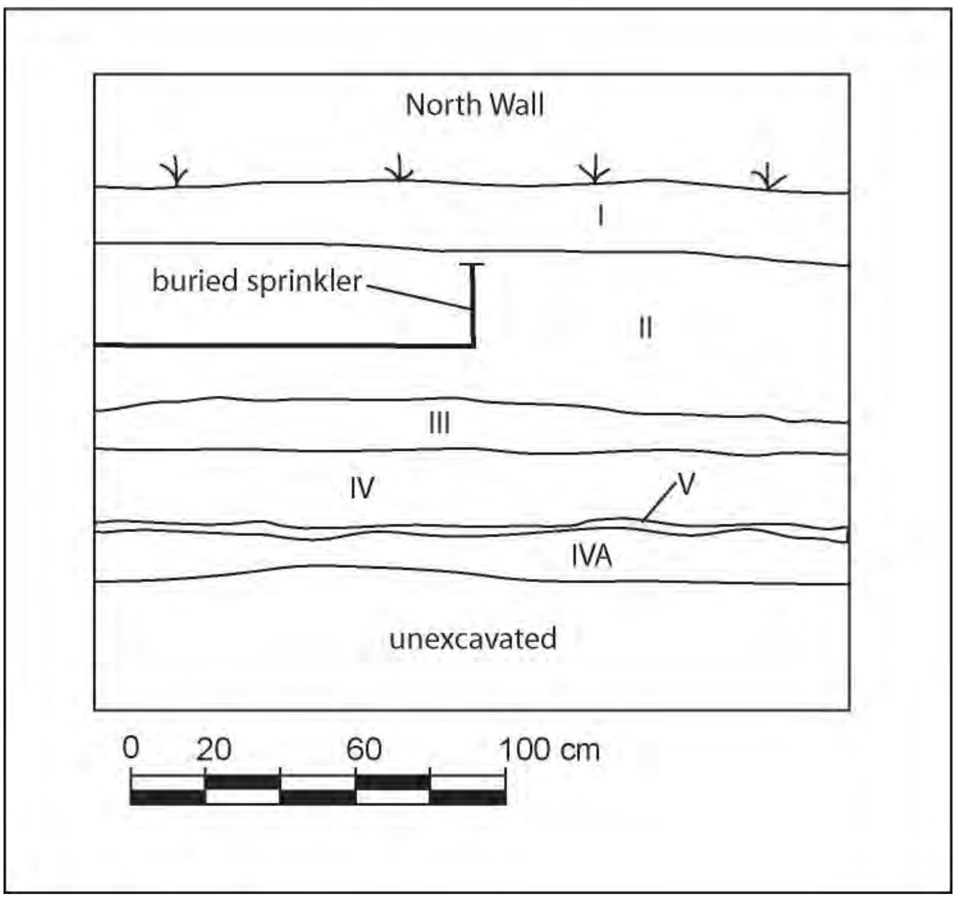


Figure 26. Trench 10 profile.

Trench 11 (Figure 27)

Layer I	0-21 cmbs	Dark brown (10 YR 3/3) clay loam; moderate medium platy; slightly sticky, slightly plastic; clear smooth boundary.
Layer II	21-60 cmbs	Very dark brown (10 YR 2/2) silty clay; weak, medium blocky; slightly sticky, slightly plastic; abrupt smooth boundary; contains cinder.
Layer III	58-105 cmbs	Pale brown (10 YR 6/3) sand; structureless, fine granular; non-sticky, non-plastic; clear smooth boundary; slightly stained but not cultural in nature.
Layer IV	65-120 cmbs	Very pale brown (10 YR 8/5) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.

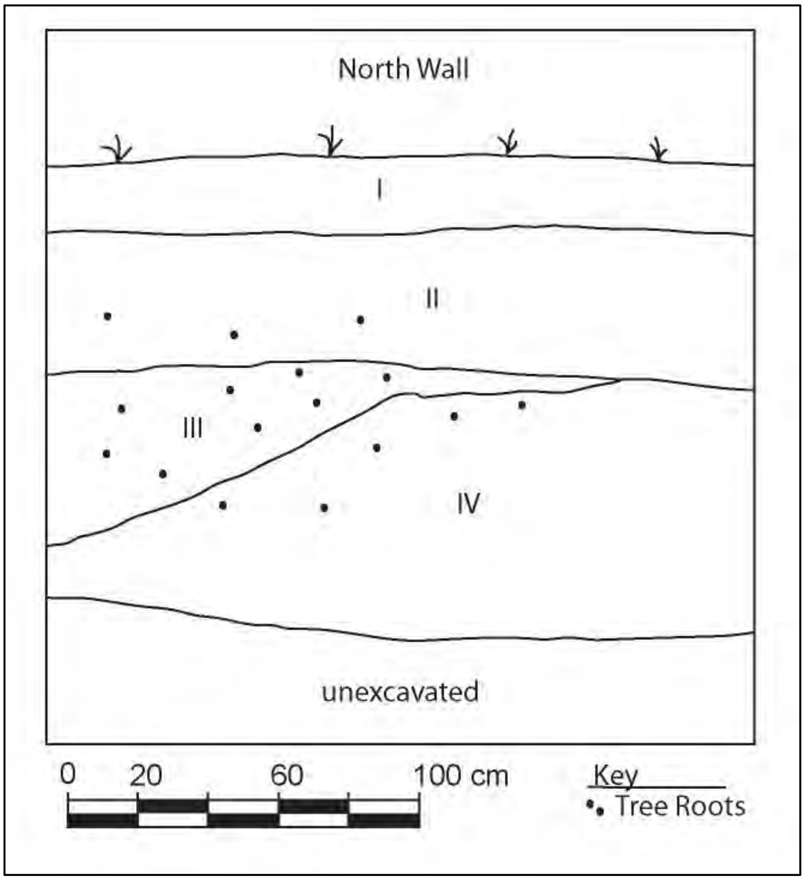


Figure 27. Profile of Trench 11.

Trench 12 (Figure 28)

Layer I	0-15 cmbs	Very dark brown (10 YR 2/2) clay loam; moderate medium platy; slightly sticky, slightly plastic; clear smooth boundary.
Layer II	10-70 cmbs	Dark brown (10YR 3/3) silty clay; weak, medium granular; slightly sticky, slightly plastic; clear smooth boundary.
Layer III	70-80 cmbs	Dark yellowish brown (10 YR 3/6) clay loam; moderate medium platy; sticky, plastic; abrupt smooth boundary.
Layer IV	76-100 cmbs	Grayish brown (10 YR 5/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt, smooth boundary; no cultural material preset.
Layer V	90-110 cmbs	Black (10 YR 2/1) sand; structureless, fine granular, non-sticky, non-plastic; clear wavy boundary; cultural layer containing feature, charcoal, and midden.
Layer VI	110-14 cmbs	Very pale brown (10 YR 8/2) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.
Feature 7	95-122 cmbs	Black (10 YR 2/1) sand; structureless, fine granular; non-sticky, non-plastic; pit containing charcoal, midden and fish scales.

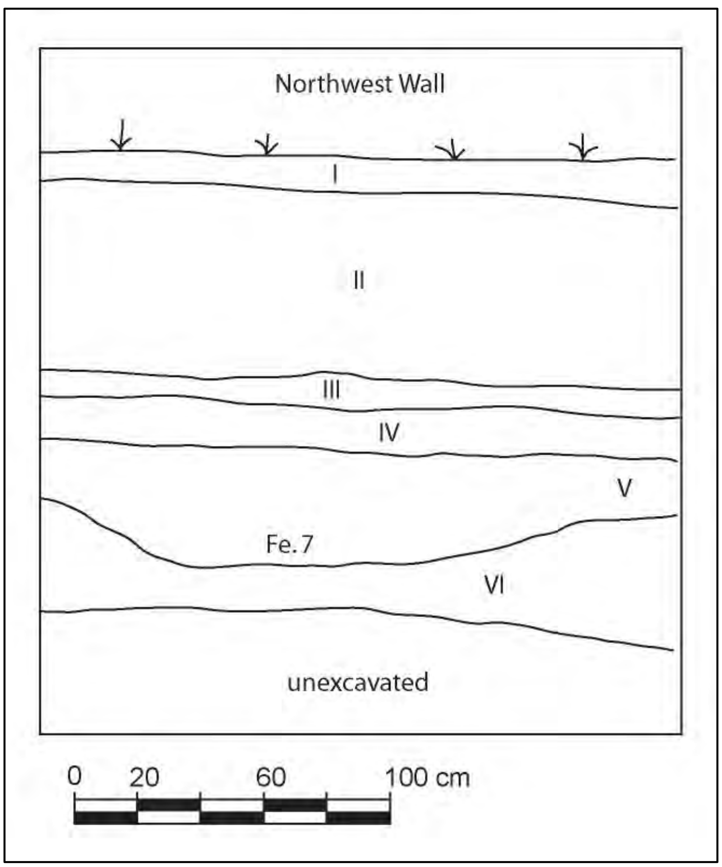


Figure 28. Trench 12 profile.

5.4 Feature Descriptions

The seven features identified as being associated with SIHP Site No. 7211 are described below, Tabulated in Table 1, and their spatial distribution is shown in Figure 13.

Feature 1
Feature 1 was located within Trench 5 and was present within both the North and South walls of the trench. This pit feature measured 80 cm wide and 33 cm thick. The top of the feature began 87 cm below surface and extended to 120 cm below surface. Numerous tree roots were present within the feature. The pit-like shape contained a grayish brown soil but no cultural material. Feature 1 is located within Layer V and is overlaid by the Layer IV fill. This is likely the remains of a tree root ball.

Feature 2
Feature 2 (Figure 29) was located within Trench 5 and present in the North wall. This feature originated in Layer V and measured 22 cm wide and 35 cm thick. The top of the feature was at 80 cm below surface and extended to 110 cm below surface. The pit contained brown sand with charcoal flecking. No midden or historic materials were observed within the feature. Feature 2 may have functioned as a posthole.

Feature 3
Feature 3 (Figure 29) was located within Trench 5 and present within the North wall. It measured 43 cm wide and 15 cm thick and originated in Layer V, 70 cm below surface and extended to 85 cm below surface. This shallow pit contained charcoal staining, charcoal and midden. No historic material was observed within the pit.

Feature 4
Feature 4 is a small pit located within Trench 6. This feature measured 15 cm wide and 15 cm deep. Originating within Layer IV the top of the feature was 80 cm below surface and extended to 95 cm below surface. The feature, which was observed only in the West wall, contained charcoal staining and flecking but no midden or artifacts. The function of this pit is undetermined.

Feature 5
Feature 5 is a shallow pit located within the West wall of Trench 6. The northern portion of the feature extended into the unexcavated portion of the trench. As a result, Feature 5 measured at least 44 cm wide and 21 cm thick. Originating within Layer IV the top of the feature was 80 cm below surface extending to 101 cm below surface. This feature contained charcoal staining and flecking but no midden or artifacts. This feature appears to have been a firepit.

Table 1. Summary of Features Identified

Feature Number	Trench Location	Feature Type
1	5	Probably the remains of a tree root ball. No midden or artifacts found
2	5	Possibly a post mold. No midden or artifacts found
3	5	Possible fire pit. Contained charcoal staining, charcoal, midden, no artifacts.
4	6	Small pit of undetermined function. Contained charcoal staining and flecking but no midden or artifacts.
5	6	Possible fire pit. Contained charcoal flecking and staining, but no midden or artifacts.
6	9	Probably a historic trash pit. Contained a glass bottle fragment and several earthenware ceramic fragments.
7	12	Probable firepit. Contained charcoal staining, charcoal. shell midden, fish scales, non-human mammal bone. Also collected from the backdirt but not necessarily associated directly with this feature was a broken basalt hammerstone.

Figure 29. Trench 5, Features 2 (left) and 3 (right).

Feature 6

Feature 6 (Figure 30) was located within Trench 9 and observed only in the North wall. The west end of the feature extended into the unexcavated portion of the trench. This feature originated in Layer IV with the top beginning at 78 cm below surface and the base extending to 103 cm below surface. Overall, the feature measured at least 100 cm wide and 27 cm deep. A glass bottle fragment was observed in the pit along with several earthenware ceramic fragments. This feature likely functioned as a historic trash pit.

Figure 30. Trench 9, Feature 6.

Feature 7

Feature 7 (Figure 31) was located within Trench 12 and observed in both the West and East walls. This feature originated within Layer V with the top of the feature 98 cm below surface and extending to 125 cm below surface. The feature consisted of black sand with charcoal, marine shell midden and fish scales. Fire-cracked rock and a medium mammal (non-human) long bone were present within the feature. Also collected from the backdirt pile but not associated directly with this feature was a broken basalt hammerstone. No historic material was observed. Feature 7 is believed to be a traditional firepit.

Figure 31. Trench 12, Feature 7.

6.0 LABORATORY ANALYSES

6.1 Artifact Analyses

Three traditional artifacts were recovered during the excavations along with several historic glass and nail fragments. The traditional artifacts included a small jabbing pearlshell fishhook recovered from STP 5, Layer III and measured 1.2 cm long, 0.8 cm wide and weighed 0.1 grams (Figure 32). Also identified in the same STP were four volcanic glass flakes and a single basalt flake (Table 2).

A coral abrader (Figure 33) was recovered from Layer III in STP 14. The abrader measures 4.6 cm long, 3.2 cm wide, 2.7 cm thick and weights 30.7 grams. The artifact is rounded on one end and was likely used to sharpen or finish fishhooks like the pearl fishhook recovered from STP 5.

A third traditional artifact, a basalt hammerstone fragment (Figure 34), was identified during trenching activities but was recovered from the backdirt pile. Thus no provenience can be established for it. The hammerstone fragment measures 5.5 cm long, 5 cm wide and weights 141 grams (Table 3).

A single historic artifact (a glass perfume bottle) was recovered from Trench 9, Feature 6 (Figure 35). This ornate clear glass and measures 5.8 cm long and 4.2 cm wide (Table 3). A series of ridges extend vertically up the side of the bottle and exhibit some grinding and cutting. The base is flat with no footing or makers marks. The bottle was likely made between the late 1800's and early 1900s.

Artifactual material such as metal nails, window and bottle glass fragments were also dispersed throughout the project area but were mainly identified in STP's 1-4. These remains are tied to the use of the area during the early 20th century.

Concrete and metal debris was recovered from STPs 17, 18, 20 and 21. These items were consistent with the concrete and metal used in the construction of the Natatorium itself and appear to have been deposited as fill fronting the wall making up the promenade. These deposits are associated with the Natatorium itself as are designated part of site 50-80-15-9701

Figure 32. A jabbing pearlshell fishhook recovered from STP 5.

Figure 33. Coral abrader recovered from STP 14.

Figure 34. Hammerstone fragment recovered from backdirt at Trench 12.

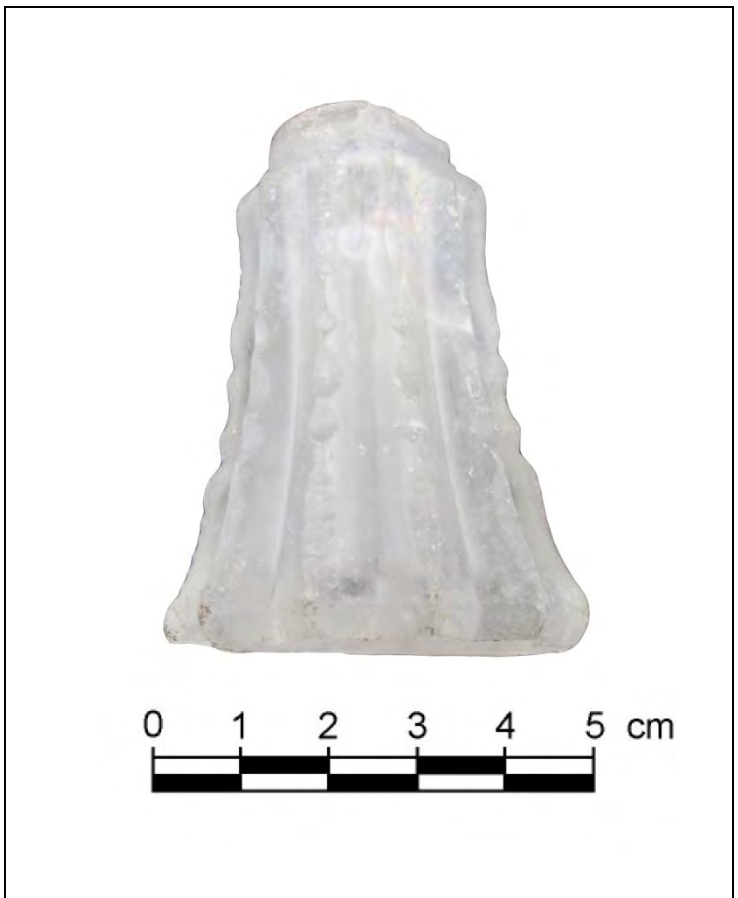


Figure 35. Decorative perfume bottle recovered from Feature 6, Trench 9.

Table 2. Artifacts Recovered From the Shovel Test Pits

Cat. #	Location	Layer/ Feature	CMBS	Category/ Material	Manufacture Style	Description	Qty	L (cm)	W (cm)	Wt. (g)	Condition	Comments
1	STP 1	II	60	Glass	Historic	Bottle, fragment	1			2.4	Poor	Clear glass bottle base fragment. Outside is very worn.
2 (A)	STP 2	III	57	Glass	Historic	Bottle, fragment	1			1.4	Poor	Amber glass bottle finish fragment. Likely from a beer bottle.
2 (B)	STP 2	III	57	Metal	Historic	Nail, Wire, fragments	1,1			5.6	Poor	Rusted metal nail and wire.
3	STP 3	II	50	Glass	Historic	Bottle, fragment	1			3.1	Poor	Amber glass bottle fragment.
4 (A)	STP 4	III	60	Glass	Historic	Window, fragment	1			0.7	Fair	Clear glass fragment. Likely window pane.
4 (B)	STP 4	III	60	Metal	Historic	Nail, fragment	1			1.3	Poor	Rusted metal nail fragment.
5	STP 4	III	70 - 80	Volcanic Glass	Traditional	Volcanic Glass, fragment	1			0.7	Fair	Volcanic glass fragment.
6	STP 4	III	70 - 80	Glass	Historic	Window, fragments	2			1.4	Fair	Clear glass fragments. Likely window pane.
7	STP 4	III	70 - 80	Lava	Natural	Lava Drip	1			2	Fair	Lava drip.
8	STP 4	III	70 - 80	Metal	Historic	Nail, fragments	5			10.8	Poor	Rusted metal nail fragments.
10	STP 5	III	80 - 90	Stone (Basalt)	Traditional	Basalt, flake	1			8.3	Fair	Basalt flake.
11 (A)	STP 5	III	80 - 90	Volcanic Glass	Traditional	Volcanic Glass, flake	1			0.6	Fair	Volcanic glass flake.
11 (B)	STP 5	III	80 - 90	Volcanic Glass	Traditional	Volcanic Glass, flake	1			0.2	Fair	Volcanic glass flake.
12	STP 5	III	80 - 90	Shell	Traditional	Shell, fish hook	1	1.2	0.8	0.1	Good	One piece, point slightly curved, unbarbed shell fish hook. IA(1).
13 (A)	STP 5	III	80 - 90	Volcanic Glass	Traditional	Volcanic Glass, flake	1			0.7	Fair	Volcanic glass flake.
13 (B)	STP 5	III	80 - 90	Volcanic Glass	Traditional	Volcanic Glass, flake	1			0.3	Fair	Volcanic glass flake.
17	STP 7	V	60-80	Glass	Historic	Bottle fragments	2			1.7	Poor	
19	STP 10	II	15	Button	Modern	Shell	2			0.4	Fair	
37	STP 14	III	50-75	Coral	Traditional	Abrader	1	4.6	3.2	30.7	Fair	Coral Abrader

Table 3. Artifacts Recovered From Test Trenches

Cat. #	Location	Layer/ Feature	CMBS	Category/ Material	Manufacture Style	Description	Qty	L (cm)	W (cm)	Wt. (g)	Condition	Comments
34	TR 9	IV / Fe. 6	95	Glass	Historic	Decorative Fragment	1	5.8	4.2	46	Fair	Possible perfume bottle
36	TR 12	-	-	Basalt	Traditional	Hammerstone	1	6	5	141	Fair	Collected from the backdirt pile

6.2 Radiocarbon Dating

A charcoal sample collected from STP 5 (80-90 cm below surface) was submitted to the Wood Identification Laboratory at the International Archaeological Research Institute, Inc. for charcoal identification. This sample was collected from the screen and directly associated with the pearlshell fishhook recovered in the same screen-full of soil. The sample contained four different types of wood --three native species from Hawaiʻi and a Polynesian introduction (Table 4 and Appendix B). The sample of *ʻaʻaliʻi* was submitted to Beta Analytic, Inc. for radiocarbon dating because this short lived species would provide the most accurate radiocarbon date.

Table 4. Taxa Identified During Wood Identification

WIDL No.	Scientific Name	Common/Hawaiian Name	Origin/Habit	Part	Count/ Weight (g)
1125-1	*Aleurites moluccana*	Kukui, candlenut tree	Polynesian introduction/Tree	Nutshell	1/0.06
1125-2	cf. *Rauvolfia sandwicensis*	*Hao*	Native/Tree	Wood	3/0.18
1125-3	cf. *Osteomeles anthyllidifolia*	*ʻŪlei*	Native/Shrub	Wood	2/0.18
1125-4	cf. *Dodonaea viscosa*	*ʻAʻaliʻi*	Native/Shrub	Wood	3/0.07

The carbon sample was quite small so that accelerator mass spectrometry (AMS) radiocarbon dating was necessary. AMS dating at Beta Analytic includes $^{13}C/^{12}C$ analysis, so all samples were adjusted based on the ^{13}C /^{12}C ratio.

The pretreatment for the AMS dating charred material samples consisted of acid/alkali/acid washes where the sample was first gently crushed and dispersed in deionized water. It was then given hot acid washes to eliminate carbonates, then alkali washes to remove secondary organic acids, then a final acid rinse to neutralize the solution prior to drying. During these serial rinses, mechanical contaminants such as associated sediments and rootlets were eliminated.

The results of the radiocarbon dating are summarized in Table 5; Appendix C presents the data sheets. The sample returned a date of 330 $\pm$ 30 and calibrated at 2 standard deviations to AD 1460 to 1650. This places the date of the layer within the mid to late pre-Contact period of Hawaiʻi.

Table 5. Radiocarbon Dating Results

Sample No.	SIHP No. (50-50-xx-xxxx) & Provenience	Material	Measured Radiocarbon Age	$^{13}C/^{12}C$ Ratio	^{13}C Conventional Age B.P.	Calibrated Age[1] (one sigma)	Calibrated Age[2] (two sigma)
Beta 3308137	Site 7211 STP 5; III 80-90 cm bs	Charred material cf. *Dodonaea viscose; ʻAʻali*ʻ	340 $\pm$ 30 BP	-25.5 o/oo	330 $\pm$ 30	AD 1490 - 1600 AD 1610 – 1640	AD 1460 – 1650

6.3 MIDDEN ANALYSIS

A small quantity marine midden (158.1 g) was recovered from four STPs (5, 7, 14 and 15) and from Trench 12, Feature 7 (Tables 6 – 10). The midden from all three units was derived from shallow offshore waters as well as inland march areas. These were varieties of marine resources that were traditionally collected and consumed by the Native Hawaiians. By far the largest collection of midden was represented by Gastropods. These were collected along the rocky shore line and were a common staple in the Native Hawaiian diet. Bivalves are also minimally represented in the collections and could be collected just offshore in the sandy substrates or in slightly brackish waters which were located within the marsh lands of Kapiʻolani Park.

Table 6. Midden Identified from STP 5, Layer III

SAMPLE	WEIGHT (g)
Bivalvia	
Isognomonidae spp.	2.0
Lucinidae spp.	0.2
Mytilidae spp.	1.2
Tellinidae spp.	2.2
Echinodermata	
Unidentified Echinodermata	0.4
Gastropoda	
Conidae spp.	2.5
Cypreaidae spp.	6.2
Nerita polita	0.5
Patellidae spp.	0.1
Turbinidae spp. w/operculum	17.5
Unidentified Gastropoda	0.3
TOTAL WEIGHT	**33.1 grams**

Table 7. Midden identified from STP 7, Layer V

SAMPLE	WEIGHT (g)
Bivalvia	
Lucinidae spp.	0.7
Mytilidae spp.	3.6
Tellinidae spp.	1.5
Echinodermata	
Unidentified Echinodermata	1.2
Gastropoda	
Conidae spp.	0.5
Turbinidae spp.	4.3
Fissurellidae spp.	3.4
TOTAL WEIGHT	**16.7 grams**

Table 8. Midden identified from STP 14, Layer III

SAMPLE	WEIGHT (g)
Bivalvia	
Lucinidae spp.	0.4
Gastropoda	
Conidae spp.	9.7
Nerita polita	0.8
Patellidae spp.	0.4
Turbinidae spp. w/operculum	22.1
Unidentified Gastropoda	0.8
TOTAL WEIGHT	**34.2 grams**

Table 9. Midden recovered from STP 15, Layer III

SAMPLE	WEIGHT (g)
Bivalvia	
Isognomonidae spp.	1.3
Lucinidae spp.	0.5
Mytilidae spp.	1.4
Tellinidae spp.	
Echinodermata	
Unidentified Echinodermata	1.8
Gastropoda	
Conidae spp.	18.3
Cypreaidae spp.	2.8
Nerita polita	0.3
Patellidae spp.	6.9
Turbinidae spp. w/operculum	16.1
Unidentified	11.8
TOTAL WEIGHT	**61.2 grams**

Table 10. Midden Identified from Trench 12, Feature 7

SAMPLE	WEIGHT (g)
Gastropoda	
Cypreaidae spp.	3.0
Nerita picea	0.2
Patellidae spp.	0.2
Turbinidae spp.	5.3
Unidentified Gastropoda, operculum	1.4
Unidentified Shell	2.5
TOTAL SHELL WEIGHT	**12.6 grams**
Fish Scales	0.3
TOTAL WEIGHT	**12.9 grams**

7.0 SIGNIFICANCE

The State of Hawaiʻi has developed a system for evaluating significance of historic properties under Hawaiʻi Administrative Rules Title 13 Chapter 284 (HAR §13-275-6, Rules Governing Procedures for Historic Preservation Review for Governmental Projects covered under sections 6E-7 and 6E-8). This system is patterned after Federal Regulations 36 CFR §60.4 and is meant to provide a framework for the evaluation of significance.

> To be significant, a historic property shall possess integrity of location, design, setting, materials, workmanship, feeling, and association and shall meet one or more of the following criteria as defined in HAR §13-275-6:
>
> Criterion "a" Be associated with events that have made an important contribution to the broad patterns of our history;
>
> Criterion "b" Be associated with the lives of persons important in our past;
>
> Criterion "c" Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;
>
> Criterion "d" Have yielded, or is likely to yield, information important for research on prehistory or history; or
>
> Criterion "e" Have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts--these associations being important to the group's history and cultural identity.

7.1 Assessments of Integrity

While the War Memorial Natatorium Site (50-80-14-9701) continues to become extremely deteriorated, it still retains may aspects of integrity. The Natatorium retains its integrity of location as it is still in the place where it was constructed and where important social and recreational events took place. The Natatorium also retains its integrity of design; the original design of the structure has been maintained, though some aspects are now deteriorated. The Natatorium also retains integrity of setting, materials, workmanship, feeling, and association.

Evaluating the integrity of a buried Pre-Contact cultural deposit (Site 50-80-14-7211 is a little more difficult. Site 7211 does retain integrity aspects of materials and association as it contains faunal (marine shell) and floral (charcoal) remains in association with artifacts (shell fishhook).

It also retains its integrity of location, as it the deposit remains in the area where it was originally developed. This site does not maintain it integrity of design, setting, materials, workmanship, feeling, and association.

7.2 Assessments of Significance

7.2.1 War Memorial Natatorium (Site 50-80-14-9701)

The significance of the War Memorial Natatorium has been recognized by it listing in both the Hawaiʻi Register of Historic Places and the National Register of Historic Places. However, the NRHP nomination form that was filled out in 1979 did not specify the qualifying significance criteria. The Natatorium is currently assessed as significant under the following criteria:

Criterion "a" It is associated with events that have made an important contribution to the broad patterns of our history. This structure was constructed as a "living memorial" to Hawaiʻi men and women who participated in World War I. Annual ceremonies are held to commemorate this. The Natatorium was also the site of national swimming competitions that were important to the social and recreations aspects of Hawaiʻi's citizenry.

Criterion "b" The Natatorium is associated with the lives of persons important in our past. World-renowned swimmers swam and competed in the Natatorium pool, including Duke Kahanamoku, Johnny Weissmuller, and "Buster" Crabb.

Criterion "c" The Natatorium was rendered ina Beaux-Arts style, which was typical of the period when it was constructed. It presents a striking monumental image within an open lawn, beach, and ocean settling.

Criterion "e" The War Memorial Natatorium has value to all Americans and especially those form Hawaiʻi, as well as the descendants of World War I participants from Hawaiʻi. This value is manifested in two annual ceremonies – Veteran's Day and Memorial Day

7.2.2 Pre-Contact Cultural Deposit (Site 50-80-14-7221)

Site 50-80-14-7211 is assessed as significance based on the following criteria:

Criterion "d" This cultural deposit has already yielded information important to our history. It has yielded artifactual, faunal, and floral remains that have provided a glimpse into the Pre-Contact life in this portion of Waikiki. The cultural deposit is in a relatively intact condition, thus having the potential to yield additional important information.

Criterion "e" This site is important to Native Hawaiians as a remnant of their ancient history in the Waikiki. I provides an appreciation and admiration for their forbearers.

8.0 SUMMARY, DISCUSSION, AND RECOMMENDATIONS

Pacific Legacy Inc., under contract to WCP Inc., conducted an AIS at the WWMC in the *ahupua'a* of Waikīkī, island of O'ahu, Hawai'i. (TMK: (1) 3-1-31). The archaeological investigations were conducted to support the EIS for the proposed changes to the WWMC.

The use of the area during the early 20th century has been well documented. Nearly the entire coastline from Diamond Head to the present day aquarium contained a residence of some sort. As we see today, people have always enjoyed living near the ocean and the Kapi'olani Park area provided a beautiful landscape for those who lived there.

During historic times, the project area was initially extensively modified in 1899 with the construction of the W. G. Irwin residence. This mansion was demolished in 1921 for the construction of the War Memorial Natatorium, which still exists today, albeit in deteriorated condition.

At the initiation of the subsurface archaeological survey, the areas to be tested were first investigated using Ground Penetrating Radar (GPR) to identify voids that might have been interpreted as human burials. It should be noted again that the entire area grass area of the Waikīkī War Memorial Complex was not surveyed using the GPR. Only the sections where subsurface survey was conducted was investigated. Although no voids that might contain human remains were noted during the GPR survey and none were found during the subsurface archaeological survey, there is still the possibility that human remains could be present within the project area.

Ten shovel test pits and 12 backhoe trenches were excavated during 2011 excavations. Seven subsurface features were identified within the trenches and a discontinuous cultural layer was also documented in most of the excavations. A single marine shell fishhook was identified in STP 5. A charcoal sample from the layer returned a calibrated date of AD 1460 to 1650. The cultural layer and features has been designated as Site 50-80-14-7211.

The cultural layer is discontinuous and does not appear in all of the trenches. Interestingly, the cultural layer is not present in Trenches 7, 10 and 11 which were all located in the area where the Kodak Hula Show was formerly located. This area was probably filled and leveled to provide a surface for the hula dancers. Any remnants of the cultural layer that may have been present were likely removed during these activities.

The 2018 excavations focused on further defining the boundary of Site 7211. STPs 14 and 15 revealed the cultural deposit, midden, a coral abrader and a possible posthole. These resources are part of the 2011 Site 7211, thus the boundary of Site 7211 was extended ca. 20 meters further to the north including the locations of STPs 14 and 15.

There is no doubt that the project area was settled during the pre-Contact period and provided a Native Hawaiian population a fine location in which to thrive.

The data uncovered during current investigations indicates the importance and use of the area by the Native Hawaiians as documented by the radiocarbon date, shell fishhook and marine shell midden obtained from STP 5 along with the midden and coral abrader from STPs 14 and 15. The numerous pits and substantial cultural layer identified throughout the project area further highlights the intense use of the site during the pre-Contact period; this use undoubtedly extended into the early post-Contact period.

Historic artifactual remains consisting mostly of metal nails window and bottle glass were recovered within several of the shovel test pits. The majority of these remains were concentrated within STPs 1-4. These remains were recovered from above 60 cm below surface and were likely brought in with the fill that was used to flatten and level the park. The single glass perfume bottle recovered from Feature 6 in Trench 9 is evidence of the project area being developed for western residences during the early 20th century. It is probable that additional historic resources and artifactual remains from the time period are present within the park.

The resources documented herein are significant and provide a unique window into the pre-Contact lifestyle within the Kapiʻolani Park area and the Waikīkī Ahupuaʻa. The current investigations identified the presence and context of the deposit as well as determined the size and scale of the cultural resources within the proposed Project Area.

In addition, the concrete and metal debris identified within STPs 17, 18, 20 and 21 are associated with the construction and backfilling of the promenade area fronting the WWMC. These deposits are associated with the Natatorium itself as are designated part of site 50-80-15-9701.

8.1 RECOMMENDATIONS

Given the significant cultural deposit documented during the current investigation along with the presence of subsurface features both traditional and historic in nature, it is recommended that Site 50-80-14-7211 be preserved.

In addition, although no human remains were uncovered during test excavations, there is still a possibility that human remains could be encountered during excavations within the park. Thus it is recommended that any excavations deeper than 50 cm below surface within this area of Kapiʻolani Park should be archaeologically monitored in the event these remains may be encountered.

9.0 REFERENCES

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APPENDIX A

WAR MEMORIAL NATATORIUM

NATIONAL REGISTER FORMS
AND
PHOTOGRAPHS

Form No. 10-300 (Rev. 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

FOR NPS USE ONLY
RECEIVED JUN 5 1980
DATE ENTERED AUG 11 1980

SEE INSTRUCTIONS IN *HOW TO COMPLETE NATIONAL REGISTER FORMS*
TYPE ALL ENTRIES -- COMPLETE APPLICABLE SECTIONS

1 NAME

HISTORIC War Memorial Natatorium

AND/OR COMMON

2 LOCATION

STREET & NUMBER Kalakaua Avenue __NOT FOR PUBLICATION

CITY, TOWN Honolulu __ VICINITY OF CONGRESSIONAL DISTRICT First

STATE Hawaii CODE 15 COUNTY Honolulu CODE 03

3 CLASSIFICATION

CATEGORY	OWNERSHIP	STATUS	PRESENT USE	
__DISTRICT	X PUBLIC	__OCCUPIED	__AGRICULTURE	__MUSEUM
__BUILDING(S)	__PRIVATE	X UNOCCUPIED	__COMMERCIAL	X PARK
X STRUCTURE	__BOTH	__WORK IN PROGRESS	__EDUCATIONAL	__PRIVATE RESIDENCE
__SITE	**PUBLIC ACQUISITION**	**ACCESSIBLE**	__ENTERTAINMENT	__RELIGIOUS
__OBJECT	__IN PROCESS	__YES: RESTRICTED	__GOVERNMENT	__SCIENTIFIC
	__BEING CONSIDERED	X YES: UNRESTRICTED	__INDUSTRIAL	__TRANSPORTATION
		__NO	__MILITARY	__OTHER:

4 OWNER OF PROPERTY

NAME State of Hawaii

STREET & NUMBER 1151 Punchbowl Street

CITY, TOWN Honolulu __ VICINITY OF STATE Hawaii

5 LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC. Bureau of Conveyances

STREET & NUMBER 1151 Punchbowl Street

CITY, TOWN Honolulu STATE Hawaii

6 REPRESENTATION IN EXISTING SURVEYS

TITLE Hawaii Register of Historic Places 80-14-9701

DATE 1973 __FEDERAL X STATE __COUNTY __LOCAL

DEPOSITORY FOR SURVEY RECORDS Department of Land and Natural Resources

CITY, TOWN Honolulu STATE Hawaii

7 DESCRIPTION

CONDITION		CHECK ONE	CHECK ONE
__EXCELLENT	X DETERIORATED	X UNALTERED	X ORIGINAL SITE
__GOOD	__RUINS	__ALTERED	__MOVED DATE______
__FAIR	__UNEXPOSED		

DESCRIBE THE PRESENT AND ORIGINAL (IF KNOWN) PHYSICAL APPEARANCE

The War Memorial Natatorium is a reinforced concrete structure which contains an open air 100 meter by 50 foot swimming pool which is fed by ocean water through a series of coffered locks.

The pool is surrounded on four sides by a twenty-foot wide deck which is enclosed on the three ocean sides by a three-foot high wall. On the fourth, mauka (mountain) side, concrete bleachers rise thirteen levels in height and provide seating for approximately 2,500 people. The bleachers are divided into two parts, each with four sections, with a central entry space separating the two parts.

The Beaux-Arts inspired main entry, with its triumphal arch flanked by two lesser round arches, is the major architectural feature of the Natatorium. A pair of Ionic pilasters support the triumphal arch's entablature which has the words, "The War Memorial" inscribed in its frieze. An elaborate sculpture rises from the entablature. It consists of a garlanded base with an American eagle perched at each corner and the Hawaiian motto and seal in the center. The triumphal arch itself, has a paneled ceiling decorated with hexagonal floral designs. Flanking the triumphal arch, and above the two lower arches, is a medallion with floral patterns and a woman's face in the center in relief. The ocean and mountain sides of the entry are similar.

To either side of the main entrance, the bleacher's rear walls extend approximately 100 feet. Locker rooms are below the bleachers and inset behind centered round arched arcades of seven bays each. Round arched windows, which correspond to the arcade openings, provide the locker rooms with ventilation and illumination. A pair of simple pilasters flank the arcade and support large concrete urns, which project above the bleacher walls and demarcate the end sections of each bleacher. A flagpole with a ball finial is located above the second and sixth openings of each arcade. The bays on either side of the arcade contain office and restroom spaces and are distinguished by rectangular windows with grills.

A ramp leads to the main entry; to either side of this ramp are a volleyball and basketball court. A concrete wall with an incised diamond pattern, encloses these courts. The end walls are stepped, and two bays long at the main entry end and three bays long at the other end. The front walls are five bays long and a tapered concrete column, which originally supported a light globe, is at each pier. At the corners of the entry ramp, these columns are fluted metal and support spotlights which illuminated the triumphal arch entry. A hau arbor, supported by pipes, is adjacent to the front walls.

The War Memorial is situated on the ocean in Kapiolani Park and is surrounded by expansive lawns with a large number of tall coconut trees, a few banyans and other varieties of vegetation.

The basic structure is in poor condition and presently is officially closed, although people still use the facility. There have been no additions, and the only alterations have been the removal of a free-standing clock and diving platform from the deck area, and the removal of several light fixtures.

8 SIGNIFICANCE

PERIOD	AREAS OF SIGNIFICANCE -- CHECK AND JUSTIFY BELOW			
_PREHISTORIC	_ARCHEOLOGY-PREHISTORIC	_COMMUNITY PLANNING	_LANDSCAPE ARCHITECTURE	_RELIGION
_1400-1499	_ARCHEOLOGY-HISTORIC	_CONSERVATION	_LAW	_SCIENCE
_1500-1599	_AGRICULTURE	_ECONOMICS	_LITERATURE	_SCULPTURE
_1600-1699	X ARCHITECTURE	_EDUCATION	_MILITARY	X SOCIAL/HUMANITARIAN
_1700-1799	_ART	_ENGINEERING	_MUSIC	_THEATER
_1800-1899	_COMMERCE	_EXPLORATION/SETTLEMENT	_PHILOSOPHY	_TRANSPORTATION
X 1900-	_COMMUNICATIONS	_INDUSTRY	_POLITICS/GOVERNMENT	_OTHER (SPECIFY)
		_INVENTION		

SPECIFIC DATES 1927 BUILDER/ARCHITECT Lewis P. Hobart

STATEMENT OF SIGNIFICANCE

The War Memorial Natatorium is significant as a major landmark along the Kapiolani Park stretch of Kalakaua Avenue. Rendered in a Beaux-Arts style, which is typical of its period, it presents a striking image of monumentality within its setting of open lawn, beach and ocean.

In 1921, the Territorial Legislature authorized the issuance of bonds to produce $250,000 for the construction, on the former Irwin property, of a memorial dedicated to the men and women of Hawaii who served in World War I. The legislature further provided for the appointment of a Territorial War Memorial Commission to decide upon the form the memorial was to take. The legislature stipulated that a swimming pool of at least 100 meter length be included and a competition be held to determine the most appropriate design. The competition was held under the general rules of the American Institute of Architects. Three architects, Bernard Maybeck of San Francisco, Ellis F. Lawrence of Portland, and W.R.B. Willcox of Seattle, were selected to judge the competition, and Louis P. Hobart of San Francisco won the first prize. Hobart's plans, however, had to be twice modified before they could be implemented in accordance with the budgetary parameters. Thus it was not until 1927 that Mr. T.L. Cliff started construction.

The Natatorium was completed in the summer of 1927, the first "living" war memorial in the United States. The opening ceremonies were held on August 24, and were the major social event of the year. The feelings of the populace were expressed in an editorial appearing in the Advertiser that day: "Tonight the Hawaii War Memorial Opens. It is highly appropriate that this Memorial to the heroes of the World War should be a public natatorium. America went to war to assure safety and independence and the privileges and rights of a free people to all her citizens, and a part of the birthright of a free people is sound health and the opportunity for wholesome recreation. The Natatorium epitomizes Hawaii's prominence in one of the world's great sports. Situated at Waikiki, it looks upon and is part of the ocean, whereof Hawaii is the "crossroad"... No such galaxy of swimming stars has ever been gathered together since the last Olympic Games. The opening of the natatorium will be signalized by the greatest competitive swimming ever seen anywhere in the Pacific, once more giving Hawaii a place of honor and distinction."

The actual ceremonies were colorful and dignified. "Duke" Kahanamoku--who traveled from Los Angeles to open the pool on his birthday--made the first swim, emerging at the end of the 100 meters to a thunderous ovation. It was an unforgettable moment--the man who symbolized the Hawaiian people to the rest of the world opening a memorial whose design captured so well the character of the Territory and its relationship to the sea.

An AAU National championship swimming meet, with swimmers from Japan and South America participating, capped the opening activities. Olympic champion, Johnny Weissmuller, was

9 MAJOR BIBLIOGRAPHICAL REFERENCES

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Honolulu Advertiser, August 24 - 29, 1927.

10 GEOGRAPHICAL DATA

UTM NOT VERIFIED

ACREAGE OF NOMINATED PROPERTY 5.347

ACREAGE NOT VERIFIED

UTM REFERENCES

	ZONE	EASTING	NORTHING		ZONE	EASTING	NORTHING
A	0 4	6 2 1 8 8 5	2 3 5 2 2 5 0	B			
C				D			

VERBAL BOUNDARY DESCRIPTION

This nomination includes the War Memorial Natatorium and Memorial Park which is designated in 1979 by the Tax Map Key: 3:1:31:3

LIST ALL STATES AND COUNTIES FOR PROPERTIES OVERLAPPING STATE OR COUNTY BOUNDARIES

STATE	CODE	COUNTY	CODE
STATE	CODE	COUNTY	CODE

11 FORM PREPARED BY

NAME / TITLE
Don Hibbard and Gary Cummins, architectural historian and historian

ORGANIZATION
State Historic Preservation Office

DATE
November 1, 1979

STREET & NUMBER
1151 Punchbowl Street

TELEPHONE
548-6408

CITY OR TOWN
Honolulu

STATE
Hawaii

12 STATE HISTORIC PRESERVATION OFFICER CERTIFICATION

THE EVALUATED SIGNIFICANCE OF THIS PROPERTY WITHIN THE STATE IS:

NATIONAL ___ STATE X LOCAL ___

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

STATE HISTORIC PRESERVATION OFFICER SIGNATURE [signature]

TITLE

DATE May 28, 1980

FOR NPS USE ONLY

I HEREBY CERTIFY THAT THIS PROPERTY IS INCLUDED IN THE NATIONAL REGISTER

W. Ray Luce [signature] KEEPER OF THE NATIONAL REGISTER DATE 8/11/80

~~DIRECTOR, OFFICE OF ARCHEOLOGY AND HISTORIC PRESERVATION~~

ATTEST: [signature] DATE 8-4-80

~~KEEPER OF THE NATIONAL REGISTER~~

GPO 892-453

Form No. 10-300a
(Rev. 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

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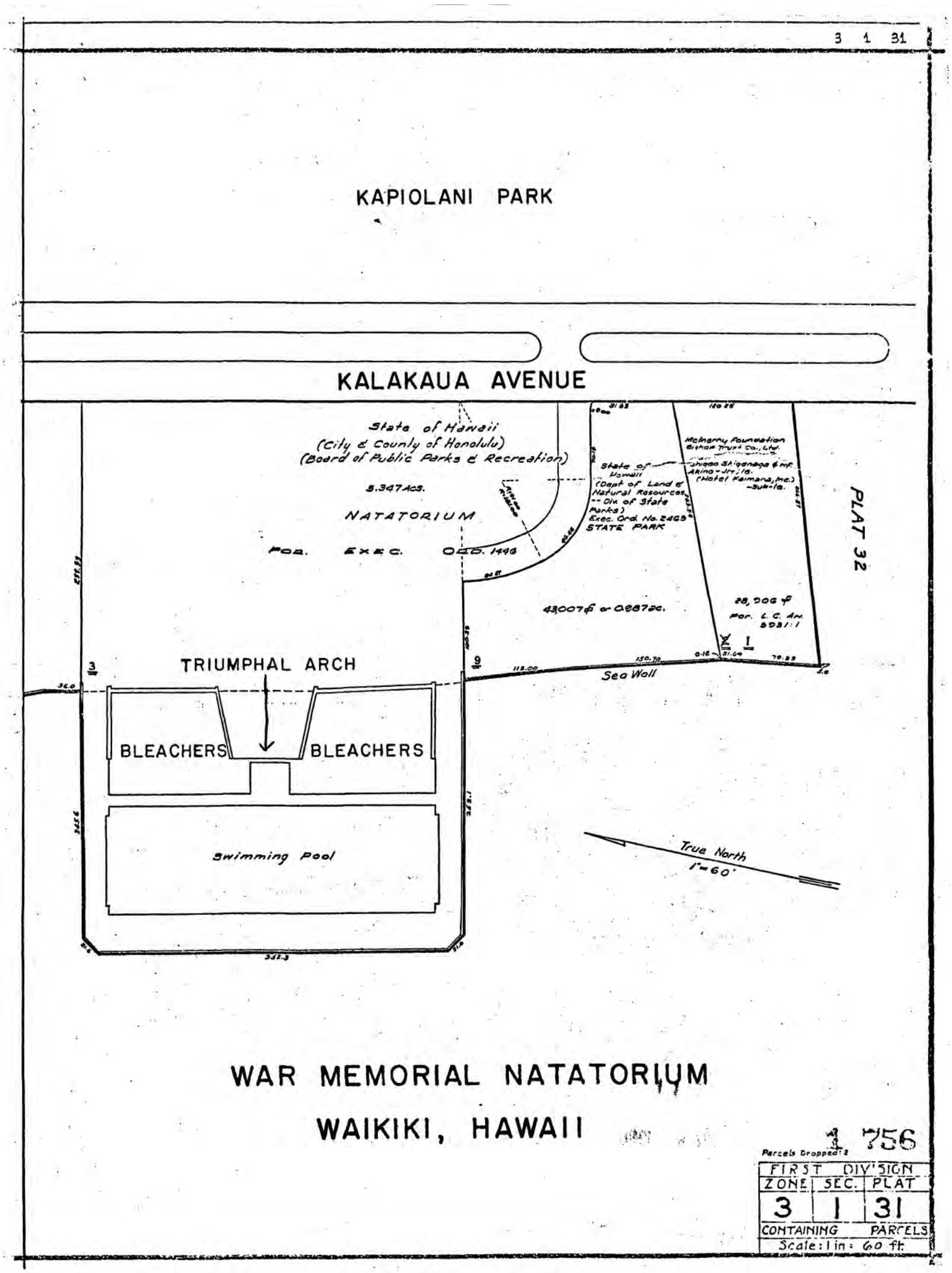
CONTINUATION SHEET ITEM NUMBER 8 PAGE 2

in excellent form, managing to break the world's record for the 100-meter freestyle swim, and in the following three days of competition, set new world's records for the 440 and 880-meter freestyles, cutting more than ten seconds off the previous world marks for these events. Clarence "Buster" Crabbe, a local swimmer, who was later to replace Weissmuller in the famous "Tarzan" series, won the 1500-meter contest.

The natatorium became a social-recreational center for local people immediately, and many important international and national swimming meets were held there. It became a factor in moves toward a "Pan-Pacific" philosophy, at least in the area of athletics.

There were, however, problems. Maintenance gradually became less and less efficient. The job of superintendent of the natatorium was awarded by the Territorial government more on the basis of political loyalty than expertise. Gradually, deterioration set in.

After Pearl Harbor, the natatorium was taken over by the army until 1943, and used for training purposes. Its physical condition continued to deteriorate, and began to take on the proportions of a scandal. In 1949, the natatorium was rehabilitated by the Territorial government at a cost of $82,000 and subsequently turned over to the City and County of Honolulu on July 1. The sporadic and inefficient maintenance of the memorial continued, however, and today, the natatorium is once again in need of extensive rehabilitation, if it is to continue to serve as a major social-recreational center. Although officially closed, the pool still attracts its share of visitors: local swimmers, people seeking to experience the ocean-park-beach scene from a unique space, and spectators who gather nightly to view a serene sunset.


3 1 31
KAPIOLANI PARK
KALAKAUA AVENUE
State of Hawaii
(City & County of Honolulu)
(Board of Public Parks & Recreation)
NATATORIUM
PLAT 32
TRIUMPHAL ARCH
BLEACHERS
BLEACHERS
Swimming Pool
Sea Wall
True North
WAR MEMORIAL NATATORIUM
WAIKIKI, HAWAII
FIRST DIVISION
ZONE SEC. PLAT
3 1 31
CONTAINING PARCELS

Honolulu Co.

War Memorial Natatorium

JUN 5 1980

Waikiki, Hawaii

Photographer: Unknown, 1979

Neg. in State Historic Preservation Office

Looking North

AUG 11 1980

Photo #1 07-5

Honolulu Co.

War Memorial Natatorium

Waikiki, Hawaii

Photographer: Nathan Napoka, 1980

Neg. in State Hist. Pres. Office

Looking North at South Wall

JUN 5 1980

AUG 11 1980 Photo #2 of 5

Honolulu Co.
War Memorial Natatorium
Waikiki, Hawaii JUN 5 1980
Photographer: Nathan Napoka, 1980
Neg. in State Hist. Pres. Office
Looking Southeast at Swimming Pool
AUG 11 1980 Photo #3 of 5

War Memorial Natatorium Honolulu Co.

Waikiki, Hawaii JUN 5 1980

Photographer: Nathan Napoka, 1980

Neg. in State Hist. Pres. Office

Looking South at Entry Elevation

AUG 11 1980 Photo #4of 5

War Memorial Natatorium Honolulu Co
Waikiki, Hawaii JUN 5 1980
Photographer: Nathan Napoka, 1980
Neg. in State Hist. Pres. Office
Looking West at Triumphal Arch
AUG 11 1980 Photo #5 of 5

APPENDIX B

WOOD IDENTIFICATION
GAIL MURAKAMI (IARII)

CHARCOAL TAXA IDENTIFICATION IN A SAMPLE FROM THE WAIKIKI NATATORIUM, O‘AHU ISLAND

By

Gail M. Murakami

October 13, 2011

INTRODUCTION

This report presents the results of taxa identification in one charcoal sample from the Waikiki Natatorium, O‘ahu, performed at the request of Pacific Legacy. Identification of charcoal found in archaeological context can give insight into the vegetation of the surrounding area at the time that the woods were burned. This information can then be used to interpret the environment as well as possible cultural use of specific plants. In this way charcoal samples may be viewed as partial records of the environmental and cultural history of an area.

METHODS

The freshly fractured transverse and tangential facets of the charcoal pieces were viewed under magnification of a dissecting microscope. Taxa identifications were made by comparing the anatomical characteristics seen during examination against those of known woods in the Pacific Islands Wood Collection at the Department of Botany, University of Hawai‘i, and published descriptions.

RESULTS

Examination of the charred wood in the sample resulted in the identification of four taxa (Table 1). Descriptions of the taxa identified are presented below.

Table 1. Taxa Identified in STP 5, 80-90 cm bs, from the Waikiki Natatorium.

WIDL No.	Scientific Name	Common/Hawaiian Name	Origin/Habit	Part	Count/ Weight, g
1125-1	*Aleurites moluccana*	Kukui, candlenut tree	Polynesian introduction/Tree	Nutshell	1/0.06
1125-2	cf. *Rauvolfia sandwicensis*	*Hao*	Native/Tree	Wood	3/0.18
1125-3	cf. *Osteomeles anthyllidifolia*	*‘Ūlei*	Native/Shrub	Wood	2/0.18
1125-4	cf. *Dodonaea viscosa*	*‘A‘ali‘i*	Native/Shrub	Wood	3/0.07

REVIEW OF TAXA

APOCYNACEAE

Rauvolfia sandwicensis A. DC (*Hao*)

This endemic species is a tree or shrub, 3 to 10 m tall, found primarily in mesic forests but also in dry forest or dry shrubland and on lava flows, on all the main Hawaiian islands except Kaho‘olawe at 100 to 800 m elevations (Wagner et al.:1990: 220).

EUPHORBIACEAE

Aleurites moluccana (L.) Wild. (*Kukui*)

Once cultivated, this Polynesian introduction has escaped into the native forest, where the pale foliage of the 10 to 20 m trees (Wagner et al. 1990:598) can be seen in abundance in moist gulches and valleys. Dyes were once extracted from the bark and roots (Buck 1957:187), the oily kernel was burned for light (Buck 1957:107) or eaten as a relish after baking (Buck 1957:48), and net floats and dugout canoes were made from the soft wood (Buck 1957:297).

ROSACEAE

Osteomeles anthyllidifolia Lindl. (‘*Ūlei*)

This indigenous plant can often be found sprawling among the rocks along the coasts but may become an erect shrub up to 3 m tall in other environments. *Osteomeles* is found on all the main islands except Ni‘ihau and Kaho‘olawe and ranges in distribution from sea level to 2300 m in elevation (Wagner et al. 1990:1104-1105). In the past, the hard wood was used to make digging sticks (‘*ō*‘*ō*, fishing spears, carrying poles (‘*auamo*), and a musical bow (‘*ukeke*) (Buck 1957:12, 357, 14, 388). The flexible smaller branches were bent into hoops for fishnets (Neal 1965:387).

SAPINDACEAE

Dodonaea viscosa Jacq. (‘*A*‘*ali*‘*i*)

These indigenous shrubs or small trees are 2 to 8 m tall and range in distribution from coastal dunes to dry, mesic, and wet forest, at 3 to 2,350 m elevations on all of the main Hawaiian Islands except Kaho‘olawe (Wagner et al. 1990:1227-1228). The red papery fruit capsule clusters and leaves of some varieties were made into *lei* (Pukui and Elbert 1986:3).

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APPENDIX C

RADIOCARBON DATING
BETA ANALYTIC, INC.

Beta Analytic Inc.
4985 SW 74 Court
Miami, Florida 33155 USA
Tel: 305 667 5167
Fax: 305 663 0964
Beta@radiocarbon.com
www.radiocarbon.com

Consistent Accuracy . . .
. . . Delivered On-time

Darden Hood
President

Ronald Hatfield
Christopher Patrick
Deputy Directors

November 1, 2011

Dr. Paul Cleghorn
Pacific Legacy, Incorporated
30 Aulike Street
#301
Kailua, HI 96734
USA

RE: Radiocarbon Dating Result For Sample NAT-STP-5

Dear Dr. Cleghorn:

Enclosed is the radiocarbon dating result for one sample recently sent to us. It provided plenty of carbon for an accurate measurement and the analysis proceeded normally. As usual, the method of analysis is listed on the report sheet and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analysis. It was analyzed with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

The cost of the analysis was charged to the VISA card provided. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood
Digital signature on file

BETA **BETA ANALYTIC INC.**

DR. M.A. TAMERS and MR. D.G. HOOD

4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305-667-5167 FAX:305-663-0964
beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Dr. Paul Cleghorn | Report Date: 11/1/2011

Pacific Legacy, Incorporated | Material Received: 10/24/2011

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 308137	340 +/- 30 BP	-25.5 o/oo	330 +/- 30 BP

SAMPLE : NAT-STP-5
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1460 to 1650 (Cal BP 490 to 300)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

Page 2 of 3

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.5:lab. mult=1)

Laboratory number: **Beta-308137**

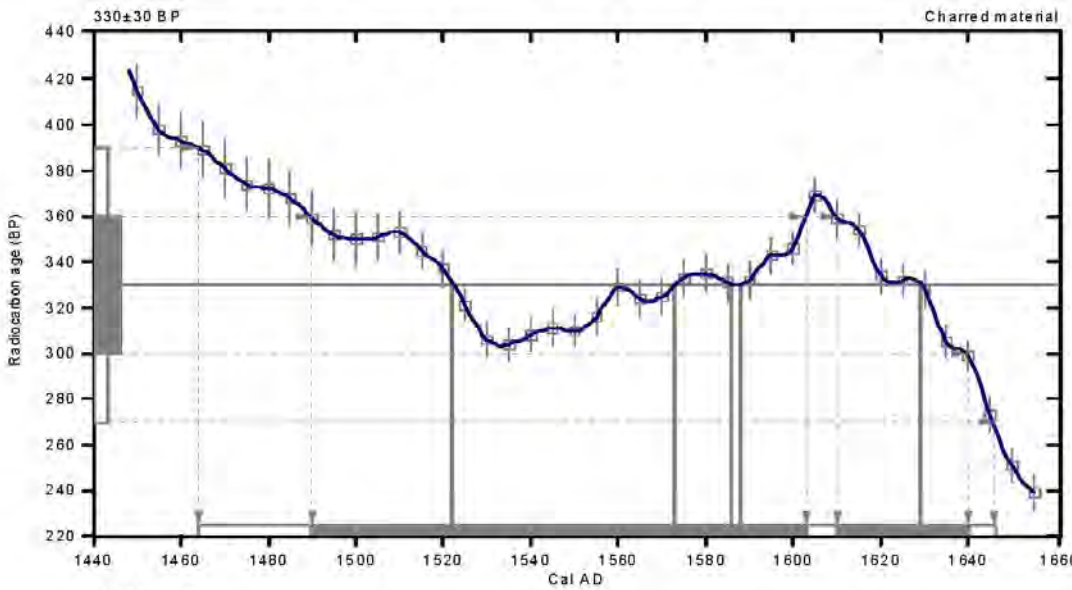
Conventional radiocarbon age: **330±30 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1460 to 1650 (Cal BP 490 to 300)**

Intercept data

Intercepts of radiocarbon age with calibration curve:
Cal AD 1520 (Cal BP 430) and
Cal AD 1570 (Cal BP 380) and
Cal AD 1590 (Cal BP 360) and
Cal AD 1590 (Cal BP 360) and
Cal AD 1630 (Cal BP 320)

1 Sigma calibrated results: (68% probability)
Cal AD 1490 to 1600 (Cal BP 460 to 350) and
Cal AD 1610 to 1640 (Cal BP 340 to 310)



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INTCAL09
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A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

Beta Analytic Radiocarbon Dating Laboratory
4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

Appendix H:
Cultural Impact Assessment

Pacific Legacy

Historic Preservation

CULTURAL IMPACT ASSESSMENT
FOR THE
WAIKĪKĪ WAR MEMORIAL COMPLEX PROJECT
AHUPUAʻA OF WAIKĪKĪ, KONA DISTRICT,
ISLAND OF OʻAHU, HAWAIʻI

[TMK (1) 3-1-031:003, 009, 010]

Pacific Legacy: Exploring the past, informing the present, enriching the future.

CULTURAL RESOURCES CONSULTANTS

Hawaiʻi Office:
Kailua, Oʻahu

California Offices:
Business Office
Bay Area
Sierra/Central Valley

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CULTURAL IMPACT ASSESSMENT
FOR THE
WAIKĪKĪ WAR MEMORIAL COMPLEX PROJECT AHUPUAʻA OF WAIKĪKĪ,
KONA DISTRICT,
ISLAND OF OʻAHU, HAWAIʻI

[TMK (1) 3-1-031:003, 009, 010]

Prepared by:
Kimberly M. Mooney, B.A.
James D. McIntosh, B.A.
and
Paul L. Cleghorn, Ph.D.

Pacific Legacy, Inc.
30 Aulike Street, Suite 301
Kailua, HI 96734
(808) 263-4800

Prepared for:
WCP, Inc.
99-061 Koaha Way, Suite 208
Aiea, Hawaii 96701

October 2018

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ABSTRACT

Pacific Legacy Inc., under contract to WCP, Inc., conducted a Cultural Impact Assessment (CIA) for the Waikīkī War Memorial Complex, located in the *ahupua*ʻ*a* of Waikīkī, Kona District, Oʻahu, Hawaiʻi [TMK (1) 3-1-031]. The project area is situated within Kapiʻolani Regional Park, *makai* of Kalākaua Avenue and between the Waikīkī Aquarium to the north and the New otani Kaimana Beach Hotel to the south. The CIA was conducted as part of an Environmental Impact Statement for the Waikīkī War Memorial Complex. The Waikīkī War Memorial, also referred to as the "War Memorial Natatorium" and simply "The Natatorium," is currently registered on both the State of Hawaiʻi Register of Historic Places (Site No. 80-14-9701) and the National Register of Historic Places (NRIS No. 80001283). However, the Natatorium, which includes the pool, bleachers, façade, and associated features, is severely deteriorated and continues to deteriorate – posing safety concerns for the public.

Archival research has revealed that the land on which the WWMC is located has long and fascinating history. From the archaeological record, traditional stories, and historic documents attributed to this vicinity, it is evident that these lands have been the stage of many significant acts in Oʻahu's pre- and post-Contact history. Oral traditions and historical references to the area are ubiquitous. The broad area surrounding the WWMC has also been subject to numerous contemporary archaeological investigations between 2000 and 2008, resulting in nine individual reports.

Ethnographical evidence obtained through community consultations upholds archival research findings that the WWMC vicinity has been used for a wide variety of cultural practices throughout time, though some of the practices did not survive the extreme changes of the coastline. Several traditional Hawaiian cultural practices have been ongoing since before the arrival of Europeans, while one practice has lain dormant for nearly two centuries and has had a recent revival. A broader community inclusive of all ethnic groups carries out other cultural practices. As evidenced by the archival findings and community consultations, several themes that appear to transcend time and bridge cultural divides have been consistently tied to this area, including ceremony, communal gathering, subsistence collecting, recreation, and sports. These activities range in scope from large organized community events, formal spiritual/religious ceremonies, to activities practiced independently.

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Frontispiece: Front Gates of the Waikīkī War Memorial.

1.0 INTRODUCTION

Pacific Legacy Inc., under contract to WCP Inc., conducted a Cultural Impact Assessment (CIA) for the Waikīkī War Memorial Complex (WWMC), also referred to as the "War Memorial Natatorium" and simply the "Natatorium," located in the *ahupua'a* of Waikīkī, Kona District, O'ahu, Hawai'i [TMK (1) 3-1-031 : 003, 009, 010]. The project area is situated within Kapi'olani Regional Park, *makai* of Kalākaua Avenue (Figure 1). The CIA was conducted as part of an Environmental Impact Statement for the WWMC.

Preparation for this document was conducted in compliance with rules outlined in Chapter 343 (HRS) and Act 50, and Hawai'i State Department of Health (DOH), Office of Environmental Quality Control (OEQC) Guidelines for Cultural Impact Assessments, adopted by the State of Hawai'i Environmental Council in 1997 and amended in 2000 (OEQC). These guidelines mandate that archival research be performed on and around the subject property as well as cultural consultations to provide pertinent information on cultural practices that may be impacted by the proposed development. A copy of the OEQC guidelines is provided in Appendix A.

Community consultations and archival research was performed by Kimberly M. Mooney, B.A. under the general guidance of Paul L. Cleghorn, Ph.D. For this study, eight community consultations were performed. While numerous contacts were pursued, concerted attempts to interview additional informants were unsuccessful. A complete list of contacted members of the community, with project affiliation and communication log is provided in Appendix B.

1.1 PURPOSE

A CIA is designed to promote and protect cultural beliefs, practices, and resources of native Hawaiians, other ethnic groups, as well as other collective groups associated with the subject area. In the State of Hawai'i, under Chapter 343 HRS, and Act 50, SLH 2000, a CIA is required as part of the EIS process, and has the stated purpose to:

1) require that environmental impact statements include the disclosure of the effects of a proposed action on the cultural practices of the community and State; and
2) amend the definition of "significant effect" to include adverse effects on cultural practices.

According to the OEQC guidelines, types of cultural practices and beliefs may include those relating to subsistence, commercial, residential, agricultural, access-related, recreational, as well as religion and spirituality. Further, the CIA was designed to promote and protect cultural beliefs, practices, and resources of native Hawaiians, other ethnic groups, as well as other collective groups (OEQC 2011: 3-4). To determine the effects of the proposed development on cultural practices and beliefs, the following tasks are undertaken:

1) identify and consult with individuals and organizations knowledgeable about cultural practices that may have taken place in the area;
2) conduct archival research about traditional practices that may have been conducted in the area;
3) describe the cultural practices that took place within the potentially affected area;
4) assess the impact of the proposed development on the cultural practices that may have taken place within the potentially affected area; and;
5) prepare a report on the findings resulting from the above investigations.

1.2 METHODS

According to the Office of Environmental Quality Control (OEQC) Guidelines for Assessing Cultural Impacts (OEQC 2011), it is recommended that preparers of CIA implement the following protocol:

1. identify and consult with individuals and organizations with expertise concerning the types of cultural resources, practices and beliefs found within the broad geographical area, e.g., district or *ahupua*ʻ*a*;
2. identify and consult with individuals and organizations with knowledge of the area potentially affected by the proposed action;
3. receive information from or conduct ethnographic interviews and oral histories with persons having knowledge of the potentially affected area;
4. conduct ethnographic, historical, anthropological, sociological, and other culturally related documentary research;
5. identify and describe the cultural resources, practices and beliefs located within the potentially affected area; and
6. assess the impact of the proposed action, alternatives to the proposed action, and mitigation measures, on the cultural resources, practices and beliefs identified.

Archival documents as well as archaeological reports and CIAs focusing on the general locality of the WWMC were consulted to supplement the interviews. Research for background information as well as finding ethnographic interviewees was performed at the following repositories:

- State of Hawaiʻi Historic Preservation Office (SHPD)
- State of Hawaiʻi Office of Environmental Quality Control (OEQC)
- State of Hawaiʻi Public Library
- Ulukau: The Hawaiian Electronic Public Library (http://ulukau.org/)

- State of Hawaiʻi Department of Accounting and General Services, Land Survey Division
- Library of Congress

A list of *kūpuna*, cultural practitioners, and cultural informants viewed as potential interviewees was developed by contacting the Office of Hawaiian Affairs (OHA), elected officials, members of civic clubs, and local *hula hālau* as well as visiting the WWMC to find willing informants. In addition, reference was also made to the Cultural Assessment Provider List available in the OEQC website (http://video.doh.hawaii.gov) and CIAs on file for the area. A full list of potential cultural informants and communication log for the preparation of this assessment is provided in Appendix B and the Ethnographic Interview Questionnaire used as a framework for the interview is provided in Appendix C. Informal interviews were conducted between 8 November 2011 and 28 March 2012. A total of eleven individuals representing a variety of cultural practices and resources were interviewed for this CIA. Transcripts of interviews were not attempted in this assessment; however, audio recordings of four of the interviews were obtained and are on file at Pacific Legacy office in Kailua, Hawaiʻi. Audio recording of the face-to-face interview with Mr. Gary Samura was not attempted due to background noises. The three over-the-phone interviews were not recorded either. Summaries of the interviews were sent to the informant for review and feedback. When the informant was satisfied with the summary, written permission to the information was given by signing an Oral History Study Personal Release of Interview Records form. Copies of release forms completed by interviewees are provided in Appendix D.

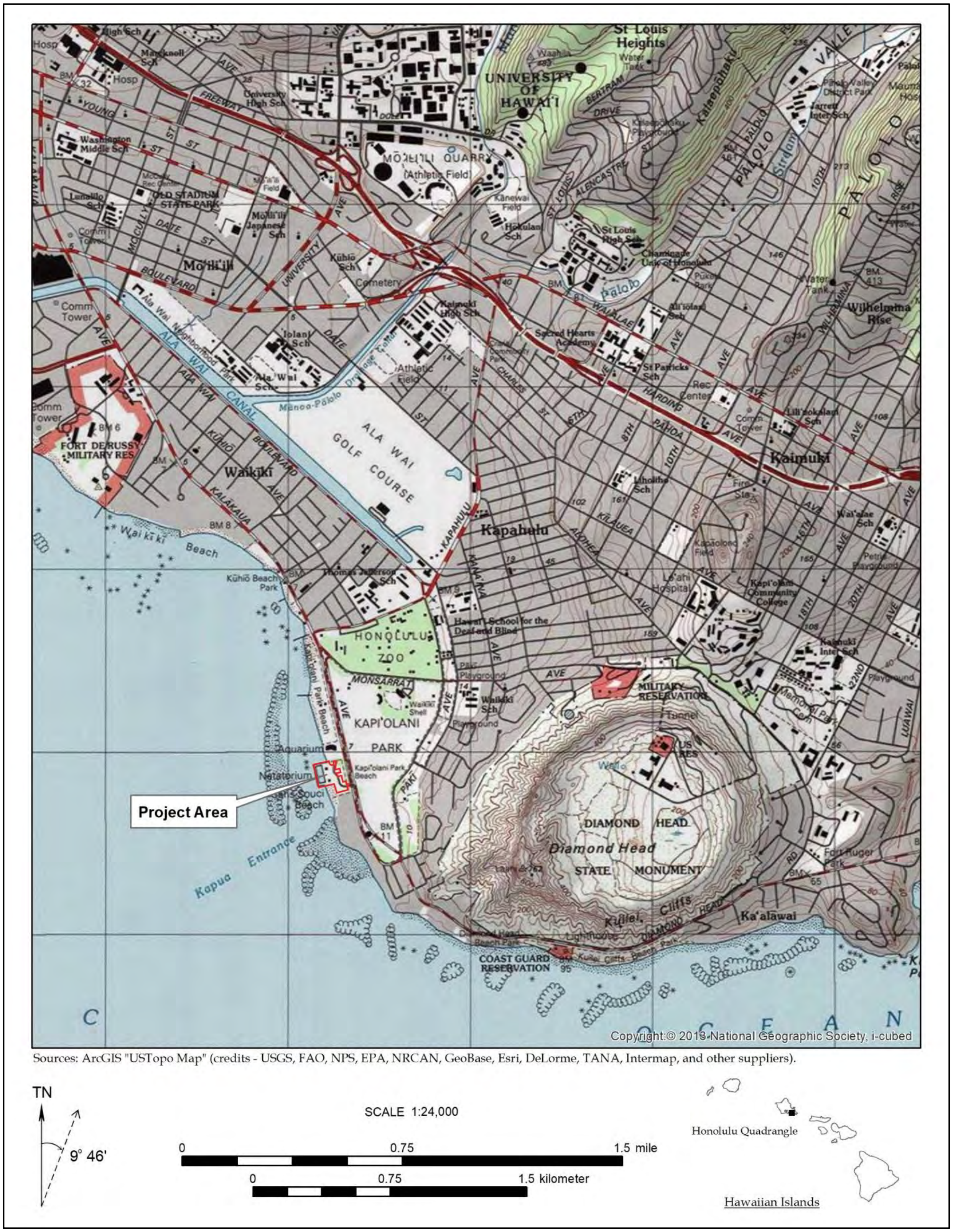

Figure 1. Project Location.

2.0 PROJECT AREA DESCRIPTIONS

Located just to the east of Waikīkī proper, the WWMC served as a "living" war memorial as well as a major outdoor venue for swimming competitions and recreation swimming (NHPR Inventory form - Appendix E) from August of 1927 until its closing in August of 1979. The structure was built upon the littoral zone into the surf zone, making it a central part of the physical as well as cultural landscape of east Waikīkī. The edifice is composed of several architectural elements, including a reinforced concrete Olympic-sized swimming pool built upon the original coastline and coral reef with concrete bleachers adjacent to the pool and an east facing façade that abuts the bleachers, enclosing its internal bathrooms, locker rooms, offices, and storage rooms.

2.1 PROJECT LOCATION

The WWMC is located in southeast Oʻahu on an area measuring ca. 6.3 acres. Specifically, it is situated in the eastern extreme of Waikīkī near Diamond Head, on the west facing shore of Kapiʻolani Park west of Kalākaua Avenue and immediately south of the Waikīkī Aquarium [TMK (1) 3-1-031:006] (Figures 1-3).

2.2 ENVIRONMENTAL SETTING

In the general, the reefs of east Waikīkī are relatively flat and extend out from the beach a few hundred feet on average. The surrounding beach slopes west, into the ocean's shallow reef system. To the immediate south of the WWMC is Sans Souci or Kaimana Beach, which is now a broad sandy expanse that slopes gently to the west into the surf zone. To the immediate north of the subject area is a narrow stretch of sandy beach, referred to as "Public Bath" or Kapiʻolani Park Beach, that is flanked to the east by a north-south running retaining wall, which separates the Waikīkī Aquarium grounds from the beach. On the *mauka* side of the subject area are access ramps, parking stalls, a volleyball court, *hau* tree arbor, grassy lawns, picnic areas, exotic landscaping, benches, a drinking fountain/wash down area, walkways, roadways, and additional components of the World War I Memorial.

The WWMC Natatorium is situated on the level, low-lying coastal area of Waikīkī, from 0 to 3ft (feet) above mean sea level (AMSL). The majority of the WWMC Natatorium is built offshore, thus, it is both below and above mean sea level. The coastal slope generally ranges from 0 to 15 percent, and in most places, does not exceed 10 percent.

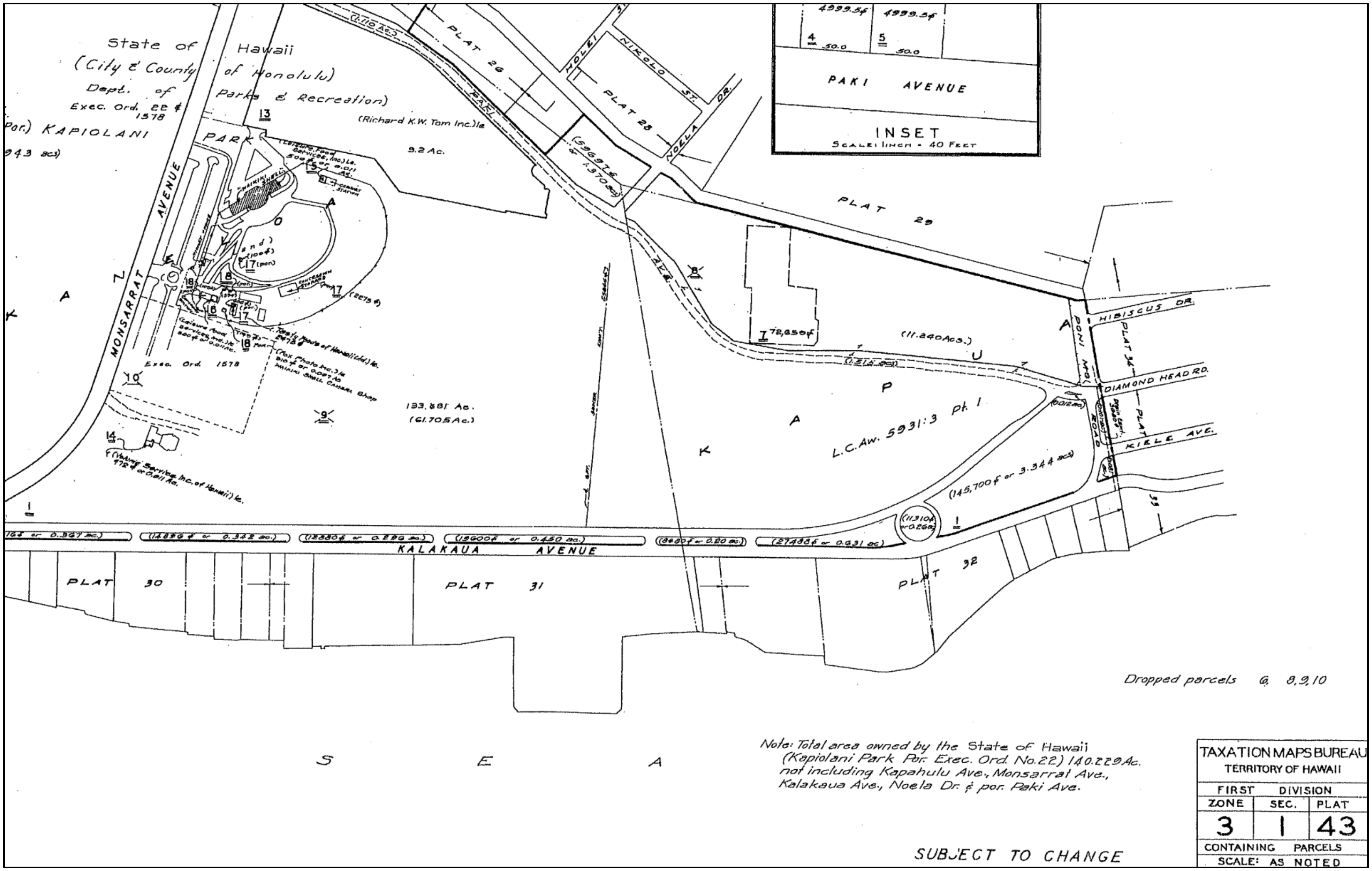

Figure 2. TMK map prior to purchase of WWMC lands.

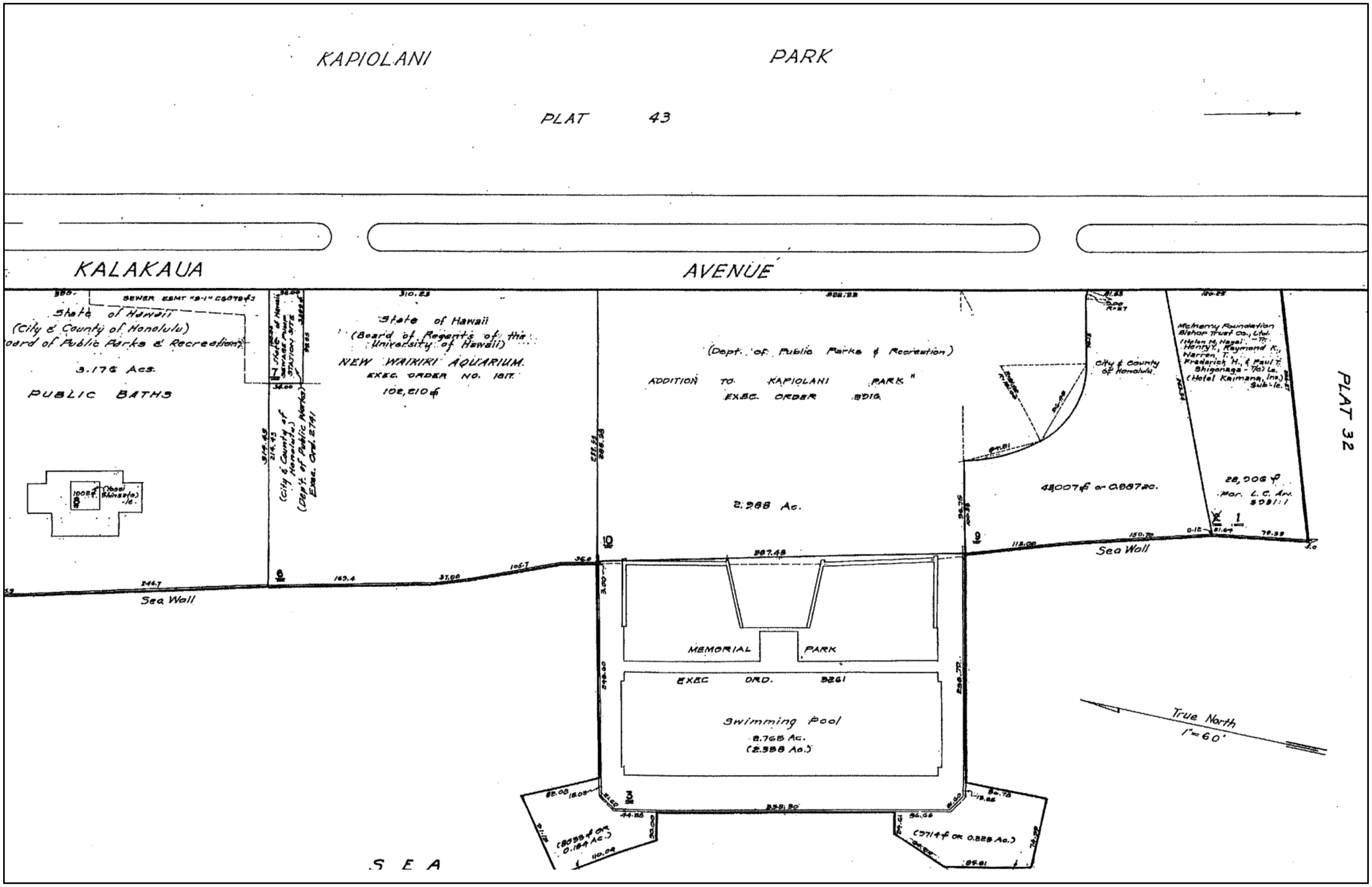

Figure 3. TMK map with WWMC plans.

This area of Waikīkī receives less than 20 inches of rainfall annually (Juvik and Juvik 1998:56) with the dominant trade winds coming from the Northeast. Vegetation within Kapiʻolani Park is ornamental in nature and consists of ironwood trees (*Casuarina equisetifolia*) coconut trees (*Cocos nucifera*), *hau* (*Hibiscus tiliaceus*), *milo* trees (*Thespesia populnea*), banyan trees (*Ficus* spp.**)**, shower trees (*Cassia* spp.) and various shrubs and grasses.

The natural soil deposits within the project area are derived from two sources: Jaucas Series and Beaches.

> **Jaucas Series**
> Jaucas series consists of excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean…They develop in wind- and water deposited sand from coral and seashells (Foote et al 1972: 48).
>
> **Beaches**
> Beaches occur as sandy, gravelly, or cobbly areas on all islands…They are washed and rewashed by ocean waves. The beaches consist mainly of light-colored sands derived from coral and seashells (Foote et al. 1972: 28).

2.3 Description of the Waikīkī War Memorial Complex

Built in 1927 to honor the soldiers who fought and died in World War I, the WWMC is made up of approximately a 6.3-acre area that consists of the Natatorium (pool area), Memorial Park (the area in the TMK between the mauka side of the Natatorium and Kalākaua Avenue), and Sans Souci Beach (land portion, not beach/water). The War Memorial Natatorium was entered in the National and State Register of Historic Places in 1980 (NHRP Reference No. 80001283; Hawaiʻi Site No. 80-14-9701). The site is also within the Urban State Land Use District, the City and County of Honolulu's P-2 General Preservation Zone, Diamond Head Special District, as well as Kapiʻolani Park (Daly 1995:1-1). The architectural style of the Natatorium is classified as Beaux-Arts style, which is typical of its construction period. A thorough description and background of the WWMC can be found in the National Register of Historic Places Inventory – Nomination Form, which is provided in Appendix E.

The natatorium sea water swimming pool measures 100 meters by 40 meters that is surrounded by a 20 foot deck on all four sides and has an unfinished bottom that is covered with sand. When in operation, the pool was fed filtered sea water by a series of coffered locks leading from the pool to open waters. Rising over 20 feet above the *mauka* side of the pool on either side of the entrance are four sets of thirteen-step concrete bleachers, which seat approximately 2,500 spectators. Below the bleachers are locker rooms, offices, restrooms, arcades, and bays. The *mauka* façade has a series of six urn sculptures and contains a 38 feet high central arch which is topped with two large eagle and a coat of arms sculptures. The central arch is flanked by two 12 feet high arches. Other architectural elements include decorative ball finial flagpoles, pilasters, a frieze, columns, light globes, ornate wall and ceiling panels, cast iron gates and grills, as well as fluted metal spotlights.

Flanking the main structure towards the east are low walled outdoor areas, including a volleyball court, sidewalks, access ramps, driveways, parking spaces, as well a walkway framed by a pipe trellis covered in *hau* (*Hibiscus tiliaceus*), grass lawns, and picnic benches. Figure 4 provides an aerial view of the WWMC grounds and Figures 5-6 provide close up views of the WWMC Natatorium.

2.4 Current State of Project Area

Since 1979, the natatorium or swimming facility of the project area has been closed to public use due to structural integrity failures causing major safety concerns. According to the NHRP nomination form (Appendix E), the structure was listed in poor condition as early as 1980. Daly (1995) describes the integrity of the Waikīkī War Memorial's architectural elements as stated in the 1990 Planning Report:

> 1. Seawall
>
> Portions of the seawall above the deck have experienced severe concrete spalling (chipping, flaking) of concrete and corrosion of concrete reinforcing.
>
> Below the deck the seawall appears to be intact, except for several vertical cracks through the wall which may be related to construction joints.
>
> 2. Pool Deck
>
> The concrete pool deck has experienced extensive corrosion of reinforcing and spalling of concrete on the underside. In some areas the deck has collapsed. The beams and pile caps have also experienced significant corrosion of reinforcing and have extensive cracking. Many of the beams that support the deck have large vertical cracks at the supports which shows large vertical movement. The piles appear to be in good condition. The diving tower is no longer a part of the facility, having been removed at an earlier date.
>
> 3. Swimming Pool Bottom
>
> In general, the bottom of the swimming pool is covered with a layer of fine gray silt ranging from a couple of inches to a foot thick. There is a pocket of silt up to 5 feet thick to the makai side of the center of the pool where the diving well was originally located. Apparently, this area has been filled with silt. Throughout the pool, the top 1-2 inches of silt has a soupy consistency. Below this, the silt is compacted and is slightly granular. The sub-bottom appears to be composed of gravel or coral rubble.
>
> 4. Bleachers
>
> The risers for the bleachers appear to be in good condition except for the delaminating of the topping. The top of the bleachers have at least two coats of cementitious topping material applied to it. The steel pipe railings that are located around the portals at the middle of each set of bleachers show signs of rusting at the supports.

5. The Area Beneath The Bleachers
The area beneath the bleachers is extremely dirty and is a complete shambles. Dirt, broken glass, spalling concrete, and debris cover the floors. The underside of the bleacher slab over the original shower and locker room areas are badly damaged due to reinforcing bar corrosion and spalling throughout its entire length. Here are extensive areas of spalling in the underside of the Ewa bleacher slab around the arcade wall.

6. Memorial Arch and Arcade Walls
The arcade wall is intact except for the concrete spalling at the base of the columns. There is a large crack on the mauka face on top of the Ewa end wall. There are also spallings in the interior face at the base of the Ewa end wall. The top portion of the arcade wall is the guard rail for the bleachers and it has spalled extensively of the makai side. The original finish and architectural features of the arcade wall were done with cement plaster. Cracks, mildew, stains, and spalls occur throughout the entire surface area. In many areas the plaster has delaminated from the substrate.

The nonbearing window walls behind the ‘Ewa arcade wall appears to have settled. Drawings for the construction of the existing facility do not show any footing under this wall. The settlements are evident in the cracking at the bleachers’ supporting beams in this location. The lack of any separation between this wall and the slab has resulted in portions of the underside of the slab being pulled off by the settling wall. It appears that the wall has pulled down the beams that support the slab. In this area the concrete beams show numerous spalls and vertical cracking.

7. Outdoor Courts, Ramps, and Guardrails
The decorative concrete guardrails that surround the outdoor courts in front of the arcade wall show extensive spalling. Large portions of the guardrails have collapsed. Severely corroding reinforcing is visible in many areas. The spalling appears to be the result of embedded conduit in the concrete which has corroded. The concrete paved areas show numerous cracks and in many areas the pavement has settled. The existing volleyball courts are located over the original Diamond Head reflecting pool which has been filled in and paved with asphalt. The volleyball courts are in usable condition but need resurfacing (Daly 1995:3-19, 3-24 to 3-26).

Daly (1995) goes on to describe the plumbing and lighting systems that also appear to be in poor condition in the early 1990s. This commentary makes evident that the War Memorial Natatorium was nearly in a state of disrepair over 20 years prior to the current CIA report.

Figure 4. Current aerial of the WWMC complex (courtesy of Google Earth).

Figure 5. State of WWMC Natatorium, view to west.

Figure 6. WWMC Natatorium south deck, view to west.

2.5 Environmental Impact Statement Alternatives

The original research for this CIA was conducted in 2011. At that time three alternatives were considered:

- Construction of a War Memorial Beach with extensive demolition of component parts of the existing Natatorium;
- Reconstruction and Restoration of the Natatorium now referred to as a Closed Pool; and
- No action.

These alternatives were not acceptable to historic preservation stakeholder. Consequently, the City re-initiated HRS Chapter 6E consultations during the summer of 2016 (see EIS Appendix A). This was followed by a workshop in July 2017 with the following participants:

- Friends of the Natatorium
- Historic Hawaiʻi Foundation
- American Institute of Architects, Honolulu Chapter
- National Trust for Historic Preservation
- State Historic Preservation Division

These meetings and workshop resulted in the advancement of a fourth alternative:

- Construction of a Perimeter Deck

Each of these alternatives are described below and illustrated in Figure 7 through Figure 9. For more details or specific information regarding these alternatives, the reader is referred to the EIS for the WWMC.

Alternative 1 - Perimeter Deck
The Perimeter Deck is illustrated in Figure 7. This alternative would retain the bleachers and arches, and rehabilitate the deck around the Natatorium, while removing the less visible submerged structures (such as the makai and ʻEwa seawalls) which block the free flow of water between the swim basin and open ocean. This alternative would expose the entire pool to the coastal waters. The Perimeter Deck would result in the demolition of the makai and ʻEwa side seawalls of the swim basin and reconstruction of the deck on support piles, allowing for the free flow of water between the ocean and a swim basin area. The shape, configuration, and size of the decking would be retained, resulting in the structure's appearance emulating the original facility when seen from above. The Diamond Head groin would remain and be structurally improved to ensure the retention of Sans Souci (also known as Kaimana) Beach. The bleachers arch, and other existing elements of the Natatorium structure would also remain and be restored to their historic appearance.

The Perimeter Deck proposes minimal land-side improvements. Existing land-side conditions including landscaping, parking, access, and drainage would remain as they currently exist at the site. Construction of a new paved walkway that extends the existing Kapiʻolani Regional Park shoreline promenade to Kaimana Beach. The promenade currently ends near the boundary between the Waikīkī Aquarium and the project site. Restore level surface leading to the Roll of Honor plaque (limited to universal access).

Alternative 2 - War Memorial Beach
The War Memorial Beach is illustrated in Figure 8. This alternative would create a beach between constructed groins, fronted by a replica memorial arch in alignment with the existing Roll of Honor plaque and hau tree arbor. The entire Natatorium structure, i.e., everything built seaward of the 1927 shoreline, would be removed. Various landside improvements would also be undertaken. As noted, this alternative (removal of the Natatorium and creation of a new beach) was the recommendation made to the City by the Task Force in September 2009 and corresponds to the City's "proposed action" at the time of the 2014 FEA-EISPN. <u>The 2011 archaeological investigations were focused on this alternative.</u>

The War Memorial Beach alternative would relocate the memorial arch, demolish other elements of the Complex, and construct a public beach and lagoon in place of the existing saltwater pool. This alternative would use portions of the existing seawall combined with new rock, concrete walls and groins to create a protected beach and swimming area within the Natatorium footprint that would remain stable while still providing for active flushing of the water. The existing hau trees, trellises, coconut trees, and three large trees on site would be maintained, as well as the exceptional and historic trees along Kalākaua Avenue. Additional plantings would conform to a master tree and shrub planting plan. Lawn areas would be rehabilitated and the irrigation systems upgraded and automated.

The War Memorial Beach landside park improvements and changes include:
Construction of a new bath house and outdoor shower facility on City park lands mauka of the Complex. Replacement of the internal road/parallel parking that bisects the site with a consolidated lot at the park's south side. The capacity of the new parking lot would be sufficient to retain the same number of stalls (77) currently at the park. The existing curb cut on Kalākaua Avenue would be reused to access the new parking lot.

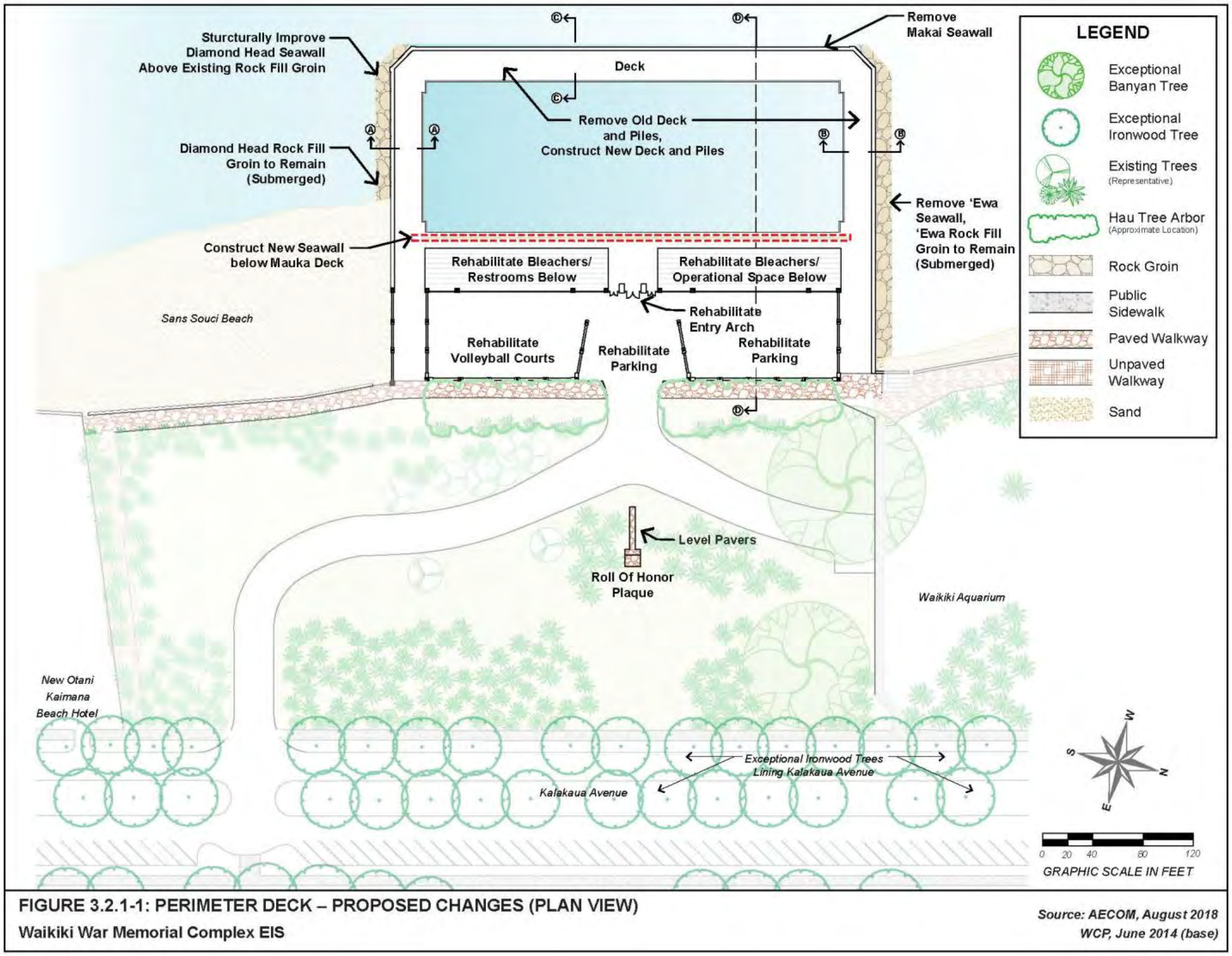

Figure 7. The Perimeter Deck Option.

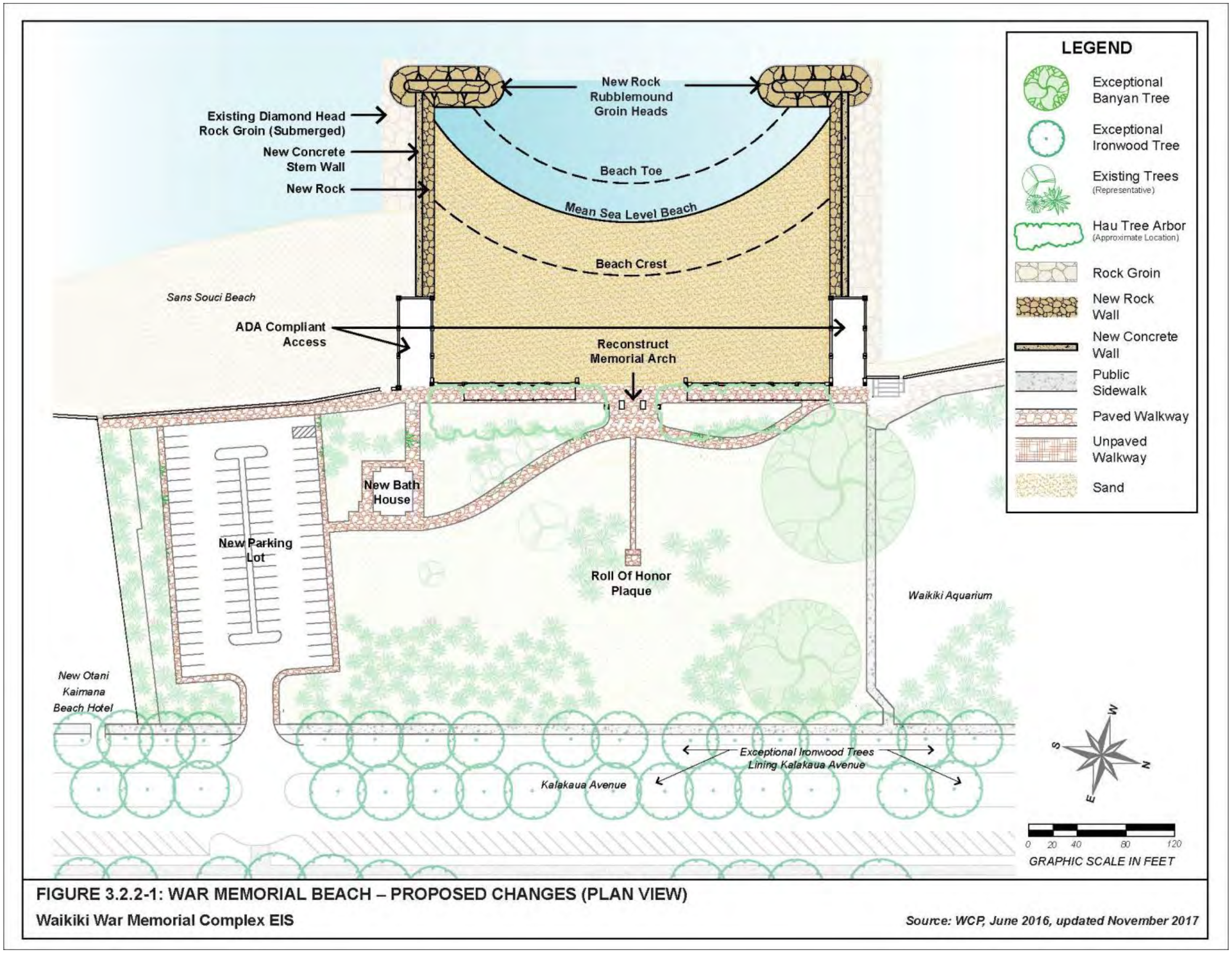

Figure 8. The War Memorial Beach Option.

Alternative 3 - Closed System Pool (previously "Reconstruction and Restoration of the Natatorium")

The intent of the Closed System Pool is to renovate the Natatorium to its historic character. This alternative involves maintaining the Natatorium structures while constructing a concrete-lined fresh water swimming pool in place of the saltwater pool (Figure 9). In addition to the pool, other challenges to the land-side mechanical facilities would need to be considered. The spaces beneath the bleachers may not be able to accommodate the required mechanical equipment, the office space currently used by the Ocean Safety and Lifeguard Services Division office, and the existing restroom facilities. Due to its historic status, and to avoid compromising its historic integrity, a new adjacent building to house the mechanical equipment (e.g., pumps, filters, and surge tanks) would need to be carefully accommodated within the site, likely in the parking area.

Under this alternative, the entire Natatorium structure would be maintained. Presently, the bleacher structure continues to deteriorate, requiring emergency work to remove loose concrete and perform limited patching that allows continued use of the bathroom facilities. A repair project and other improvements would have to be implemented to ensure continued use of the bleacher structure and spaces below. Repair work would include, among other things, waterproofing and new plasterwork for the bleachers, addressing areas that have spalled and cracked, and possible localized reconstruction in targeted areas. Due to the lifecycle costs of continual monitoring and maintenance, the option of reconstructing the bleacher structure, as originally planned, should be explored. This alternative assumes that the bleacher structure would be repaired and would require continual monitoring and maintenance.

The Closed System Pool does not propose any land-side improvements. Existing land-side conditions including landscaping, parking, access, and drainage would remain as they currently exist at the site.

Alternative 4 - No Action

No action represents the baseline conditions for which the action alternatives are evaluated. Under No Action, the WWMC would remain in its current dilapidated condition and the pool and bleachers would remain closed to the public. There would be no change to the land use or facilities that currently exist at the site. This alternative would maintain the status quo and all structures would remain in place and continue to deteriorate.

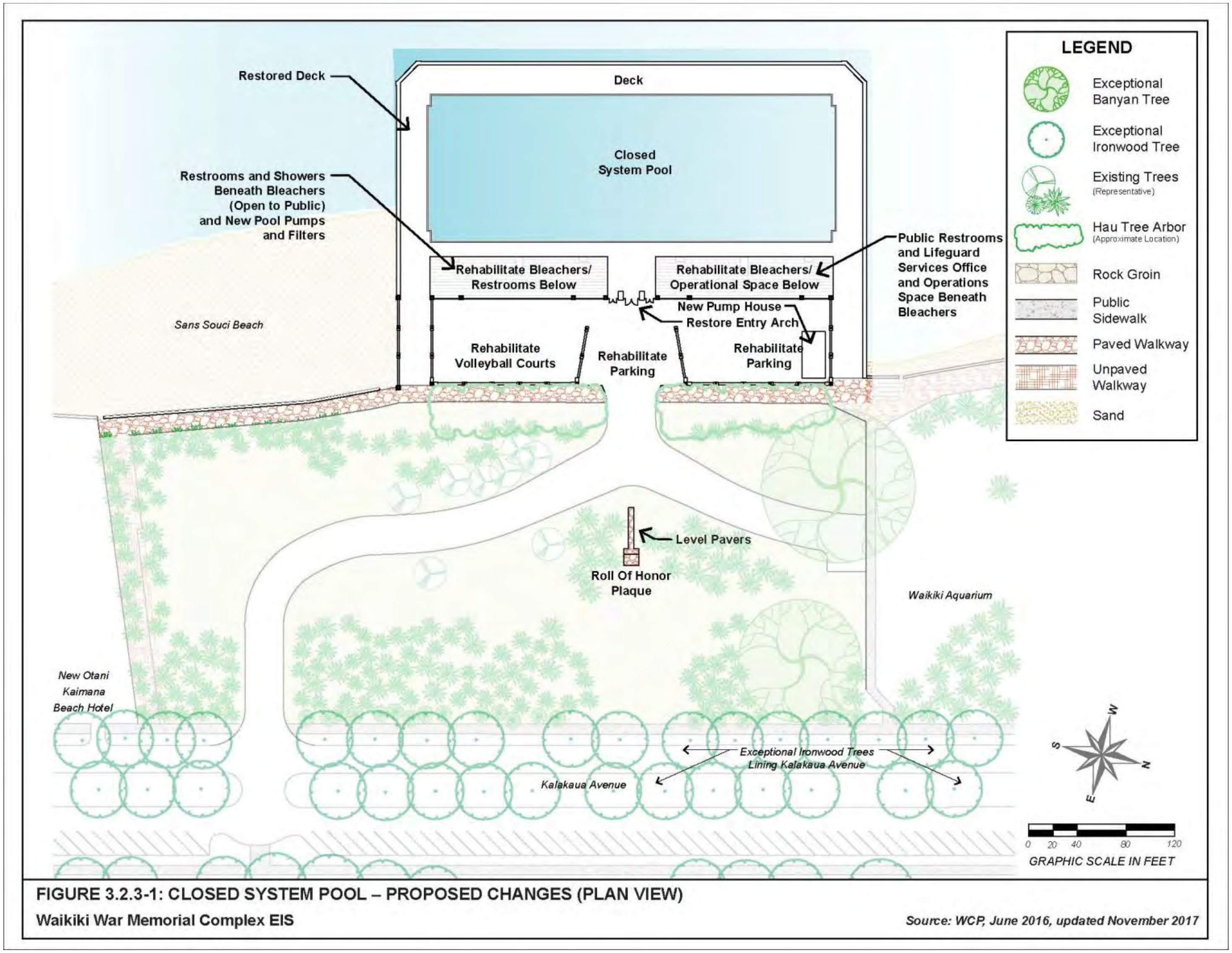

Figure 9. The Closed System Pool Option.

3.0 THE PRE- EUROPEAN CONTACT LANDSCAPE

A number of oral traditions have been recorded that help describe the physical, mystical, and cultural landscapes of Waikīkī and Diamond Head areas. The WWMC is located in an area that has considerable significance in terms of traditional Hawaiian history and legend.

3.1 TRADITIONAL LOCALES

The WWMC is situated on the western flank of Waikīkī and is the easternmost *ahupua*ʻ*a* of Oʻahu's Kona District, or *moku*, which extends from Mānoa on the west to the *ahupua*ʻ*a* of Maunalua on the east. However, in the well referenced book, *Sites of Oahu*, Sterling and Summers (1978) do not list Waikīkī as an *ahupua*ʻ*a* but, rather, as a locality bordering Diamond Head to the west and at the *makai,* or coastal, extremity of Mānoa and Pālolo *ahupua*ʻ*a*. The *O*ʻ*ahu Pre-Mahele Moku and Ahupua*ʻ*a* map created by Kamehameha School's Hawaiian Studies Institute in 1987 also has a different interpretation of Waikīkī's borders (Figure 10).

In pre-Contact times, the landmarks and localities of Waikīkī carried a variety of colorful names, connotations, and cultural functions. The traditional name for the general area in which the WWMC is located was referred to as Kapua in ancient times. Several Historic maps of the area (Lyons 1837, 1881; Brown and Monsarrat 1883) show the general area in which the WWMC is located as Kapua (Figures 11 and 12). Accounts of Kapua as a coastal and inland locality, surfing spot, and boat channel/landing in the pre-Contact and early Contact era are ubiquitous, although there are several references to Kapua Heiau. Pukui et al. (1974:89) suggest that the name of the Waikīkī surf spot, Kapua, may simply carry the literal translation to English, "the flower" as the meaning. However, Clark (2003) maintains that Kapua translates to English as "the fish spawn or the fry" (Clark 2003:165).

One cultural practice that has had a constant association with Kapua is surfing. Thrum (1925) translated an 4 August 1869 article from Kuokoa, which holds that Kaʻahumanu, in her grief over the recent deaths of Kanihonui and Keʻeaumoku, proclaimed Kapua as a exceptional surfing locality and invited all of the *ali*ʻ*i* to recreate there. The translation is as follows:

> After the death of Kanihonui the mind of Kaahumanu dwelt thereon; she could not readily dismiss the thought. This event was preceded by the death of Keeaumoku, the father of this chiefess, by the plague; therefore she was sent to a disconcerting place, but to no purpose. And because it gave her no rest, she thought to take the government from the king and the young prince by the process of war.
>
> But prior to the time for conference relative to the war, a great surfing day at Kapua, Waikiki, was proclaimed. i.e., the flag announced the fine surf at that place, and it afforded an unobstructed view of the Leahi heiau, where was placed the dead body of Kanihonui, till the end of the ceremonies connected therewith as practiced in those days. It is said that Kaleihaeana alone was the watcher over the dead body till its decomposition.

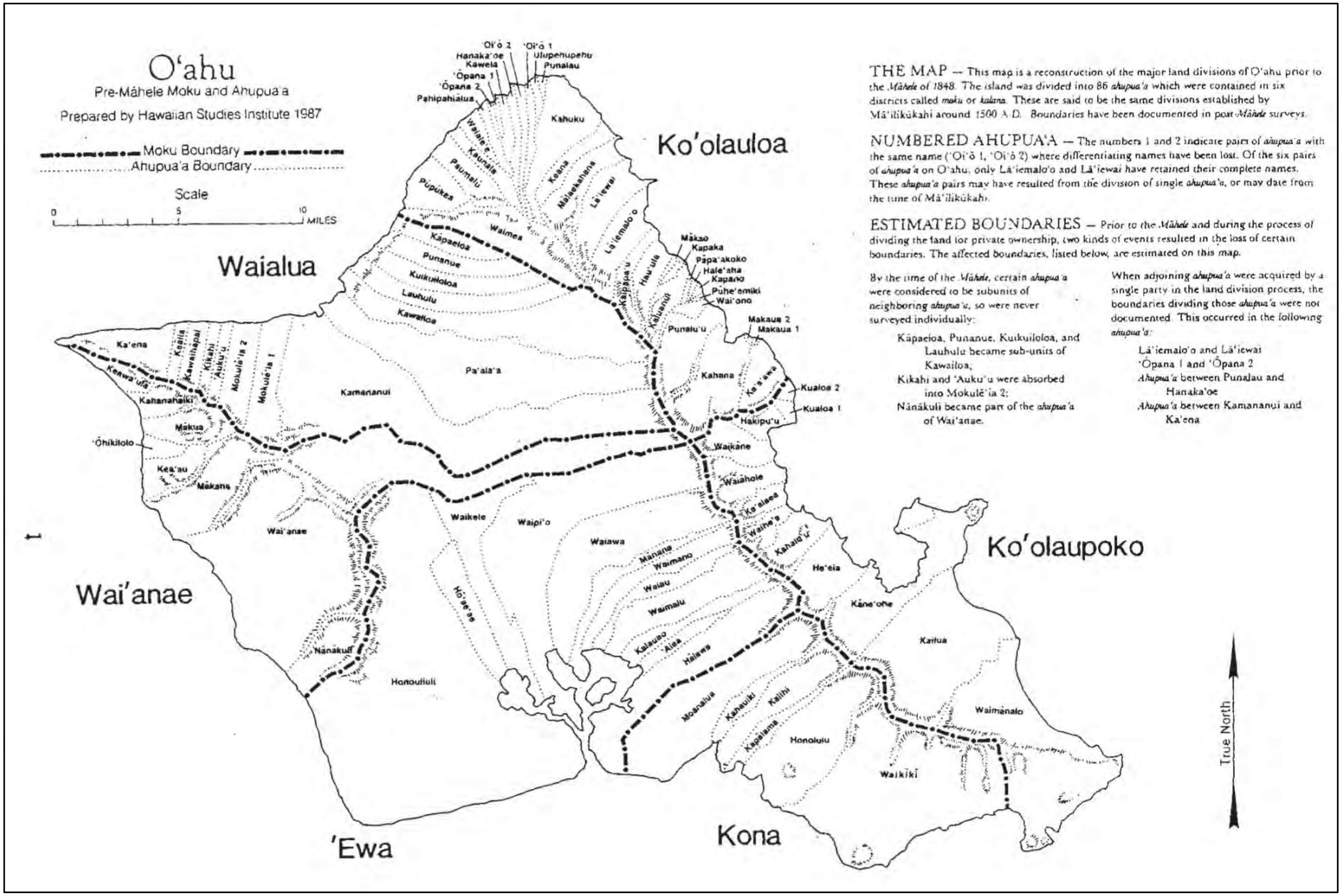

Figure 10. ***O'ahu Pre-Mahele Moku and Ahupua'a*** **map (Courtesy of Kamehameha Schools)**

On the day of the announcement all the chiefs, chiefesses, nobles, and the young prince also, gathered together, as the king had summoned all his people from near and far to be ready. And so it was that he sent a messenger after them who would report to him their conferences. It is said that Kenopu was the first messenger; also that Kapua held three main attractions; these were surfing, the many gathered to participate therein, and the bringing with them of intoxicating liquor. This was their idle pleasure there till evening. (as translated in Thrum 1925:112).

There are also many references to Kapua as a channel, boat harbor, canoe landing, and a sea. In Fornander's (1917) story of "The Sixth Battle, "which was between Kamehameha and Kalaikupule at Nu'uanu, Kamehameha's first canoe fleet landed at Kapua.

Figure 11. Portion of 1880 C.J. Lyons Map of O'ahu showing Kapua as a region.

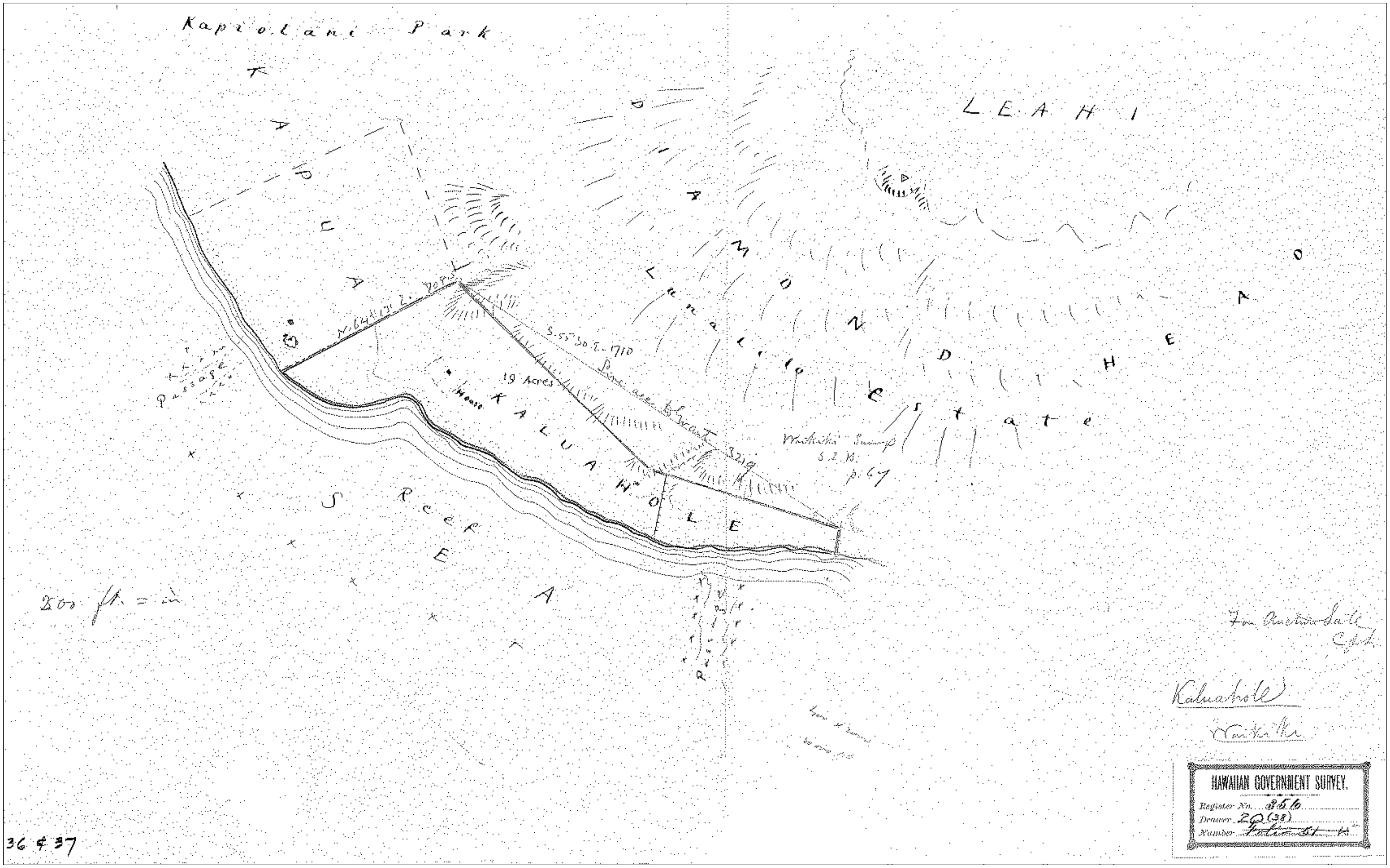

Figure 12. C. J. Lyons 1837 Map of Kaluahole, Waikīkī showing the area of Kapua.

3.2 MOʻOLELO

In the "Legend of Pumaia," Fornander (1917:470-476) retells a story about a pre-Contact pig farmer, who had such love for a certain pig that he refused to give it to the Oʻahu *mōʻī,* Kualiʻi, who was in the process of building Kapua Heiau and needed sacrificial pigs at the completion of the project. When Kualiʻi sent his warriors to obtain the last and most beloved of Pumaia's pigs, Pumaia killed all but one of the warriors, who returned to Kualiʻi with the story of Pumaia's triumph over his men. Kualiʻi sent war party after war party to capture Pumaia, but he overcame each group of warriors until Kualiʻi prayed to his god, Kanemuka. Kualiʻi's god helped him capture and kill Pumaia, whose body was then dragged back to Kapua Heiau, mutilated, and then thrown into a pit with the bodies of the men he had killed. His spirit returned to his wife soon after, to explain to her what had happened to him and to ask that she retrieve his body. His wife, accompanied by his "blazing" spirit found the pit at Kapua Heiau that contained all of the bodies and found his at the base of the pit. She wrapped his lifeless, tattered body in *kapa* and buried his body in the floor of their house, hidden under a mat. As Kualiʻi's men continued to ask Pumaia's wife about the disappearance of his body, Pumaia suggested his wife and daughter take his remains up to a cave near the Nuʻuanu Pali. There the wife and daughter camped until all of their food was gone and became hungry. Pumaia's spirit saw the plight of his family and made a series of raids on the homes of Waikīkī, bringing back food, *kapa*, and other goods. Kualiʻi was puzzled by the string of thefts and asked his priest what to do. His priest informed him that the thief was the powerful spirit of Pumaia and that if he wanted to stop the thievery and prevent Pumaia from taking Kualiʻi's life, he had to build homes for his wife, daughter, and his bones. This Kualiʻi did and his spirit was then settled. This ancient legend not only tells of who commissioned the *heiau*, but its history and how it was used.

In the legend of Kepakailiula, the hero son of Hina and Kū and one of the strongest, most handsome men in Hawaiʻi in his day, several localities near the subject area were visited. The story tells of one of Kepakailiula's two adoptive fathers, Kiʻihele traveled from their home in Keaʻau, Puna, Hawaiʻi Island, to search for a wife for his son. On his journey, Kiʻihele came across many flawed women before encountering Makolea, the daughter of the chief of Kona District, who was, in his eyes, flawless. However, she was engaged to a high chief of Maui, named Kakaalaneo, who was also widely held as the best spear thrower in the islands. When Kiʻihele told Makolea of the beauty of Kepakailiula, she ordered Kiʻihele to bring him back to her. The two were secretly married after Makolea saw Kepakailiula's beauty. When Makolea's parents found out about the secret union, they were angered and took Makolea to Maui to marry Kakaalaneo. On Kepakailiula's journey to reunite with Makolea, he was invited to marry the daughter of the chief of Kohala, which he agreed to before continuing his journey to find Makolea. Several days later, he found Makolea and her new husband in Hāna, Maui. After playing a prank on the intoxicated Kakaalaneo, Kepakailiula took Makolea into a hiding place where they spent the night while Kakaalaneo slept. The next day, Kepakailiula travelled back to Kohala and had his second wife convince her people to follow Kepakailiula to Hāna for a sightseeing trip. When Kepakailiula and his large entourage arrived at Hāna, Kakaalaneo tried to kill him with a spear, but was not successful and fled. Kepakailiula then pursued and killed Kakaalaneo and the rest of the Maui chiefs. The island was then given to his second wife's family.

Upon hearing of the battle, the chief of Oʻahu, Kakuhihewa, decided to ally with Kepakailiula and offer control of Oʻahu to him. The chief of Oʻahu brought canoes to Hāna for Kepakailiula, his two wives, and his adoptive parents. The first place he arrived at on Oʻahu was Waikīkī. Kepakailiula gave reign of the island to his adoptive fathers, Kiʻinoho and Kiʻihele. Kepakailiula and his family stayed in Waikīkī for several days, where his first wife took to surfing. One day, she ventured out to the prominent surf break for the area, known as Kalehuawehe, now referred to as Castle's (Clark 2002:153). As she surfed at Kalehuawehe, two servants of the chief of Kauaʻi and undefeated boxer, Kaikipaananea, saw her beauty and kidnapped her to be his wife.

Kepakailiula journeyed to Kauaʻi to retrieve his wife and was challenged by Kaikipaananea to a game of honuhonu. Ultimately, Kepakailiula knocked over his opponent. Soon after, Kaikipaananea followed Kepakailiula and challenged him again, only to have both of his arms broken. Perhaps to pamper his ego, Kaikipaananea decided to notify his people that all men, women, and children were required to solve a riddle or be burnt alive and only those who could answer the riddle would not be eaten. His ill-treated servant, Kukaea, was tasked gathering the chief's people to participate and was shown kindness by one person, who was none other than Kepakailiula. Kukaea, who was never allowed to eat or drink anything but Kaikipaananea's excrement and urine, was offered real food for the first time by Kepakailiula. For his kindness, he was rewarded by Kukaea with the answer the riddle. Kepakailiula went to the Kauaʻi chief and correctly answered the riddle and put the defeated chief into his own oven. When his warriors tried to rescue their chief, Kepakailiula killed all but those who ran away. He then took his wife back home to Oʻahu (Fornander 1919: 384-405).

Kapua, which is also the name of the *heiau* associated with the area, was traditionally a surf break used by the *ali*ʻ*i*, according to a tale about a one-toothed shark:

> …There was, however, a shark who did bite in the old days—a shark with one tooth, who nipped like a crab. He was known to all the poʻe kahiko. He frequented the waters of Kahaloa at Waikiki, and Mokoliʻi, at Hakipuʻu and Kualoa, in Koʻolaupoko. Malihini may be skeptical that he had only one tooth, but this was [Kamakau 1968:73] known to everybody.* We all know that sharks have rows and rows of teeth, but this shark, called ʻUnihokahi (One-toothed), had but one tooth. He was known to Peleioholani, Kahekili, and Kamehameha I. When the chiefs went surfing at Kapua in Waikiki, if a man was bitten by this particular shark that left a single tooth mark, it was a warning that an enemy of the sea was approaching. Chiefs and people went hurriedly to shore; it would not do to hesitate, for soon the dorsal fin and side fins of an approaching shark would be visible.
>
> In 1834, during the time of Kaomi, a malihini shark came to Waikiki in search of food. When he reached Kaʻalawai and Kaluaahole, he was refused by the guardian sharks of that place (ka poʻe kamaʻaina kiaʻi o ia wahi) and then he came to Kapua, where the guardians of Waikiki were, and argued with them. They decided to kill him and to leave visible proof of it, so they forced his head into a cleft in the rocks at Kukaʻiunahi, makai of Kūpalaha. It could not get free, and there it was with its tail—two or more anana in length—flapping in the air, and a little companion shark swimming around it.

> If this had been done by men it would have been impossible to hold it fast without tying it with ropes, but as it was done by those whom men had made into supernatural beings, the shark was made fast without ropes. When this wondrous sight was seen, men ran with ropes and tied them to the tail and dragged the shark ashore, still alive, with its eyes blinking and its body turning from side to side. It died from being dragged here and there, and by the time they reached Honolulu it was all flabby (Kamakau 1968:73 as cited in Maly and Maly 2003).

This story also brings up an obscure location referred to as Kukaʻiunahi, which would be along the coast near to the present site of the Waikīkī War Memorial.

3.3 HEIAU

The general area in which the WWMC is presently located appears to have a relatively high density of *heiau* and other significant landmarks in the pre-Contact and early Contact era, many of which are *luakini*, or temples for human sacrifice (Figure 13).

According to Kanahele (1995: 60-61) there were seven ancient *heiau* in Waikīkī: Kapua, Kūpalaha, Papaenaena, Kumukaʻaha, Makahuna, Mauʻoki, Helumoa or ʻĀpuakēhau, Kulanihakoi, and Kamuakapu. The ancient sites of Kūpalaha and Kapua *heiau* appear to have been located in very close proximity to where the WWMC stands today. While each of these *heiau* are mentioned in traditional *moʻolelo,* and several appear on historic maps, no remains of the structures are known to exist nor the exact locations of where the *heiau* once stood.

In the early European Contact period, Captains Portlock and Dixon describe what they had witnessed while anchored at Waikīkī Bay from the 12th to the 18th of December, 1786 (Portlock 1789:161-6). Through their informants and observations, they describe the construction and offerings. Further, they gleaned information on what would prompt the building of a *heiau* as well as what would cause them to destroy one. According to the Captains,

> My friend the priest now grew very restless and uneasy; on my enquiring the reason, he hinted that Taheeterre and his principal warriors were meditating some mischief against us, and taking me upon deck, he pointed to a large house on the top of a hill over the Eastern point of the bay which ascends from Point Dick : this house the old man assured me was building for an Eatooa, or God's house, wherein they were going to make great offerings to their different Eatooas (for almost every chief has his separate one), and to consult them on the event of an attack, which he assured me they intended to make on us if their oracles gave them encouragement…
>
> I HAD [sic] observed the natives building this house a day or two before the priest pointed it out to me, and had seen people constantly going up towards it loaded, probably with offerings to their different deities.
>
> Towards noon I could fee, with the help of a glass, that the house was nearly finished, and the natives were covering it with red cloth…

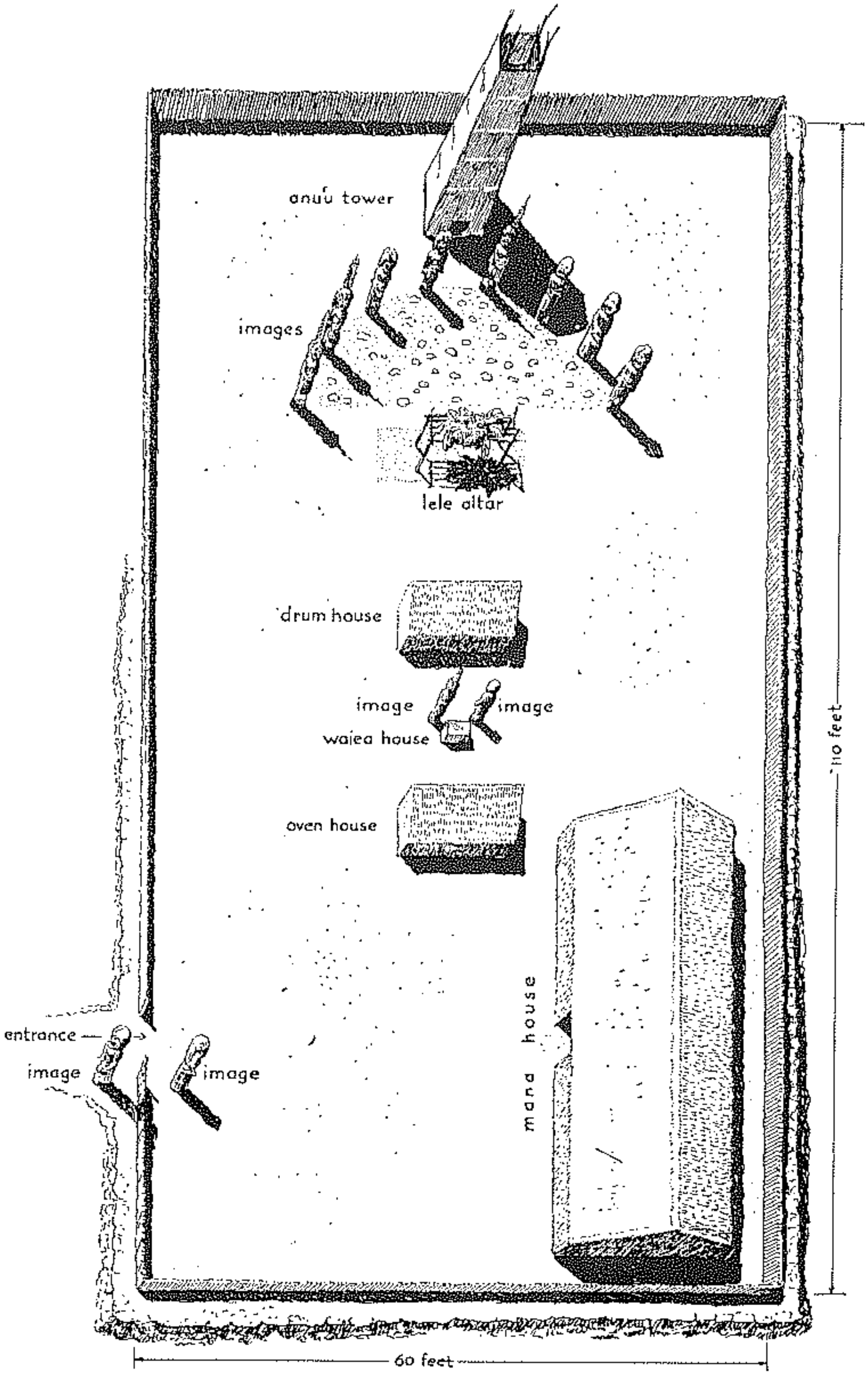

Figure 13. Rockwood's rendering of a *luakini heiau* (in ʻĪʻī 1959:34).

> …In the afternoon we had a fresh gale from the East North East, with frequent squalls, which prevented any canoes coming near us. Towards evening I observed the natives uncovering and pulling to pieces their new built house on the hill ; and about eight o'clock several large houses were on fire along shore near the bay; but as we had no Indians on board, I could not learn whether they were set on fire by accident or design, till the next morning, when the old priest and our two passengers coming on board, I enquired the reason of the fires we had seen on shore the preceding evening; and was given to understand, that they were Eatooa's, or houses belonging to gods with whom the chiefs were displeased; therefore out of revenge they had burnt gods and houses both together… (Portlock 1789:161-166).

While the exact locations and names of these *heiau* are not provided in the commentary, much is divulged about the finished look of a war temple in Waikīkī and what happens to *heiau* when prayers are left unanswered.

Kapua Heiau

Accounts of Kapua as a general locale, boat harbor, and surfing spot in the pre-Contact and early Contact era are ubiquitous, there are only a few accounts of Kapua Heiau. Located near Kapiʻolani Park was a *heiau poʻokanaka* referred to as Kapua, which was torn down in 1860. According to McAllister (1933:78), a chief named Kaolohaka was sacrificed at this *heiau*. Thrum (1906:44) maintains that Kapua Heiau is another *heiau* in the vicinity of Papaʻenaʻena Heiau, and that it measured 240 square feet, which makes it the largest to have existed in the area. He elaborates that Kapua was located opposite of Camp McKinley and that fragments of its walls were demolished in 1860. This *heiau* is also reported as being the place where Kaolohaka, the chief accused of being a spy from Hawaiʻi Island, was sacrificed by Oʻahu's *mōʻī* (sovereign), Kaleikupule. This act is suspected to have caused Kamehameha's invasion of Oʻahu (Thrum 1906:59). The "Legend of Pumaia," Fornander (1917:470-476) not only informs us that Kapua Heiau was commissioned by Kualiʻi, but offers an interesting look at its history and how it was used as a repository for human remains, likely as sacrifices.

Kūpalaha Heiau

The speculated location of the *heiau* referred to as Kūpalaha was suggested by Thrum as being near the Cunha residence in Kapiʻolani Park (Figure 11). This *heiau* was further described by Thrum as "entirely obliterated" with undetermined class, yet is said to be associated with Papaʻenaʻena (as cited in McAllister 1933:78). The name Kūpalaha, is translated as, "1) designation for a koa tree with a thick, straight trunk, perhaps flat on one side or leaning close to the ground, good for a canoe hull; and 2) temporary heiau temple" (Pukui and Elbert 1986:184). Kamakau (1976:144) holds that Kūpalaha is a *heiau poʻokanaka,* which translates as "human head temple" indicating that it was used for human sacrifice. McAllister was unable at the time to gather any additional information on the location of this *heiau*. However, Hammatt and Chiogioji (2002:9) suggest that Kūpalaha *heiau* was located on or adjacent to Kalākaua Avenue on the southeast side of Monsarrat Avenue, which places the site roughly 600 meters north of the Waikīkī War Memorial. Following the failed rebellion of Oʻahu's chiefs in 1875, Chiefess Kekelaokalani, who was related to Kahahana and Kahekili, gathered soil from a number of sacred areas on Oʻahu, including Kūpalaha, before she fled to Kauaʻi (Fornander 1880:227).

Papaʻenaʻena Heiau

Papaʻenaʻena Heiau (Figures 14 and 15) is the most storied and described *heiau* for the area, perhaps due to its prominence in the landscape and its significance in the early historic period. In *Leahi Heiau (Temple): Papa-ena-ena*, Thrum (1925:109-114) has compiled years of data on Papaʻenaʻena Heiau, which he holds was once located "at the western base of Leahi, or Diamond Head," but was completely demolished in about 1856. John Papa ʻĪʻī, the Hawaiian *aliʻi*, scholar, and historian (ca. 1800-1870) described an actively used Papaʻenaʻena Heiau and its internal features in his report on ceremonies that took place at the *heiau* in late 1803 or early 1804 (ʻĪʻī 1959:33-48). In this account, he holds that Kamehameha and his chiefs gathered at Papaʻenaʻena Heiau to "seek peace and prosperity" for his kingdom as fast-spreading sickness, later to develop into the ʻ*okuʻu* epidemic, had befallen him, his family, and people (ʻĪʻī 1959:33). He and his chiefs slept in a structure, referred to as Hale Pahu (house of the drums), which he described as, "closed from top to bottom on the side and back walls, whereas the front had only posts, like a *lānai*. It faced the ʻ*anuʻu* tower and the row of idols in front of the ʻ*anuʻu*" (ʻĪʻī 1959:35). He goes on to describe the rest of the *heiau* complex, as such:

> Between them [Hale Pahu and row of idols] was the *lele* altar. Three of the houses were thatched with the leaves of the *loulu* palm (*lau lauliʻi*). The largest house, called the Hale Mana, was long, like a *halau*. Its front and door faced the entrance of this *luakiki* heiau. The third house was the Hale Umu, or Oven House, which stood on the left side of the Hale Mana, extending forward of it a little, with front and door directly toward the back of the Hale Pahu. The fourth house, called the Hale Waiea, was a small one between the Hale Umu and the Hale Pahu. It was twice the length of the distance from fingertip to elbow in length, its height and breadth being half of that measure. Two images stood before it on either side of the opening, and the king and kahuna conducted their ʻaha services at the right side of the opening, in the dark of the night before the birds began to twitter (ʻĪʻī 1959:35).

He goes on to describe the *kapu loulu* rites that occurred at Papaʻenaʻena Heiau during this period, including the ʻ*aha* (prayer), *kauila nui* (major taboo ceremony consecrating the temple), Hoowilimoo (specific prayer/*hula*), and *hono* (a rite performed after the *kapu loulu*) ceremonies. This commentary is extremely detailed and allows an inside view of ancient ceremonial practices and religious structure of the *aliʻi* during the early post-Contact period.

An account, through the perception of missionaries, of the human sacrifices that were performed at Papaʻenaʻena Heiau during the *kapu loulu* rites are provided by Tyerman and Bennet (1832). The grisly account is as follows:

> In 1804 when the late king, Tamehameha, was on his way from Hawaii, to invade Tauai [Kauaʻi], he halted with an army of eight thousand men at Oahu. The yellow fever broke out among the troops, and in the course of a few days swept away more than two thirds of them. During the plague, the king repaired to the great marae at Wytiti, to conciliate the god, whom he supposed to be angry. The priests recommended a ten day's tabu, the sacrifice of three human victims, four hundred hogs, as many coconuts, and an equal number branches of plantains. Three men, who had been guilty of the enormous turpitude of eating cocoa-nuts with the old queen (the present king's mother), were accordingly seized and led to the marae. But there being yet three days before the offerings could be duly presented, the eyes of

> the victims were scooped out, the bones of their arms and legs were broken, and they were then deposited in a house, to await the coup de grace on the day of sacrifice. While these maimed and miserable creatures were in the height of their suffering, some persons, moved by curiosity, visited them in prison, and found them neither raving nor desponding, but sullenly singing the national huru [hula] – dull as the drone of a bagpipe, and hardly more variable - as though they were insensible of the past, and indifferent to the future. When the slaughtering time arrived, one of them was placed under the legs of the idol, and the other two were laid, with the hogs and fruit upon the altar-frame. They were then beaten with clubs upon the shoulders till they died of the blows. - This was told us by an eye witness of the murderous spectacle. And thus men kill one another, and think that they do God service (Tyerman and Bennet 1832:48-49).

One of the earliest recorded descriptions of the abandoned *heiau* was given by the missionary, Charles Samuel Stewart in 1824. Stewart (1828) offered the following description of the physical characteristics of the *heiau*, setting, and former function, as well as a discussion about the *heiau* with one of the locals:

> On reaching the settlement…I improved the necessary delay in visiting a large hei-au, which had often attracted my attention, situated about a mile above the bay and groves of Waititi, immediately under the promontory of Diamond Hill. It seems well situated for the cruel and sanguinary immolations of the heathen, standing far from every habitation, and being surrounded by a wide extent of dark lava, partially decomposed, and slightly covered with an impoverished and sun-burnt vegetation. It is the largest and most perfect ruin of the idolatry of the Islands I have yet seen; and was the most distinguished temple in Oahu. By a rough measurement, I made its length forty, and its breadth twenty yards. The walls of dark stone are perfectly regular and well built, about six feet high, three feet wide at the foundation, and two feet at the top. It is enclosed only on three sides, the oblong area, formed by the walls being open on the west; from this side there is a descent by three regular terraces or very broad steps, the highest having five small *kou* trees, planted upon it at regular distances from one another.
>
> A native of whom I had inquired on the beach the direct path to the hei-au, and who had obligingly offered his services as a guide, gave me an explanation of some of the rites of the former system, interspersing his statement every few moments, with an emphatic – "*aore maitai*!" "*naau po*!" – "no good!" – "dark hearted!"
>
> Pieces of cocoa-nut shells, and fragments of human bones, both remains of offerings to false gods, or rather to demons, were discoverable in different parts of the area, and forcibly hurried the mind back to the times of superstitious horror now gone, as we firmly believe, from this interesting people, for ever [sic]. It was at this place that ten men were doomed to be sacrificed about twenty years since, for the recovery of our late patroness Keopuolani, then dangerously ill, in the neighbouring groves of Waititi…
>
> The terraces of the hei-au command a beautiful prospect of the bay and plantations of Waititi, of the plain and village of Honoruru, rendered more picturesque by the lofty embankments of Fort Hill [Punchbowl] on one side, and the tall masts of the shipping on the other, and still farther in the back ground [sic], of the dark eminences

> in the vicinity of the Salt Lake, and the picturesque chain of mountains that forms the north-western boundary of the island. The view to the east is of a perfectly different character, presenting nothing but the precipitous projections and shelvings of the indescribably rude promontory of Diamond Hill. This, on the side next the hei-au, is entirely inaccessible, and though it is without a single germ of vegetation in its whole extent from top to bottom, a space of many hundred feet, is still one of the most imposing and beautiful features in the scenery of Oahu (Stewart 1828:220).

This *heiau* was thoroughly described several decades later by Bates (1854:94) in *Sandwich Island Notes: by a Häolé* in the following excerpt:

> Just beyond Waikiki stand the remains of an ancient *heiau* or pagan temple. It is a huge structure, nearly quadrangular, and is composed merely of a heavy wall of loose lava stones, resembling the sort of inclosure [sic] commonly called a "cattle-pen." The temples dedicated to the Hawaiian gods were always roofless. The altars were rudely reared in the same way, and composed of the same materials as the walls of the main inclosure [sic]. This heiau was placed at the very foot of Diamond crater, and can be seen at some distance from the sea. Its dimensions externally are 130 by 70 ft. The walls I found to be from six to eight feet high, eight feet thick at the base, and four at the top. On climbing the broken wall near the ocean, and by carefully looking over the interior, I discovered the remains of three altars located at the western extremity, and closely resembling parallelograms. I searched for the remains of human victims once immolated on these altars, but found none; for they had returned to their primitive dust, or have been carried away by curious visitors. But my fancy conjured up the deeds of some of the high-priests of paganism. It seemed as though I could see one of these deceived and deceiving torturers before me, with his demonical visage, his arm bared, his uplifted hand grasping the instrument of death, and the human victim lying on the bloody altar. I seemed to behold the vast audience awaiting, with a death-like silence, the fatal blow, and to hear the agonizing groans of the expiring victim. And when I remembered that these very tragedies *were* enacted, and on *these* ruined altars too, my heart sickened, and I sprung out of the inclosure [sic] (Bates 1854:94).

This excerpt provides a very detailed account of Papaʻenaʻena Heiau as well as commentary on what foreigners thought about *heiau* and their functions in traditional Hawaiian culture. In Thrum (1925) and Kanahele (1995) suggest that Papaʻenaʻena was the "sister" *heiau* to Kūpalaha Heiau. Thrum also suggests that Papaʻenaʻena Heiau was built sometime after and essentially replaced ʻĀpuakēhau Heiau. In 1803 or 1804, Hale Pahu at Papaʻenaʻena is where the chiefs, including Keʻeaumoku, gathered at the beginning of the *kapu loulu* (ceremony dedicated to the god Lono-i-ka-ʻou-aliʻi) to "seek peace and prosperity for the kingdom" (ʻĪʻī 1959:33).

<u>Kumukaʻaha Heiau</u>

Kanahele (1995:61) also describes Hale Kumukaʻaha as a *heiau* located at the foot of Diamond Head, built by Kaʻihikapu, ruler of Waikīkī and father of Kakuhihewa. Kaʻihikapu built this *heiau* in fear of overthrow by his brother, Haʻo, the powerful ruling chief of ʻEwa District. At this *heiau*, he prayed for guidance from the gods on this issue. The resulting plan was to send a giant shark, a Trojan horse of sorts, into his brother's camp as an offering. Inside of the shark were a few of Kaʻihikapu's warriors, who burst out of the shark, killing Haʻo and his men.

However, Haʻo's son escaped the surprise attack and was raised as a warrior in Waiʻanae. The son of Haʻo later led several bloody battles that split the island into two kingdoms, where Waiʻanae, Waialua, and Koʻolau Loa were one kingdom, leaving ʻEwa, Kona, and Koʻolau Poko as the kingdom ruled by Kaʻihikapu. While the murder of his brother does not appear to be a judicious act, he was well remembered for presiding over a peaceful and thriving kingdom for a long period of time.

Makahuna Heiau

Another large *heiau,* once located less than a mile southeast of the Waikīkī War Memorial, was referred to as Makahuna (Thrum 1904; McAllister 1933; Kanahele 1995). According to McAllister (1933), Makahuna Heiau was located at Diamond Head, overlooking a place called "Aqua Marine," adding:

> Thrum writes: "A large heiau enclosure dedicated to Kane and Kanaloa, of Kuula character, so said." Tucker reports: "Opposite the residence of the Honorable Sanford B. Dole. The ruins of a heiau of the Pookanaka class. Was located at this place in order to propitiate, by human sacrifice, the departure of the Aliis to foreign shores, and Black Point, between that and Kahala, was called Keala o Kahiki [the way to Tahiti]. these ruins are mostly all overgrown and have been used probably to make fences or for road purposes. A dense growth of lantana and kiawe, scrub kiawe, covers the ruins" (McAllister 1933:196).

This early observation suggests that Makahuna was located less than a mile to the southeast of the Waikīkī War Memorial. The meaning of the name Makahuna has not been found in any traditional references. However, *maka* (eyes) followed by *huna* (secret or hidden) suggests that it is a location of hidden

ʻĀpuakēhau Heiau

ʻĀpuakēhau Heiau, also referred to as Helumoa Heiau (Fornander 1919:285; Kanahele 1995), has been noted in numerous traditional texts. However, there is some confusion as to whether they were the same structure, part of the same ceremonial complex, two separate *heiau,* or a *heiau* within a locality named ʻĀpuakēhau or Helumoa. In contrast, some references list ʻĀpuakēhau and Helumoa as place names. Adding to the confusion, the site(s) of the (or these) *heiau* and ancient localities are unclear. Sterling and Summers (1978:279) speculate that ʻĀpuakēhau was located somewhere around 3rd Street and Waiʻalae Avenue, nearly two miles north of the War Memorial Waikiki. Many references allude to ʻĀpuakēhau as stream as well, likely within the locality (Fornander 1920; Pukui et al. 1974). However, Clark (2003:304) states that, "Helumoa is the section of Waikīkī where the Sheraton and other hotels are now," which is less than a mile to the northwest. Parker (1922) also refers to Helumoa, which translates as "chicken scratching," as the name of a land section in Waikīkī. ʻĀpuakēhau has some association with Mauʻoki Heiau in an article in the newspaper, *Kuokoa,* which holds that Kihapiilani, possibly the renown Maui chief, was born at ʻĀpuakēhau, Waikīkī, and was then taken to Mauʻoki Heiau (Kamakau n.d. as cited by Sterling and Summers 1978:279). Fornander (1917:227) also mentions ʻĀpuakēhau in "The Story of Kahahana" as one of the locations that Kekelaokalani, cousin of Kahahana's mother and Kahekili, gathered soil in reverence, before fleeing to Kauaʻi to avoid persecution by Kahekili.

In nearly all references to ʻĀpuakēhau as a *heiau*, sacrifice was a major theme. Commentary by Thrum (1904) provides some insight as to the function and history of this *heiau*:

> Some confusion exists between [Papaenaena] and the Apuakehau heiau, Helumoa, from the prominent sacrifices that took place at one or the other. The Apuakehau temple must have been of a more ancient period than Papaenaena, else this latter would not likely have had the preference of Kamehameha's sacrifices and services, nor that two of similar class or character so near each other should be at their zenith in royal favor and priestly power at the same time. The Apuakehau heiau was the place of sacrifice of Kauhi-a-Kama, the defeated Moi of Maui, in his raid on Oahu in the reign of Kaihikapu. It is not learned when its service ceased and Papaenaena's began, but the scene of activities center in the latter at the opening of the last century (Thrum 1904: 57-58).

In the "The History of Maui," Fornander (1880:208) relates that Kauhi, a *moʻi* of Maui, "… landed at Waikiki and was met by the Oahu chiefs in battle, defeated and slain, and his body exposed at the *heiau* of ʻĀpuakēhau and that great indignities were committed with his bones. The memory of this great outrage instigated his descendant, Kahekili, to the fearful massacre of the Oahu chiefs, when, after the battle at Nuihelewai, he had defeated the Oahu king, Kahahana, and conquered the island." Another account of this execution by Fornander (1920: 321) described Kauhi being taken prisoner from Maui by the Oʻahu chiefs and burnt at ʻĀpuakēhau, who subsequently used his skull as an *ipu honowā* (excrement receptacle).

Mauʻoki Heiau

Once located in Mōʻiliʻili, the *heiau* referred to as Mauʻoki was dedicated to Lono and said to have been built by Menehune with stones from Mount Kawiwi. Although it was demolished in 1883, it was reported to be of good size and walled on three sides with an opening to the west (Kanahele 1995). In Thrum (1907), he relays the story of Kahalaopuna, the stunning "Princess of Manoa," and mentions an underground water-cave in Kamoiliili (Mōʻiliʻili), named Mauoki, which had the power to heal. In the tale, Kahalaopuna's jealous future husband killed her numerous times, but her ʻ*aumākua*, the *pueo* and ʻ*elepaio,* resurrected her every time her grave was dug too shallow. When the cruel fiancé buried her lifeless body under a tree, her ʻ*aumākua* could not get to her. As two travelers passed by, her spirit cried out. These young men, seeing her unrivaled beauty, took her to this water-cave to rub (*kākelekele*) the water onto her and bring her back to life (Thrum 1907: 126).

Kulanihakoi Heiau

In Thrum's (1904) *List of Heiau,* this *heiau* is described more as a grass house on Kalākaua's property. These ruins were noted in 1862 around the time of Prince Albert Edward Kauikeaouli Leiopapaakamehameha's death. Fornander describes Kulanihakoi in *A Lamentation of Young Kaahumanu* as the name of a fountain in heaven that opened up when Kalani prayed to Kauakahi (Fornander 1920:452). Kanahele (1995:61) holds that it is located near Helumoa.

Kamuakapu Heiau

Kamuakapu Heiau is said to have been erected by Kalākaua in 1888 in Kapahulu as a place for his "Naua Society" to study the ancient Hawaiian religion and genealogies (Thrum 1904; Kanahele 1995).

The husbandry class *heiau* reportedly measured a mere 11x18.5 feet in size and was in partial ruins by the early 1900s.

3.4 Sea and Shore

Clarke (2003) maintains that Kapua, also referred to as Kaimana and Sans Souci, is the name of a beach in Waikīkī, and the name of a former fishery in Waikīkī that incorporates the beach next to the Waikīkī War Memorial. Further, Kapua Offshore Mooring, also known as Diamond Head Offshore Mooring, once faced Kapua Beach and holds that it was the mooring site off the Outrigger Canoe Club. However, numerous historic maps use the name Kapua for a wider geographic area.

Kapua is mentioned in traditional accounts as a sea (Lyons 1893:173). For instance, in the Song for Kualiʻi, Lyons (1893) translated verse 520 as:

Ia makani anu o Kahaloa,	The cold blast of Kahaloa,
E lu ana i ka pua kou,	Scattering the blossoms of *kou,*
E kui ana a paa ia,	Strung firmly in garlands,
E leia ana i ke kai o Kapua la,	Worn in (bright) wreaths at the sea of Kapua.
Aohe i like, Kū.	Not like to these, art thou Kū.
	(Lyons 1893:173)

Several Historic maps (Covington 1881; Harvey 1902) indicate that Kapua was a well established boat harbor with a dredged channel (Figures 15 and 16).

At least one ancient religious site was identified on the coast near the project area. McAllister (1933) mentions that some *koʻa* were sacred to certain species of fish. An example was one located, “merely a stone at the edge of the water, but it had a great attraction for mullet.” This site, called Palielaea, was located on the Waikīkī side of Diamond Head (as cited in Titcomb 1972:38).

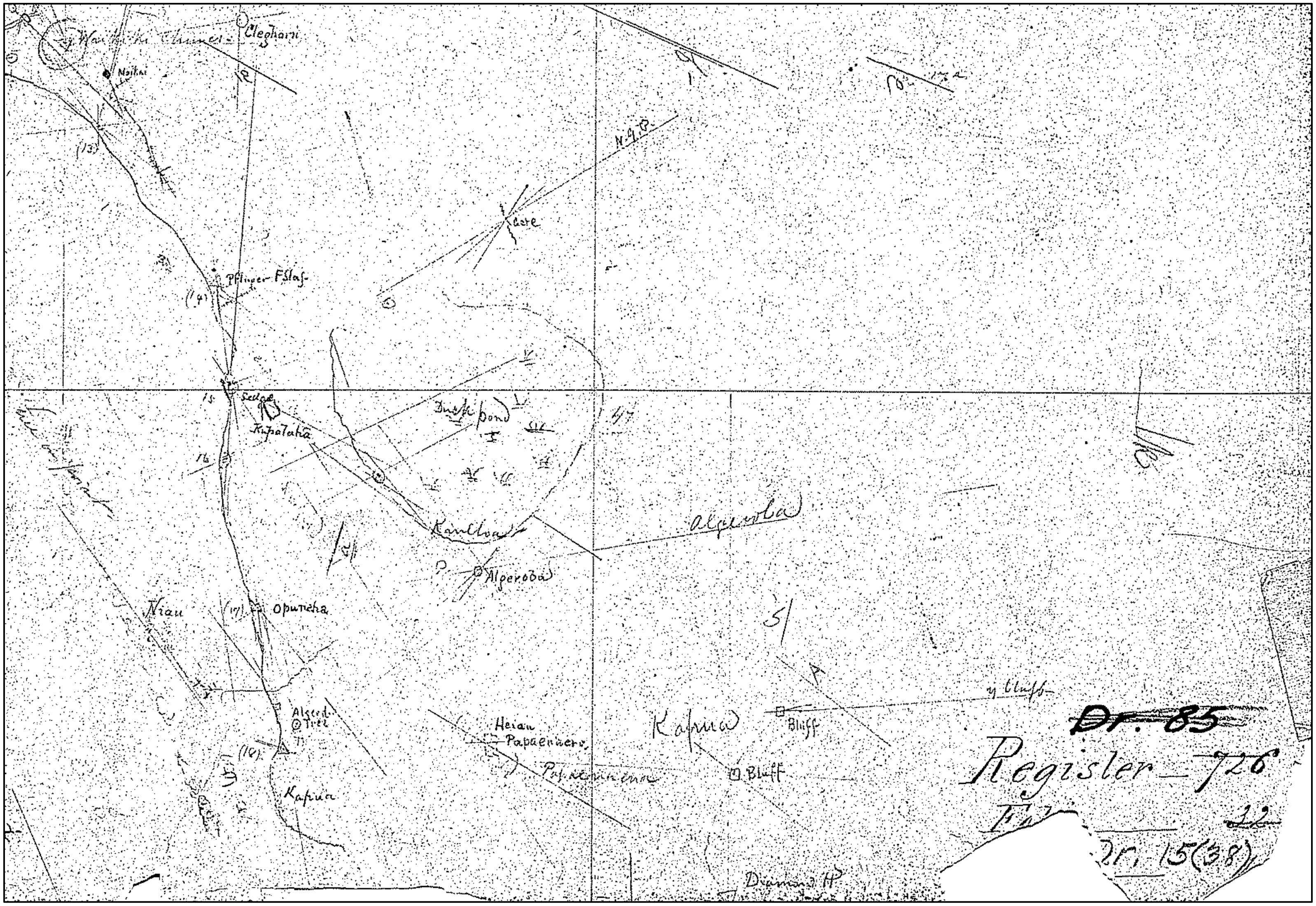

Figure 14. Portion of C.J. Lyons (n.d.) sketch map of Diamond Head showing location of Kūpalaha Heiau, Papaʻenaʻena Heiau, and Ōpūnahā as the location of the project area.

Figure 15. Portion of 1881 Covington map showing Kapua Channel and Papa‘ena‘ena Heiau.

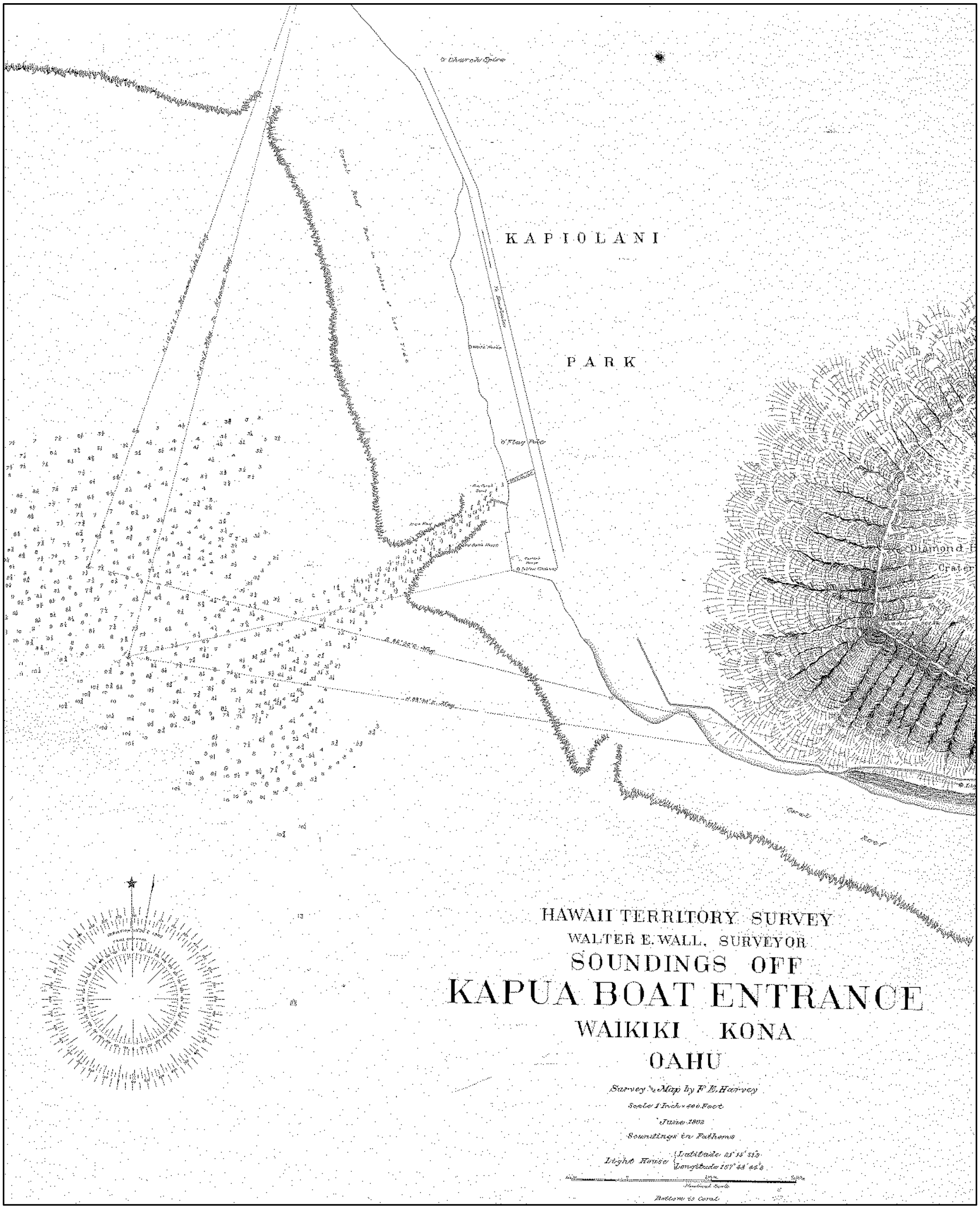

Figure 16. 1902 Map of Kapua Boat Entrance.

3.5 CHRONICLES AND CONFLICTS

In Fornander's (1918) story of "The Sixth Battle, "which was between Kamehameha and Kalaikupule at Nuʻuanu, Kamehameha's first canoe fleet landed at Kapua. There the fleet was met by Pihana, the celebrated Oʻahu warrior, and a battle ensued. He holds that "the men from Hawaii under Kalaimoku, at that time, were eight times forty in number. All of them threw their spears and lances at Pihana and his nine soldiers, but none were hit nor were any killed…"(Fornander 1918:474). He later suggests that the disparity in numbers is a result of partisanship. Subsequently, Kamehameha's warriors advanced over the plains, battling as much as 9,000-10,000 of Kalanikūpule's warriors. The battle proceeded *mauka*, terminating at the Nuʻuanu Pali where Kamehameha's troops drove many of Kalanikūpule's warriors over the edge of the cliffs.

3.6 WAIKĪKĪ, THE ROYAL SEAT OF POWER

According to legend, Waikīkī became "the ruling seat of chiefs of Oahu" when Māʻili-kūkahi was made Oʻahu's ruling chief long before European Contact (Beckwith 1970: 383). Kamakau (1991: 53-54) upholds this tenet in the tradition of Māʻili-kūkahi, where he became "*mōʻī* over the land" and was taken to Waikīkī to be the first in a line of ruling chiefs to govern from there.

Prior to European contact, rulers who reigned from Waikīkī included Pele-io-holani (son of Ku-i-ke-ala-i-ka-ua-o-kalani Ku-nui-akea Ku-aliʻi), Ku-mahana (son of), Ka-hekili (ruler of Oʻahu, Maui, and Molokaʻi), Ka-lani-ku-pule (son of Ka-hekili), and Ka-hahana (foster son of Ka-hekili) also referred to as "the tabu chief" of Oʻahu. By order of Ka-hekili, Ka-hahana replaced Ku-mahana in 1773 because he "slept late, was stingy, penurious, deaf to the advice of others, and used to take himself off to the plains to shoot rats" (Kamakau 1992: 128). Thrum (1907a) translated the traditional prophesy "This Land is the Sea's," originally recorded by Moke Manu, which includes an account of Ku-mahana and Kahahana's reign in Ulukou, Waikīkī, stating:

> When Kahekili, King of Maui, heard of the stealthy flight of the governing chief of Oahu, he placed the young prince Kahahana, his foster-son, as ruler over Oahu in the place of his deposed relative, Kumahana. This occurred about the year 1773, and Kahahana took with him as his intimate friend and companion, one Alapai. Kahahana chose as his place of residence the shade of the kou and cocoanut trees of Ulukou, Waikīkī, where also gathered together the chiefs of the island to discuss and consider questions of state. (Thrum 1907b: 204)

After ruling Oʻahu for nearly eight years, Ka-hahana was sentenced to death by Ka-hekili for betrayal and had his body sent to Waikīkī (Kamakau 1992: 128-141). Ka-hekili died in 1793 at Ulukou, Waikīkī of an unknown illness at the age of eighty-seven (Kamakau 1992: 166).

4.0 POST EUROPEAN CONTACT CULTURAL LANDSCAPE

The islands of Hawai‘i have undergone dramatic changes since its discovery by Native Hawaiians, which is now debated to be no earlier than 1200 years before present (Kirch and McCoy 2007). The arrival of Europeans in the late 1700s sets the scene for a different drama to unfold. After European contact until the present, Waikīkī has gone through even more radical changes in the physical and cultural landscape due to the decline of the Native Hawaiian population and the increasing influence of Western and Asian immigrants. In this period, Waikīkī has gone from a collection of intensively farmed valleys and coastal plains (Figure 14) to the seat and playground of O‘ahu’s royalty and *ali‘i*, subsequently, the playground for the Western elite.

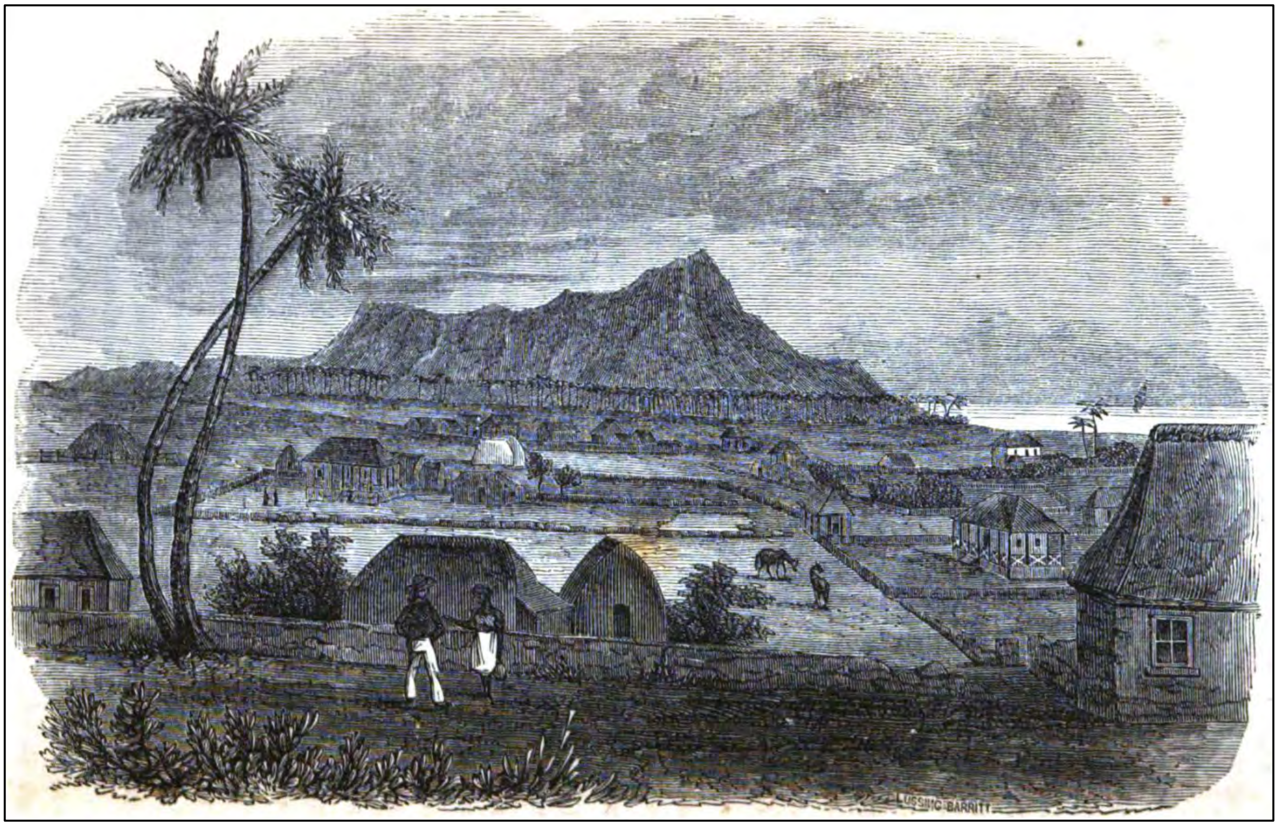

Figure 17. Early Historic Image of Diamond Head from East Honolulu (Bates 1854:95)

4.1 EUROPEAN CONTACT

Technically, the historic record begins with the arrival of Europeans to the Hawaiian Islands in 1778. Many of these accounts depict Waikīkī as abundant in resources and intensively farmed to utilize those resources.

At about the arrival of Europeans in 1778, Waikīkī was densely populated, verdant, and prosperous. One observation given by Captain George Vancouver in 1792 upholds this view of the post-Contact period Waikīkī. Vancouver states:

> …in this bay, which the natives call Whyteete, seemed nearly as eligible as most of the anchoring places these islands are generally found to afford…On the shores, the villages appeared numerous, large, and in good repair; and the surrounding country pleasingly interspersed with deep, though not extensive valleys; which, with the plains near the sea-side, presented a high degree of cultivation and fertility…our guides led us to the northward through the village, to an excavation exceedingly well-made causeway, about twelve feet broad, with a ditch on each side… This opened to our view a spacious plain, which, in the immediate vicinity of the village, had the appearance of open common fields in England; but on advancing, the major part appeared to be divided into fields of regular shape and figure, which were separated from each other by low stone walls, and were in a very high state of cultivation …planted with the eddo or taro root, in different stages of inundation… some from three to six or seven inches under water…At Woahoo, nature seems only to have acted a common part in her dispensations of vegetable food for the service of man; and to have almost confined them to the taro plant, the raising of which is attended with much care, ingenuity, and manual labour…(Vancouver 1798: I, 161-164).

Vancouver's descriptions illustrate the intensity of agriculture in *mauka* Waikīkī as well as the fitness of its irrigation and infrastructure at the period of European Contact. Archibald Menzies, who travelled on the Vancouver Expedition as a surgeon and naturalist also commented on the flourishing state of Waikīkī at this time period:

> … the shore was planted with a large grove of cocoanut palms, affording a delightful shade to the scattered habitations of the natives. Some of those near the beach were raised a few feet from the ground upon a kind of stage, so as to admit the surf to wash underneath them. We pursued a pleasing path back to the plantation, which was nearly level and very extensive, and laid out with great neatness into little fields planted with taro, yams, sweet potatoes, and the cloth plant. These, in many cases, were divided by little banks on which grew the sugar cane and a species of Dracena without the aid of much cultivation, and the whole was watered in a most ingenious manner by dividing the general stream into little aqueducts leading in various directions so as to be able to supply the most distant fields at pleasure, and the soil seemed to repay the labor and industry of these people by the luxuriancy of its productions. Here and there we met with ponds of considerable size, and besides being well stocked with fish, they swarmed with water fowl of various kinds such as duck, coots, water hens, bitterns, plovers, and curlews…They frequently offered us both musk and water melons, which they thought might be more acceptable to us as they received the seeds from Britannee…On returning to the beach after a circuit of about three miles, we found that they had dressed hogs and taro for us, but as we had neither time nor much inclination to eat anything, they insisted on packing them up cleanly in leaves and putting them into our boats (Menzies 1920: 23-24).

An earlier account of Waikīkī given by Captains Portlock and Dixon in 1785, offers interesting commentary on the pre-Contact Hawaiian religion and culture.

Next morning at eight o'clock the long-boat came along-side, and Mr. Hayward informed me, that on going down to the place where his guide conducted him in Queen Charlotte's Bay, he found a small bay with very deep water, close to a sandy beach, where the natives generally landed with their canoes, but no place for a ship to ride in with safety ; adjoining to the beach, in a beautiful valley, surrounded by fine groves of cocoanut trees and a delightful country, there was a large town, where (as Towanooha informed him) the king generally resided, and the district round it was called Whyteetee. According to Mr. Hayward's account, there were very few canoes in the bay; neither did he see any great number of inhabitants; so that we may reasonably suppose they were come into the bay where we lay, led either by business or curiosity.

Not a single native came near the ships for two days, and their canoes were hauled out of sight, but we could perceive vast numbers of the inhabitants about the house on the hill. During this time our people were busily employed about the rigging, and getting the ship ready for sea.

At daylight in the morning of the 17th the old priest, attended by his yava-chewer Towanooha, came on board. The old man seemed quite enraged at the king's recent conduct; he told me that the king and all his principal chiefs had been making offerings to their gods, and consulting them ; but that the gods were good for nothings and that the king and his adherents were no better than villains, for intending to do us any mischief, after the many presents they had received from both ships. I thanked my old friend for his intelligence, and told him that we should be constantly on our guard.

For some days past I had been strongly importuned by Towanooha, and a very fine young man of the first consequence in the island, who was a constant companion of the king's, to take them along with me to Atoui; and indeed Taheeterre had more than once urged me to take them; but I never thought they were in earnest until this forenoon, when the young chief, whose name is Paapaaa, came on board, and joined his entreaties with those of Towanooha in so very pressing a manner, that I promised to take them on board; and they returned on shore in order to prepare themselves for the passage. The yava-chewer, being now as it were a gentleman passenger, no longer considered himself as a servant, but took to drinking yava heartily, and laid in a plentiful stock of that root.

In the afternoon we had a fresh gale from the East North East, with frequent squalls, which prevented any canoes coming near us. Towards evening I observed the natives uncovering and pulling to pieces their new built house on the hill ; and about eight o'clock several large houses were on fire along shore near the bay ; but as we had no Indians on board, I could not learn whether they were set on fire by accident or design, till the next morning, when the old priest and our two passengers coming on board, I enquired the reason of the fires we had seen on shore the preceding evening ; and was given to understand, that they were Eatooa's, or houses belonging to gods with whom the chiefs were displeased; therefore out of revenge they had burnt gods and houses both together. In the forenoon a great number of large and small canoes came off and brought us a tolerable supply of various sorts of vegetables and a few hogs. Since our water was completed, having expended several casks, I directed the natives to bring us a further supply, which they very soon did in great abundance.

> The king also, with his retinue, paid me a visit; at his first coming on board he seemed rather shy, but upon the whole he conducted himself nearly in his usual manner. On my taking notice of the red house on the hill he appeared a good deal confused, and waving that conversation, begun to talk about his two countymen who were going with me to Atoui. He seemed very much interested in Paapaaa's welfare; he particularly requested me to take care of him and treat him well, and if we flopped at Atoui, he begged that I would leave him under the care of Taaao, who it seems is brother to Taheeterre, and a relation of Paapaaa's. The two passengers asked me for a few trifles to leave amongst their friends before they set off, which I readily gave, and also made the king a present; on which he took leave of me for the last time, and after taking a very affecting one of his countrymen, particularly of Paapaaa, he quitted the ship and went on shore; the other canoes remained along-side to dispose of their cargoes, and we procured a supply of good hogs, which enabled me to set the falters to work again. In the afternoon the rigging was set up, the fails bent, and every thing ready for sea (Portlock 1789:164-167).

This account also upholds that the political center of Oʻahu was in Waikīkī during the early contact period. Further, it describes the social structure as well as religious and political systems of Hawaiians at this time.

Another account of Waikīkī's coastal area and abundant fishponds in the early historic period was provided by Andrew Bloxam, who was the naturalist on the HMS Blonde in the mid 1820s. Bloxam stated in 1825:

> …The whole distance [along the coast from Honolulu] to the village of Whyteete is taken up with innumerable artificial fishponds extending a mile inland from the shore, in these the fish taken by nets in the sea are put, and though most of the ponds are fresh water, yet the fish seem to thrive and fatten. Most of these fish belong to the chiefs, and are caught as wanted. The ponds are several hundred in number and are the resort of wild ducks and other water fowl. It [Waikīkī] is pleasantly situated and built along the shore among numerous groves of coconut and other trees, and in this respect far better than Honoruru, as scarcely any trees are to be found there. Diamond Hill, the southeast point of the island, is about two miles beyond…Near one of its sides are the remaining walls of an old *morai* or temple; the sea washes its base and hence it forms a good landmark for ships (Bloxam 1925: 35-36).

Hence, Waikīkī was highly developed with a variety of traditional Hawaiian agricultural and habitation complexes at the time of European contact.

In the early European contact period the islands were not yet "united." Captain George Vancouver, who was "the friend of every chief and of every government," went to Waikīkī and met with Ka-lani-ku-pule, who ruled Oʻahu from there after Ka-hekili's death. According to Kamakau (1992: 162), "Vancouver went on to Waikīkī at Oahu and met Ka-lani-ku-pule…who gave him forty hogs and a great quantity of foodstuff in return for red cloth, and the two became friends." Vancouver met with Ka-lani-ku-pule a second time in Waikīkī to discuss the murder of two men from Vancouver's ship, *Daedalus,* in the Waimea area.

Later, Kamehameha I, originally of the Hawaiʻi Island and considered by some to be the son of Ka-hekili, began his campaign to "unify" the islands in 1778. It was on the shores stretching from Waikīkī to Waiʻalae that Kamehameha I and his fleet landed to wage war on Ka-lani-ku-pule. After Kamehameha I gained control over Oʻahu by defeating Ka-lani-ku-pule at Nuʻuanu in 1795, he set up residence in Waikīkī near the present location of the Royal Hawaiian Hotel as noted by Hawaiian *aliʻi*, scholar, and historian, John Papa ʻĪʻī (ca. 1800-1870). John ʻĪʻī's own family relocated from Lā-hainā to Ka-wehewehe, Waikīkī, which is now Saratoga Road, before settling in Waipiʻo, ʻEwa District, where he was born. ʻĪʻī was taken to the royal court of Kamehameha I in Waikīkī when he was 10 years old to be a companion of Prince Liholiho (Day 1984). ʻĪʻī states:

> Kamehameha's houses were at Puaaliilii, *makai* of the old road, and extended as far as the west side of the sands of Apuakehau. Within it was Helumoa, where Kaahumanu ma went to while away the time. The king built a stone house there, enclosed by a fence…This place had long been a residence of chiefs. It is said that it had been Kekaupoiʻe home through her husband Kahahana, since the time of Kahekili [ca. 1780] (ʻĪʻī 1959: 50-51).

Kamakau (1992) maintains that after Kamehameha I ended his campaign to unify the islands, he shifted his focus to improving the economic situation of *aliʻi* and commoners in Waikīkī, stating:

> …After the pestilence had subsided the chiefs again took up farming, and Kamehameha cultivated the land at Waikīkī, Honolulu, and Kapalama, and fed the people. He fished, made huge hauls, and gave food to the chiefs and people. Thus he cared for both chiefs and commoners… (Kamakau 1992: 190).

Waikīkī was also a place where kings were conceived. According to Kamakau (1992), Chiefess Ke-opu-o-lani was "formally united (*hoʻao*) with Kamehameha" in Waikīkī, conceiving Liholiho, who was born in Hilo in 1797. After his father's death, Liholiho was proclaimed King Kamehameha II.

4.2 EARLY TO MID-1800S

This period represents, perhaps, the most drastic changes to traditional Hawaiian land use, cultural practices, and politics.

Waikīkī was highly developed with a variety of traditional Hawaiian agricultural and habitation complexes at the time of European contact. Yet, when missionary Levi Chamberlain visited Waikīkī some years later, he noted the deterioration of traditional agriculture, writing in 1828:

> …we took a path on our right leading through a grove of tall cocoanut trees towards Waikīkī – Our path led us along the banks on one or more sides, and which were once filled with water, and replenished abundantly with esculent fish; but now overgrown with tall rushes waving in the wind. The land all around for several miles has the appearance of having been once under cultivation.

> I entered into conversation with the natives respecting its present neglected state. They ascribed it to the decrease of population… (Chamberlain 1957: 26)

Nakamura (1979) lists three factors in the revival of agriculture and aquaculture in Waikīkī: changes in land tenure, sugar and pineapple plantations, and rice production. After Waikīkī saw a plunge in its Native population and subsequent decline in traditional land use, there was an influx of mostly Western immigrants. Westerners brought with them not only disease that most Hawaiians could not stave off, but a form of land ownership, which was an alien concept for Native Hawaiians.

The lands, traditionally held in stewardship by the *ali'i* of Hawai'i, were divided in 1848 under Kamehameha III in a land reformation event called the Mahele 'Āina. Land titles, or Land Commission Awards (LCA), were granted by the Board of Commissioners also known as the Land Commission (Chinen 1958). As a result of a general misunderstanding of new land ownership laws and influence of alcohol during transactions, many Native Hawaiians lost rights to lands that they inhabited and farmed for generations. Not long after, a marked increase in lucrative, non-traditional agriculture occurred on these lands, dominated by Western owned sugar and pineapple plantations. Accompanying this was another surge of immigrants, mostly from China and Japan, to work in the plantations. Chinese and Japanese immigrants soon became the most numerous ethnic group and eventually they became land owners. As a result, the need to sustain these populations gave way to another non-traditional agricultural production: rice farming. Most rice farms were owned and operated by Chinese and Japanese. Waikīkī had ca. 542 acres of rice paddy by 1892 (Nakamura 1979).

<u>Land Court Awards</u>

A review of the LCA's for the current project determined that only a single LCA had been awarded in the vicinity of the current project area. LCA 5593:1 was awarded to an individual named Pehu (Figure 15). The land was given to Pehu in 1823 by King Liholiho. Pehu was installed as the land agent of Honolulu under J.A. Kuakini in 1830 (Kamakau 1961:303). Additionally, Pehu was found to be the claimant of an ocean fishery (Helu 1776) in an area described as Pālolo, Waikīkī, O'ahu.

<u>Rights to Ocean Resources and Fishing Rights</u>

Not only were Land Court Awards granted, but the rights to ocean resources and fishing rights were also granted. Maly and Maly (2003) offer a good explanation of this new system:

> In pre-western contact Hawai'i, all *'āina* (land), *kai lawai'a* (fisheries) and natural resources extending from the mountain tops to the depths of the ocean were held in "trust" by the high chiefs (*mō'ī ali'i 'ai moku*, or *ali'i 'ai ahupua'a*). The right to use of lands, fisheries, and the resources therein was given to the *hoa'āina* (native tenants) at the prerogative of the *ali'i* and their representatives or land agents (often referred to as *konohiki* or *haku 'āina*). Following a strict code of conduct, which was based on ceremonial and ritual observances, the people of the land were generally able to collect all of the natural resources, including fish—and other marine and aquatic resources—for their own sustenance, and with which to pay tribute to the class of chiefs and priests, who oversaw them.

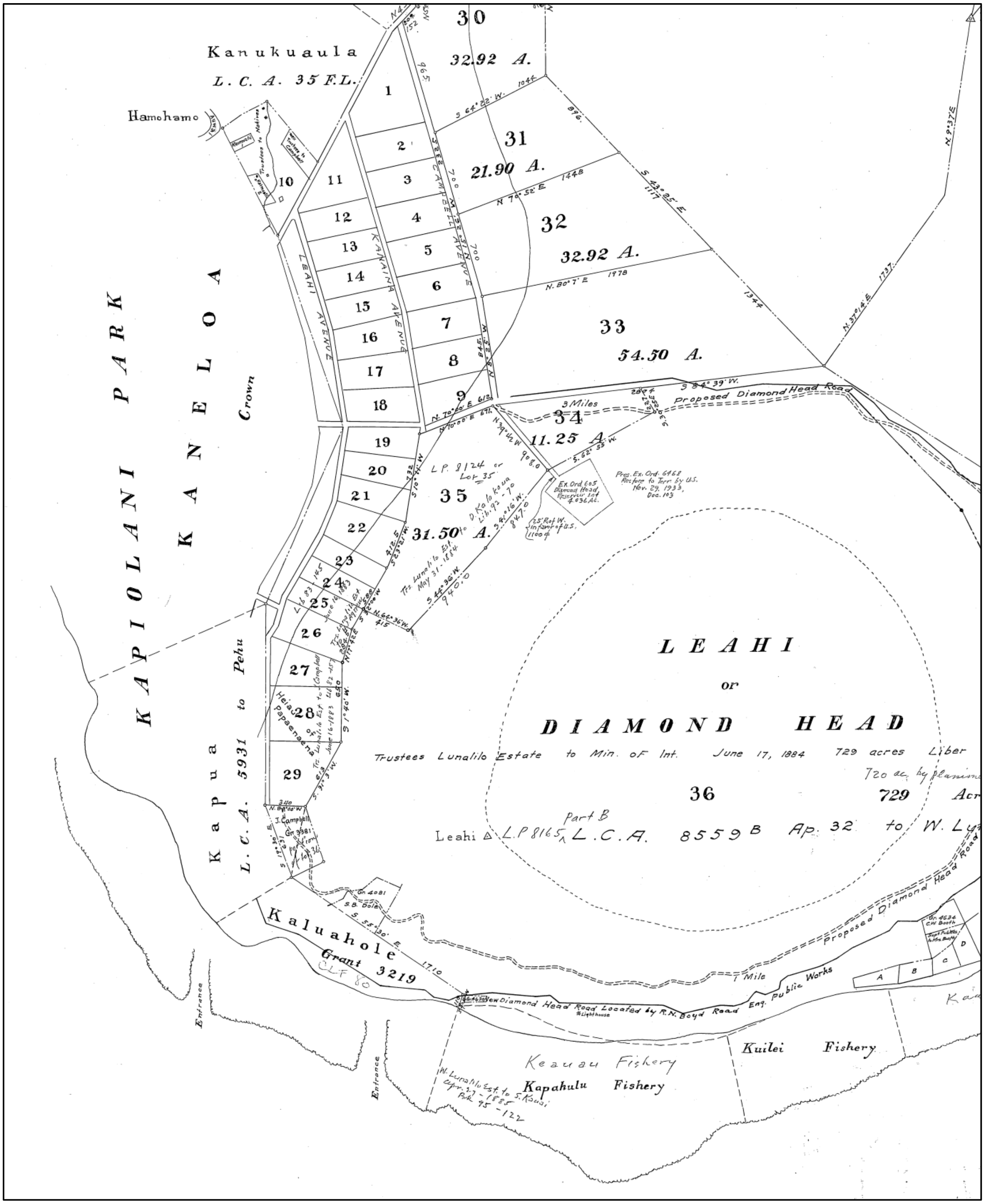

Figure 18. Portion of 1883 Monsarrat Map of Govt. Lands around Lē‘ahi, showing LCA 5931.

Shortly after the arrival of foreigners in the islands, the western concept of property rights began to infiltrate the Hawaiian system. While Kamehameha I, who secured rule over all of the islands, granted perpetual interest in select lands and fisheries to some foreign residents, Kamehameha, and his chiefs under him generally remained in control of all resources. Following the death of Kamehameha I in 1819, and the arrival of the Calvinist missionaries in 1820, the concepts of property rights began to evolve under Kamehameha II and his young brother, Kauikeaouli (Kamehameha III), who ruled Hawaiʻi through the years in which private property rights, including those of fisheries, were developed and codified.

Kamehameha III formally defined the ancient fishing rights and practices of the Hawaiian people in the Constitution and Laws of June 7, 1839, and reconfirmed them on November 9, 1840 (Hawaiian Laws, 1842; Hawaiian Laws compiled from between the years of 1833 to 1842).

By the Law respecting fisheries, Kamehameha III distributed the fishing grounds and resources between himself, the chiefs and the people of the land. The law granted fisheries from near shore, to those of the deep ocean beyond the sight of land to the common people in general. He also specifically, noted that fisheries on coral reefs fronting various lands were for the landlords (*konohiki*) and the people who lived on their given lands (*ahupua*ʻ*a*) under the *konohiki* (Maly and Maly 2003:v-vi).

According to Maly and Maly's (2003) review of documented fisheries and fishing rights recorded during the Mahele ʻĀina, only one fishing rights claim known to have existed in the area. A claimant named Pehu, who also was granted the single largest LCA for the area, had the nearest *helu* (account) 1776, which was located in Pālolo, Waikīkī and was described as an ocean fishery. As no maps have been found, the exact location of this fishery is undetermined.

Several *heiau* had survived in eastern and upland areas of Waikīkī into the historic period (Thrum 1907: 44-45). Papaʻenaʻena *heiau*, in Waikīkī, was reportedly used by Kamehameha I to offer sacrifices to Hawaiian gods (see Section 3.3).

However, traditional use of these *heiau* ended after Kamehameha I's death in 1819 along with the old *kapu* system. While extreme Hawaiian religious traditions were eradicated in Waikīkī in the early 1800s, some pre-Contact subsistence traditions were still practiced into mid-1800. Harriet Newell Foster Deming wrote of a typical ocean harvest at Waikīkī, writing in 1850:

> The event of each morning was to watch the return of the fishing canoes with their daily catch. Native women and children from round about came to help in the division of the fish. According to the unwritten law one fish in every five belonged to the King. Sometimes four canoes would be drawn up on the beach at once, filled with shining beauties in nets…the wealth of color fascinated us as we hung over the sides of the canoes watching the bronzed fishermen who, naked except for a loincloth, scooped up the fish in their hands and laid them in piles on the sand. The head of every fifth fish was bitten off to count it for the King. (Deming n.d. as cited by Nāpōkā 1986: 3).

At this time, however, Waikīkī was losing its pre-Contact traditional lifestyle. Instead, it was becoming increasingly Western in architecture and infrastructure, as well as in its culture and demographics. For the elite of Oʻahu and Western immigrants, Waikīkī was already a key destination for relaxation and recreation. Though, by the 19th century, the buzz about Waikīkī's exotic charm, calm surf, warm waters, white sand beaches, fair weather, and the increasing availability of "creature comforts" by Western standards was spreading fast. As a result, Waikīkī became a haven for tourists and with that came the hotel and tourism industry.

Although early Hawaiian *mōʻī* likely chose Waikīkī for its reef-sheltered, sandy beaches ideal for canoe landing, Kamehameha I moved his court to Honolulu in 1809 as Honolulu's harbor was deep enough to accommodate Western sailing ships, which were becoming an integral part of local economy and politics at that time. According to Kamakau (1992:298), several royal properties located in Punchbowl and Waikīkī were transferred to Paki by the authority of Liliha, unbeknownst to Queen Kaʻahumanu, as these lands diminished in value to the throne.

4.3 MID-1800S TO EARLY 1900S

After the arrival of Europeans, the Native Hawaiian population of Waikīkī declined (as a result of European diseases), and traditional agriculture, aquaculture, and infrastructure was severely neglected from lack of manpower. However, a revival in the use of these traditional systems occurred in the latter half of the 19th century (Nakamura 1979).

The landscape of east Waikīkī, just below Diamond Head was depicted as being an expanse of seasonal duck ponds and stands of *kiawe* (*Prosopis pallida*) in the mid-1870s. At this time, these lands were owned by Kalākaua and a Swedish immigrant, named Allen Herbert. Kalākaua leased the lands of Kaneloa and Herbert leased the lands of Kapua to the top business men of the day, including Archibald Cleghorn and John O. Dominis, for the creation of Kapiʻolani Park, which would dramatically alter the panorama. When the grand park was opened in 1877, it featured expansive lawns, manicured landscaping, and a horse racing track.

After Kamehameha shifted the seat of power to Honolulu, scores of Waikīkī traditional agricultural features were deserted. Even Kamehameha I's Waikīkī lands fell into rapid decay by 1852. As Honolulu grew and became more Westernized, Waikīkī reserved a casual island manner. The beaches of Waikīkī became simply the playground and relaxation destination of Oʻahu's *aliʻi* and upper class. From 1854 to 1874, generations of the royal family and *aliʻi* maintained residences in Waikīkī (Stassen-McLaughlin 1986: 8).

In 1896, Sanford B. Dole deeded the land on which the WWMCis located to W.G. Irwin.

4.4 Early to Mid-1900s

The "Reclamation" Project was, perhaps, the most dramatic of changes in Waikīkī's history. On the face of it, the project was an undertaking to fill in mostly agricultural ponds and wetlands that were supposedly compromising public health by acting as a breeding ground for disease bearing mosquitoes. However, according to Nakamura (1979), this project served to generate capital for Hawaiian construction companies while increasing residential land and land value as well as gentrifying the area by forcing out farmers and underprivileged families. This decade-long project not only transformed the coastline of Waikīkī, but altered the ecology and cultural landscape forever.

As part of the "Reclamation" Project, construction of the Ala Wai Drainage Canal was launched in the 1920s, to divert stream waters of Pālolo, Makiki, and Mānoa Valleys away from the wetlands and allow those soils to dry and solidify for building (Glenn and McMurty 1995). Dredging for the project was performed by Hawaiian Dredging, owned by Walter Dillingham, who sold the dredged sediment to Waikīkī developers for building up land, as buildings were required by the city to be built above sea level. Without doubt, many archaeological features related to habitation, agriculture, and aquaculture were destroyed in the process of constructing the canal.

The Waikīkī War Memorial

The idea of having a memorial dedicated to Hawaiian born soldiers that died during World War I was first seriously discussed in 1918. The initial design consisted of a shaft of local lava rock that would display the names of the fallen. Later, officials led a public discussion on the proposed memorial's design, which led to two forms: 1) a grouping of statues with a fountain; and 2) a building containing an auditorium, displays, statues, and other practical features. The location of the proposed memorial was undecided until the committee's minority submitted a report suggesting the Irwin beach property, which had been unused for some time, to be considered as the memorial location. During Honolulu Ad Club committee discussions about the construction of a war memorial in 1918-1929, the idea of purchasing the Irwin Beach property arose (Kuykendall 1928) (Figure 16). The committee researched the property and found that it could be purchased at the price of $200,000, which would be covered by the "Victory Fund." The fund, a total of $600,000, was comprised of two equal shares of capital: "popular subscription" and "special taxation." These funds were allocated to the purchase of the property in 1919, which would secure 6.4 acres for the memorial (Daly 1995). After much thought and consideration, the development committee proposed in 1921 to dedicate a natatorium that contained an Olympic size swimming pool, pavilion, and attractive landscaping to the fallen heroes of Hawai'i (Kuykendall 1928:447-551; Figure 17). However, it would not be until 1925 that funds to build the WWMC would be allocated. In 1927, the WWMC Natatorium was finally built.

In 1922, Louis P. Hobart of San Francisco was selected to design the War Memorial and Natatorium. However, no bids were submitted to construct the proposed structure due to the grandiose scope of the project, the nature of the building site, and the decidedly diminutive budget of $250,000.

After the plans were modified several times, J.L. Cliff was awarded the contract to build the structure for approximately $218,000. While the WWMC was not fully completed by the first scheduled swimming championship on 24 August 1927, the Natatorium was complete enough to hold the contest and a formal dedication to the fallen soldiers of Hawaiʻi. The opening ceremony was inaugurated by patriotic music, addresses from elected officials, and exhibition swims from the likes of Duke Kahanamoku (ibid.:552-554).

Three previously written reports (Kuykendall 1928; Daly 1995) provide excellent summaries of the historical background of the Waikīkī War Memorial. All three references are provided in Appendix E.

Figure 19. The Irwin Residence (1907) formerly located on the site of the WWMC(photo from Weyeneth 1991: Plate 16).

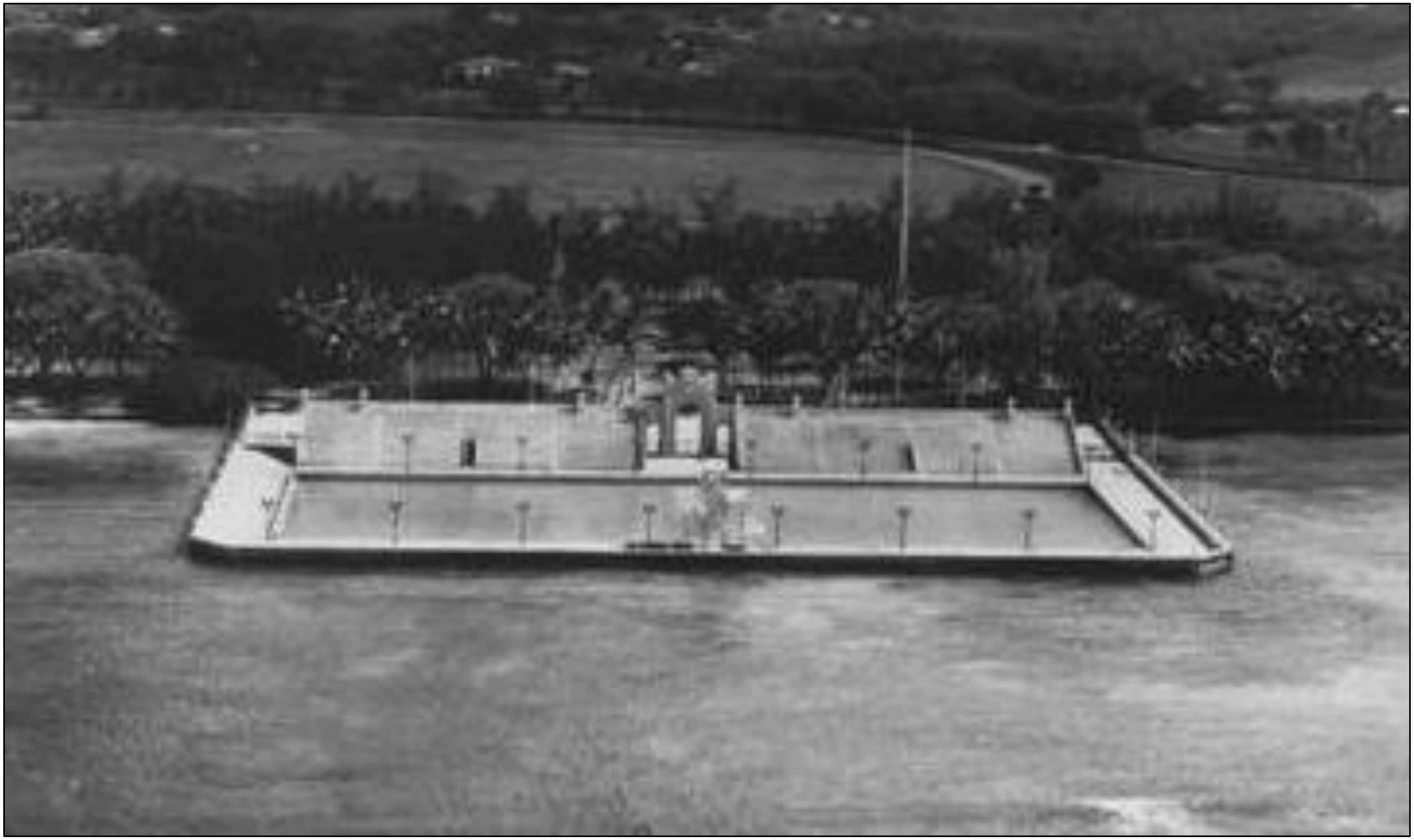

Figure 20. The War Memorial Natatorium circa 1928 (courtesy of the Hawai‘i State Archives).

5.0 PREVIOUS ARCHAEOLOGY

Numerous archaeological investigations have been conducted in the *ahupua*ʻ*a* of Waikīkī, yielding buried subsurface archaeological features, sites, and *iwi kūpuna* (human burials) (Figure 18). Buried fishponds are known to exist in the Fort DeRussy and Hale Koa Hotel area, the remains of which were encountered during several recent development projects (Davis 1989, Carlson et al. 1994, Denham and Pantaleo 1997). Habitation features, such as pits and post holes, as well as *iwi kūpuna*, have been discovered in this area.

5.1 EARLY ARCHAEOLOGICAL INVESTIGATIONS

The first discovery to be treated as an archaeological site is that recorded by N.B. Emerson in 1901. During the 1901 excavation of trenches for the installation of water lines at the home of James B. Castle (near what is today the Elks Club), the remains of at least four individuals were exposed. The individuals were buried in white sands (Jaucus sands). Found with the burials were a variety of goods, including conical whale teeth, large, round, glass beads, and a small *niho palaoa,* an ornament commonly worn by *ali*ʻ*i*. (Emerson 1902:19). J.G. McAllister (1933) recorded four *heiau* (temple) in Waikīkī, three in lower Mānoa Valley, and the fourth (Papaʻenaʻena) being at the foot of Diamond Head crater.

5.2 RECENT ARCHAEOLOGICAL INVESTIGATIONS

In April of 2000, Perzinski and Hammatt (2002) of Cultural Surveys Hawaiʻi conducted archaeological monitoring for excavations associated with the Waikīkī Bandstand and associated ponds. Perzinski and Hammatt (2002) identified a charcoal layer in several areas of the park and recovered a broken basalt stone lamp on the *makai* side of the bandstand.

In early 2001, Perzinski and Hammatt (2001a) conducted archaeological monitoring for a lighting improvement project along Kalākaua Avenue between the WWMC and Ponimōʻī Road. The monitoring documented a single historic trash pit which yielded glass bottles dating to the early 20th century. Two traditional artifacts (an adze preform and a cowry shell octopus preform) were recovered from a back-dirt pile. No traditional cultural deposits or human remains were identified.

Also in April 2001, Perzinski and Hammatt (2001b) conducted archaeological monitoring for the re-interment facility for the Waikīkī *iwi kūpuna* located on the *mauka* corner of Kalākaua and Kapahulu Avenues fronting the Honolulu Zoo. The excavations did not exceed 60 cm in depth and only a single fragment of bottle glass was identified.

In mid-2001, Bush et al. (2002) conducted archaeological monitoring for the Queen Surf Promenade improvements located north of the current project area. No traditional or historic artifacts or deposits were uncovered, however, given the presence of burials in the Waikīkī area, archaeological monitoring for any future work was recommended.

Between July 2002 and May 2003, Bush et al. (2004) conducted archaeological monitoring for the proposed improvements to the Honolulu Zoo located north of the current project area. The monitoring focused on three areas on the west side of the zoo. In most excavations, remnants of previous zoo structures and fill deposits were encountered. Natural sand deposits were observed in on area near the Elephant Exhibit; however no cultural material was encountered. Given the presence of burials in the Waikīkī area, archaeological monitoring for any future work was recommended.

In May 2004, Cultural Surveys Hawaiʻi conducted archaeological monitoring (CSH 2004) associated with a new sewer pump station near the Waikīkī Aquarium (TMK [1] 3-1-031:006). The excavations consisted of two electrical trenches totaling ca. 80 meters in length. A single historic trash pit was uncovered (Site 50-80-14-6704). The pit contained items including butchered animal bone, ceramic pieces, and glass bottles that dated between 1880 and the 1920s.

In October 2004, Scientific Consulting Services (Tome and Spear 2005) conducted archaeological monitoring associated with the Public Baths Pump Station Modification Improvements Project located adjacent to the Waikīkī Aquarium (TMK: [1] 3-1-31:07), situated just northwest of the current project area. The monitoring identified a single archaeological site (50-80-14-6702) consisting of a single subsurface trash pit containing glass bottles manufactured between the 1870s and the 1920s. The site was assessed as significant under Criteria D with no further work recommended at the site. Archaeological monitoring was suggested for work conducted along the coastal areas.

In 2006, Cultural Surveys Hawaiʻi (Whitman et al. 2008) conducted archaeological monitoring for a 12-inch water installation along Kalākaua Avenue and Ponimōʻī Road, located just to the south of the current project area. The investigations uncovered a single fully articulated human burial (Site 50-80-14-6946) interred in a flexed position. The burial was disinterred and was identified as a sub adult of Native Hawaiian ancestry. Archaeological monitoring within the area was recommended for any future work.

In 2008, Archaeological Consultants of the Pacific, Inc. (Liebhardt and Kennedy 2008) conducted archaeological monitoring at the Waikīkī Aquarium (TMK [1] 3-1-031:006) located on the opposite end of the WWMC from the current project area as part of an electrical system upgrade to the aquarium. The investigations focused on several tranches excavated from Kalākaua Avenue and entering the aquarium property. They excavations uncovered various fill layers overlaying Jaucus sand deposits. No cultural remains were encountered.

5.3 CONCURRENT ARCHAEOLOGICAL INVESTIGATIONS

Pacific Legacy Inc., under contract to WCP Inc., conducted an archaeological inventory survey at the Waikīkī War Memorial Complex in the *ahupuaʻa* of Waikīkī, island of Oʻahu, Hawaiʻi [TMK (1) 3-1-031] (McIntosh and Cleghorn in preparation). Specifically, the project area is situated within Kapiʻolani Beach Park, in an area often referred to as Sans Souci Beach. The archaeological investigations were conducted as part of an Environmental Impact Statement for the Waikīkī War Memorial Complex.

During the course of the project two different archaeological testing episodes were conducted: first in 2011 and again in 2018. The second episode was the result of changes to the Area of Potential Effect and consultations with the State Historic Preservation Division.

In all, 22 shovel test pits and 12 backhoe trenches were excavated during the course of the project. Seven subsurface features were identified within the trenches and a discontinuous cultural layer was also identified. Several traditional artifacts were recovered along with historic vestiges documented throughout the project area. A single marine shell fishhook was identified in Shovel Test Pit 5 (60 cmbs) and an associated charcoal sample returned a date of AD 1460 to 1650. This layer and associated features have been designated as Site 50-80-14-7211.

Further testing was conducted in 2018 to further clarify the boundaries of Site 7211. During this episode, a coral abrader was recovered within STP 15 along with marine shell midden (50 cmbs). This deposit is attributed to the same cultural deposit identified in 2011. This layer and associated features have been designated as Site 50-80-14-7211. No human remains were observed during the subsurface testing.

It is recommended that preservation be undertaken for Site 50-80-14-7211, a significant cultural deposit within the APE. In addition, archaeological monitoring is recommended for any excavations within this portion of Kapiʻolani Park deeper than 50 cm below surface.

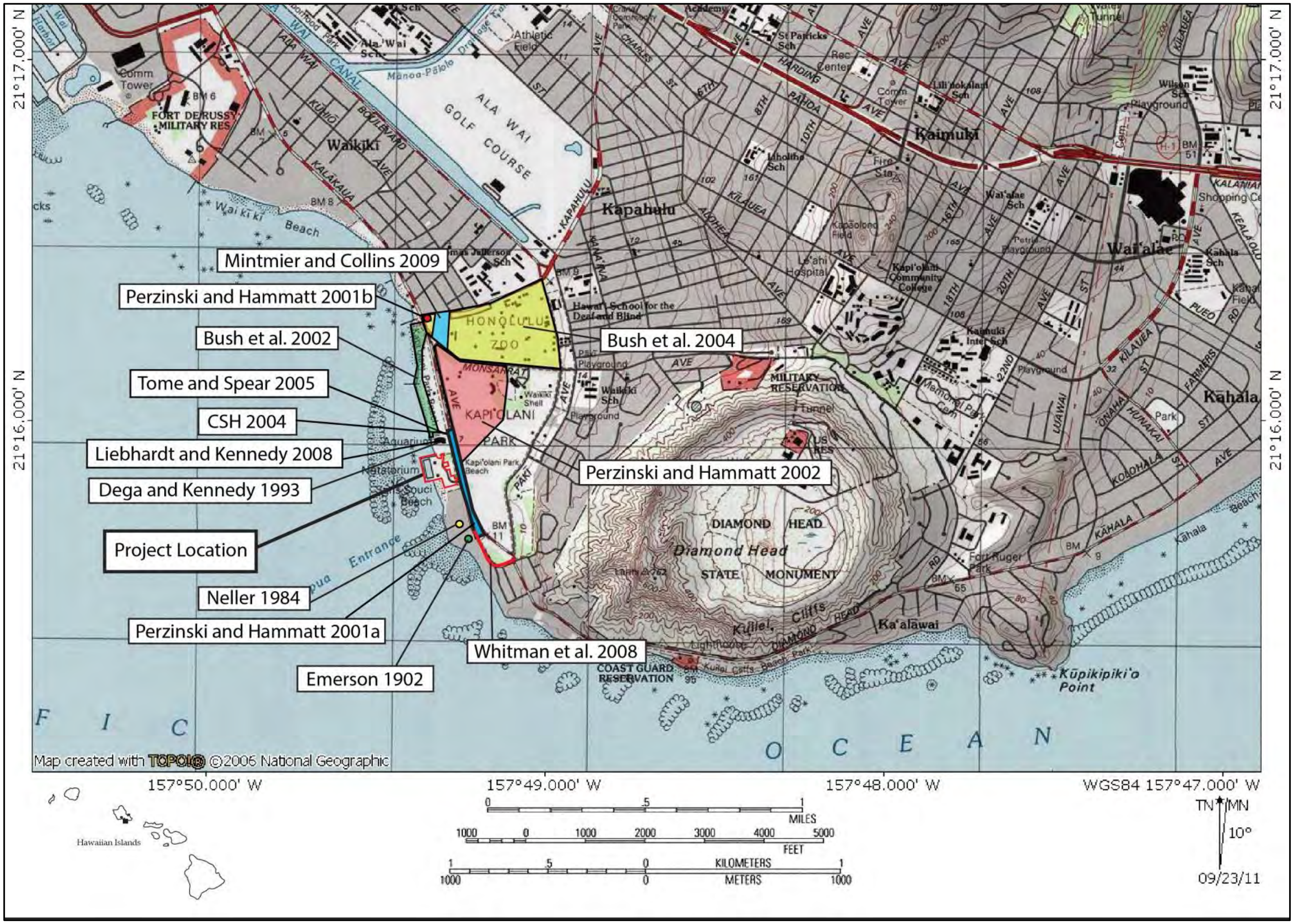

Figure 21. Locations of previous archaeological investigations near the project area.

6.0 CONTEMPORARY USE

6.1 THE WAIKĪKĪ WAR MEMORIAL

The WWMC is the site of organized annual events for both Veterans Day and Memorial Day for the last 23 years (Friends of the Natatorium 2011; Gutierrez 2011; Star-Advisor 2011) (Figure 19). These events include the participation of active-duty and retired military speakers, Color Guard, as well as traditional Hawaiian song and dance. Several private sector groups also contribute to the event, including the Friends of the Natatorium, Elks Lodge 616, and the Kaʻahumanu Society. According to the President of the Friends of the Natatorium (FoN), Peter Apo, about annual Memorial Day services, "We've had a pretty loyal audience over the years…The people show up year in and year out, and it's a rather intimate gathering" (Gutierrez 2011). According to the FoN website,

> The Natatorium is a particularly appropriate place for a Veterans Day ceremony. It has been, since it opened in 1927, Hawaiʻi's official memorial to more than 10,000 volunteers from here who served in the Great War.
>
> Friday's [Veterans Day 2011] ceremony will include flower, lei and wreath laying and brief remarks honoring the service of U.S. soldiers, sailors, marines, airmen and coast guards throughout the nation's history, with special attention to those from Hawaiʻi. A U.S. Marine bugler will play Taps in memory of the nation's war dead (FoN 2011).

Thus, the grounds of the WWMC are still utilized for annual memorial services for U.S. service men and women who have fought and/or fallen while serving the country. The associated volleyball courts are still used as well (Figure 20).

6.2 SURROUNDING BEACHES AND PARKS

Sans Souci/Kaimana Beach is a popular destination for its broad sandy beach and easy open water access. On any given day, people utilize the beach for sunbathing, picnicking, swimming, surfing, body surfing, body boarding, stand-up paddle boarding, paddleboarding (kneeling), and snorkeling. Many of these beachgoers utilize the WWMC bathrooms and water fountain/spigot (Figures 21 and 22).

The Kapua Channel, which is located at the south end Sans Souci/Kaimana Beach, is one of a few safe passages from the shore to the open ocean. This submarine feature is utilized by a number water sports competitions, water sport enthusiasts, and recreationists. Other organized events occurring in adjacent areas include the Waikīkī Rough Water Swim, Hawaiian Christmas Long Distance Invitational Rough-H20 Swim, and the Windsock Swim. While no paddling events are permitted by the City and County at this time, many single and double person outrigger canoe paddlers train and race out of this location (Figures 22 and 23). The popular surf break, "Old Man's" is accessed from the Kapua Channel. Fishing is also allowed in coastal waters south of the natatorium on even years only. Diving (spear fishing) is a popular activity during these years (Figure 24).

Figure 22. 2011 Memorial Day services at the WWMC(courtesy of the FoN).

Figure 23. WWMCvolleyball court.

Figure 24. WWMC restrooms, still open to the public.

Figure 25. Water fountain area used by water sports enthusiasts.

Figure 26. Single-seat outrigger canoe enthusiasts exiting the ocean at Sans Souci/Kaimana Beach.

Figure 27. Fishing regulations posted for the Waikīkī-Diamond Head Shoreline Fisheries Management Area.

7.0 COMMUNITY CONSULTATIONS

Over 25 individuals and associations were identified as potential sources for cultural information regarding the Waikīkī War Memorial. Nearly 30 potential informants and associations were invited to participate in an interview using a variety of methods to contact the individuals and often trying numerous times (Appendix B). Nevertheless, only eleven individuals agreed to be interviewed (Table 1). Many individuals who declined to participate had recommended other informants, as they felt the recommended individuals were more knowledgeable on the subject area. A few of the interviewed informants were referred by other informants. Numerous potential informants did not respond to the requests, this was either because they simply did not wish to participate or the contact information was no longer current. Interviews were performed between 8 November 2011 and 28 March 2012 by Kimberly Mooney, B.A. Seven interviews were conducted in a face-to-face, "talk story" format and three were over-the-phone interviews.

Table 1. List of Participating Cultural Informants

Name(s)/Title	Association	Form of Interview
Dr. Lynette Cruz, Cultural Practitioner	Native Hawaiian area descendent; raised in the area; cultural practitioner; retired Professor of Cultural Anthropology and Hawaiian Studies at Hawaiʻi Pacific University	Person-to-person
Dr. Samuel M. ʻOhukaniʻōhiʻa Gon III	Native Hawaiian Cultural practitioner, currently practicing in vicinity; Cultural Advisor for The Nature Conservancy of Hawaiʻi	Person-to-person
Mrs. Bertha Nahoopii, Kupuna	Former WWMC swim team; Neighborhood Board, No. 5 (30 yrs); lifelong resident of Kapahulu	Person-to-person
Mr. Rick Kaimi Scudder	Researcher of traditional Hawaiian practices and sites in project area; 1970s recreated/surfed in area; Administrator of ʻAhahui Mālama i ka Lōkahi	Over-the-phone
Ms. Kaia Hedlund	Administrator Waikiki Rough Water Swim; 12 yrs of recreation and water sports at Sans Souci/Kaimana Beach	Over-the-phone
Mr. Edward "Kepa" Freitas	Kapiʻolani Regional Park Manager; 20 yrs. diving and surfing in area	Person-to-person
Mr. Gary Samura	Competitive paddler; 40 yr. regular of Sans Souci/Kaimana Beach	Person-to-person
Mr. Frederick A. Wong, Kupuna	Adjutant/Quarter Master VFW Honolulu, Post 8616; Founding member and planner for Veterans Day and Memorial Day ceremonies at Waikīkī War Memorial; Native Hawaiian ancestry	Person-to-person, joint with Ms. Donna L. Ching and Jill Radke
Ms. Donna L. Ching	Vice President for Friends of the Natatorium	Person-to-person, group interview w/ Ms. Radke & Mr. Wong
Ms. Jill Radke	Board Member for Friends of the Natatorium; historian	Person-to-person, group interview w/ Ms. Ching & Mr. Wong
Mr. Rick Bernstein	Kaimana Beach Coalition member; 46 years swimming at Sans Souci/Kaimana Beach	Over-the-phone

7.1 DR. LYNETTE CRUZ

Dr. Lynette H. Cruz is currently the Kupuna-in-Residence and Assistant Professor of Anthropology with an emphasis in Cultural anthropology and Hawaiian Studies at Hawaiʻi Pacific University. Having spent the majority of her formative years swimming and learning Hawaiian cultural practices in the vicinity of the WWMC as well as being one of the founders of the Changing of the Seasons (Hoʻoilo to Kau Wela) ceremony revival held annually on Waikīkī Aquarium grounds bordering the subject area, Dr. Cruz stands as a key informant on the cultural significance of the WWMC vicinity. Dr. Cruz was interviewed by Kimberly Mooney, B.A., of Pacific Legacy at Govinda's Restaurant in Nuʻuanu on 5 December 2011.

Lynette Hiʻilani Cruz was born in Hilo, Hawaiʻi, to Anna and Antone Machado in February of 1944. Her family relocated to her grandparents' house in Kapahulu on the island of Oʻahu when she was five years old. Dr. Cruz lived in Kapahulu, which is located less than half a mile north, or *mauka*, of the project area, until she was about 25 years old. Therefore, the WWMC was, to some degree, continuously in the backdrop of her childhood. She learned to swim at the Natatorium and learned many traditional Hawaiian cultural practices in the general area. Dr. Cruz's mentors were mainly her mother, grandparents, and great-aunt who taught her how to gather traditional marine resources and how to sing and *hula* (dance) according to Hawaiian traditions; yet she also learned from her many aunties and uncles.

To her recollection, the beach now commonly referred to as Kaimana, was referred to as Sans Souci in her formative years. Her earliest memory of Sans Souci depicts a beach that was nearly void of sand, but had a shallow, abundant reef ecosystem that her family walked upon to gather *limu* (seaweed) when it was accessible at low tide. By her account, the majority of reef was approximately a foot under water at low tide. She also remembers a low, retaining wall that paralleled the surf, rather than the sandy expanse of today's Kaimana Beach. On the ocean side of this two foot high wall was about a three to four foot breadth of sand which met the surf and shallow reef. The irregular reef spread quite a distance out from shore and was traversable all the way across at low tide.

Dr. Cruz recalls her mother and grandmother, Amelia Machado, teaching her to properly pick the finest *limu* at Sans Souci Beach, such as *līpeʻepeʻe* (*Laurencia parvipapillata*), by pinching off the tips, leaving the body and root portion of the seaweed to replenish itself. While *ogo* is a type of edible *limu* found in that area, she does not recall her family collecting it as they considered it rubbish and beneath them to eat. Her mother collected *limu* from this area for as long as she could remember, until a fateful incident occurred. This incident was recapped by Dr. Cruz during our interview,

> …One day, my mother…she used to wear this hat, you know, like the plantation guys wear…this big hat tied onto her [head]. And then one day the string came untied - her ribbon. Then her hat flew off and flew over and hit the water upside down. Then a fish jumped into it. An *uhu*! It was big and it frightened her, because that doesn't happen...she stopped, and then picked up the hat and went home and showed it to my grandma and told my grandma what happened. My grandma told her, "Well, do you know what that means?"

> And my mom says "What?" And she says, "You cannot go anymore…this is it…" So, my grandma cooked the fish…she cooked the fish and they had it for dinner. A couple days later, of course my Mom wants to eat *limu* and goes down to the beach. She goes into the water and then the soles of her feet start to crack. It's like dry skin and it starts to crack and bleed. And she realized that she couldn't go in [the water] again, that was it…

When Lynette's mother, Anna, realized her mother was right, she heeded the omen and neither she nor her children returned to Sans Souci Beach to pick *limu* again. According to Dr. Cruz, this story touches upon the concept that cultural practices are not necessarily about performing an act, but rather, she states, "it's in the ability to read signs…to commune and to say…well, ok this is the meaning or this is probably what that means. That's a practice too. You don't have to be physically doing it in order to be able to interpret [it] appropriately." Hence, she holds that her grandmother appropriately interpreted the omen and tried to pass on this cultural knowledge, but her mother didn't believe the interpretation, returning to the reef to collect *limu* and having to experience painful manifestations that ultimately reinforced the initial warning of the divine decree. This anecdote of abiding by cues transmitted from the natural world also illustrates how deeply in tune Hawaiians were with their environment and how strong some of the traditional belief systems were even at this late date.

Other marine resources were traditionally caught and collected from this area as well. Octopus, also known as, *mū he*ʻ*e* and *he*ʻ*e*, were caught in these reefs by using a "squid box" according to Dr. Cruz, which is simply a box with a glass bottom to view the reef and its inhabitants clearly. When the octopus was spotted through the glass bottomed box, it would be speared and collected. Pole fishing for smaller varieties of fish was also performed at Sans Souci as she remembers. Some species of shellfish were collected for consumption from these reefs, such as *hā*ʻ*uke*ʻ*uke* (shingle urchin, *Colobocentrotus atratus*) and *pipipi* (*Nereta* spp.). She did not recall any traditional Hawaiian throwing of net to catch fish at Sans Souci.

Dr. Cruz is also knowledgeable on the ceremonial and astronomical significance of the general area. In the mid-1990s, she was informed by a friend employed at the Waikīkī Aquarium that there once was a *pā* (enclosure) located in or near the aquarium's storage area and according to traditional *mo*ʻ*olelo* (story), if you stood at that location on or about May 1st or 2nd, you could see the sun set right into the crater of Puʻu Kapolei. Upon hearing this, she consulted with the late Kumu John Lake, who maintained that there were traditional Hawaiian ceremonies held to venerate this astronomical event long ago. The two decided it was a good time to revive this tradition and subsequently organized a ceremony to celebrate the "Changing of the Seasons," in other words the transition from the Hoʻoilo (winter or rainy season) to the Kau Wela (summer or hot/dry season), as their ancestors did in the nearly forgotten past. The first solstice ceremony held by Dr. Cruz and Kumu Lake in the mid-1990s was performed on the northern ramp of the Natatorium, which had over a hundred attendees and attracted scores of onlookers. The two were then asked by aquarium officials to hold the ceremony inside the aquarium and later on the exterior grounds of the aquarium, where they are still held annually on May 2nd to this day.

The area surrounding the WWMC has had a venerable tradition of Hawaiian song and dance associated with it as well. Dr. Cruz's family was prominent in the Hawaiian music and dance scene during her childhood, practicing and performing these traditions in the vicinity of the project area much of the time. For example, her great-aunt, Lena Machado, was a world renowned singer, often referred to as "The Songbird of Hawaiʻi," was also the *kumu hula* who taught Dr. Cruz and her siblings to sing and *hula.* Her mother, Anna Kaolelo Machado, was a musician for the Kodak Hula Show, which was held on the grass just inland of Kaimana Beach from the 1930s up to its finale in 2002. The Kodak Hula show was a memorable experience for tourist as well as a longstanding tradition for locals to demonstrate and preserve an array of Hawaiian cultural practices. Dr. Cruz recalls that the Kodak musicians' families were like one family and the children of the musicians became one *hui* (club), playing together at Sans Souci Beach, exploring Kapahulu and the Honolulu Zoo, as well as snatching taro corms left over from the *poi* pounding demonstration as their parents performed.

Dr. Cruz suggests that the WWMC still maintains a cultural function in the community, but has mixed feelings about what to do with the failing facilities. Her thoughts are that the War Memorial was built to honor the fallen soldiers of World War I, which is important to remember. The Natatorium, when it was still in working condition, was a central locus for Oʻahu residents of Dr. Cruz's generation as the principal community educational facility for swimming and generally as a safe place to swim. It was at the Natatorium that Dr. Cruz learned to swim as a child, as did most of her peers. She recalled that when she was a child, all students attending public school were required to learn how to swim and at that time the Waikīkī Natatorium was designated as the location for swimming classes until one of the students drowned, which subsequently ended the program. She also recollects that on the outer perimeter of the Natatorium was a bustling reef system that was a popular snorkeling and diving spot. However, the last few times Dr. Cruz visited the Natatorium, she found the facility in gross disrepair. She feels that at this time, the Natatorium is not safe for swimmers and somebody should repair the facility if it is to remain in place. Yet, she asked during the interview, "if it were to be repaired, what would be the justification for it? In other words, what would be the future use of it? Would it be inviting the same communities back in?" If repairs are not an option, she would like the public to be able to reclaim the use of the area. Yet, she always questioned the Natatorium water filtration system's ability to keep a relatively small body of water in which 500 people were swimming hygienic. That was a question she hadn't heard growing up. Nonetheless, to her, the bottom line is:

> I don't live there anymore, and I think that the people that live there ought to make that determination because they are going to be the ones that are going to, basically, be using it the most …and I think a lot of it has to do with what people remember…like me. I don't have any bad memories of that place. It's all good. But, I'm not there.

In spite of that, Dr. Cruz has no problem with leaving the structure as is and fixing it slowly. She would simply like to see it used. Dr. Cruz added that she would not like to see that area demolished for the expressed purpose of building more beach, as there are still reefs in the area and does not want them smothered in sand like Sans Souci Beach. In other words, she would not like to see Kaimana to extend over to the aquarium side of the Natatorium.

Further, if the plans call for the WWMC demolition she would like to see the reef restored or at least left alone. She would even like to see the Waikīkī Aquarium, as stewards of the marine environment, expand its grounds to cover some of that area. To her, it's not all about recreation, but education and environmental restoration.

In regards to the current cultural significance of the WWMC to Hawaiians, there have been so many radical changes to the project area and surrounding environment in the last 40-50 years, traditional Hawaiian cultural practices have long been impacted if not completely extinguished, according to Dr. Cruz. She holds that the cultural practices she learned can no longer be practiced by her, as access to these resources no longer exists.

7.2 DR. SAMUEL M. ʻOHUKANIʻŌHIʻA GON III

Dr. Samuel Gon III is the Senior Scientist and Cultural Advisor for The Nature Conservancy of Hawaiʻi, who is renowned for his contributions to ecological and zoological studies in Hawaiʻi and abroad as well as the preservation of Native Hawaiian history, culture, and language. Born December 1955 in Honolulu and having been raised in Honolulu, Dr. Gon is very familiar with the WWMCand Natatorium area. Frequenting the WWMC area as a child to swim at the beach and in the Natatorium as well as visit the Waikīkī Aquarium gives him a respectable perspective of this area's past cultural significance. His participation as an attendee and more recently as the *Kahuna Pule* (prayer master) in the revived annual ancient Hawaiian "Changing of the Seasons Ceremony" held on the Waikīkī Aquarium grounds adjacent to the subject area each May for nearly a decade deepens his affiliation with the area and adds a perspective on the area's cultural significance today. Dr. Gon III was interviewed by Kimberly M. Mooney, B.A., of Pacific Legacy on 8 November 2011 at his Nature Conservancy office in Honolulu.

The traditional Hawaiian solstice ceremony, referred to now as "Changing of the Seasons Ceremony," marks the transition from Hoʻoilo (winter or rainy season) to the Kau Wela (summer or hot/dry season) and is heralded when the sun aligns as it sets with Puʻu Kapolei from the perspective of those observing it from Waikīkī Aquarium to Kaimana Beach. To his knowledge, the revival of this ceremony was born of a discussion between Dr. Lynette Cruz and the late Kumu John Keolomakaʻāinana Lake about Kūpalaha Heiau, which they found through archival research to have once stood in the vicinity of the WWMCand Waikīkī Aquarium. He holds that the first ceremony was held on the ramp of the Natatorium, but has since been held on the Waikīkī Aquarium grounds, ʻEwa of the aquarium on the grassy lawn.

During the 2011 interview, Dr. Gon maintained that Kūpalaha Heiau, which is thought to have been located near to the Waikīkī War Memorial, is associated with many traditional Hawaiian stories, or *moʻolelo,* and with ancient cultural practices such as astronomy. The most memorable story that he touched upon was the tale of Kapoʻi and the *pueo* (owl). In his summary of the story, the protagonist, Kapoʻi, came across *pueo* eggs as he was gathering *pili* grass on the slopes of Punchbowl. Kapoʻi collected the eggs for his dinner, but the owl pleaded for Kapoʻi to return the eggs. After the *pueo* shamed the protagonist and correctly answered the correct number of eggs he found, Kapoʻi gave in to the *pueo* and returned the eggs.

According to Dr. Gon in a later email communication, "His hesitation on relinquishing the eggs is related to the precedent of obeying a supernatural being: Once you obey, you are bound to continue to obey. His acquiescence and return of the eggs reflects his acceptance of the owl as his ʻ*aumākua*." As Kapoʻi was beholden to the owl, he was commanded to erect a *heiau,* make it *kapu* (sacred), and perform rites there. These actions were strictly prohibited by the ruling chief of Oʻahu, Kekuhihewa. Upon hearing the actions that Kapoʻi took, Kekuhihewa ordered the lawbreaker to be captured and killed upon Kūpalaha Heiau. However, the *pueo* then amassed an army of owls who successfully freed Kapoʻi from his gruesome fate at Kūpalaha Heiau. Dr. Gon was also able to share more detail about Kūpalaha Heiau. He holds that Ōpūnahā, a name that was listed on Historic maps of the area near the current location of the Waikīkī War Memorial, was once a shrine within or an element of Kūpalaha Heiau.

In regards to potential impacts on cultural practices by the proposed project, Dr. Gon maintains that construction activity in the vicinity would scarcely impact the solstice ceremony as nothing remains of these ancient ceremonial structures. Moreover, he holds that if more can be learned about these archaeological sites and associated practices during project related construction, it would be a positive outcome. His only stipulation is that during the solstice ceremony, which takes place in the beginning of May each year, the view plane from the current location on the aquarium grounds to Puʻu Kapolei must remain clear of obstructions and construction noises. However, he suggests that there may be other cultural practitioners, for instance those who may collect *limu* or shellfish from the area may be impacted by construction activities by eliminating these cultural marine resources in the area.

7.3 MRS. BERTHA NAHOOPII

Mrs. Bertha S.J. Nahoopii is a lifelong resident of Kapahulu and has spent nearly her entire life living, working, and serving her community in the Kapahulu area. She has held station for over 30 years on the Neighborhood Board, No. 5 (Diamond Head/Kapahulu/St. Louis Heights Districts) and is currently the Kapahulu Sub District Chair. She is a Retired Police Officer (Juvenile Division), and the former Recreation Instructor and Athletic Director of Pālama Settlement. Further, Mrs. Nahoopii spent over 30 years swimming at Sans Souci Beach and the Waikīkī War Memorial, from childhood as a beginning swimmer, to her teen years on the swim team, to coaching as an adult. Although Aunty Bertha chose to pursue a career in Recreation Leadership and later Law Enforcement, she was a serious swimmer and very much part of the Natatorium *hui* that many world-renowned Olympic and competitive swimmers also belonged to. Mrs. Nahoopii was interviewed by Kimberly M. Mooney, B.A., of Pacific Legacy at the Elks Club 616 in Waikiki on 2 December 2011.

Bertha S.J. Lee was born in Honolulu to the Lee family in April of 1931. Her mother, Mew Sin Hee was born and raised in Kauaʻi and came to Oʻahu to attend Normal School in Honolulu for a certificate in teaching before settling down in Kapahulu. After graduating from Roosevelt High School, she attended the University of Hawaiʻi at Mānoa and got her Bachelor's Degree in Recreation Leadership. In the early 1950s after receiving her B.S., Aunty Bertha became a swimming instructor at Pālama Settlement and advanced all the way to Athletic Director of the settlement.

From Pālama Settlement, she pursued a career in law enforcement and found satisfaction in helping wayward juveniles, which seemed like a suitable transition from the troubled youth at Pālama Settlement. Aunty Bertha remained with the Honolulu Police Department, Juvenile Division, for 32 years. Still wanting to serve the community, she pursued a seat on the Neighborhood Board for the area in the late 1970s and holds the seat still today.

At about the age of 14 years old, Aunty Bertha, through her natural athleticism and love for sports, became a regular at the Waikīkī War Memorial. She quickly became close with the lifeguards and competitive swimmers of the Natatorium and Sans Souci Beach. Not long after, Aunty Bertha, along with other serious swimmers and lifeguards formed a swim team representing the Natatorium under the leadership of Coach George Laikupu and Coach Chris Manuwai. Her team was one of the first to compete at the Keo Nakama Swim Meet held at the Natatorium. Although the Keo Nakama Swim Meets are no longer held at the Natatorium, they have been going strong for over 63 years. In the early swim meets, the teams would use the full 100 meter length of the Natatorium pool for competitions, but later reduced the course to 50 meters in length, using pontoons to separate the competition area from the rest of the pool.

Many famous swimmers were closely tied to the WWMC according to Aunty Bertha. She worked closely with, perhaps, the most famous swimming coach of Hawaiʻi, Soichi Sakamoto. While, Coach Sakamoto never learned how to swim, he trained a long list of Olympic medalists and world record holders at the Natatorium and irrigation ditches in Maui. One of his prodigies was Bill Smith, a two-time Olympic gold medalist with eight world records and 12 national records, who at the age of 15 started his competitive swimming career at the Natatorium. After World War II, he came back to the Natatorium to be the head director of the lifeguard program. Best friend and fellow swim team member, Thelma Kalama, also made it onto the USA Olympic Team in 1948 to win a gold medal in the 400 meter freestyle relay. Another Olympian who swam with Aunty Bertha at the Natatorium was Evelyn Kawamoto, who won two bronze medals at the 1952 Summer Olympics. Duke Kahanamoku, the world famous swimmer and Olympic gold medalist, was also closely associated with the Natatorium, having the honor of being the first to swim in its waters on the opening ceremonies in 1927. Yet, by the time Aunty Bertha started frequenting the Natatorium, he did not swim there much.

Other community activities were held at the WWMC in the 1940s and 1950s, such as the Learn-to-Swim program. This swimming class, typically 5th grade students, would start their lessons at the beach of Sans Souci and then move on to the Natatorium pool. Volleyball was also a popular sport at the Waikīkī War Memorial, which had a designated court on the grounds in front of the main façade. According to Aunty Bertha, everyone in her *hui* played volleyball after swimming.

When not spending time at the Natatorium, a teenaged Bertha would hang out with the family of Arthur and Irene Lee at Public Bath located on the north side of the Natatorium, which was an area that had good surfing, restrooms, a concession stand, and the occasional live band. The Lee family, who lived on Williams Street, Kapahulu, was a very large family with plenty *hānai* kids, teenagers, and young local veterans who came back from WW II. One of the *hānai* teens was her best friend and future Olympic swimmer, Thelma Kalama.

Surfing was another passion of Bertha and Thelma, and according to Aunty Bertha, Public Bath was one of the spots that they loved to surf. Public Bath was also a good place to catch fish. Arthur Lee was the head of the Lee family and often fished in the area to help feed his large brood. According to Aunty Bertha, Arthur Lee would catch fish off of Public Bath by throwing net. She recalls Mr. Lee catching mullet (Mugilidae spp.) when in season, but also *weke* (goat fish; Mullidae spp.), and other reef fish. On the opposite side of the Natatorium, just south of Sans Souci Beach, was a large, old, castle-like house imported from Mānoa belonging to the family of her friend, Patsy Darrow, who also hung out at the Natatorium. The house no longer stands and was likely demolished by the affluent family to build the Colony Surf.

In her lifetime, Aunty Bertha observed many changes to the WWMCand its surroundings. Back in the late 1940s, Aunty Bertha maintains that the Natatorium was clean enough to swim in, but due to the fact that it was salt water, they could never really keep it as clean as modern fresh water pools. However, for quite some time now, the WWMC has been unfit for swimming, as it is filled with mud and marine life not fit for swimming with. To her recollection, there was more sand in the 1950s-1960s between the Waikīkī Aquarium and the Natatorium, but very little sand on the Sans Souci side of the Natatorium - which is the opposite of what you would find today. In addition, she recalls that before there was a volleyball court, there were salt water fish ponds (as water features) on either side of the Natatorium entrance. Both fishponds were demolished and a volleyball court was built to the left of the entrance and parking lots were built in front and to the right of the entrance. According to Aunty Bertha, there were also World War I cannons in front of the Waikīkī War Memorial, but she could not remember when or why they were removed.

Regarding the proposed changes to the Waikīkī War Memorial, Aunty Bertha has a few suggestions. She would like to see the structure of the Natatorium left in place, but filled with sand to create a sand volleyball arena and venue for hula shows. This, in her opinion, would help maintain the sand at Sans Souci, now commonly referred to as Kaimana Beach. She feels as though the War Memorial features in the front of the façade and the bleachers should also stay in place. In summation, Aunty Bertha would simply like the swimming pool to be filled with sand and the rest of the structure restored. This way, the structure can be used by the community.

7.4 MR. RICK KAIMI SCUDDER

Mr. Richard Kaimi Scudder is a geography consultant and current Administrator of the non-profit group, ʻAhahui Mālama i ka Lōkahi, which is devoted to the preservation of native Hawaiian ecosystems and educating the public of the relationship between the Hawaiian culture and the environment. During his college years, between the late 1960s and mid-1970s, he spent most of his days surfing and hanging out around the WWMCand the Waikīkī Aquarium. In the mid-1980s, Mr. Scudder began researching ancient Hawaiian traditions in astronomy and ceremony about the area, eventually publishing an article about the subject. Mr. Scudder was interviewed over-the-phone on 10 January 2012 by Kimberly Mooney, B.A. of Pacific Legacy.

Born in 1947 and raised in Long Island, New York, Richard Scudder moved to Hawaiʻi in 1969. He attended the University of Hawaiʻi at Mānoa from 1969 to 1975, receiving his Master's Degree in geography. As a college student with friends who grew up local and were well connected to Waikīkī, Mr. Scudder had many colorful stories to share of his adventures in and around the subject area. He hung out with a long list of characters, from fellow academics, including Steve Montgomery to famous surfers, such as George Downing and Fred Hemmings. When not attending school or studying, he frequently surfed "Old Man's" surf break, located just off of the Kaimana Channel on his "paipo" board, which he described as a boogey board with skegs. He also spent time with staff at the Waikīkī Aquarium. Mr. Scudder recalls viewing and photographing the surf from atop the Natatorium as well, which he remembers as being very run down by that time.

While hanging out at the Waikīkī Aquarium, he began to observe the changing pattern of the sun setting on the west side of the island. Like clockwork, the sun would set over Puʻu Kapolei near the changing of the seasons. He began to realize that the aquarium must have been an important observation location to view this phenomenon. As a community specialist working with Alu Like, Inc. he got to team up with Joyce and Michael Akin to research Hawaiian astronomy and the history of Waikīkī and Puʻu Kapolei. His research led them to make some significant findings, where the site of the aquarium is on or near the location of a *heiau,* now thought to be Kūpalaha. Mr. Scudder also made the observation that Papaʻenaʻena Heiau (now the site of La Pietra School) aligned with the speculated location of Kūpalaha Heiau at roughly the same bearing of Puʻu Kapolei. It also led to the connection between celestial movements and ancient Hawaiian farming traditions. Eventually, he co-authored an article with Joyce and Michael Akin in November of 1985, titled "Puʻu o Kapolei," which was published in *The Native Hawaiian* (volume IX, no. 12). In this article, the area just "ʻEwa" or west of the Waikīkī Aquarium was speculated to be the viewing point of the sun setting over Puʻu Kapolei, which traditionally marked the changing of the seasons from Hoʻolio to Kau Wela. Incidentally, this research led to the revitalization of ceremonially observing this solstice phenomenon, which is still practiced annually on May 1st.

Regarding the Waikīkī War Memorial, Mr. Scudder believes that the structure is too old to utilize. He is in favor of demolishing the structure and associated features as proposed by the City to rebuild the arches inland and build new bathrooms. He would, however, like to see the City dedicate some of the park to sand volleyball, which is a popular sport in Hawaiʻi.

7.5 MS. KAIA HEDLUND

While born and raised in southern California, fifty-six year old Kaia Hedlund has been participating in and directing a wide variety of water sports and recreation activities in Sans Souci/Kaimana Beach, which is immediately to the south of the Waikīkī War Memorial, for over 12 years. During her residency on Oʻahu, she has enjoyed swimming, surfing, and paddling at Sans Souci/Kaimana Beach and tries to return to this beach to enjoy these activities on business and pleasure trips to Oʻahu. Ms. Hedlund is currently the President of the Waikīkī Roughwater Swim Committee as well as Associate Director at Mountain Pacific Sports Federation, President at Kaico Sports (Sole Proprietorship), and Director of Recipient

Relations/Board Member at Swim With Mike (Physically Challenged Athletes Scholarship Fund). Further, Ms. Hedlund has held many top positions in the field of athletics that have strengthened her ties to Hawai'i, such as Director of Athletics at Chaminade University (two years) and Assistant Athletics Director at University of Hawai'i at Mānoa (ten years). Ms. Hedlund was interviewed over the phone by Kimberly Mooney, B.A., of Pacific Legacy 29 November 2011.

Although she recently moved back to Southern California, Ms. Hedlund continues to run the Waikīkī Rough Water Swim competition, which starts at Kaimana/Sans Souci Beach and ends at Duke Kahanamoku Beach near Hilton Hawaiian Village. This 2.348 mile rough water competition has been going on annually in September for over 42 years. On the day of the race, she states, a registration booth is set up in the grassy area next to the New Otani. After the swimmers sign up at the registration booth, they line up at the water's edge at Sans Souci Beach and begin the swim by groups of approximately 150 to 200 swimmers that start every 5 minutes after 9:00 a.m. Typically, there are 800 to 1,000 swimmers per competition who start showing up as early as 6:00 a.m. to practice. After the last group enters the water, the registration booth and associated signage is broken down and the supporters make their way to the finishing area across the bay at Duke Kahanamoku Beach. Ideally, the beach is returned to the state it was prior to the race. Annual swim clinics have also been held for over 30 years in July to prepare swimmers for the competition at Sans Souci/Kaimana Beach.

According to Ms. Hedlund, other water sports and non-competitive activities take place daily at Sans Souci/Kaimana Beach, such as stand-up paddling, paddling, snorkeling, recreational swimming, surfing, as well as sunbathing, fishing, and *limu* (seaweed) collecting. Many of these activities have organizations and clubs that regularly meet at this beach. For example, the Waikīkī Swim Club meets every Sunday at 8:00 a.m. at the Sans Souci/Kaimana Beach lifeguard tower. Additionally, Ms. Hedlund holds, Sans Souci/Kaimana Beach is the preferred beach in Waikīkī for locals. While all other beaches in Waikīkī are swarming with tourists, this beach, perhaps because of its relatively remote location from the Waikīkī strip, is typically used by local water sports enthusiasts.

In regards to the proposed changes to the Waikīkī War Memorial, Ms. Hedlund fears that there will be inevitable changes to the coast line, as the sands will migrate more easily with the currents. If the beach is depleted of sand, thousands of water sports and recreation enthusiasts will be displaced. Further, she sees the structure as an attractive example of classical architecture that is part of the Waikīkī visual and cultural landscape. Ms. Hedlund feels that it is a travesty and an embarrassment that the Natatorium had been allowed to reach such a dilapidated state. While she understands that the swimming pool is not likely to be restored, she would like to see it used by the public in some capacity.

7.6 MR. EDWARD "KEPA" FREITAS

Mr. Edward Iokepa Freitas has been an employee of the City and County of Honolulu, Department of Parks and Recreation at Kapi'olani Park for a total of six years, working initially as the park's maintenance foreman and currently as Kapi'olani Regional Park Manager.

However, his ties to the park extend at least twenty years, with a good portion of his formative and adult years spent surfing and diving in the waters flanking the Waikīkī War Memorial. As the WWMCis one of many features of Kapiʻolani Park, Mr. Freitas deals constantly with issues related to the aging facility as well as its affects on the park, beach, and ocean patrons. Mr. Freitas was interviewed at his office in Paki Hale on 2 December 2011 by Kimberly Mooney, B.A. of Pacific Legacy.

Mr. Edward Iokepa Frietas was born in Honolulu in the early 1970s to Edward and Cora Freitas and raised in Honolulu and Hawaiʻi Kai. According to Mr. Freitas, this area was his father's stomping grounds. His father, who grew up in an orphanage in Nuʻuanu, was a regular to the WWMC area during his childhood, swimming at the Natatorium during the day and occasionally sneaking into it at night. His father also reminisced about the Kodak Hula Show as it was in his youth. As a young man in the 1950s-1960s, Edward Freitas, Senior, would frequent the Queen's Surf Nightclub, which was located near to the subject area prior to its demolition in the early 1970s. By his father's recollection, the area had experienced some significant changes to the cultural landscape in his lifetime.

Fishing has long been a popular cultural practice in areas surrounding the Waikīkī War Memorial. According to Mr. Freitas, most people fish this area fish by spear diving, but some pole fishing has been observed as well. In the late 1980s and early 1990s, Mr. Freitas would dive regularly in these waters, but when the fish stocks became severely depleted he stopped diving there altogether. This massive fish decline eventually led to legislation calling for a fishing moratorium, where fishing is prohibited during odd numbered years at the Waikīkī-Diamond Head Shoreline Fisheries Management Area (FMA). Mr. Freitas maintains that since the moratorium has been enforced, it is typically on the first day of each new year that fishermen will come to the Waikīkī-Diamond Head Shoreline Fisheries FMA in significant numbers. After the beginning of the year, the numbers generally dwindle, but later in the year there are peaks of fishing when certain species come into season. Mr. Freitas adds that not all who fish the waters around the Natatorium access the area from Sans Souci/Kaimana Beach, but from nearby shoreline access areas and either dive up and down the coast or use a variety of marine vessels to do the same. Therefore, it is hard for him to give accurate numbers on the numbers of people fishing in the area.

Other marine resources are known to be available in the WWMC area. Although Mr. Freitas does not collect *limu* (seaweed) from the locale, he has witnessed people collecting these marine resources. He professed to have no clue of how much is collected, what *limu* species are available, and how regularly these people come, but he knows they are out there. Another traditional marine edible that is popular in many oceanic cultures is *wana* (sea urchin), which were more abundant to the south of the Natatorium when he surfed and dove in the area about 20 years ago.

In terms of current cultural use of the WWMC vicinity, Mr. Freitas maintains that there are many sanctioned and unsanctioned water sports and recreational activities occurring throughout the year. For instance, the locale is a popular place to paddle single person outrigger canoes. Some of these paddlers meet regularly, but no permits from the Department of Parks and Recreation currently exist for any canoe clubs to utilize this area. People still come from all around to surf the well known off-shore surf breaks near the Natatorium. According to Mr. Freitas, there have been no noticeable fluctuations in the number of surfers utilizing these waters. Paddleboarding, a sport created in the 1930s and not to be confused with stand-up paddle surfing, has also become a common activity in the area for distance and speed training. Some of these paddleboarders come from as far as Hawaiʻi Kai by kneeling or lying on the long, hollow core board and paddling solely with arm strokes. The increasingly popular sport of stand-up paddle boarding, which uses a long necked paddle, has also become a very common activity at Sans Souci/Kaimana Beach, either for learning to paddle when the waves are calm or surfing when the local surf breaks are active. Many of these stand-up paddle boarders use rentals from the New Otani, which is just south of Sans Souci/Kaimana Beach.

The WWMC area is used for a variety of non-aquatic activities as well, according to Mr. Freitas. Prior to its being moved to the area *makai* of the Waikīkī Shell, he recalls the 65 year old Kodak Hula Show, last performed in 2002, as occupying the grassy area just between the War Memorial Parking and the New Otani. This cultural event was held three times a week and has not been replaced by any other regular *hula* shows. The grassy area just *mauka* of the WWMCis also a well-liked picnicking locality. The main problems that Mr. Freitas experiences as the Regional Park Manager are related to unsanctioned tents and bounce houses that take away from the beauty of the park for others. Another major facet of the subject area is the volleyball court, which is still regularly used.

Aside from its failing structural integrity, Mr. Freitas has witnessed several modern day plagues to the Waikīkī War Memorial. He holds that there are several cracks in the structure leading from the pool to the ocean has allowed a variety of deep sea and reef fish, shark, and other marine organisms to frequent the pool. This miniature marine ecosystem, which includes a variety of corals and algae, has become so established that cleaning the pool interior would be an expensive endeavor. Further, homeless persons have not only become fixtures in public areas, but also make regular attempts to set up camps inside areas of the Natatorium that are currently closed to the public. Yet, he adds that the trespassing is not only carried out by the homeless, but kids and young adults who are curious about the pool's marine life and to hide from the authorities. For the City and County, this structure in its current state is a liability nightmare.

In regards to the proposed changes to the Waikīkī War Memorial, Mr. Freitas feels no real emotional attachment to the swimming pool, as he was not old enough to enjoy it when the waters were clean and clear. Though his father had fond memories of the Natatorium, he personally would rather swim in the ocean than in a sea water swimming pool.

7.7 MR. GARY SAMURA

Sixty-two year old competitive paddler, Gary Samura, has been a regular of Sans Souci/Kaimana Beach for a nearly 40 years. He participates in a wide range of water sports and other activities in and around the Waikīkī War Memorial. Gary Samura was born and raised on the Big Island, and moved to Oʻahu in 1971. He currently lives in Kāneʻohe. Mr.

Samura was interviewed by Kimberly B.A., of Pacific Legacy at the grounds of the WWMC on 8 November 2011.

In the early 1970s, Mr. Samura came to this area quite regularly to sunbathe, picnic, and swim with friends. He also used to free dive and spearfish regularly in the waters around the Natatorium to catch a variety of fish and *tako* (octopus) for sport and consumption. Mr. Samura still dives, though less frequently, during open season on even years. Mr. Samura has paddled one-man canoes for over 20 years, practicing regularly and often competing at Sans Souci/Kaimana Beach.

Being a regular at Sans Souci/Kaimana Beach, Mr. Samura is familiar with what activities are taking place in and around the WWMC daily. The WWMC provides parking and bathroom facilities for: surfers, swimmers, scuba divers (commercial classes), standup paddlers, one-man canoes, sunbathers, bikers, homeless, joggers, picnickers, and free divers. The park area in front of the WWMCis a popular place to relax for local retirees. According to Mr. Samura, an older gentleman takes the liberty of raking the *hau* leaves off of the volleyball court every morning before playing chess with his friends on the bench.

According to Mr. Samura, a great variety of people use the waters around the WWMC for an array of water sports, recreation, and cultural practices. Spear fishing and pole fishing, which is only allowed on even years, takes place in the waters from Waikīkī side wall of the Natatorium to Diamond Head Lighthouse. However, since the passing of the moratorium, no diving or fishing allowed at all from the Waikīkī Aquarium wall to the Kapahulu Groin, as it now a fish reserve. Starting 1 January 2012, people will be able to spear fish and *tako* for the duration of a year. Sans Souci/Kaimana Beach is also a hot spot for one-man canoe paddlers. There is a popular coastal water route that starts at Hawai‘i Kai and ends up at Sans Souci/Kaimana Beach. Mr. Samura maintains that it is typically a fun, downwind paddle because of the trade winds and ocean swells. Most who paddle this route will usually park at Sans Souci/Kaimana Beach, then load up canoes and drive over to Hawai‘i Kai. After they are done, someone will drive the paddler(s) back to Hawai‘i Kai to pick up their vehicles, usually taking turns driving. According to Mr. Samura, there are two associations that hold canoe races for one-man, two-man, stand-up paddle boards, and surf skis that start at Hawai‘i Kai or Makai Pier and end at Sans Souci/Kaimana Beach. There is also a state race that starts from Waimānalo and ends in Sans Souci/Kaimana Beach. These races are held from December to May. Each race typically has good number of entrees, ranging from 80 to 150 canoes, surf skis and stand-up paddlers. The October race is the most popular, according to Mr. Samura, because the paddlers are allowed to race in Halloween costumes.

Regarding the Waikīkī War Memorial, Mr. Samura has some memories of the swimming facility before it was closed down. He recalls the Natatorium in the early seventies as having a tower with diving platforms set at different heights. However, he did not swim in the swimming pool, as he preferred the cleaner ocean. In terms of its status today, he hopes the current studies will help guide the City to make improvements to the structure that will benefit the public. In addition, he hopes more parking will be created rather than just matching the existing number of stalls. During the weekends, people are always desperately looking for someone to leave so they can get their stall.

7.8 MR. FREDERICK A. WONG, MS. DONNA L. CHING, AND MS. JILL RADKE

To represent the fallen soldiers and veterans' interests in the Waikīkī War Memorial, the following informants were interviewed: Mr. Frederick A. Wong, Ms. Donna L. Ching, and Ms. Jill Byus Radke. Mr. Frederic A. Wong is currently the Adjutant/Quarter Master of the Veterans of Foreign Wars (VFW), Department of Hawaiʻi, Post 8616 – Honolulu, who bi-annually participates in and helps to organize memorial services at the Waikīkī War Memorial. Mr. Wong has also spent a total of 81 years recreating in and around the Waikīkī War Memorial. Ms. Donna L. Ching is currently the Vice President of the nonprofit organization, Friends of the Natatorium (FoN), as well as Director of Business Development at the international architecture and engineering firm, Leo A Daly. Since the age of 5 years old, Ms. Ching has recreated in and around the Waikīkī War Memorial, which amounts to approximately 45 years. Ms. Jill Byus Radke is currently a Board Member for FoN and has held positions at the Historic Hawaiʻi Foundation, Bishop Museum, and the USS Missouri Memorial Association. She also swims and recreates near the WWMC occasionally. The three informants participated in a group interview conducted by Kimberly M. Mooney, B.A., on 1 February 2012 at the Honolulu offices of Leo A Daly.

Mr. Frederick A. Wong was born in Honolulu, 7 December 1925 to Mrs. Elsie Chun Wong, who was of Chinese and Native Hawaiian ancestry. As his father passed away just prior to his birth, Mr. Wong was raised solely by his mother. In his childhood, Mr. Wong spent a great deal of his time in and around the Waikīkī War Memorial. He has fond memories of learning to swim at Sans Souci Beach and swimming at the Natatorium in its heyday. He also recalls that the trolley ended near the corner of Kalākaua and Kapahulu, and participants walked from there to the Waikīkī bandstand and the Natatorium War Memorial, which was a key destination for Honolulu's water recreation. Surfing was also very popular in waters near to the Natatorium as he calls to mind, with such breaks as "Castles" and "Publics," which have retained their popularity to this day. It was not until World War II that Mr. Wong stopped going to the Natatorium, as the military closed off the area with barbed wire to deter possible invading forces. Several years into WW II, Mr. Wong was drafted into the U.S. Army in 1945. He reenlisted in the Army then transferred into the Army Air Corp in 1946 and served for nearly a decade. After his military service, he had a short stint in the private sector before starting his final career first as an electronic technician, then electronic engineer for the Federal Aviation Administration. Though Mr. Wong is retired, he remains active in Veterans affairs and currently holds the position of Adjutant/Quarter Master of the Honolulu VFW, Post 8616.

In May of 1962, Ms. Donna Ching was born to Philip and Gerry Ching of Honolulu. Though she is of Chinese decent, her family has been in Hawaiʻi since 1886. Ms. Ching grew up in Honolulu and also spent much of her childhood swimming and recreating in the WWMCand Sans Souci/Kaimana Beach. Ms. Ching returned to Hawaiʻi after obtaining a MBA from Yale, taking a position as development director at Leo A Daly. She has acted as a consultant for public, nonprofit, and private organizations, such as the Carnegie Corporation and the Mahakea Group. Ms. Ching also sits on the Boards of Directors for several community-based local non-profits, such as the Friends of the Natatorium, Waikīkī Health Center, Hawaiʻi

Family Support Center, and Kapiʻolani Park Preservation Society as well as the Mānoa Neighborhood Board.

Ms. Jill Radke was born in Beach Grove, Indiana, to John and Marilyn Byus in 1974. She has lived on Oʻahu for approximately 12 years and has been deeply involved with historic preservation and military history in Hawaiʻi for many of those years. Although she was not able to swim in the Natatorium, Ms. Radke has performed historic research for and advocated for the restoration of the Waikīkī War Memorial. While she admits that she has no attachments to the Historic structure in terms of personal experiences that manifest later as sentiment, her attachment is to the story and to make sure she represents that history with authenticity.

According to the group, organized Memorial Day and Veterans' Day services have been held annually at the WWMC for over 20 years. However, Mr. Wong has a more personal attachment to these ceremonies. As Mr. Wong maintains that the main concern of the VFW is to "honor our dead," he and other members of the VFW Honolulu Post 8616 decided to initiate annual commemoration services at the WWMC for Armistice Day, which came to be known as Veterans Day in 1954. These ceremonies were initially small and moderately formalized, where he and other veterans representing the VFW, paid their respect for the fallen at the Waikīkī War Memorial, which is located only a few blocks from his post. Beginning around 1986 when the Friends of the Natatorium was incorporated, Kay Napoleon, the widow of Walter Napoleon, the last Superintendent of the Natatorium undertook the *kuleana* of Memorial Day Services. For the last 24 years, the Napoleon ʻOhana, now led by Kay and Walter's grandson, Frank Weight, have lead the FoN's annual observance of Memorial Day. The annual celebration has come to include top-ranking active duty military commanders of all services as well as elected officials as keynote speakers. The participation of these officials and other active duty military, such as the color guard and rifle detail demonstrate the commitment of active duty service men and women to honor the fallen at a memorial edifice erected and dedicated in their honor.

As a representative of the FoN, Ms. Ching reminds people that the monument stone, commemorative plaque (which were added later), and decorative arches are not the actual Waikīkī War Memorial. Rather, as the enabling legislation, Act 15 of the 1921 Territorial Legislature states, "a living memorial that includes a 100 yard swimming course" is intended to honor the more that 10,000 from Hawaiʻi who served in WW I. Thus, it is the pool itself that the founders intended as the memorial. Ms. Ching argues that demolishing the natatorium while proclaiming to preserve the "memorial" features of the complex is disingenuous and neither in keeping with the original concept of the memorial nor historic preservation. She adds that if the City and County of Honolulu demolishes the Natatorium, they ought to "call a spade a spade;" and admit that they are demolishing the WWMC itself. She offers an interesting analogy to the concept of demolishing the structure for the purpose of satisfying those who claim the cost is better suited to other uses:

> It's sort of like people saying, "Well you know, Punchbowl Cemetery was like this really good idea in its time, but that's really valuable real estate…and we really need to just put condos up in there because that's the current highest and best use of that land."

Ms. Ching adds, "…at some level, the idea of razing a war memorial viscerally insults peoples' sense of what's right and what's wrong." She is not in favor of reconstructing memorial arches near to the original location of the Waikīkī War Memorial.

Ms. Radke agrees with Ms. Ching on the subject of the pool as a living memorial, but also holds that the location of the WWMCis significant. According to Ms. Radke the founders knew what they wanted to express to their contemporaries. She further stated,

> …it's not important what our generation thinks, what we want to do is… to keep as much of that gift [as possible] for the future. What I think doesn't matter right now, as far as what's the best way to memorialize them. But, what I'm looking at is – what kind of message were they sending back then that we need to keep in its original format? And not try to retranslate what's important and what's not, because it's not really ours to do that with…

Further, Ms. Radke found through her research that many of the fallen soldier's bodies were never recovered or repatriated to Hawai'i, which means that there are no graves for these individuals. Thus, the WWMCis the only place where family and friends can pay respect to these soldiers. However, according to Ms. Radke and Ms. Ching, out of over 10,000 people from Hawai'i who served in the U.S. military in World War I, only 101 names are on the War Memorial plaque. Both Ms. Radke and Ms. Ching believe that there are many more that died while serving in the war. In her research, Ms. Radke had stumbled upon numerous records supporting this notion. It is not clear to either woman what methods or criterion were used to compose the list of fallen soldiers of WW I represented on the bronze plaque. Therefore, the WWMC may serve as a spiritual repository for more soldiers than are listed on the plaque.

The WWMC was also a significant institution for swimming and other water sports in Hawai'i as suggested by the group. As Mr. Wong recalls, when he was young the WWMC was the community's center for recreation. According to Ms. Ching, the WWMC was really the birthplace of competitive and modern swimming for Hawai'i as well as the United States, because the most medaled Olympic swimmers from the United States trained in that facility. In the 1940s and 1950s, such greats as Bill Smith and Soichi Sakamoto were heroes to the community and the WWMC became a cultural icon for Hawai'i and the international swimming community. In this sense, it fulfilled its original vision that the founders had in mind for the facility — as a living memorial. When the Natatorium was fully functional, the WWMC was not just a solemn, sacred place to honor those that did not come back from the war, but rather a water sports haven and a gathering place for the people of Hawai'i that was full of life as the founders had intended.

In regards to the cost factor of restoration and upkeep of the facility, Ms. Ching and Ms. Radke state prior to its closure in 1979, the last recorded public investment in improvements at the Natatorium was $89,886 in 1949. Ms. Ching adds that the whole notion that we as a community cannot afford to maintain the WWMCis ridiculous because, as she states: "…we've never maintained it…and despite the utter neglect…it is (so far) still standing." Ms. Ching points out that without chemicals and utility costs for pumps, a tidal flow circulated salt water pool is much cheaper to maintain than any chlorinated pool of comparable size.

Furthermore, Ms. Ching and Ms. Radke maintain the City's proposed demolition is being incorrectly sold to the community as "beach restoration." In fact, every ocean engineering study performed on that area has shown that removing the swimming pool would result in the erosion of Kaimana Beach and the return of the shoreline to its natural state of scrubbed rock, similar to that currently fronting the Aquarium on the ʻEwa side of the Natatorium. The cost of the legal battle to obtain permits and constructing a retention system for the sand at Sans Souci/Kaimana would far outstrip the cost of renovating the existing pool.

The sentiment that the three informants shared was that the WWMC should be restored to its original function as a living memorial, complete with fully functional swimming pool. All three noted that the composition of the Natatorium Task Force members made support of then-mayor Hannemann's intent to demolish the WWMC a foregone conclusion. The fact that six of the fifteen task force members voted to preserve the Natatorium has never been made public by the city. The informants hold that they will not stop fighting for the restoration of the facility.

7.9 MR. RICK BERNSTEIN

Mr. Rick Bernstein was born in Sacramento in 1945 and raised in Palo Alto, California. He has lived in and around the Diamond Head area since 1965. Mr. Bernstein is an avid swimmer and has been swimming at Sans Souci/Kaimana Beach for approximately 46 years. As a Sans Souci/Kaimana Beach regular and Kaimana Beach Coalition founder, he is in favor of removing the Natatorium and replacing it with appropriate groins and beach sand to create a new and stable two acre beach and return the area, as closely as possible, to its original and natural state. He feels that redevelopment of the structure and or pool would necessitate the need to commercialize the Natatorium. This would have the undesirable effect of making access to the beach and park area adjoining the Natatorium, very difficult for the countless community members who count on this area as a prime recreational resource and access point to the ocean. Mr. Bernstein was interviewed over-the-phone on 18 March 2012 by Kimberly M. Mooney of Pacific Legacy.

According to Mr. Bernstein, Sans Souci/Kaimana Beach provides the entire Honolulu community with the opportunity to enjoy an array of water sports as well as non-competitive water and beach activities. It is one of the few places where there is parking, a safe beach and easy access to the ocean. Many regular users, occasional users, and visitors enjoy water sports such as swimming, snorkeling, surfing, stand-up paddling, and paddling. All these activities take place in Sans Souci/Kaimana Beach waters on a daily basis. In addition, people train for marathons and triathlons at this location. Other community members and visitors utilize the sandy beach, grassy areas, and sea wall to meet and recreate. Weddings, funerals, birthday parties, *luau*, and barbeques are also continually occurring events at Sans Souci/Kaimana Beach. Groups that regularly meet in the area include moms and babies, university student, senior citizens, etc. etc. Mr. Bernstein maintains that the groups and individuals who meet at Sans Souci/Kaimana Beach on a regular basis are a cross section of Honolulu's diverse and multicultural population. "What is special about Kaimana Beach is how so many different people from so many different backgrounds come together so harmoniously. It is the

Everyman's Outrigger Canoe Club and is a living experience of the aloha spirit manifest[ed]…" according to Mr. Bernstein.

Mr. Bernstein recalls swimming in the Natatorium in the mid-1960s. He remembers the pool as dark and murky with sides that were too high to get a hand hold. He said he remembers periods when the pool was closed for health and safety reasons and that the state of the pool and bleachers showed signs of cracking, spalling, rusting and deterioration from the salt water ocean environment on its concrete and rebar structure.

The waters surrounding the north and west sides of the Natatorium are home to a diverse array of marine wildlife protected every other year under HAR Chapter 13-48 within the Waikīkī-Diamond Head Shoreline Fisheries Management Area and every year in the Waikīkī Marine Life Conservation District (MLCD). Mr. Bernstein notices a significant decline in the numbers of reef fish on the even years the fishing moratorium is lifted. His concerns are for the health of the reef ecosystem and the proliferation of the reef fish that live in the area and would like to see a permanent moratorium on fishing in these waters. Further, he believes that spear fishing in such a heavily used water recreation area is dangerous. During the last week of April 2012, a large shark was seen trying to eat the fish from the stringer of a spear fisherman. At the same time there were numerous swimmers in the immediate area. "This dangerous mix of fishermen with bleeding fish and recreational ocean users could be avoided by banning fishing altogether in this confined and heavily utilized ocean channel and swimming area" stated Mr. Bernstein.

In regards to the proposed project, Mr. Bernstein is an outspoken advocate for replacing the Natatorium with a "Memorial Beach" protected with groins and repositioning the Memorial Arches to frame a new Memorial Beach.

7.10 2018 FOLLOW-UP CONSULTATIONS

In August of 2018, because of the addition of the new Perimeter Deck alternative, it was decided to provide the original informants with the opportunity to provide additional information of traditional and contemporary practices taking place in the vicinity of the WWMC. In addition, the Department of Hawaiian Home Lands suggested contacting four additional organizations. On 21 August a letters were emailed and mailed to the informants identified in Table 2 (a copy of the text of this letter is presented in Appendix F):

Table 2. List of informants re-contacted in 2018

Original Participating Cultural Informants	DHHL Recommendations
Rick Bernstein	Kalawahine Streamside Association
Donna Ching	Kewalo Hawaiian Homestead Community Association
Lynette Cruz	Papaikōlea Community Development Corporation
Edward Freitas	
Samuel Gon	
Kaia Hedlund	
Bertha Nahoopii	
Jill Radke	
Gary Samura	
Rick Scudder	
Fredrick Wong	

No further input was received.

8.0 SUMMARY AND DISCUSSION

Pacific Legacy Inc., under contract to WCP. Inc., conducted a Cultural Impact Assessment (CIA) for the WWMC in the *ahupuaʻa* of Waikīkī, island of Oʻahu, Hawaiʻi [TMK (1) 3-1-031 : 003, 009, 010]. Archival research and community consultations were conducted to support the Environmental Impact Statement for the Waikīkī War Memorial. Guidelines provided by the Office of Environmental Quality Control (OEQC; Appendix A) outline acceptable methods to identify the types of cultural practices and beliefs that are subject to a CIA were adhered to during this assessment. To carry out the WWMC CIA, archival research was conducted followed by community consultations to identify cultural practices, cultural resources, and beliefs associated with the area. Cultural practices are typically customs relating to subsistence, commerce, residency, agriculture, recreation, religion, spirituality, and collection of cultural resources, which may be carried out by Hawaiian practitioners or practitioners from other ethnicities or collective groups. Further, cultural resources, such as natural features, archaeological sites, and collectable materials associated with these types of customs, as well as traditional cultural properties and historic sites were also subject to this CIA.

Concerted attempts were made to identify and locate persons knowledgeable about traditional practices that took place in the past or that are currently taking place in the WWMC area and potentially impacted by the proposed project. The State Office of Environmental Quality Control (OEQC) and Office of Hawaiian Affairs (OHA) were consulted for a listing of Cultural Assessment Providers as well as various neighborhood boards, civic clubs, and other Waikīkī community associations to obtain cultural informants. Appendix B provides a listing of potential cultural informants and their detailed contact history. While over 30 potential informants were solicited, a total of eleven cultural informants agreed to be interviewed for this CIA.

8.1 SUMMARY OF FINDINGS

Archival research has revealed that the land and coastal waters on which the WWMCis located has long and fascinating history. From the archaeological record, traditional stories, and historic documents attributed to this vicinity, it is evident that this locality has been the stage of many significant acts in the long drama of Oʻahu's pre- and post-Contact history. Oral traditions and historical references to the area are ubiquitous. The broad area surrounding the WWMC has also been subject to numerous contemporary archaeological investigations between 2000 and 2008, resulting in nine individual reports. Based on these investigations, this area has the potential to contain archaeological deposits and *iwi kūpuna*. The concordant Archaeological Inventory Survey is likely to add a significant amount of data to the area's existing archaeological record as well.

Ethnographical evidence obtained through community consultations upholds the archival research findings that the WWMC vicinity has been used for a wide variety of cultural practices throughout time, though some of the practices did not survive the extreme changes of the coastline and economy (Table 3).

Some of the traditional Hawaiian cultural practices have been ongoing since before the arrival of Europeans, while one practice that was dormant for nearly two centuries has recently been revived. Other cultural practices are carried out by a broader community, which is inclusive of all ethnic groups. As evidenced by the archival findings and community consultations, several themes that appear to transcend time and across cultural divides have been consistently tied to this area, including: ceremony, communal gathering, subsistence collecting, recreation, and sports. Activities that fall under these themes are listed in Tables 2 and 3. These activities range in scope from organized community events, formal spiritual/religious ceremonies, to activities practiced independently.

Table 3. Cultural Resources and Activities Identified in Community Consultations by Area

Area	Activity	Type	Date(s)/Frequency
WWMC Grounds	WWMC	Historic, Architectural, & Social	Static/Year round
	Veterans Day Ceremony	Ceremonial	Nov. 11/Annually
	Memorial Day Ceremony	Ceremonial	May 28/Annually
	Limu collecting (exterior north wall)	Subsistence collecting	Random/Year round
	Picnicking/barbeques/celebrations	Communal gathering	Random/Year round
	Volleyball	Sport/Recreation	Random/Year round
	Parking	Secondary/Supportive	Random/Year round
	Restroom and water fountain use	Secondary/Supportive	Random/Year round
Sans Souci/Kaimana Beach	Waikīkī Rough Water Swim	Sport	1st Monday of Sept. (Labor Day)/Annually
	Hawaiian Christmas Long Distance Invitational Rough H20 Swim	Sport	Early Dec./Annually
	Windsock Swim	Sport	Sundays/Weekly
	Swimming, recreational	Sport/Recreation	Random/Year round
	Surfing	Sport/Recreation	Random/Year round
	Stand-up Paddle Surfing	Sport/Recreation	Random/Year round
	Paddleboarding (kneeling)	Sport/Recreation	Random/Year round
	Paddling (one-man outrigger)	Sport/Recreation	Random/Year round
	Snorkeling	Recreation	Random/Year round
	Scuba Diving	Recreation/ Subsistence collecting	Random/Year round
	Free diving/Spear fishing (*heʻe* and variety of fish)	Subsistence collecting	Random/Even Years only, Year round
	Pole fishing	Subsistence collecting	Random/Even Years only, Year round
	Limu collecting	Subsistence collecting	Random/Even Years only, Year round
	Picnicking/barbeques/celebrations	Communal gathering	Random/Year round
	Yoga/Mom & Baby/University - classes and gatherings	Communal gathering	Random/Year round
	Sunbathing	Recreation	Random/Year round
Waikīkī Aquarium Grounds	"Changing of the Seasons Ceremony" (Solstice), Traditional Hawaiian	Ceremonial	May 2/Annually
Off-shore Breaks	Surfing	Sport/Recreation	Random/Year round

The WWMC grounds are still home to Veteran's Day and Memorial Day ceremonies and may be a "spiritual repository" for the fallen soldiers of World War I, as suggested by Ms. Donna Ching. Many people utilize the grassy areas, park benches, parking, and water fountain. While the natatorium (pool) is not currently open to the public, the restrooms are still relied upon by picnickers and Sans Souci/Kaimana Beach users.

Sans Souci/Kaimana Beach is a popular destination for many reasons, including its wide, sandy beach, clean waters, protected shoreline, nearby surf breaks, and Kapua channel from which people can safely access the open ocean. Activities include competitive and recreational swimming, surfing, stand-up paddle surfing, paddleboarding (kneeling), paddling (one-man outrigger), snorkeling, scuba diving, free-diving/spear fishing, pole fishing, *limu* collecting, picnicking, barbequing, celebrating, and sunbathing. Traditional Hawaiian activities include surfing, spear fishing, *limu* collecting, pole fishing (hook and line), and paddling.

The Waikīkī Aquarium now hosts the annual "Changing of the Seasons Ceremony," which is the revival of an ancient Hawaiian tradition of observing and honoring the solstice when the sun sets into the crown of Pu'u o Kapolei. This celestial event is only viewable once a year from the perspective of the subject area. The solstice marks the change of seasons – from Ho'olilo (wet season) to Kau Wela (hot or warm/dry season). This ceremony, now a component of the Aquarium's "Seasons and the Sea" event which features traditional Hawaiian *mele* (chant), *hula* (dance), and *mo'olelo* (storytelling) at a site just 'Ewa of the aquarium grounds. The public is invited to participate in this ceremony.

Several off-shore breaks are surfed in the area, including: "Publics" also known as "Public Bath," "Old Man's," and "Castles." It is likely that these breaks are the very same ones identified in the archival research.

For several reasons identified, such as the reduced availability of the resource and inconvenience of location, several informants no longer practice traditional resource gathering in the area. The gathering of various *limu* and shellfish is no longer practiced in Sans Souci/Kaimana Beach by Dr. Cruz as she no longer lives in the area and the reef has been smothered by sand. Mr. Freitas also claims that the availability of fish and shellfish has decreased dramatically since the late 80s and early 90s. Similarly, Ms. Nahoopii mentioned that she knew people that threw net in the area regularly in her childhood, but knew of no one who still practiced this. However, Ms. Hedlund and Mr. Freitas have witnessed people gathering *limu* in the area. Dr. Gon holds that it is possible people are gathering *limu* and shellfish and suggested I speak to a few cultural practitioners. Unfortunately, contact information for those people was not obtained. This cultural activity is limited to even years and forbidden in the Waikiki MLCD between the Natatorium and the Kapahulu Groin at any time. Table 4 provides a list of past and present cultural activity areas according to community consultations.

While the grassy lawn of the WWMCis still being utilized for the annual Memorial and Veterans Day ceremonies, most informants feel that the natatorium (pool) is not serving the public in its current state. However, the group of informants are split between those who would like to see it returned to its original structural and functional state.

Table 4. List of Informants with Cultural Resource Locations

Cultural Informant/Title	WWMC Affiliation	Past Resource Areas/Type	Present Resource/Activity Areas	Project Related Concerns/Opinions
Dr. Lynette Cruz, *Kupuna*	Native Hawaiian area descendent; raised in the area; cultural practitioner; retired Professor of Cultural Anthropology and Hawaiian Studies at HPU.	Sans Souci/Kaimana Beach, general reef: *limu līpeʻepeʻe, ogo; mū heʻe, heʻe; hāʻukeʻuke,* and *pipipi.* Unspecified area between the WWMCand the Waikīkī Aquarium: ceremonial space, to observe annual traditional solstice event (Hoʻoilo to Kau Wela). Kaimana Beach/New Otani lawn: Kodak Hula Show with *hula*, music, and *poi* pounding demonstrations. The Waikīkī War Memorial: place to honor the fallen soldiers of WW I and swimming.	Waikiki Aquarium grounds, ʻEwa of the aquarium on the grassy lawn: Changing of the Seasons solstice ceremony. No traditional resource gathering areas that she knows of; no longer practicing in the area.	Further reef damage; not for the creation of more sandy and unnatural beaches.
Dr. Samuel M. ʻOhukaniʻōhiʻa Gon III	Native Hawaiian Cultural practitioner, currently practicing in vicinity; Cultural Advisor for The Nature Conservancy of Hawaiʻi.	Unspecified area between the WWMCand the Waikīkī Aquarium: ceremonial space, to observe annual Changing of the Seasons solstice event (Hoʻoilo to Kau Wela); The Waikīkī War Memorial: possible location of Kūpalaha Heiau, setting of the "Battle of the Owls" *moʻolelo.*	Waikiki Aquarium grounds, ʻEwa of the aquarium on the grassy lawn: Changing of the Seasons solstice ceremony, annually. Not familiar with traditional resources in the area.	Would like any project related construction to cease during the solstice ceremony.
Mrs. Bertha Nahoopii, *Kupuna*	Former WWMC swim team; Neighborhood Board, No. 5 (30 yrs); lifelong resident of Kapahulu.	The Waikīkī War Memorial: swimming, competitive swimming, volleyball. Public Bath: surfing, throw net fishing (mullet and *weke*).	The Waikīkī War Memorial: volleyball. Public Bath: still popular surf breaks. No traditional resource gathering areas that she knows of.	Would like the structure to remain in place and filled with sand for volleyball and hula events.
Mr. Rick Kaimi Scudder	Researcher of traditional Hawaiian practices and sites in project area; 1970s recreated/surfed in area; Administrator ʻAhahui Mālama i ka Lōkahi.	Unspecified area between the WWMCand the Waikīkī Aquarium: ceremonial space, to observe annual Changing of the Seasons solstice event (Hoʻoilo to Kau Wela); The Waikīkī War Memorial: possible location of Kūpalaha and/or Opunaha Heiau.	Off-shore surf break: "Old Man's" located just off of the Kaimana Channel (surfing).	In favor of demolishing structure and associated features; would like to have a sand volleyball park in place.
Ms. Kaia Hedlund	Administrator Waikīkī Rough Water Swim; 12 yrs of recreation and water sports at Sans Souci/Kaimana Beach.	No traditional resource gathering areas that she knows of.	Sans Souci/Kaimana Beach: Waikīkī Rough Water Swim annual competition, stand-up paddle surfing, paddling, snorkeling, recreational swimming, surfing, as well as sunbathing, fishing, and *limu* collecting.	Displacement of water sports and recreation enthusiasts; structure is part of Waikīkī's visual and cultural landscape.

Cultural Informant/Title	WWMC Affiliation	Past Resource Areas/Type	Present Resource/Activity Areas	Project Related Concerns/Opinions
Mr. Edward "Kepa" Freitas	Kapiʻolani Regional Park Manager; 20 yrs. Diving and surfing in area.	Sans Souci/Kaimana Beach: spear diving, (various fish); no longer practices.	The Waikīkī War Memorial: has witnessed people collect *limu* off the exterior north wall; volleyball. Sans Souci/Kaimana Beach: spear diving, (various fish) on even years.	Not concerned with keeping the pool.
Mr. Gary Samura	Competitive paddler; 40 yr. regular of Sans Souci/Kaimana Beach.	The Waikīkī War Memorial: swimming; high diving. No traditional resource gathering areas that he knows of.	The Waikīkī War Memorial: restrooms for water sports and recreation enthusiasts. Sans Souci/Kaimana Beach: (recreational and competitive) surfing, swimming, scuba diving (commercial classes), stand-up paddlers, Paddling (one-man outrigger), sunbathing, biking, picnicking, and free diving (*tako* and variety of fish).	Hopes whatever the outcome, the changes will benefit the public and more parking will become available.
Mr. Frederick A. Wong, *Kupuna*	Adjutant/Quarter Master VFW Honolulu, Post 8616; Founding member and planner for Veterans Day and Memorial Day ceremonies at Waikīkī War Memorial.	The Waikīkī War Memorial: living memorial to honor the fallen soldiers of WW I, competitive and recreational swimming. No traditional resource gathering areas that he knows of.	Sans Souci/Kaimana Beach: swimming. Off-shore surf break: "Castles" and "Publics" (surfing). The Waikīkī War Memorial: the complex itself as a cultural resource; Veterans and Memorial Day ceremonies on its grounds.	Wants the WWMC restored to its original function as a living memorial.
Ms. Donna L. Ching	Vice President for Friends of the Natatorium.	The Waikīkī War Memorial: living memorial to honor the fallen soldiers of WW I, competitive and recreational swimming. No traditional resource gathering areas that she knows of.	Sans Souci/Kaimana Beach: rough water swimming through Kapua Channel, variety of recreational activities. The Waikīkī War Memorial: the complex itself as a cultural resource; Veterans and Memorial Day ceremonies on its grounds.	Wants the WWMC restored to its original function as a living memorial.
Ms. Jill Radke	Board Member for Friends of the Natatorium; historian.	The Waikīkī War Memorial: living memorial to honor the fallen soldiers of WW I, competitive and recreational swimming. No traditional resource gathering areas that she knows of.	Sans Souci/Kaimana Beach: rough water swimming through Kapua Channel. The Waikīkī War Memorial: the complex itself as a cultural resource; Veterans and Memorial Day ceremonies on its grounds.	Wants the WWMC restored to its original function as a living memorial.
Mr. Rick Bernstein	Kaimana Beach Coalition, Save Kaimana Beach!, regular swimmer at Sans Souci/Kaimana Beach	Not privy to traditional resource gathering areas in area.	Sans Souci/Kaimana Beach: open ocean swimming through Kapua Channel; meeting and event locality for various groups and individuals; favored location for local water sports enthusiasts	Wants the WWMC demolished and replaced with a Memorial Beach with preserved arches

8.2 DISCUSSION

Over a dozen individual cultural activities were identified as currently being performed by an array of Hawaiian and non-Hawaiian cultural practitioners in or around the Waikīkī War Memorial Complex. Activities range from ceremonial, communal gathering, subsistence collecting, recreational, and sporting in nature. The WWMC Natatorium itself, also referred to as the "War Memorial Natatorium" and simply "The Natatorium," is currently registered on both the State of Hawaiʻi Register of Historic Places (Site No. 80-14-9701) and the National Register of Historic Places (NRIS No. 80001283). This cultural resource is significant for the era and style of its construction as well as its status as the first "living" war memorial in the United States. However, the Natatorium, which includes the pool, bleachers, façade, restrooms, locker rooms, and other associated features, is severely deteriorated and continues to deteriorate – posing safety concerns for the scores public who continue to participate in cultural activities and recreate in the area. Therefore, the City and County of Honolulu is investigating various alternatives for the treatment of the WWMC:

- **Alternative 1 - Perimeter Deck**
- **Alternative 2 – War Memorial Beach**
- **Alternative 3 – Closed System Pool**
- **Alternative 4 – No Action**

Each alternative will have its own effects on cultural resources identified in the community consultations. Impacts to cultural resources will be identified by the following seven criteria:

- **NE –** No or very limited effect.
  - Defined as have little or no effect on cultural resources or cultural practices.
- **D – Destruction** of the Cultural Activity or Resource Area.
  - Defined as the complete destruction of the area or eradication of identified cultural resource(s) caused by project related activities.
- **LA – Limits Access** to the Cultural Activity or Resource Area.
  - Defined as any project related environmental change that permanently limits the access to a cultural resource or activity area.
- **TLA – Temporarily Limits Access** to Cultural Activity or Resource Area.
  - Defined as any project related environmental change that temporarily limits the access to a cultural resource or activity area.
- **VI – Visual Impacts** to Cultural Activity or Resource Area.
  - Defined as any project related activity or outcome that impacts the visual plane in which a cultural activity takes place.
- **CH – Compromises Health** of a Cultural Resource, Area, and/or Practitioner.
  - Defined as any threat to the physical condition of identified cultural resources, cultural resource area, and/or cultural practitioners caused by the proposed actions.

- **TCH – Temporarily Compromises Health** of a Cultural Resource, Area, and/or Practitioner.
    - Defined as any temporary threat to the physical condition of identified cultural resources, cultural resource area, and/or cultural practitioners caused by the proposed actions.

Assessments of the impacts to each of the identified cultural resources and cultural activities are presented in Table 4 (Alternative 1 – Perimeter Deck), Table 5 (Alternative 2 War Memorial Beach) and Table 6 (Alternative 3 – Closed System Pool). The impacts of No Action (Alternative 4) are not assessed. It seems clear that Alternative 1 – Perimeter Deck causes the least impact and has the benefit of preserving the historic nature of the WWMC and associated activities.

Table 5. Potential Impact Table for Alternative 1 – Perimeter Deck

Cultural Resource or Activity		Alternative 1	Explanation of Impact
Waikīkī War Memorial	WWMC	NE	There will be limited impact by the replacement of existing decking with perimeter deck; ʻEwa and *makai* sea walls will be removed
	Veterans Day Ceremony	VI	Visual impacts will occur if construction is active during ceremony
	Memorial Day Ceremony	VI	Visual impacts will occur if construction is active during ceremony
	Limu collecting	LA; TCH	During construction there would be limited access for *limu* collecting; waters may contain silts that could affect *limu*
	Picnicking / barbeques / celebrations	TLA	Construction will close off areas of the beach and park; parking will be limited
	Volleyball	TLA	Construction will limit use of the volleyball court
	Parking	TLA	Parking will likely be limited during construction
	Restrooms & water fountain use	TLA	Access to bathrooms and water fountain may be limited during construction
Sans Souci/Kaimana Beach	Waikīkī Rough Water Swim, Hawaiian Christmas Long Distance Invitational Rough H20 Swim, & Windsock Swim	TLA; TCH	If construction is active during race, access to staging areas may be limited; waters may contain silts that impair visibility and contaminants that may cause illness in swimmers
	Swimming (recreational, exercise, & training)	TLA; TCH	During construction, access to beach and parking may be limited; waters may contain silts that impair visibility and contaminants that may cause illness in swimmers
	Surfing	TLA; TCH	During construction, access to beach and parking may be limited and waters may contain silts and contaminants
	Stand-up Paddle Surfing, Paddleboarding (kneeling), & Paddling	TLA	During construction, access to beach and parking may be limited
	Snorkeling, Scuba Diving, Free diving, & Spear fishing	TLA; TCH	During construction, access to staging areas may be limited; waters may contain silts that impair visibility and contaminants that may cause illness
	Pole fishing	TLA; TCH	During construction, access to beach and parking may be limited; waters may contain silts and contaminants
	Limu collecting	TLA; TCH	During construction, access to beach and parking may be limited; waters may contain silts and contaminants
	Picnicking / barbeques / celebrations	TLA; VI	During demo construction, limited access to beach and parking may be limited; creates visual impacts for those enjoying the scenery
	Yoga/Mom & Baby/University student gatherings	TLA	During construction, access to beach and parking may be limited; creates visual impacts for those enjoying the scenery
	Sunbathing	TLA	During construction, access to beach and parking may be limited; creates visual impacts for those enjoying the scenery
Waikiki Aquarium	"Changing of the Seasons" (Solstice) Ceremony, Traditional Hawaiian	TLA	During construction, parking may be limited; creates visual impacts for those enjoying the scenery
Off- shore Breaks	Surfing (Publics, Old Man's, Castles)	TLA; TCH	During construction, access to staging areas may be limited and waters may contain silts that impair visibility and contaminants that may cause illness

Key: NE = No or limited effect; D = Destruction of the cultural activity area; LA = Limits access to the cultural activity area; TLA = Temporarily limits access to cultural activity area; VI = Visual impacts to cultural activity area; CH = Compromises health of the cultural resource, area, and/or practitioner; TCH = Temporarily compromises the health of the cultural resource, area, and /or practitioner.

Table 6. Potential Impact Table for Alternative 2 – War Memorial Beach

Cultural Resource or Activity		Alternative 2	Explanation of Impact
Waikīkī War Memorial	WWMC	D	Demolition of complex will destroy the cultural resource
	Veterans Day Ceremony	VI	Visual impacts will occur if construction is active during ceremony; reduced size of façade will change the visual plane in which the event takes place
	Memorial Day Ceremony	VI	Visual impacts will occur if construction is active during ceremony; reduced size of façade will change the visual plane in which the event takes place
	Limu collecting	D; CH	Demolition of the structure will destroy the collection area
	Picnicking / barbeques / celebrations	TLA, VI	Demolition of structure will close off areas of the beach and park; parking will be limited; creates visual impacts to the scenery
	Volleyball	D	Demolition of structure will likely destroy adjacent volleyball court
	Parking	TLA	Parking will likely be limited during demolition phase
	Restrooms & water fountain use	TLA	Demolition of structure will destroy existing bathrooms and limit access to adjacent water fountain
Sans Souci/Kaimana Beach	Waikīkī Rough Water Swim, Hawaiian Christmas Long Distance Invitational Rough H20 Swim, & Windsock Swim	TLA; TCH	If demolition is active during race, access to staging areas may be limited; waters may contain silts that impair visibility and contaminants that may cause illness in swimmers
	Swimming (recreational, exercise, & training)	TLA; TCH	During demolition, access to beach and parking may be limited; waters may contain silts that impair visibility and contaminants that may cause illness in swimmers
	Surfing	TLA; TCH	During demolition, access to beach and parking may be limited and waters may contain silts and contaminants
	Stand-up Paddle Surfing, Paddleboarding (kneeling), & Paddling	TLA	During demolition, access to beach and parking may be limited
	Snorkeling, Scuba Diving, Free diving, & Spear fishing	TLA; TCH	During demolition, access to staging areas may be limited; waters may contain silts that impair visibility and contaminants that may cause illness
	Pole fishing	TLA; TCH	During demolition, access to beach and parking may be limited; waters may contain silts and contaminants
	Limu collecting	TLA; TCH	During demolition, access to beach and parking may be limited; waters may contain silts and contaminants
	Picnicking / barbeques / celebrations	TLA; VI	During demolition, access to beach and parking may be limited; creates visual impacts for those enjoying the scenery
	Yoga/Mom & Baby/University student gatherings	TLA	During demolition, access to beach and parking may be limited; creates visual impacts for those enjoying the scenery
	Sunbathing	TLA	During demolition, access to beach and parking may be limited; creates visual impacts for those enjoying the scenery
Waikiki Aquarium	"Changing of the Seasons" (Solstice) Ceremony, Traditional Hawaiian	TLA	During demolition, parking may be limited; creates visual impacts for those enjoying the scenery
Off- shore Breaks	Surfing (Publics, Old Man's, Castles)	TLA; TCH	During demolition, access to staging areas may be limited and waters may contain silts that impair visibility and contaminants that may cause illness

Key: NE = No or limited effect; D = Destruction of the cultural activity area; LA = Limits access to the cultural activity area; TLA = Temporarily limits access to cultural activity area; VI = Visual impacts to cultural activity area; CH = Compromises health of the cultural resource, area, and/or practitioner; TCH = Temporarily compromises the health of the cultural resource, area, and /or practitioner.

Table 7. Potential Impact Table for Alternative 3 – Closed System Pool

	Cultural Resource or Activity	Alternative 3	Explanation of Impact
Waikīkī War Memorial	WWMC	NE	Limited effects would be experienced on rehabilitation of pool decking, bleachers, etc. However the overall historic nature of the structure would be maintained
	Veterans Day Ceremony	TLA; VI	During construction, access to park and parking may be limited and construction site will be a visual impact to the scenery
	Memorial Day Ceremony	TLA; VI	During construction, access to park and parking may be limited and construction site will be a visual impact to the scenery
	Limu collecting	LA; TCH	During construction there would be limited access for *limu* collecting; waters may contain silts that could affect *limu*
	Picnicking / barbeques / celebrations	TLA; VI	During construction, areas of the beach and grassy areas will be closed off; parking will be limited; creates visual impacts to the scenery
	Volleyball	TLA	Construction will limit use of the volleyball court
	Parking	TLA	During construction, access to parking may be limited
	Restrooms & water fountain use	TLA	Access to bathrooms and water fountain may be limited during construction
Sans Souci/Kaimana Beach	Waikīkī Rough Water Swim, Hawaiian Christmas Long Distance Invitational Rough H20 Swim, & Windsock Swim	TLA; TCH	If construction is active during race, access to staging areas may be limited and waters may contain silts impacting visibility
	Swimming (recreational, exercise, & training)	TLA, TCH	During construction, access to beach and parking may be limited and waters may contain silts impacting visibility
	Surfing	TCH	During construction, access to beach and parking may be limited and waters may contain silts impacting visibility
	Stand-up Paddle Surfing, Paddleboarding (kneeling), & Paddling	TLA	During construction, access to beach and parking may be limited
	Snorkeling, Scuba Diving, Free diving, & Spear fishing	TLA; TCH	During construction, access to beach and parking may be limited and waters may contain silts impacting visibility
	Pole fishing	TLA	During construction, access to beach and parking may be limited
	Limu collecting	TLA; TCH	During construction, access to beach and parking may be limited and waters may contain silts impacting visibility and *limu* health
	Picnicking / barbeques / celebrations	TLA; VI	During construction, areas of the beach and grassy areas will be closed off; parking will be limited; creates visual impacts to the scenery
	Yoga/Mom & Baby/University -classes and gatherings	TLA; VI	During construction, access to beach and parking may be limited and construction site will be a visual impact to the scenery
	Sunbathing	TLA; VI	During construction, access to beach and parking may be limited and construction site will be a visual impact to the scenery
Waikiki Aquarium	"Changing of the Seasons" (Solstice) Ceremony, Traditional Hawaiian	TLA; VI	During construction, access to beach and parking may be limited and construction machinery may cause visual impact if they are in the view plane
Off- shore Breaks	Surfing (Publics, Old Man's, Castles)	TLA; TCH	During construction, access to beach and parking may be limited and waters may contain silts impacting visibility

Key: NE = No or limited effect; D = Destruction of the cultural activity area; LA = Limits access to the cultural activity area; TLA = Temporarily limits access to cultural activity area; VI = Visual impacts to cultural activity area; CH = Compromises health of the cultural resource, area, and/or practitioner; TCH = Temporarily compromises the health of the cultural resource, area, and /or practitioner.

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APPENDIX A

GUIDELINES FOR ASSESSING CULTURAL IMPACTS
OBTAINED FROM
OFFICE OF ENVIRONMENTAL QUALITY CONTROL WEBSITE

Guidelines for Assessing Cultural Impacts

Adopted by the Environmental Council, State of Hawaii
November 19, 1997

1. INTRODUCTION

It is the policy of the State of Hawaii under Chapter 343, HRS, to alert decision makers, through the environmental assessment process, about significant environmental effects which may result from the implementation of certain actions. An environmental assessment of cultural impacts gathers information about cultural practices and cultural features that may be affected by actions subject to Chapter 343, and promotes responsible decision making.

Articles IX and XII of the State Constitution, other state laws, and the courts of the state require government agencies to promote and preserve cultural beliefs, practices, and resources of Native Hawaiians and other ethnic groups. Chapter 343 also requires environmental assessment of cultural resources, in determining the significance of a proposed project.

The Environmental Council encourages preparers of environmental assessments and environmental impact statements to analyze the impact of a proposed action on cultural practices and features associated with the project area. The Council provides the following methodology and content protocol as guidance for any assessment of a project that may significantly affect cultural resources.

Background

Prior to the arrival of westerners and the ideas of private land ownership, Hawaiians freely accessed and gathered resources of the land and seas to fulfill their community responsibilities. During the Mahele of 1848, large tracts of land were divided and control was given to private individuals. When King Kamehameha the III was forced to set up this new system of land ownership, he reserved the right of access to privately owned lands for Native Hawaiian ahupua'a tenants. However, with the later emergence of the western concept of land ownership, many Hawaiians were denied access to previously available traditional resources.

In 1978, the Hawaii constitution was amended to protect and preserve traditional and customary rights of Native Hawaiians. Then in 1995 the Hawaii Supreme Court confirmed that Native Hawaiians have rights to access undeveloped and under-developed private lands. Recently, state lawmakers clarified that government agencies and private developers must assess the impacts of their development on the traditional practices of Native Hawaiians as well as the cultural resources of all people of Hawaii. These Hawaii laws, and the National Historic Preservation Act, clearly mandate federal agencies in Hawaii, including the military, to evaluate the impacts of their actions on traditional practices and cultural resources.

If you own or control undeveloped or under-developed lands in Hawaii, here are some hints as to whether traditional practices are occurring or may have occurred on your lands. If there is a trail on your property, that may be an indication of traditional practices or customary usage. Other clues include streams, caves and native plants.

Another important point to remember is that, although traditional practices may have been interrupted for many years, these customary practices cannot be denied in the future. These traditional practices of Native Hawaiians were primarily for subsistence, medicinal, religious, and cultural purposes. Examples of traditional subsistence practices include fishing, picking opihi and collecting limu or seaweed. The collection of herbs to cure the sick is an example of a traditional medicinal practice. The underlying purpose for conducting these traditional practices is to fulfill one's community responsibilities, such as feeding people or healing the sick.

As it is the responsibility of Native Hawaiians to conduct these traditional practices, government agencies and private developers also have a responsibility to follow the law and assess the impacts of their actions on traditional and cultural resources.

The State Environmental Council has prepared guidelines for assessing cultural resources and has compiled a directory of cultural consultants who can conduct such studies. The State Historic Preservation Division has drafted guidelines on how to conduct ethnographic inventory surveys. And the Office of Planning has recently completed a case study on traditional gathering rights on Kaua'i.

The most important element of preparing Cultural Impact Assessments is consulting with community groups, especially with expert and responsible cultural practioners within the ahupua’a of the project site. Conducting the appropriate documentary research should then follow the interviews with the experts. Documentary research should include analysis of mahele and land records and review of transcripts of previous ethnographic interviews. Once all the information has been collected, and verified by the community experts, the assessment can then be used to protect and preserve these valuable traditional practices.

Native Hawaiians performed these traditional and customary practices out of a sense of responsibility: to feed their families, cure the sick, nurture the land, and honor their ancestors. As stewards of this sacred land, we too have a responsibility to preserve, protect and restore these cultural resources for future generations.

TEXT OF ACT 50, SLH 2000

A BILL FOR AN ACT RELATING TO ENVIRONMENTAL IMPACT STATEMENTS

UNOFFICIAL VERSION

HOUSE OF REPRESENTATIVES H.B. NO, 2895 H.D.1

TWENTIETH LEGISLATURE, 2000

STATE OF HAWAII

A BILL FOR AN ACT

RELATING TO ENVIRONMENTAL IMPACT STATEMENTS.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

SECTION 1. The legislature finds that there is a need to clarify that the preparation of environmental assessments or environmental impact statements should identify and address effects on Hawai'i's culture, and traditional and customary rights.

The legislature also finds that native Hawaiian culture plays a vital role in preserving and advancing the unique quality of life and the "aloha spirit' in Hawaii. Articles IX and XII of the state constitution, other state laws, and the courts of the State impose on government agencies a duty to promote and protect cultural beliefs, practices, and resources of native Hawaiians as well as other ethnic groups.

Moreover, the past failure to require native Hawaiian cultural impact assessments has resulted in the loss and destruction of many important cultural resources and has interfered with the exercise of native Hawaiian culture. The legislature further finds that due consideration of the effects of human activities on native Hawaiian culture and the exercise thereof is necessary to ensure the continued existence, development, and exercise of native Hawaiian culture.

The purpose of this Act is to: (1) Require that environmental impact statements include the disclosure of the effects of a proposed action on the cultural practices of the community and State; and (2) Amend the definition of "significant effect" to include adverse effects on cultural practices.

SECTION 2. Section 343-2, Hawai`i Revised Statutes, is amended by amending the definitions of "environmental impact statement' or "statement" and "significant effect", to read as follows:

"'Environmental impact statement" or "statement" means an informational document prepared in compliance with the rules adopted under section 343-6 and which discloses the environmental effects of a proposed action, effects of a proposed action on the economic [and] welfare, social welfare, and cultural practices of the community and State, effects of the economic activities arising out of the proposed action, measures proposed to minimize adverse effects, and alternatives to the action and their environmental effects.

The initial statement filed for public review shall be referred to as the draft statement and shall be distinguished from the final statement which is the document that has incorporated the public's comments and the responses to those comments. The final statement is the document that shall be evaluated for acceptability by the respective accepting authority.

"Significant effect" means the sum of effects on the quality of the environment, including actions that irrevocably commit a natural resource, curtail the range of beneficial uses of the environment, are contrary to the State's environmental policies or long-term environmental goals as established by law, or adversely affect the economic [or] welfare, social welfare[.], or cultural practices of the community and State."

SECTION 3. Statutory material to be repealed is bracketed. New statutory material is underscored.

SECTION 4. This Act shall take effect upon its approval.

Approved by the Governor as Act 50 on April 26, 2000

2. CULTURAL IMPACT ASSESSMENT METHODOLOGY

Cultural impacts differ from other types of impacts assessed in environmental assessments or environmental impact statements. A cultural impact assessment includes information relating to the practices and beliefs of a particular cultural or ethnic group or groups.

Such information may be obtained through scoping, community meetings, ethnographic interviews and oral histories. Information provided by knowledgeable informants, including traditional cultural practitioners, can be applied to the analysis of cultural impacts in conjunction with information concerning cultural practices and features obtained through consultation and from documentary research.

In scoping the cultural portion of an environmental assessment, the geographical extent of the inquiry should, in most instances, be greater than the area over which the proposed action will take place. This is to ensure that cultural practices which may not occur within the boundaries of the project area, but which may nonetheless be affected, are included in the assessment. Thus, for example, a proposed action that may not physically alter gathering practices, but may affect access to gathering areas would be included in the assessment. An ahupuaʻa is usually the appropriate geographical unit to begin an assessment of cultural impacts of a proposed action, particularly if it includes all of the types of cultural practices associated with the project area.

In some cases, cultural practices are likely to extend beyond the ahupua'a and the geographical extent of the study area should take into account those cultural practices.

The historical period studied in a cultural impact assessment should commence with the initial presence in the area of the particular group whose cultural practices and features are being assessed. The types of cultural practices and beliefs subject to assessment may include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs.

The types of cultural resources subject to assessment may include traditional cultural properties or other types of historic sites, both man-made and natural, including submerged cultural resources, which support such cultural practices and beliefs.
The Environmental Council recommends that preparers of assessments analyzing cultural impacts adopt the following protocol:

1. identify and consult with individuals and organizations with expertise concerning the types of cultural resources, practices and beliefs found within the broad geographical area, e.g., district or ahupuaʻa;
2. identify and consult with individuals and organizations with knowledge of the area potentially affected by the proposed action;
3. receive information from or conduct ethnographic interviews and oral histories with persons having knowledge of the potentially affected area;
4. conduct ethnographic, historical, anthropological, sociological, and other culturally related documentary research;
5. identify and describe the cultural resources, practices and beliefs located within the potentially affected area; and

6. assess the impact of the proposed action, alternatives to the proposed action, and mitigation measures, on the cultural resources, practices and beliefs identified.

Interviews and oral histories with knowledgeable individuals may be recorded, if consent is given, and field visits by preparers accompanied by informants are encouraged. Persons interviewed should be afforded an opportunity to review the record of the interview, and consent to publish the record should be obtained whenever possible. For example, the precise location of human burials are likely to be withheld from a cultural impact assessment, but it is important that the document identify the impact a project would have on the burials. At times an informant may provide information only on the condition that it remain in confidence. The wishes of the informant should be respected.

Primary source materials reviewed and analyzed may include, as appropriate: Mahele, land court, census and tax records, including testimonies; vital statistics records; family histories and genealogies; previously published or recorded ethnographic interviews and oral histories; community studies, old maps and photographs; and other archival documents, including correspondence, newspaper or almanac articles, and visitor journals. Secondary source materials such as historical, sociological, and anthropological texts, manuscripts, and similar materials, published and unpublished, should also be consulted.

Other materials which should be examined include prior land use proposals, decisions, and rulings which pertain to the study area.

3. CULTURAL IMPACT ASSESSMENT CONTENTS

In addition to the content requirements for environmental assessments and environmental impact statements, which are set out in HAR §§ 11-200-10 and 16 through 18, the portion of the assessment concerning cultural impacts should address, but not necessarily be limited to, the following matters:

1. A discussion of the methods applied and results of consultation with individuals and organizations identified by the preparer as being familiar with cultural practices and features associated with the project area, including any constraints or limitations which might have affected the quality of the information obtained.
2. A description of methods adopted by the preparer to identify, locate, and select the persons interviewed, including a discussion of the level of effort undertaken.
3. Ethnographic and oral history interview procedures, including the circumstances under which the interviews were conducted, and any constraints or limitations which might have affected the quality of the information obtained.
4. Biographical information concerning the individuals and organizations consulted, their particular expertise, and their historical and genealogical relationship to the project area, as well as information concerning the persons submitting information or interviewed, their particular knowledge and cultural expertise, if any, and their historical and genealogical relationship to the project area.
5. A discussion concerning historical and cultural source materials consulted, the institutions and repositories searched, and the level of effort undertaken. This discussion should include, if appropriate, the particular perspective of the authors, any opposing views, and any other relevant constraints, limitations or biases.
6. A discussion concerning the cultural resources, practices and beliefs identified, and, for resources and practices, their location within the broad geographical area in which the proposed action is located, as well as their direct or indirect significance or connection to the project site.
7. A discussion concerning the nature of the cultural practices and beliefs, and the significance of the cultural resources within the project area, affected directly or indirectly by the proposed project.
8. An explanation of confidential information that has been withheld from public disclosure in the assessment.
9. A discussion concerning any conflicting information in regard to identified cultural resources, practices and beliefs.
10. An analysis of the potential effect of any proposed physical alteration on cultural resources, practices or beliefs; the potential of the proposed action to isolate cultural resources, practices or beliefs from their setting; and the potential of the proposed action to introduce elements which may alter the setting in which cultural practices take place.
11. A bibliography of references, and attached records of interviews which were allowed to be disclosed.

The inclusion of this information will help make environmental assessments and environmental impact statements complete and meet the requirements of Chapter 343, HRS. If you have any questions, please call 586-4185.

APPENDIX B
COMMUNICATION LOG

Natatorium Cultural Impact Assessment - Cultural Informants				
Name	**Affiliation/Association**	**Contact Log**	**Interview**	**Comments**
Apo, Peter	Friends of the Natatorium, President	10/5/11 sent an email requesting assistance with finding informants; 10/5/11 Mr. Apo replied to email recommending Friends of the Natatorium, Office of Hawaiian Affairs, and Historic Hawaii Foundation; 10/5/11 I sent an email response to Mr. Apo listing the organizations I have contacted; 10/31/11 sent an email		
Becket, Jan	Cultural Assessment Provider for Waikiki (specializes in Cultural Sites)	Sent email (mass email to OEQC CAP) 10/3/11; Received response from him same day mentioning a ceremony performed by Kapolei HCC (poss solstice) and a heiau up in Mānoa; 10/4/2011 declined interview, recommends Shad Kane		
Bernstein, Rick	Kaimana Beach Coalition, Save Kaimana Beach!, regular swimmer at Sans Souci/Kaimana Beach	Sent email (mass email sent to Save Kaimana Beach! website) 10/3/11; no response; obtained new contact info from Barrie Morgan 3/15/12; 3/18/12 called Mr. Bernstein and made appointment for phone interview; 3/28/12 interview conducted	**YES**	
Carson, Mike	Cultural Assessment Provider for Mānoa (specializes in Archaeology, Cultural Anthropology, Cultural Landscapes, Historic Preservation)	Sent email (mass email to OEQC CAP) 10/3/11;; no response		
Chang, Stan	City Council Member, District 4, spanning from Ala Moana to Hawaii Kai	10/5/11 sent an email requesting assistance with finding informants; 10/5/11 Mr. Chang replied to email stating that he would forward my email to at least on potential informant		
Chang-Wo, Henry	Co-founder of the Ewa Seaweed Project	11/15/11 called phone number; no answer, left message on answering service		
Ching, Donna L.	Friends of the Natatorium, Vice President	Sent 10/5/11 email requesting assistance with finding informants; 10/6/11 was sent a reply saying she wasn't qualified to be an informant; 10/7/11 says to look into the families whose homes were in the area prior to the Natatorium (McInenerny Family); 1/16/12 was emailed by D. Ching after she was emailed by Fred Wong (VFW Post 8616) requesting her to consider participating. She expressed that although she was contacted by me earlier for participation, she did not know that I was interested in information other than the architecture etc, as I am an archaeologist; 1/17/12 emailed me offering to set up a group interview with Frank Weight, Fred Wong, and Jill Radke.; group interview takes place 2/1/12 at Leo Daly offices	**Yes**	
Cruz, Lynette	Cultural Assessment Provider for Waikiki (specializes in Ahupua`a Resource Management, Cultural Practices, Waikiki Ahupua`a and Streams)	Sent email (mass email to OEQC CAP) 10/3/11; Sent email again to Dr. Cruz to request participation again; responded and agreed to meet with me 12/5/11 at 11 am in town (Govinda's in Nuuanu).	**YES**	
Faulkner, Kiersten	Historic Hawaii Foundation	Emailed the Historic Hawaii Foundation requesting participation on 10/5/11; no response		
Freitas, Edward "Kepa"	Kapiolani Park Regional Manager; formerly surfed at Sans Souci/ Kaimana	Interviewed 12/2/11	**YES**	
Gon, Sam III	Officiates the Traditional Hawaiian solstice ceremony near the Natatorium; Senior Scientist and Cultural Advisor to the Nature Conservancy - HNL	Sent email 10/4/11 requesting participation in CIA; 11/2/11 called and left message with Nature Conservancy (answering service); interviewed 11/8/11	**YES**	

Natatorium Cultural Impact Assessment - Cultural Informants				
Name	**Affiliation/Association**	**Contact Log**	**Interview**	**Comments**
Ha`ole, William Papa`i`ku	Cultural Assessment Provider for Waikiki (specializes Mo`olelo); Ukulele Teacher, Docent at Iolani Palace	Did not reply to request email sent (mass email to OEQC CAP) 10/3/11		
Heckman, Mark	Worked at the Waikiki Aquarium for many years, knew of a traditional *pā* (enclosure) in the aquarium grounds	Was referred to me by L. Cruz; shared several email exchanges: 1/5/112 & 1/6/12, referred me to Rick Scudder		
Hedlund, Kaia	Waikiki Rough Water Swim, director	Sent an email 11/2/11 asking for participation; received response agreeing to participation, says she is on the mainland but would be happy to participate via telephone; I reply by asking her to let me know what day and time is good to call; 11/29/11 interviewed over the phone	**Yes**	
Kane, Shad	General ethnography of Oahu; practices Solstice ceremony at Kapolei	Sent Uncle Shad request email 10/5/12, 10/5/12 Uncle Shad responded by email and referred me to Dr. Sam Gon for Solstice ceremony		Referred Dr. Sam Gon
Kobayashi, Ann	Diamond Head NB (No.5), Chair	Sent email 10/3/11 requesting participation, no response		
Lapilo, Lani Maʻa	Aukahi: Burials, Law, Cultural Resources Planning, Regulatory Compliance & Permitting (e.g. NHPA, NEPA, HRS 6E, NAGPRA); Native Hawaiian Rights specialist/ facilitator; Executive Director of Judiciary History Center	10/11/11 sent Ms. Lapilio an email requesting her participation; 10/18/11 received email response letting me know she was looking for informants; 10/31/11 refers me to Uncle Shad		Referred Uncle Shad Kane
Lee, Michael Kumukauoha	Limu protection activist/gatherer	Called phone number 11/15/11 no answer, left message		Referred by Dr. Gon
Lilley, Rick	Regular surfer, diver, rough water swimmer at Kaimana/Sans Souci	Spoke with Rick at the wheelchair access ramp 11/8/11, said he was interested in an interview; shared several email exchanges: 11/13/11, 11/29/11, no time for interview		
Matson, Michelle S.	Diamond Head NB (No.5)	Sent 10/5/11 email requesting assistance with finding informants;, no response		
Nahoopii, Bertha	Was part of a hui that regularly swam at the Natatorium in the 50s-60s. Incumbent NB#5 28 years. Sub-district representative for Palolo, Kaimuki, Kapahulu, and Diamond Head. Lifelong resident of Kapahulu. Retired Police Officer HPD.	Was contacted by Aunty Bertha 10/4/11 by phone, she was forwarded my email by Linda Wong, seems willing to interview; I told her that I would email her with an outline of what type of information I'm looking for; 10/5/11 sent email outlining the CIA goals and defining what cultural practices and activities are	**Yes**	
Pacific War Memorial Association	Natatorium Events	Sent 10/5/11 email requesting assistance with finding informants;		
Persons, Don A.	Diamond Head NB (No.5)	Sent 10/5/11 email requesting assistance with finding informants;		
Radke, Jill	Friends of the Natatorium, board member/historian	Sent 10/5/11 email requesting assistance with finding informants;; group interview with FoN 2/1/12 w/D. Ching (FoN) & F. Wong (VFW) at Leo Daly offices	**Yes**	
Reef Watch Waikiki	Possible knowledge of cultural practices in area of interest	Sent email 11/22/11 requesting participants;		
Samura, Gary	Regular Paddler at project area, member of Kaimana Canoe Club	Approached at Natatorium drinking fountain/ hose down area as he was rinsing his outrigger after paddling; on-site interview ensued	**Yes**	

Natatorium Cultural Impact Assessment - Cultural Informants				
Name	**Affiliation/Association**	**Contact Log**	**Interview**	**Comments**
Scudder ,Rick Kaimi	Administrator of Ahahui Mālama I ka Lokahi; researched Opunaha/ Kapulaha Heiau	Sent email 11/22/11 requesting participation; replied to email 11/23/11 asking for me to contact him Tues 11/29/11; 11/29/11 called Kaʻimi Scudder and he said he was busy and to call tomorrow or later in week	**Yes**	
Veterans of Foreign Wars (VFW – Hawaii Headquarters	Waikiki War Memorial	Called 1/13/12 to request an interview regarding CIA; Admin. said he would ask around;		
Waikiki Aquarium	Adjacent to Natatorium	Sent email 10/3/12 requesting participation; no response		
Wong, Fred	VFW Post 8616, Annual Memorial Day and Veterans Day Ceremonies at the War Memorial Natatorium	Called 1/13/12 to request an interview regarding CIA; said he would ask around; 2/1/12 interview with D. Ching & J. Radke (FoN) at Leo Daly offices	**Yes**	
Wong, Linda	Diamond Head NB (No.5)	Mass email10/5/11, responded by email with a news article about the Natatorium		

APPENDIX C

ETHNOGRAPHIC INTERVIEW QUESTIONNAIRE

Pacific Legacy, Inc.

Cultural Impact Assessment (CIA)
Ethnographic Interview Form

Job Name/#:______________________ Interviewer Name:______________________

Location:______________________ Date/Time:______________________

Permission to Record Audio (Y/N):______________________

Interviewee Full Name:	Birth Name:
Birth Date:	Occupation/Title:
Current Residence:	Birth Place & Place of formative years:
Years spent in or near subject area:	Affiliation with subject area:
Parents:	Informants/Mentors:

1) How familiar are you with the subject area?

2) What is this area traditionally called? Can you recall any other names of the area?

3) What stories or mythologies have you heard of this area?

4) How would you describe the physical characteristics of the area from your earliest memory?

5) Are there any significant or special features (i.e. landmarks or unique topography) in this area as it relates to land use and/or its history?

6) How was the area used by people in the past?

Land Use Details:

Activity	Types (specific names)	When	Intensity and Frequency	By Who
7) Hunting/ Fishing				
8) Gathering				
9) Agriculture/ Aquaculture				
10) Habitation				
11) Ceremonial				
12) Burial				
13) Other				

14) Have you observed changes to the land or its resources? Please Explain.

15) What are your thoughts about the project proposal?

16) Additional Comments by the Interviewee:

17) Additional Comments:

Would you like to view the synopsis of the interview prior to CIA report submittal(Y/N)?_________________

Time Interview Concludes :____________________________

Interviewee Signature: ____ Date: ______________________

APPENDIX D
ORAL RELEASE FORMS

Pacific Legacy
Historic Preservation

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: Waikiki War Memorial + Natatorium

Date of Interview: 12/5/2011

I, Lynette Cruz, have been interviewed by Kim Mooney of Pacific Legacy, Inc. for the above referenced project. I agree that the interview information may be used in a report that may be made public.

Lynette Cruz
Interviewee Signature

1/11/2012
Date

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: Natatorium Cultural Impact Assessment

Date of Interview: 8 November 2011

I, Samuel M. Ohukaniʻōhiʻa Gon III, have been interviewed by Kimberly M. Mooney, B.A., of Pacific Legacy, Inc. for the above referenced project. I agree that the interview information may be used in a report that may be made public.

Interviewee Signature

13 January 2012
Date

Jan-11-12 07:01A uxb hawaii 808 532 8983 P.01

Pacific Legacy

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: Waikiki War Memorial & Natatorium

Date of Interview: December 2 2011

I, Bertha Nakoopii have been interviewed by Kimberly Flood of Pacific Legacy, Inc. for the above referenced project. I agree that the interview information may be used in a report that may be made public.

Bertha Nakoopii
Interviewee Signature

Jan 11, 2012
Date

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: Waikiki War Memorial/Natatorium

Date of Interview: Jan. 10, 2012

I, Richard Scudder, have been interviewed by Kimberly Mooney of Pacific Legacy, Inc. for the above referenced project. I agree that the interview information may be used in a report that may be made public.

Richard Kaimi Scudder
Interviewee Signature

Jan. 15, 2012
Date

Feb 28 2012 6:50PM HP LASERJET FAX 562-434-5907 p.1

808-263-4300

Pacific Legacy Historic Preservation

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: Waikiki War Memorial - 11/29/11

Date of Interview: 11/29/11

I, Keio Hedlund, have been interviewed by Kimberly Mooney of Pacific Legacy, Inc. for the above referenced project. I agree that the interview information may be used in a report that may be made public.

Interviewee Signature

2/26/12
Date

Feb. 17. 2012 10:20AM KAPI'OLANI REGIONAL PARK 9712507 No. 8933 P. 1

PACIFIC LEGACY, INC.

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: Waikiki War Memorial Natatorium

Date of Interview: 2 Dec 2012

I, Kepa Freitas, have been interviewed by Kim Mooney of Pacific Legacy, Inc. for the above referenced project. I agree that the interview information may be used in a report that may be made public.

Interviewee Signature

2/17/12

Date

PACIFIC LEGACY, INC.

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: Natatorium CIA

Date of Interview: 8/11/12

I, Gary Sammer, have been previously interviewed by Kimberly Mooney of Pacific Legacy, Inc. for the above referenced project. I have reviewed the typed summary of the interview and agree that this documentation is complete and accurate, except for the clarifications and corrections noted below. I further agree that the interview information may be used in a report that may be made public, subject to my specific objections and restrictions set forth below.

CLARIFICATIONS AND CORRECTIONS:

SPECIFIC OBJECTIONS AND RESTRICTIONS:

Gary Sammer
Interviewee Signature

11/8/11
Date

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: Natatorium CIA

Date of Interview: 2-1-12

I, FRED WONG, have been interviewed by KIM MOONEY of Pacific Legacy, Inc. for the above referenced project. I agree that the interview information may be used in a report that may be made public.

Frederick Q. Wong
Interviewee Signature

2/1/12
Date

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: Natatorium CIA

Date of Interview: Feb 1, 2012

I, Donna L. Ching, have been interviewed by Iain Murray of Pacific Legacy, Inc. for the above referenced project. I agree that the interview information may be used in a report that may be made public.

[signature]
Interviewee Signature

Feb 1, 2012
Date

PACIFIC LEGACY, INC.

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: WAR MEMORIAL NATATORIUM CIA

Date of Interview: Feb 1, 2012

I, Jill Byus Radke, have been previously interviewed by

Kim Mooney of Pacific Legacy, Inc. for the above referenced project.

I have reviewed the typed summary of the interview and agree that this documentation is complete and accurate, except for the clarifications and corrections noted below. I further agree that the interview information may be used in a report that may be made public, subject to my specific objections and restrictions set forth below.

CLARIFICATIONS AND CORRECTIONS:

The only correction/ clarification in on the amount spent on the maintenance or restoration of the Natatorium over the years. I don't know the exact number, only that in 1949 there was $89,886 paid for refurbishment plus whatever was allocated in 1929 for the dredging of the pool to make it deeper. I'm not sure if the grand total will come close to $350k stated in the summary.

SPECIFIC OBJECTIONS AND RESTRICTIONS:

Jill Byus Radke
Interviewee Signature

2/27/12
Date

PACIFIC LEGACY, INC.

ORAL HISTORY STUDY
PERSONAL RELEASE OF INTERVIEW RECORDS

Project: Waikiki War Memorial Natatorium CIA

Date of Interview: 28 March 2012

I, Rick Bernstein, have been interviewed by Kimberly Mooney of Pacific Legacy, Inc. for the above referenced project. I agree that the interview information may be used in a report that may be made public.

Interviewee Signature

May 10, 2012
Date

APPENDIX E

NATIONAL REGISTER OF HISTORIC PLACES NOMINATION FORM FOR THE WAIKĪKĪ WAR MEMORIAL

Form No. 10-300 (Rev. 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

FOR NPS USE ONLY
RECEIVED JUN 5 1980
DATE ENTERED AUG 11 1980

SEE INSTRUCTIONS IN *HOW TO COMPLETE NATIONAL REGISTER FORMS*
TYPE ALL ENTRIES -- COMPLETE APPLICABLE SECTIONS

1 NAME

HISTORIC War Memorial Natatorium

AND/OR COMMON

2 LOCATION

STREET & NUMBER Kalakaua Avenue — NOT FOR PUBLICATION

CITY, TOWN Honolulu — VICINITY OF — CONGRESSIONAL DISTRICT First

STATE Hawaii — CODE 15 — COUNTY Honolulu — CODE 03

3 CLASSIFICATION

CATEGORY	OWNERSHIP	STATUS	PRESENT USE	
_DISTRICT	X PUBLIC	_OCCUPIED	_AGRICULTURE	_MUSEUM
_BUILDING(S)	_PRIVATE	X UNOCCUPIED	_COMMERCIAL	X PARK
X STRUCTURE	_BOTH	_WORK IN PROGRESS	_EDUCATIONAL	_PRIVATE RESIDENCE
_SITE	**PUBLIC ACQUISITION**	**ACCESSIBLE**	_ENTERTAINMENT	_RELIGIOUS
_OBJECT	_IN PROCESS	_YES: RESTRICTED	_GOVERNMENT	_SCIENTIFIC
	_BEING CONSIDERED	X YES: UNRESTRICTED	_INDUSTRIAL	_TRANSPORTATION
		_NO	_MILITARY	_OTHER:

4 OWNER OF PROPERTY

NAME State of Hawaii

STREET & NUMBER 1151 Punchbowl Street

CITY, TOWN Honolulu — VICINITY OF — STATE Hawaii

5 LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC. Bureau of Conveyances

STREET & NUMBER 1151 Punchbowl Street

CITY, TOWN Honolulu — STATE Hawaii

6 REPRESENTATION IN EXISTING SURVEYS

TITLE Hawaii Register of Historic Places 80-14-9701

DATE 1973 — _FEDERAL X STATE _COUNTY _LOCAL

DEPOSITORY FOR SURVEY RECORDS Department of Land and Natural Resources

CITY, TOWN Honolulu — STATE Hawaii

7 DESCRIPTION

CONDITION		CHECK ONE	CHECK ONE
__EXCELLENT	X DETERIORATED	X UNALTERED	X ORIGINAL SITE
__GOOD	__RUINS	__ALTERED	__MOVED DATE______
__FAIR	__UNEXPOSED		

DESCRIBE THE PRESENT AND ORIGINAL (IF KNOWN) PHYSICAL APPEARANCE

The War Memorial Natatorium is a reinforced concrete structure which contains an open air 100 meter by 50 foot swimming pool which is fed by ocean water through a series of coffered locks.

The pool is surrounded on four sides by a twenty-foot wide deck which is enclosed on the three ocean sides by a three-foot high wall. On the fourth, mauka (mountain) side, concrete bleachers rise thirteen levels in height and provide seating for approximately 2,500 people. The bleachers are divided into two parts, each with four sections, with a central entry space separating the two parts.

The Beaux-Arts inspired main entry, with its triumphal arch flanked by two lesser round arches, is the major architectural feature of the Natatorium. A pair of Ionic pilasters support the triumphal arch's entablature which has the words, "The War Memorial" inscribed in its frieze. An elaborate sculpture rises from the entablature. It consists of a garlanded base with an American eagle perched at each corner and the Hawaiian motto and seal in the center. The triumphal arch itself, has a paneled ceiling decorated with hexagonal floral designs. Flanking the triumphal arch, and above the two lower arches, is a medallion with floral patterns and a woman's face in the center in relief. The ocean and mountain sides of the entry are similar.

To either side of the main entrance, the bleacher's rear walls extend approximately 100 feet. Locker rooms are below the bleachers and inset behind centered round arched arcades of seven bays each. Round arched windows, which correspond to the arcade openings, provide the locker rooms with ventilation and illumination. A pair of simple pilasters flank the arcade and support large concrete urns, which project above the bleacher walls and demarcate the end sections of each bleacher. A flagpole with a ball finial is located above the second and sixth openings of each arcade. The bays on either side of the arcade contain office and restroom spaces and are distinguished by rectangular windows with grills.

A ramp leads to the main entry; to either side of this ramp are a volleyball and basketball court. A concrete wall with an incised diamond pattern, encloses these courts. The end walls are stepped, and two bays long at the main entry end and three bays long at the other end. The front walls are five bays long and a tapered concrete column, which originally supported a light globe, is at each pier. At the corners of the entry ramp, these columns are fluted metal and support spotlights which illuminated the triumphal arch entry. A hau arbor, supported by pipes, is adjacent to the front walls.

The War Memorial is situated on the ocean in Kapiolani Park and is surrounded by expansive lawns with a large number of tall coconut trees, a few banyans and other varieties of vegetation.

The basic structure is in poor condition and presently is officially closed, although people still use the facility. There have been no additions, and the only alterations have been the removal of a free-standing clock and diving platform from the deck area, and the removal of several light fixtures.

8 SIGNIFICANCE

PERIOD	AREAS OF SIGNIFICANCE -- CHECK AND JUSTIFY BELOW			
__PREHISTORIC	__ARCHEOLOGY-PREHISTORIC	__COMMUNITY PLANNING	__LANDSCAPE ARCHITECTURE	__RELIGION
__1400-1499	__ARCHEOLOGY-HISTORIC	__CONSERVATION	__LAW	__SCIENCE
__1500-1599	__AGRICULTURE	__ECONOMICS	__LITERATURE	__SCULPTURE
__1600-1699	X ARCHITECTURE	__EDUCATION	__MILITARY	X SOCIAL/HUMANITARIAN
__1700-1799	__ART	__ENGINEERING	__MUSIC	__THEATER
__1800-1899	__COMMERCE	__EXPLORATION/SETTLEMENT	__PHILOSOPHY	__TRANSPORTATION
X 1900-	__COMMUNICATIONS	__INDUSTRY	__POLITICS/GOVERNMENT	__OTHER (SPECIFY)
		__INVENTION		

SPECIFIC DATES 1927 BUILDER/ARCHITECT Lewis P. Hobart

STATEMENT OF SIGNIFICANCE

The War Memorial Natatorium is significant as a major landmark along the Kapiolani Park stretch of Kalakaua Avenue. Rendered in a Beaux-Arts style, which is typical of its period, it presents a striking image of monumentality within its setting of open lawn, beach and ocean.

In 1921, the Territorial Legislature authorized the issuance of bonds to produce $250,000 for the construction, on the former Irwin property, of a memorial dedicated to the men and women of Hawaii who served in World War I. The legislature further provided for the appointment of a Territorial War Memorial Commission to decide upon the form the memorial was to take. The legislature stipulated that a swimming pool of at least 100 meter length be included and a competition be held to determine the most appropriate design. The competition was held under the general rules of the American Institute of Architects. Three architects, Bernard Maybeck of San Francisco, Ellis F. Lawrence of Portland, and W.R.B. Willcox of Seattle, were selected to judge the competition, and Louis P. Hobart of San Francisco won the first prize. Hobart's plans, however, had to be twice modified before they could be implemented in accordance with the budgetary parameters. Thus it was not until 1927 that Mr. T.L. Cliff started construction.

The Natatorium was completed in the summer of 1927, the first "living" war memorial in the United States. The opening ceremonies were held on August 24, and were the major social event of the year. The feelings of the populace were expressed in an editorial appearing in the Advertiser that day: "Tonight the Hawaii War Memorial Opens. It is highly appropriate that this Memorial to the heroes of the World War should be a public natatorium. America went to war to assure safety and independence and the privileges and rights of a free people to all her citizens, and a part of the birthright of a free people is sound health and the opportunity for wholesome recreation. The Natatorium epitomizes Hawaii's prominence in one of the world's great sports. Situated at Waikiki, it looks upon and is part of the ocean, whereof Hawaii is the "crossroad"... No such galaxy of swimming stars has ever been gathered together since the last Olympic Games. The opening of the natatorium will be signalized by the greatest competitive swimming ever seen anywhere in the Pacific, once more giving Hawaii a place of honor and distinction."

The actual ceremonies were colorful and dignified. "Duke" Kahanamoku--who traveled from Los Angeles to open the pool on his birthday--made the first swim, emerging at the end of the 100 meters to a thunderous ovation. It was an unforgettable moment--the man who symbolized the Hawaiian people to the rest of the world opening a memorial whose design captured so well the character of the Territory and its relationship to the sea.

An AAU National championship swimming meet, with swimmers from Japan and South America participating, capped the opening activities. Olympic champion, Johnny Weissmuller, was

9 MAJOR BIBLIOGRAPHICAL REFERENCES

Ralph S. Kuykendall and Lorin Tarr Gill, Hawaii in the World War, Honolulu, 1928, pp. 447 - 454.

Honolulu Advertiser, August 24 - 29, 1927.

10 GEOGRAPHICAL DATA

UTM NOT VERIFIED

ACREAGE OF NOMINATED PROPERTY 5.347

UTM REFERENCES

ACREAGE NOT VERIFIED

	ZONE	EASTING	NORTHING		ZONE	EASTING	NORTHING
A	0 4	6 2 1 8 8 5	2 3 5 2 2 5 0	B			
C				D			

VERBAL BOUNDARY DESCRIPTION

This nomination includes the War Memorial Natatorium and Memorial Park which is designated in 1979 by the Tax Map Key: 3:1:31:3

LIST ALL STATES AND COUNTIES FOR PROPERTIES OVERLAPPING STATE OR COUNTY BOUNDARIES

STATE	CODE	COUNTY	CODE
STATE	CODE	COUNTY	CODE

11 FORM PREPARED BY

NAME / TITLE

Don Hibbard and Gary Cummins, architectural historian and historian

ORGANIZATION: State Historic Preservation Office

DATE: November 1, 1979

STREET & NUMBER: 1151 Punchbowl Street

TELEPHONE: 548-6408

CITY OR TOWN: Honolulu

STATE: Hawaii

12 STATE HISTORIC PRESERVATION OFFICER CERTIFICATION

THE EVALUATED SIGNIFICANCE OF THIS PROPERTY WITHIN THE STATE IS:

NATIONAL ___ STATE X LOCAL ___

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

STATE HISTORIC PRESERVATION OFFICER SIGNATURE Susumu Ono

TITLE

DATE May 28, 1980

FOR NPS USE ONLY

I HEREBY CERTIFY THAT THIS PROPERTY IS INCLUDED IN THE NATIONAL REGISTER

W. Ray Luce for KEEPER OF THE NATIONAL REGISTER DATE 8/11/80

~~DIRECTOR, OFFICE OF ARCHEOLOGY AND HISTORIC PRESERVATION~~

ATTEST: DATE 8-4-80

~~KEEPER OF THE NATIONAL REGISTER~~

GPO 892-453

Form No. 10-300a
(Rev. 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

**NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY -- NOMINATION FORM**

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DATE ENTERED AUG 11 1980

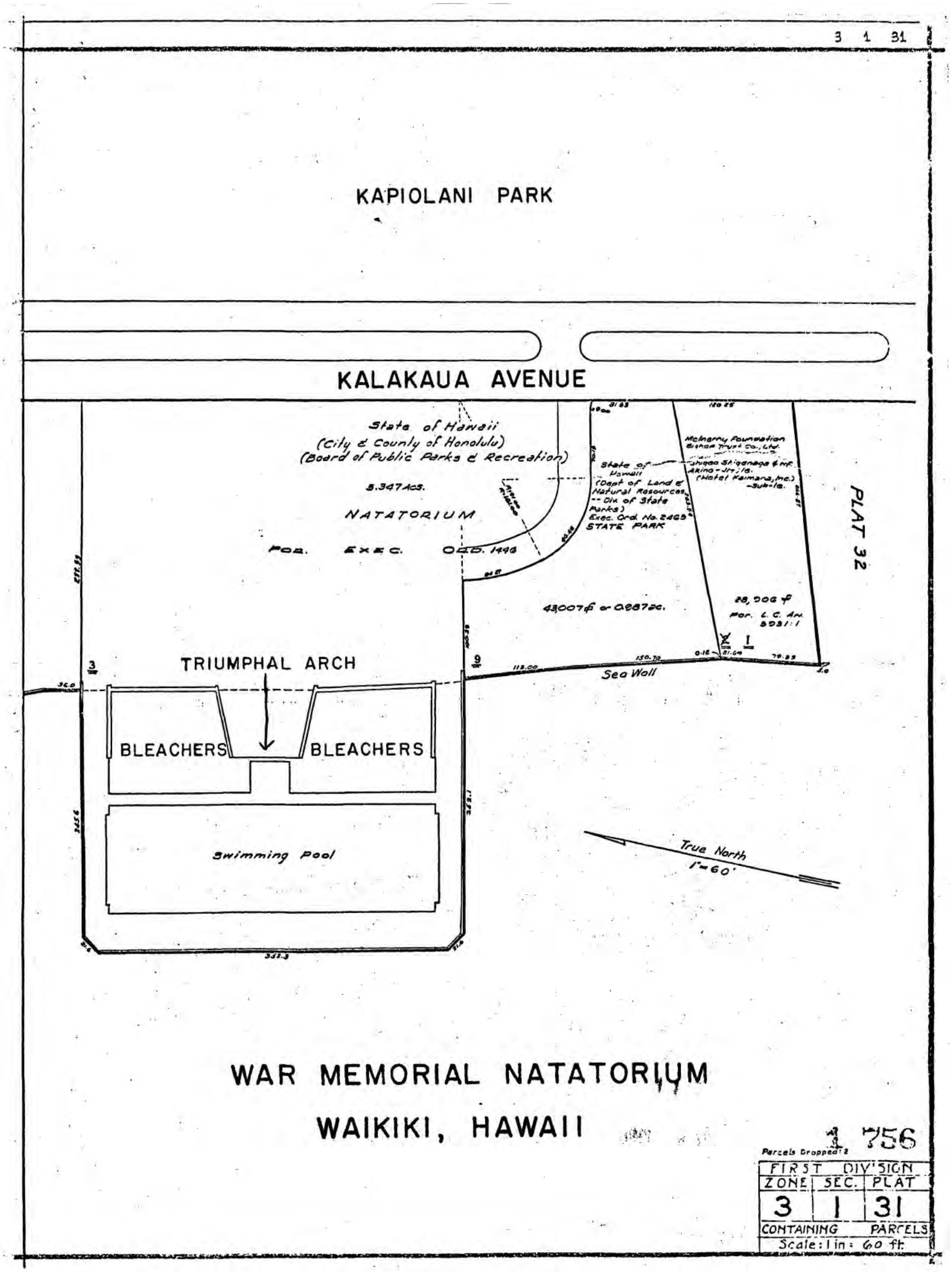
CONTINUATION SHEET ITEM NUMBER 8 PAGE 2

in excellent form, managing to break the world's record for the 100-meter freestyle swim, and in the following three days of competition, set new world's records for the 440 and 880-meter freestyles, cutting more than ten seconds off the previous world marks for these events. Clarence "Buster" Crabbe, a local swimmer, who was later to replace Weissmuller in the famous "Tarzan" series, won the 1500-meter contest.

The natatorium became a social-recreational center for local people immediately, and many important international and national swimming meets were held there. It became a factor in moves toward a "Pan-Pacific" philosophy, at least in the area of athletics.

There were, however, problems. Maintenance gradually became less and less efficient. The job of superintendent of the natatorium was awarded by the Territorial government more on the basis of political loyalty than expertise. Gradually, deterioration set in.

After Pearl Harbor, the natatorium was taken over by the army until 1943, and used for training purposes. Its physical condition continued to deteriorate, and began to take on the proportions of a scandal. In 1949, the natatorium was rehabilitated by the Territorial government at a cost of $82,000 and subsequently turned over to the City and County of Honolulu on July 1. The sporadic and inefficient maintenance of the memorial continued, however, and today, the natatorium is once again in need of extensive rehabilitation, if it is to continue to serve as a major social-recreational center. Although officially closed, the pool still attracts its share of visitors: local swimmers, people seeking to experience the ocean-park-beach scene from a unique space, and spectators who gather nightly to view a serene sunset.


3 1 31
KAPIOLANI PARK
KALAKAUA AVENUE
State of Hawaii
(City & County of Honolulu)
(Board of Public Parks & Recreation)
5.347Acs.
NATATORIUM
Por. Exec. Ord. 1446
State of Hawaii
(Dept of Land & Natural Resources -- Div. of State Parks)
Exec. Ord. No. 2463
STATE PARK
43,007 sf or 0.9872ac.
McInerny Foundation
Bishop Trust Co., Ltd.
(Hotel Kaimana, Inc.)
28,306 sf
Por. L. C. Aw.
PLAT 32
TRIUMPHAL ARCH
Sea Wall
BLEACHERS
BLEACHERS
Swimming Pool
True North
1" = 60'
WAR MEMORIAL NATATORIUM
WAIKIKI, HAWAII
1756
Parcels Dropped: 2
FIRST DIVISION
ZONE
SEC.
PLAT
3
1
31
CONTAINING
PARCELS
Scale: 1 in = 60 ft.

APPENDIX F

TEXT OF CONSULTATION LETTER DATED 21 AUGUST 2018

Pacific Basin — O'ahu
30 Aulike Street, Suite 301
Kailua, HI 96734

Phone: 808.263.4800
Fax: 808.263.4300
www.pacificlegacy.com

21 August 2018

Re: Follow up for the Cultural Impact Assessment for the Waikiki War Memorial and Natatorium located in the *ahupua'a* of Waikiki, O'ahu Island, Hawai'i

Dear:

In 2011 and 2012, you assisted Pacific Legacy (Kim Mooney) with the preparation of a draft Cultural Impact Assessment (CIA) for work to be done to the Waikiki War Memorial Complex (WWMC). The information you provided us that was included in the draft CIA is included in Attachment A of this letter. This information is also being used to meet requirements of HRS Chapter 6E and for anticipated future National Historic Preservation Act Section 106 consultation.

The City and County of Honolulu has added one additional alternative, the Perimeter Deck, to address past concerns of some of the historic partners without subjecting the Natatorium to the State requirements for public swimming pools, Hawaii Administrative Rules (HAR) Title 11, Chapter 10. This brings the total number of alternative up to four (see Attachment B):

1. Perimeter Deck
2. War Memorial Beach
3. Closed System Pool
4. No Action

We are in the process of finalizing the CIA for this project and are extending an invitation to all those who assisted in the original CIA research to provide additional input given the addition of the fourth alternative. As time is of the essence we request your input within 30 days of this letter. Please do not hesitate to contact me if you have any questions.

Mahalo nui loa,

Paul L. Cleghorn, Ph.D.
Principal and Senior Archaeologist

Attachments

Business Office
2641 Hwy 4
PO Box 6080
Arnold, CA 95223
209.795.4481 Ph.
209.795.1967 Fax

Bay Area
900 Modoc St.
Berkeley, CA 94707
510.524.3991 Ph.
510.524.4419 Fax

Sierra/Central Valley
4919 Windplay Dr., Ste. 4
El Dorado Hills, CA 95762
916.358.5156 Ph.
916.358.5161 Fax

ATTACHMENT A

CIA INFORMATION

Customized for each individual.

ATTACHMENT B

DRAFT DESCRIPTIONS OF WWMC ALTERNATIVES

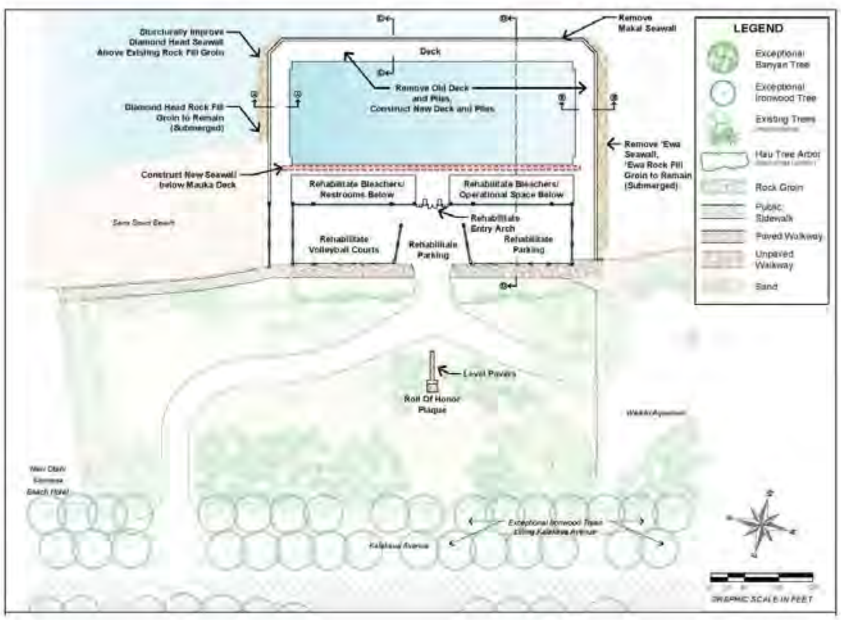
Perimeter Deck

This alternative would comply with the rehabilitation approach outlined in the U.S. Secretary of Interior's *Standards for the Treatment of Historic Properties*. It would retain as much of the physical structure that defines the historic integrity of the NATATORIUM as possible, while falling outside of the definition of Public Swimming Pools in HAR 11-10.

The Perimeter Deck would retain the bleachers and arches, and rehabilitate the deck around the Natatorium, while removing the less visible submerged structures (such as the makai and 'Ewa seawalls) which block the free flow of water between the swim basin and open ocean. This alternative would expose the entire pool to the coastal waters without subjecting the structure to the water quality requirements of DOH pool rules in HAR 11-10. Rather, the open swim basin would be governed by the same water quality rules of the adjoining shoreline and nearshore areas.

The Perimeter Deck would result in the demolition of the makai and 'Ewa side seawalls of the swim basin and reconstruction of the deck on support piles, allowing for the free flow of water between the ocean and a swim basin area. The shape, configuration, and size of the decking would be retained, resulting in the structure's appearance emulating the original facility when seen from above. The Diamond Head groin and lower portion of seawall would remain and be structurally improved to retain Sans Souci Beach. The bleachers, arch, and other existing elements of the Natatorium structure would also remain and be rehabilitated to their historic appearance.

To provide resiliency against the potential impacts of sea level rise over the next few decades (beyond the scope of this evaluation), the new deck could be constructed approximately 12 to 16 inches higher than the current elevation. Minor modifications to the slope of the deck entrances would assure ADA compliance. Currently, no change to the existing deck elevation is proposed.

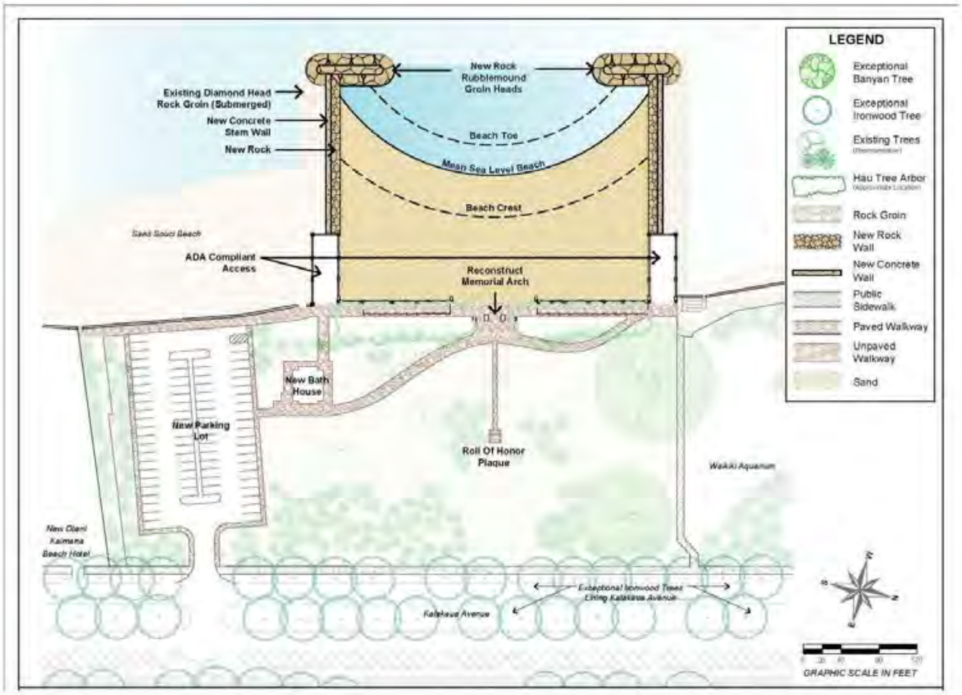


Page 4 of 7

War Memorial Beach

This alternative would create a beach between constructed groins, fronted by a replica memorial arch in alignment with the existing Roll of Honor plaque and hau tree arbor. The entire Natatorium structure, i.e., everything built seaward of the 1927 shoreline, would be removed. Various landside improvements would also be undertaken. As noted, this alternative (removal of the Natatorium and creation of a new beach) was the recommendation made to the City by the Task Force in September 2009 and corresponds to the City's "proposed action" at the time of the 2014 FEA-EISPN.

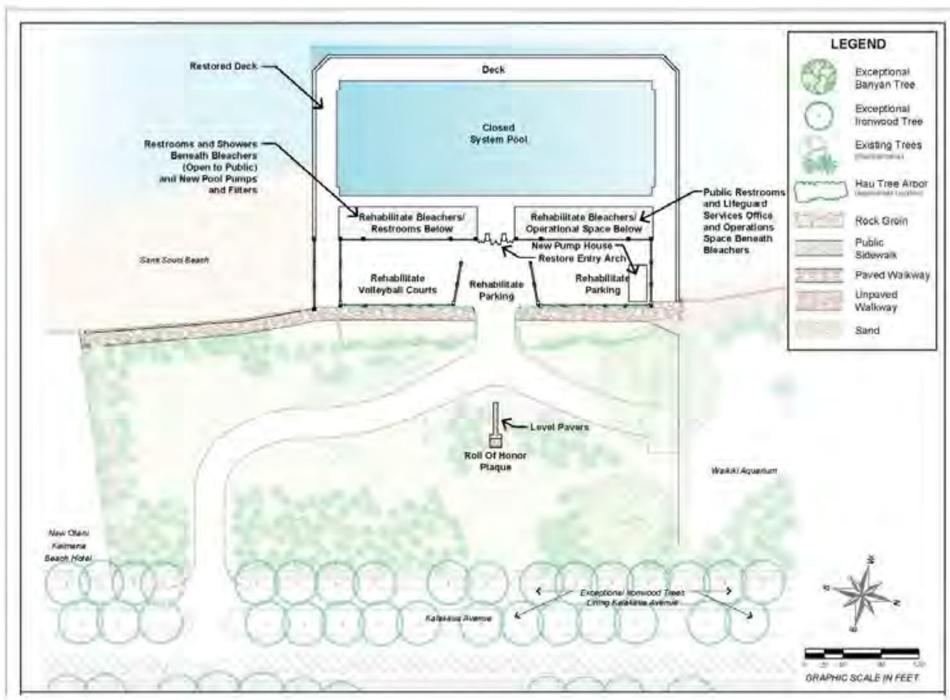
The War Memorial Beach alternative would relocate the memorial arch, demolish other elements of the NATATORIUM, and construct a public beach and lagoon in place of the existing saltwater pool. This alternative would use portions of the existing seawall combined with new rock, concrete walls and groins to create a protected beach and swimming area within the Natatorium footprint that would remain stable while still providing for active flushing of the water.



Page 5 of 7

Closed System Pool
It would involve the reconstruction and restoration of the Natatorium in general accordance with the 1998 plans, except for the ocean-fed pool design (DDC 1998). The open-cycle saltwater pool design proposed in the 1998 plans meets the definition of a "public swimming pool" as defined in HAR 11-10 and would therefore be subject to the provisions found within. This alternative envisions a filtered, fresh water, chlorinated, closed system pool designed to comply with provisions of HAR 11-10 and specifically with those provisions related to water quality requirements and maintainability, including exchange rates and turbidity.
The intent of the Closed System Pool is to renovate the Natatorium to its historic character while also satisfying the requirements of HAR 11-10. This alternative involves maintaining the Natatorium structures while constructing a concrete lined fresh water swimming pool in place of the saltwater pool.

To provide resiliency against the potential impacts of sea level rise over the next few decades, the new deck could be constructed approximately 12 to 16 inches higher than the current elevation. Minor modifications to the slope of the deck entrances would be designed to comply with the ADA.



No Action

No Action represents the baseline conditions for which the action alternatives are evaluated. Under No Action, the WWMC would remain in its current dilapidated condition and the pool and bleachers would remain closed to the public. There would be no change to the land use or facilities that currently exist at the site. This alternative would maintain the status quo and all structures would remain in place and continue to deteriorate.

Due to the public safety hazards presented by the current condition of the Natatorium and related liability borne by the City, monitoring of the structural condition would continue and, if warranted, imminent hazards would be mitigated in accordance with the recommendations of the *Waikiki War Memorial Complex (Natatorium) Emergency Preparedness Contingency Plan* (WCP 2008). The 2008 Contingency Plan proactive mitigation measures would be implemented and are described below.

Appendix I:
HRS Chapter 6E Letter

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 768-4567
Web site: www.honolulu.gov

KIRK CALDWELL
MAYOR

ROBERT J. KRONING, P.E.
DIRECTOR

MARK YONAMINE, P.E.
DEPUTY DIRECTOR

782614

August 15, 2019

Dr. Alan Downer, Administrator
State Historic Preservation Division
Department of Land and Natural Resources
State of Hawaii
601 Kamokila Boulevard, Suite 555
Kapolei, Hawaii 96707

Dear Dr. Downer:

Subject: HRS Chapter 6E Historic Preservation Review
Waikkiki War Memorial Complex, Waikiki Ahupuaa,
Kona District, Oahu, Hawaii, TMK: (1) 3-1-031

The City and County of Honolulu, Department of Design and Construction (City), is proposing repairs to the Waikiki War Memorial Complex (also known, and referred to in this letter, as the Natatorium). It is part of the Kapiolani Regional Park (Enclosure A) and located in TMK: (1) 3-1-031 (Enclosure B). This letter requests preservation review of the project under Hawaii Revised Statutes (HRS) Chapter 6E-8.

The City's proposed action is to construct and operate a rehabilitated Waikiki War Memorial Complex as presented in the Perimeter Deck described in its *Waikiki War Memorial Complex Draft Environmental Impact Statement* (AECOM, 2018). The proposed project, per Hawaii Administrative Rules (HAR) 13-275-2, includes modifications to the National Register-listed Natatorium structure, detailed in the enclosures.

- The project area, as defined under HAR 13-275-2, is illustrated in Enclosure C.
- Consultation with interested parties in 2017, per HRS 13-284, leading to the proposed project is in Enclosure D.
- Conceptual plans supporting the proposed action are presented as Enclosure E.
- Photos of the existing structures are Enclosure F.
- The draft Archaeological Inventory Survey (Pacific Legacy, March 2019) is provided as Enclosure G.

Considering the proposed action and mitigation commitments detailed in Enclosure A and in accordance with HAR 13-275, the City is seeking your office's concurrence of the City's determination of "Effect, with proposed mitigation commitments." We respectfully request your concurrence or comment within 90 days of this letter.

Thank you for your consideration. We look forward to your response.

Should there be any questions, please contact Lansing Sugita at 768-8461.

Very truly yours,

R. M. Kroning

Robert J. Kroning, P.E.
Director

RJK:ln

Enclosures:

A. Project Information
B. TMK Map
C. Property Map showing project area.
D. Minutes from Technical Preservation Workshop Meeting, July 20, 2017
E. Conceptual plans of the Proposed Action ("Perimeter Deck")
F. Photographs of property
G. Archaeological Inventory Survey

Enclosure A

PROJECT INFORMATION

Existing Conditions and Project Area Description

The project area encompasses the Natatorium and adjacent lands situated on the coastline of Kapiʻolani Park *makai* of Kalākaua Avenue, Waikīkī, in the vicinity of Sans Souci Beach Park (Kaimana Beach), within Tax Map Key (TMK) (1) 3-1-031 (see Enclosure B, TMK map). A project area map is shown in Enclosure C.

The Natatorium opened in 1927, dedicated as a war memorial commemorating the men and women of Hawaiʻi who served in World War I. A distinctive Beaux-Arts triumphal arch inscribed with the words "The War Memorial" marks the central entranceway to the Natatorium. The structure consists of a 100-meter open-air swim area that extends off the natural shoreline and is naturally fed with seawater flowing through openings in the submerged seawall. A 20-foot-wide deck surrounds the swim area, and the land side has a large concrete bleacher structure with seating for 2,500 spectators, with restrooms and lifeguard office space below. Closed to the public since 1979, the facility has deteriorated over the decades of disuse. Continued exposure to the ocean environment and weathering is causing continued deterioration of the Natatorium's reinforced concrete. The majority of the reinforced concrete pool deck appears to be structurally unsound with large portions having already collapsed into the water below, the outer corners of the seawall rotating out and are no longer vertical, and in some areas the seawall is separating from the deck (WCP, Consulting Structural Hawaii, Inc., and EKNA Services, Inc. 2008). The pool deck has deteriorated such that no access is permitted on it, except for inspection and emergency work. Please refer to Enclosure F for photographs.

Project Description

The proposed action, titled "Perimeter Deck" to distinguish from other/previous alternative plans, is illustrated in Enclosure D. The Perimeter Deck plan as proposed complies with the rehabilitation approach outlined in the U.S. Secretary of Interior's *Standards for the Treatment of Historic Properties*. The goal of this plan is to retain as much of the physical structure that defines the historic character of the Natatorium as practicable without subjecting the Natatorium to the State of Hawaiʻi Department of Health requirements for public swimming pools, Hawaiʻi Administrative Rules (HAR) Title 11 Chapter 10. The Perimeter Deck plan retains land facilities including the bleacher structure and arch. On and in the water, this plan rehabilitates the perimeter deck, while removing the deteriorated less-visible submerged structures (such as the makai and ʻEwa seawalls). The proposed action would allow for the free flow of water between the ocean and swim area and would, therefore, be governed by the same water quality rules of the adjoining shoreline and nearshore areas.

The proposed action requires the demolition of the existing, heavily deteriorated deck as well as the makai and ʻEwa side seawalls of the swim area. Subsequent reconstruction of the deck would occur on support piles, allowing for the free flow of water between the ocean and swim area. The shape, configuration, and size of the original historic decking would be retained, resulting in the structure's appearance emulating the original facility, and complying with the Rehabilitation approach as defined in the U.S. Secretary of Interior's *Standards for the Treatment of Historic Properties*. To retain Sans Souci Beach, the Diamond Head groin and lower portion of seawall would remain and be structurally improved or replaced. The bleachers, memorial arch, and other existing elements of the Natatorium structure would also remain and be restored to their historic appearance.

To provide resiliency against the potential impacts of sea level rise (SLR) over the next few decades, the Perimeter Deck would be designed accordingly. The slope of the deck entrances would be designed in accordance with Americans with Disabilities Act (ADA) Standards for Accessible Design. The existing deck elevation, shown in Enclosure E, does not reflect such design changes.

Swim Area

The makai and ʻEwa sides of the swim area would be open to the ocean below the new deck. For the protection of swimmers, designs would incorporate measures to prevent injury to swimmers from entrapment below the perimeter deck, e.g., a fiberglass reinforced plastic (FRP) grate system installed below both the inside and outside edges of the deck, extending to the swim area bottom. On the outside edge of the ʻEwa deck, the grate could extend down to the top of the existing rock fill groin, approximately 2 feet below mean lower low water (MLLW). These safety measures would be developed with input from concerned agencies such as the City and County of Honolulu Emergency Services Department (HESD), DOH, DLNR Division of Aquatic Resources, and NOAA NMFS.

A pre-cast concrete wall would be installed below, and prior to, the deck along the mauka (toward the mountain) side of the swim area to protect the bleachers from storm waves. The design details of the bulkhead wall would be determined based on future structural analyses. To further improve swimmers' access to the pool, a pre-fabricated floating dock could be considered, with public safety input from HESD, and installed at a later date.

Groins and Deck

The entire dilapidated concrete deck surrounding the pool, including beams, pile caps, and portions of the seawall would be removed. Existing exposed portions of piles would be removed. The existing rock fill below the Diamond Head seawall would remain, though some temporary rock removal will be required during pile installation. Portions of the existing rock fill groin below the ʻEwa seawall may also be partially removed, if recommended by further structural analysis during the design phase of the project.

Because the Diamond Head seawall is important for the retention of the neighboring Sans Souci Beach, the lower portion of the wall (below the existing deck) would either remain and be structurally improved or be replaced. If the wall is determined to require full replacement during the design phase, a temporary barrier would be installed just outside the existing Diamond Head seawall prior to its removal. The existing seawater pipes within the rock fill would be grouted in place.

The entire deck would then be reconstructed of pre-cast concrete segments on pre-cast concrete piles to visually match, to the extent practical, the appearance of the original deck structure. Reinstallation of the pile support system presumes use of the existing number of piles. During the design phase of the project, the number of piles and cost may be reduced without diminishing structural stability.

Bleachers and Memorial Arch

The Natatorium structure (including the landside deck, visible portions of the landside seawall, the bleachers, restrooms, office/operational space, arched arcade and triple-arched entry, and parking lot) would be retained and rehabilitated in their current location. Repairs and improvements would be coordinated to provide continued safe use of the bleacher structure and spaces below. Repair work would include, among other things, waterproofing, new plasterwork, and continual monitoring and maintenance. Work would comply with the Secretary of Interior *Standards* referenced above.

Landscaping

The Perimeter Deck would involve minimal landside improvements. Existing landside conditions including landscaping, parking, access, and drainage would continue. Minor changes would include:

- Construction of a new paved walkway to extend the existing Kapiʻolani Regional Park shoreline promenade from the Waikiki Aquarium to Sans Souci Beach. The promenade currently ends near the boundary between the Waikiki Aquarium and the project site.
- Restore a level, ADA-compliant surface leading to the Roll of Honor plaque.

The existing landscape character of open spaces and tree clusters would be retained and enhanced with additional plantings. The existing hau trees, trellises, coconut trees, and three large trees on-site would be maintained, as well as the exceptional and historic trees along Kalakaua Avenue. Any landscaping or irrigation upgrades would be done in accordance with existing authorizations. No new landscaping is proposed under this proposed action.

Proposed Ground Disturbance

Minimal ground disturbance is proposed as part of this project, which will be focused on the aboveground and in-water portions of the historic Natatorium structure. The proposed action does not include any substantial utility upgrades that would require trenching. The minor activities proposed under landscaping are the only land-side alterations proposed in the park area mauka of the building wall.

Construction Period Activities

During the construction period, best practices for protecting the site, including historic structures and trees, will be implemented as part of the project specifications. These include, in summary:

- Document pre-construction conditions (structures, tree survey)
- Use accurate information
- Include appropriate professionals on team (historical architect, certified arborist, archaeologist)
- Show utilities on plans
- Identify affected areas including trees and structures

- Consider alternatives to minimize construction impacts to trees/structures
- Consider alternative construction techniques
- Monitor construction and address any impacts as they occur
- Avoid soil compaction
- Use geotextiles for temporary access routes/storage areas
- Protect root zones (hurricane fencing)
- Designate specific areas for equipment cleaning, staging materials, disposing debris
- Should it occur, repair construction damage promptly.

Project Background

This letter provides an update to a project that has been in development for many years; SHPD has received status updates and participated in previous Natatorium efforts initiated by the City. The proposed action presented here was developed in 2017 in consultation with SHPD and interested parties (as defined in HRS 13-284) as part of the HRS Chapter 6E process. See Enclosure C, minutes from technical preservation workshop meeting, for reference.

Since the Natatorium was closed in 1979, there have been numerous planning efforts to address its dilapidated condition. In 1999, restoration was initiated based on a 1995 Environmental Impact Statement (EIS), only to be halted by a lawsuit. By the time the lawsuit was settled and attempts could be made to address the water quality terms of the settlement, State of Hawaiʻi Department of Health (DOH) Hawaiʻi Administrative Rules (HAR) Title 11, Chapter 10, *Public Swimming Pools* were promulgated in 2002. Among other things, the DOH rules include rigorous requirements for water quality, clarity, and exchange rates; the installation of mechanical pumping and filtration systems and cleanable side and bottom structures at the Natatorium would be required in order to meet these rules. Under HAR 11-10, the original open-system saltwater pool is noncompliant and the 1995 EIS plans are unusable.

In 2009, the Natatorium Task Force was formed and represented members of City & County of Honolulu (City) government; the armed forces and war veteran groups; outdoor recreation interests; the Waikīkī Aquarium; the community of Waikīkī; residents of the surrounding Kapiʻolani Park area; and historic preservation interests (WCP 2009). After consideration of a range of factors, including permits and regulatory issues, shoreline studies from the United States (U.S.) Army Corps of Engineers (USACE), and costs, the Task Force selected the War Memorial Beach option for implementation. This plan involved the complete demolition of the Natatorium and addition of a replica memorial arch in the adjacent park area. Founded on this recommendation, the City published a 2014 Final Environmental Assessment-Environmental Impact Statement Preparation Notice (FEA-EISPN) with the beach alternative identified as the City's proposed action.

In 2016, HRS Chapter 6E consultations were initiated. In comments, interested parties expressed concerns with the demolition of the Natatorium given its status as a National Register listed historic property and war memorial. In July of 2017, the City convened knowledgeable concerned parties to help identify a feasible and prudent alternative that aligns with national historic preservation standards. This alternative, named the "Perimeter Deck," is detailed and evaluated in the November 2018 *Draft Waikiki War Memorial Complex Environmental Impact Statement* (WWMC DEIS). The proposed action reflects input received in the HRS Chapter 6E consultation at that time.

Summary Historical Background

The waterfront of Waikīkī has been inhabited intensively since approximately 1000-1200 AD. The vicinity of the Natatorium, once known as Kapua, has been the site for many cultural practices over time (Mooney and Cleghorn 2012). In early European accounts, it was described as a highly developed area with large groves of coconut palms, intensive agriculture including crop fields, gardens, and fishponds, and many dwellings.

The project area was a part of the Crown Lands and adjacent waters after the Māhele ʻAina, or "Great Māhele," redistribution of Hawaiian lands that was carried out under Kamehameha III starting in 1848. King David Kalakaua established Kapiʻolani Park as a charitable trust in 1896, providing the Crown Lands for public recreational use (Weyeneth 2002). After the overthrow of the Hawaiian monarchy, the trust deeded most of the park land to the Republic, but also sold portions of it as fee-simple parcels. The current project area was purchased by a park trustee, W.G. Irwin, who constructed a dwelling on it.

After the conclusion of World War I in 1919, the Territorial Legislature purchased 6.4 acres of Irwin's property makai of the Kapiʻolani Park boundary and designated it as a new "Memorial Park" (Territorial Legislature, 1919) commemorating the men and women of Hawaiʻi who served in World War I.

In 1921, the Territorial Government appointed a Territorial War Memorial Commission to oversee a competition for the design of the memorial to "include a swimming course at least 100 meters in length" (Territorial Legislature, 1921). The winning design by architect Lewis Parsons Hobart, FAIA (a graduate of University of California at Berkeley the École des Beaux-Arts in Paris) was constructed under the direction of T. L. Cliff and completed in 1927 (Figures 1 through 3). The opening ceremony took place on August 24, 1927, the birthday of Duke Kahanamoku, who had the honor of performing the inaugural dive into the swim basin before a large crowd.

The Natatorium quickly became a significant recreational and social center on Oʻahu (CIS Group Architects 1985). The Beaux-Arts structure's distinctive arch and symmetrical, arcaded façade (Figure 4) became a landmark along the Waikīkī shoreline and Kalakaua Avenue, framed originally by reflecting pools and coconut palms (Figure 5), and later, by courtyards in the 1930s and an arbor supporting a row of flowering hau trees by the 1950s.

A popular venue for local, national, and even international swimming competitions and exhibitions, the Natatorium was also in use on a daily basis as the place where many local youth learned to swim (Figures 6 through 8). Nationally and locally renowned athletes (Figure 9) including Duke Kahanamoku, Buster Crabbe, and Johnny Weissmuller swam there. The adjacent park was also a popular public amenity. From 1937 to 1969, the popular Kodak Hula Show took place in the grassy areas near the Natatorium and at the adjacent Sans Souci Beach Park (Figure 10). The Army used the Natatorium swim basin for training during World War II.

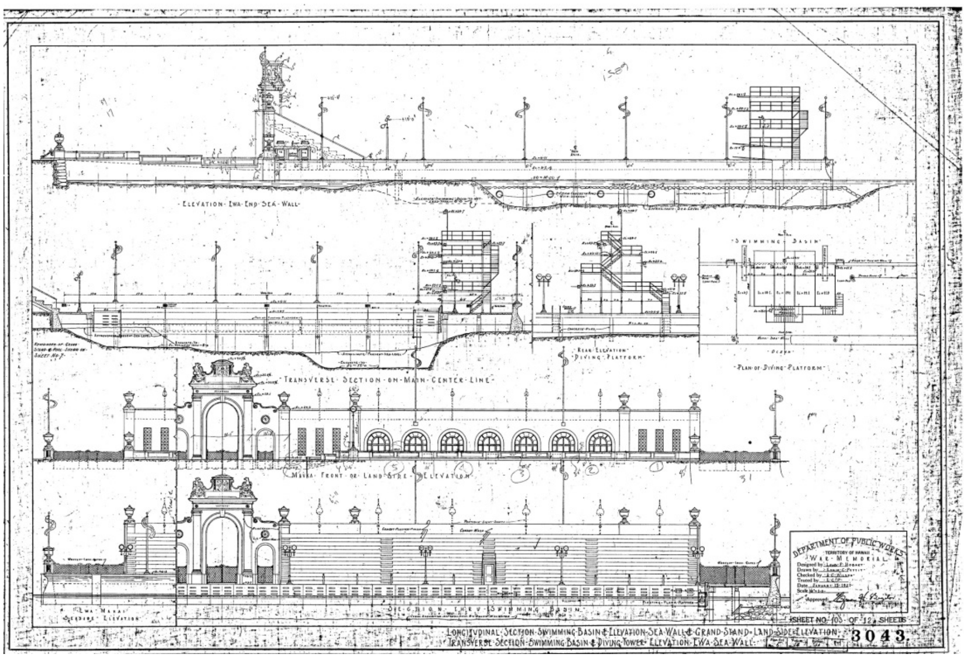


Figure 1. Sheet from original Natatorium drawing set, 1927. Source: City & County of Honolulu.

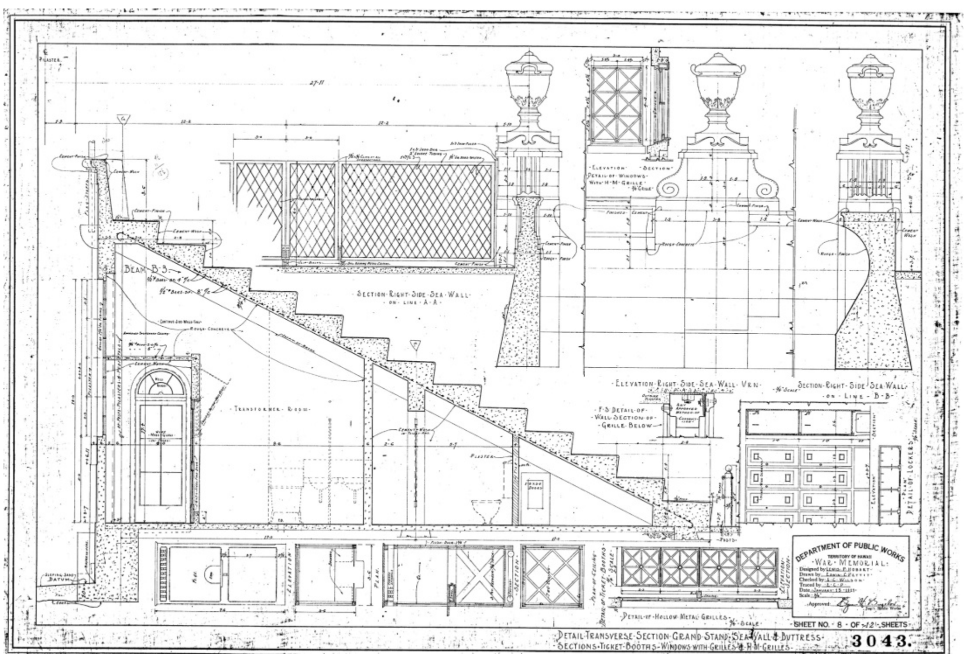


Figure 2. Sheet from original Natatorium drawing set, 1927, including section through bleachers and lighting details. Source: City & County of Honolulu.

Figure 3. Natatorium under construction in 1927 off the shoreline at the time, viewed from what is now Sans Souci Beach Park. Source: City and County of Honolulu.

Figure 4. Undated historic photograph of the Natatorium's mauka façade, with clock and diving tower. Source: Honolulu Star-Bulletin File Photo.

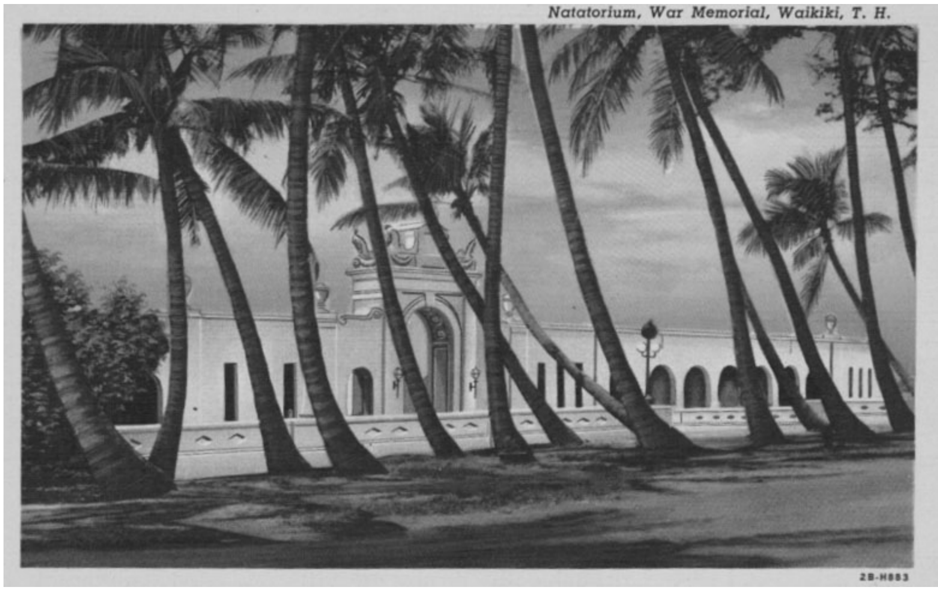


Figure 5. Postcard view of the Natatorium, c. 1930. Source: Hawai'i State Archives.

Figure 6. Young swimmers diving in at the Natatorium, undated, c. 1930s. Source: Hawai'i State Archives.

Figure 7. Keiki swimming at the Natatorium, undated (c. 1930s). Source: Hawaiian Historical Society Photograph Collection.

Figure 8. Keiki learning to swim at the Natatorium in the 1930s, where teachers suspend them in the water by ropes to teach them to coordinate their arm and leg movements. Source: Honolulu Star-Bulletin File Photo.

Figure 9. Paddleboarders at the Natatorium, 1940. Source: Collection of Ian Lind.

Figure 10. Kodak Hula Show c. 1950; performers on the lawn near the Natatorium. Source: Hawaiian Historical Society Photograph Collection.

However, as early as 1929, concerns existed about the conditions of the facility and a lack of proper maintenance. Improper maintenance appears to have been exacerbated due to a complex layering of jurisdiction and responsibility making it unclear whether responsibility lay with the Territory or with the City and County. The land on which the Natatorium was constructed was owned by the Territory (and later the State); through a series of executive orders, the Territory turned over management and maintenance to the City and County in 1949. A structural assessment in 1949 revealed deficiencies with some of the original construction techniques on the water side of the structure, such as the concrete mix, which had resulted in premature deterioration (CIS Group Architects 1985). Repair and partial refurbishment were undertaken in 1929 and 1949.

In the 1960s, many fresh-water recreational swimming pools were constructed on Oʻahu, providing new public and private venues for swim meets and competitions. In 1965, demolition of the Natatorium structure was endorsed by City Council, citing its condition and an interest in additional beach space close to the burgeoning visitor areas of Waikīkī. However, proponents of retaining the memorial and renovating it succeeded in gaining a court injunction against demolition in 1972. This initial series of legal actions and political decisions precipitated decades of seesawing between plans for demolition and plans for restoration, which stalled efforts to effectively address the problems of the facility. The Natatorium has remained officially closed to the public since 1979.

Since the 1970s, the importance of the property to veterans' groups has been evident in annual Memorial Day and Veterans Day events, and other memorial activities that currently take place on the lawn mauka of the Natatorium.

Identification and Inventory of Historic Properties

The following section provides an identification and inventory of historic properties in the project area. See Figure 11 for a map of the project area showing the locations of aboveground historic properties and Figure 13 for a map of the project area showing the belowground archaeological sites.

Waikīkī War Memorial Natatorium

The Waikīkī War Memorial Natatorium is a historic structure that was completed in 1927 as the first "living" war memorial in the United States. The Beaux-Arts structure commemorates the men and women of Hawaiʻi who served and sacrificed their lives in World War I (1914-1919). It has been listed as a historic building in the HRHP since 1973 (SIHP #84-14-9701) and the NRHP since 1980 (NHRP #80001283). It was also designated a National Treasure by the National Trust for Historic Preservation in 2014. The Natatorium has been determined significant under National Register Criterion A for its memorial importance and its role as an important swimming venue for the Honolulu community and for national and international swimming competitions; and Criterion C for its Beaux-Arts architectural design. It may also have significance under Criterion B and possibly Criterion E for its association with the famed Duke Kahanamoku and other well-known swimmers.

Figure 11. Historic properties within the project area include the Natatorium and Kapi'olani Park. Source: WWMC DEIS.

Character-defining features of the Natatorium’s design include the following:

- Grand Beaux-Arts style arch, flanked by smaller round arches
- Sculpture and inscribed entablature atop arch frieze
- Façade with arcades of seven bays extending symmetrically
- Round arched windows and rectangular grille windows
- Concrete walls with incised diamond pattern enclosing courtyards
- Lighting: tapered columns on walls formerly topped with globe luminaires; fluted metal columns with spotlights illuminating arch entry
- Landscape features: coconut grove, mature banyans (two are listed Exceptional Trees)
- Large urns flanking arcade and projecting above bleacher walls
- Flagpoles with ball finials
- Stadium seating structure (bleachers), 13 levels, facing swim basin
- 20-foot-wide concrete deck enclosed by a 3-foot concrete wall
- 100-by-36-meter rectangular swimming basin

Aside from its increasingly dilapidated condition, there have been few changes to the facility over the past 91 years. For example, the two concrete courtyard areas enclosed by a wall along the front façade area were originally reflecting pools, although they were modified within a few years after construction and appear to have had their current concrete paving in place by the late 1930s. Additionally, a diving platform and clock that were originally installed on the swim basin side are now missing (see Figure 4). The hau tree arbor, while mentioned in the NRHP nomination, has recently been identified as a later addition post-1940s and not a part of the original design. This was determined based on review of historic plans and photographs (see Figure 5). Because it is a much later addition not connected to the property’s original design intent, the hau arbor falls outside the definition of character-defining features.

Kapiʻolani Park

Kapiʻolani Park (Figures 11 and 12) is a recreational open space listed on the HRHP (SIHP# 80-14-9758) since 1992 as a historic site. Kapiʻolani Park has been determined significant under NRHP and HRHP Criterion A, for events that have made a significant contribution to the broad patterns of our history. In addition to its individual listing on the HRHP and NRHP as a building, the entirety of the Natatorium project area lies within Kapiʻolani Park’s listed historic property boundary.

According to the NRHP nomination statement of significance, “Kapiʻolani Park is historically significant for its past association with indigenous Hawaiian culture and royalty. Hawaiian King Kalakaua envisioned the park as a place of recreation for all and named it after his famous Queen, Kapiʻolani. Since its dedication in 1877 it has been in continuous use as a location for recreational activities valued by local residents and visitors alike. It provides a sense of place to a special part of Honolulu and is identified with the world famous image of Hawaiʻi as a recreational resort. Over the years it has been the scene of a variety of sports and leisure time activities that reflects the recreational development of Honolulu and Hawaiʻi into the modern world." The Kapiʻolani Park Preservation Society has also noted that the driveway to the Natatorium is a portion of a former park carriageway and is considered historic (June 2016 HRS Chapter 6E pre-consultation meeting comments).

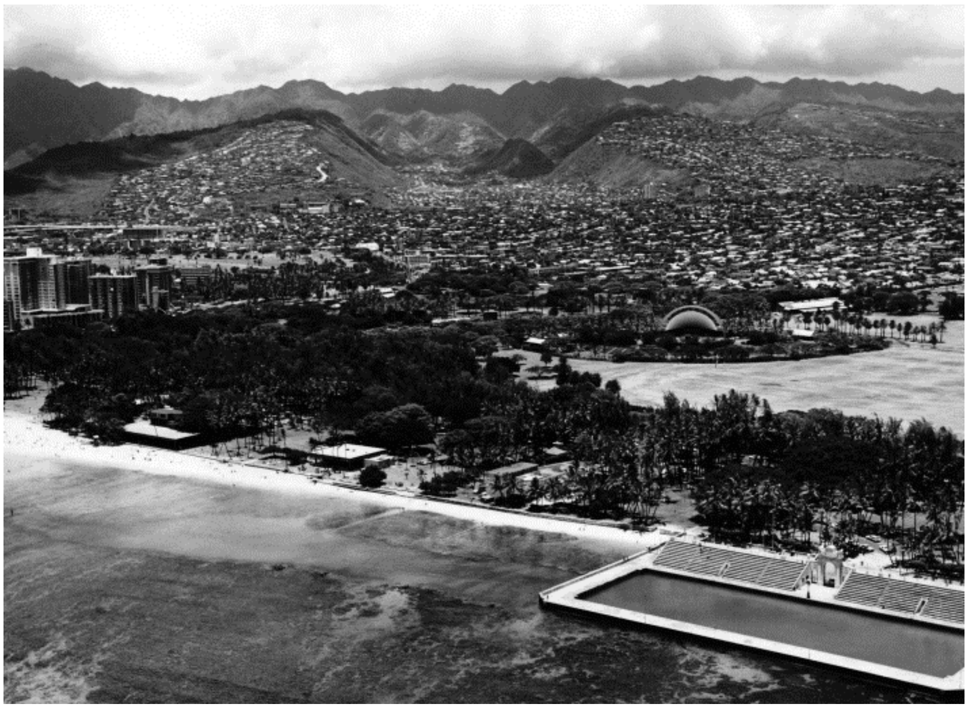


Figure 12. Historic aerial photo of Natatorium and portion of Kapiʻolani Park, undated. Source: City & County of Honolulu Municipal Resource Center.

According to the National Register nomination statement of significance, "Kapiolani Park is historically significant for its past association with indigenous Hawaiian culture and royalty. Hawaiian King Kalakaua envisioned the park as a place of recreation for all and named it after his famous Queen, Kapiolani. Since its dedication in 1877 it has been in continuous use as a location for recreational activities valued by local residents and visitors alike. It provides a sense of place to a special part of Honolulu and is identified with the world-famous image of Hawaiʻi as a recreational resort. Over the years it has been the scene of a variety of sports and leisure time activities that reflects the recreational development of Honolulu and Hawaiʻi into the modern world."

Archaeological Properties and Surveys

The Natatorium project area is within a region that had many *heiau* and other traditional Hawaiian ceremonial and spiritual sites, although these generally went out of use after the *ʻAi Noa*, the breaking of the *kapu* system by Liholiho (Kamehameha II) in 1819, and the arrival of European missionaries in 1820. Ruins of some of the *heiau* were noted in later accounts, while the locations or remains of others have not been found. Because the area on which the Natatorium stands was built on twentieth-century fill, archaeologists do not believe any remains of these sites are present in the project area (McIntosh and Cleghorn 2012).

The project area mauka of the Natatorium structure has been subject to periodic ground disturbance over the past century or more, with the construction and modification of park features, driveways, and the Natatorium itself. Little ground alteration has occurred since the mid-twentieth century, however.

While human burials have been uncovered during construction projects elsewhere in Waikīkī, none were identified in the field investigations, and no significant excavation is proposed as part of this project.

In 2011 and 2018, archaeological testing was undertaken in the project area, with test pits and trenches dug to identify potential subsurface resources. Pacific Legacy Inc., under contract to Wil Chee-Planning & Environmental (WCP), conducted an archaeological inventory survey (AIS) of the WWMC project area in 2011, updated with additional field investigations in 2018 (McIntosh and Cleghorn 2018). See Figure 13 for the boundary of the AIS survey area. Archaeological testing was limited to the terrestrial portion of the project area. No underwater archaeological investigations were conducted during either testing episode. The limits of the project area are the edge of the existing historic pool structure, and it was thought that no useful information would be generated by examining the structural foundation.

Figure 13. Archaeological Inventory Survey (AIS) area, 2019. Site 50-80-14-7211 is outlined in yellow dashed line. Source: Pacific Legacy.

Based on previous archaeological investigations in the vicinity, and the project area's adjacency to ocean resources and the locations of former inland marshes and streams, the archaeological survey concluded that it is likely that this area would have been traditionally inhabited and used. Typical habitation features could have included living floors, hearths and ovens, and activity areas where traditional artifacts were made; there was also potential for human burials (McIntosh and Cleghorn 2018).

The AIS investigations in 2011 and 2018 included a total of 22 shovel test pits and 12 backhoe trenches. Seven subsurface features and a discontinuous cultural layer were identified. Ground-penetrating radar and subsurface testing within the project area did not identify any burial sites or potential human remains. The survey recovered several artifacts, most notably a single marine shell fishhook dated to AD 1460-1650. This artifact and associated features were designated as Site 50-80-14-7211 (shown in Figure 13). This site is recommended as significant under Hawaiʻi State Criterion D, because it has the potential to yield information regarding traditional use of the area and coastal settlement in Waikīkī. No other significant cultural features were identified in the project area (Cleghorn 2018).

EVALUATION OF SIGNIFICANCE

Significance of the Waikīkī War Memorial Complex Project Area

From before European contact to the present, Waikīkī has been an important locale in Hawaiʻi. In early times, it was known as the seat of the ruling chiefs of Oʻahu (Beckwith 1970). The area was continuously well populated and intensively used over the centuries, during which the area around the WWMC has been a locus of many practices and activities. Based on archival research and community consultations in the 2012 Draft Cultural Impact Assessment (CIA) (Mooney and Cleghorn 2012), “several themes that appear to transcend time and across cultural divides have been consistently tied to this area, including: ceremony, communal gathering, subsistence collecting, recreation, and sports. These activities range in scope from large organized community events, formal spiritual/religious ceremonies, to activities practiced independently.” (Mooney and Cleghorn 2012)

Some traditional Hawaiian cultural practices in the WWMC vicinity have been ongoing for centuries in the area, such as surfing, boating, marine resource collection, and fishing. Others have been revived in the twentieth century, such as hula. Some meaningful cultural and spiritual practices at the Natatorium and in its vicinity originated in the twentieth century, such as competitive swimming and memorialization.

The War Memorial function of the Natatorium is an important aspect of its significance and its role in cultural practices in the community. As a “living memorial,” it has meaning and value in particular to national and state-level veterans’ groups, military service members, and to the descendants of the Hawaiʻi residents who served and sacrificed their lives in World War I. Many of the war dead were never returned to Hawaiʻi, and so the Memorial serves to memorialize them in lieu of graves (Radke interview in Mooney and Cleghorn 2012).

The WWMC served as a venue for swimming competitions, lessons, and a center for recreational swimming from its opening in 1927 through its closure to the public in 1979. Many of Hawaiʻi’s famous swimmers, including numerous Olympians, had connections to the Natatorium, using the facility as competitors, coaches, or students. Some include Coach Soichi Sakamoto, Keo Nakama, Halo Hirose, Bill Smith, Thelma Kalama, Evelyn Kawamoto, and Duke Kahanamoku. One annual swim competition, now known as the Keo Nakama Swimming Invitational, has been held for over 70 years and is believed to be one of the oldest invitational meets in the nation. Named in honor of an Olympian who was one of Hawaiʻi’s famed Maui Ditch swimmers (and who swam regularly in competitions at the Natatorium), it was originally held every year at the

Natatorium; the event continues at other Honolulu-area pools today (Ms. Bertha Nahoopii interview in Mooney and Cleghorn 2012; Reardon 1997; Wade n.d.).

Evaluation of significance based on Hawaiʻi significance criteria a-e (per HAR 13-275-6) is provided in the table below.

Historic property	Period of significance	Applicable criteria of significance	Integrity	Justification	Sources
Waikīkī War Memorial Natatorium (SIHP # 50-80-14-9701, NHRP #80001283)	1927	a, b, c	Retains integrity of location, association, design, and setting. Diminished integrity of materials, feeling, and workmanship due to long-term disuse and degradation of structure.	Listed in NRHP and HRHP	NRHP nomination form (Hibbard and Cummins 1979)
Kapiʻolani Park (SIHP # 50-80-14-9758)	1877-1942	a	Retains integrity for all seven aspects.	Listed in HRHP	NRHP nomination form (Abel 1992)
Archaeological site (SIHP # 50-80-14-7211)	1460-1650	d	n/a (artifact scatter)	Identified in Draft AIS	Draft AIS (Mooney and Cleghorn 2018)

EFFECT (IMPACT) DETERMINATION AND PROPOSED MITIGATION COMMITMENTS

The proposed action would have an adverse effect on the Waikīkī War Memorial Natatorium, but would be mitigated as an integral part of the project. The action proposes to rehabilitate the Natatorium in compliance with the guidance in the Secretary of Interior's *Standards for the Treatment of Historic Properties*, resulting in improved conditions that retain the property's historic integrity and reinstate its historic public use.

The proposed action does not include any excavation or alteration of the land areas that lie within Kapi'olani Park. Because there is no planned ground disturbance, archaeological resources would not be affected. Therefore, there are no adverse effects to the park or archaeological site.

Historic Property	Project Effect	Proposed Mitigation
Waikīkī War Memorial Natatorium (SIHP # 80-14-9701, NHRP #80001283)	The project would modify the WWMC through repairs, replacement of dilapidated areas (such as the deck and swim basin), removal of structurally unstable seawalls; and construction of new deck and swim basin.	Project will be designed and implemented per the guidance provided in the U.S. Secretary of Interior's *Standards for the Treatment of Historic Properties*: *Rehabilitation*. See section that follows for more detailed description of how this is proposed to be accomplished.
Kapi'olani Park (SIHP # 80-14-9758)	No effect	Protect during construction.
Archaeological site (SIHP # 50-80-14-7211)	No effect	Protect during construction.

The action proposes to rehabilitate the Natatorium in compliance with the guidance in the Secretary of Interior's *Standards for the Treatment of Historic Properties*, resulting in improved conditions that retain the property's historic integrity. Rehabilitation is defined in the *Standards* as "the process of returning a property to a state of utility, through repair or alteration, which makes possible an efficient contemporary use while preserving those portions and features of the property which are significant to its historic, architectural, and cultural values." The *Standards* apply to all historic buildings, exterior and interior, as well as related landscape features, site, and environment, and related new construction. The *Standards* are intended to be applied to rehabilitation projects in a reasonable manner, taking into consideration economic and technical feasibility.

The Secretary's *Standards for Rehabilitation* (codified in 36 CFR 67) are as follows:

1. A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.
2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.
3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.
4. Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.
5. Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a historic property shall be preserved.
6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.
7. Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.
8. Significant archeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.
9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.
10. New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Additionally:

- The project will utilize the related *Guidelines for Rehabilitating Historic Buildings* (the most up to date version, available at https://www.nps.gov/tps/standards/rehabilitation/rehab/guide.htm).
- A licensed architect meeting the Secretary of Interior's Historic Preservation Professional Qualification Standards for Historic Architect, per 36 CFR Part 61, as amended, will be included in the design team (the standards are available online at https://www.nps.gov/history/local-law/gis/html/table_of_contents.html).

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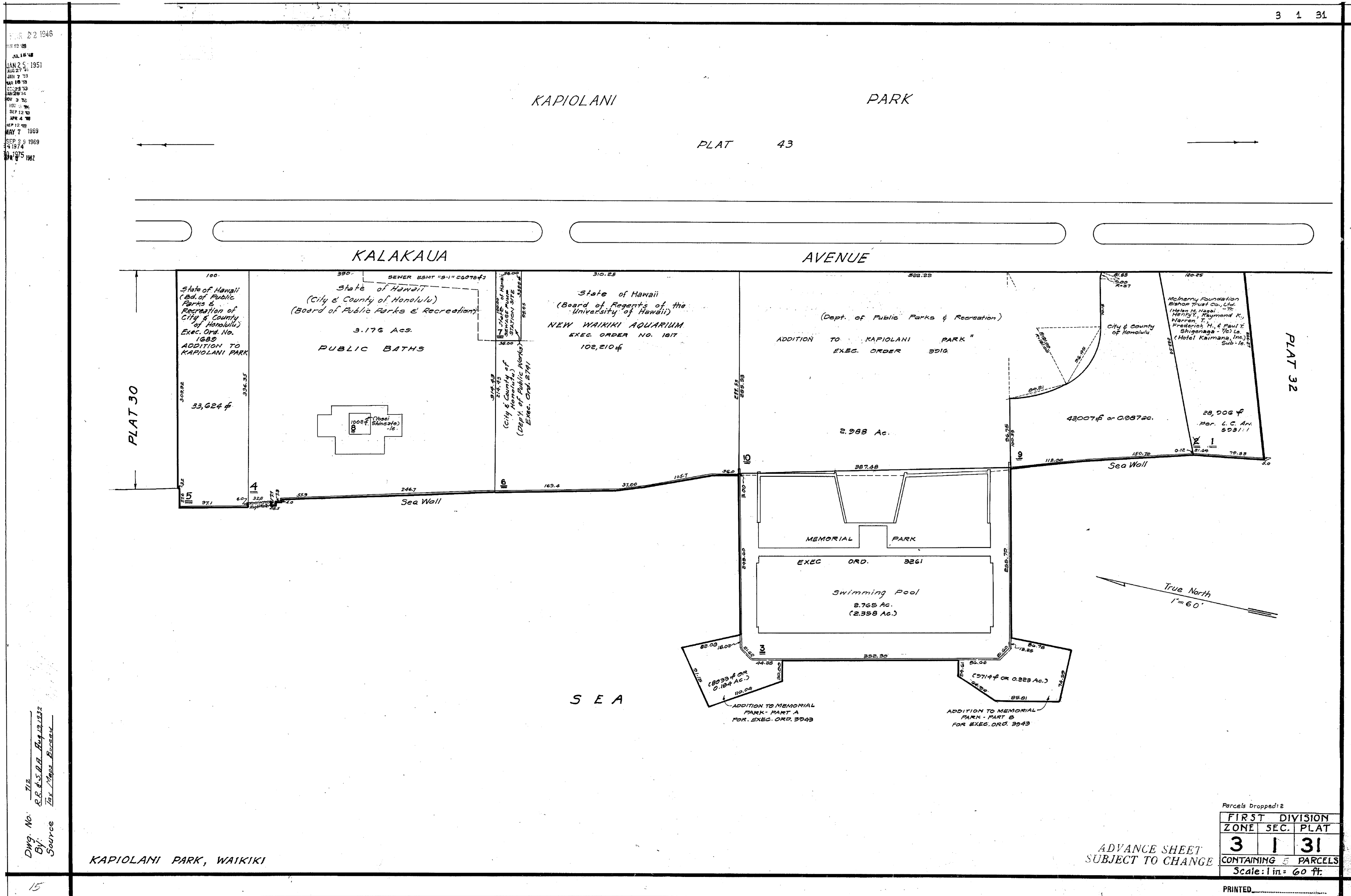
Enclosure B



3 1 31
KAPIOLANI PARK
PLAT 43
KALAKAUA AVENUE
PLAT 30
PLAT 32
State of Hawaii (Bd. of Public Parks & Recreation of City & County of Honolulu) Exec. Ord. No. 1689 ADDITION TO KAPIOLANI PARK
33,624 ♯
State of Hawaii (City & County of Honolulu) (Board of Public Parks & Recreation)
3.176 Acs.
PUBLIC BATHS
SEWER ESMT
(City & County of Honolulu) (Dep't. of Public Works) Exec. Ord. 2741
State of Hawaii (Board of Regents of the University of Hawaii)
NEW WAIKIKI AQUARIUM
EXEC. ORDER NO. 1817
102,210 ♯
(Dept. of Public Parks & Recreation)
ADDITION TO KAPIOLANI PARK
EXEC. ORDER 3916
2.988 Ac.
City & County of Honolulu
43007♯ or 0.987 ac.
McInerny Foundation
Bishop Trust Co., Ltd.
28,906 ♯
Por. L. C. Aw. 5931:1
Sea Wall
MEMORIAL PARK
EXEC ORD. 3261
Swimming Pool
2.765 Ac.
(2.398 Ac.)
ADDITION TO MEMORIAL PARK - PART A
POR. EXEC. ORD. 3943
ADDITION TO MEMORIAL PARK - PART B
FOR EXEC. ORD. 3943
SEA
True North
1" = 60'
Dwg. No. 712
By: R.R. & S.A.A. Aug. 19, 1932
Source Tax Maps Bureau
KAPIOLANI PARK, WAIKIKI
ADVANCE SHEET SUBJECT TO CHANGE
Parcels Dropped: 2
FIRST DIVISION
ZONE 3
SEC. 1
PLAT 31
CONTAINING 5 PARCELS
Scale: 1 in. = 60 ft.
PRINTED

Enclosure C

PROJECT AREA HRS CHAPTER 6E

Waikiki War Memorial Complex EIS

Source: Aerial Imagery - Google Earth, January 2013

Enclosure D

AECOM
Design + Planning
1001 Bishop St Ste 1600
Honolulu, HI 96813
www.aecom.com

808 529 7290 tel
808 529 7289 fax

Meeting Minutes

Technical Workshop Meeting
Waikiki War Memorial Natatorium HRS Chapter 6E Consultation

Thursday, July 20, 2017 from 2:00 PM to 4:30 PM
Frank F. Fasi Municipal Building, 620 South King Street, 11th Floor Large Conference Room

I. INTRODUCTIONS

A. Attendees

1. Maurice “Mo” Radke, President, Friends of the Natatorium
2. Donna L. Ching, Vice-President, Friends of the Natatorium
3. Kiersten Faulkner, Executive Director, Historic Hawaii Foundation
4. Scott Wilson, Honolulu Chapter, American Institute of Architects (AIA)
5. Brian Turner, Senior Field Officer, San Francisco Field Office, National Trust for Historic Preservation
6. Jessica Puff, Architectural Historian, State Historic Preservation Division, Department of Land and Natural Resources
7. Clifford Lau, Lansing Sugita, Department of Design and Construction (DDC)
8. Kevin Butterbaugh, Lesley Matsumoto, Jeff Merz, Adriane Truluck, Mark Hofferbert, AECOM

B. Project Update and Meeting Purpose (Clifford Lau)

1. Lansing is the City’s project manager
2. There has been a change in the consultant team performing the work from WCP to AECOM
3. Based on the past HRS Chapter 6E meetings and other comments received as part of the 6E consultation, there was a general consensus that the City’s range of alternatives presented in the Environmental Impact Statement Preparation Notice (EISPN) were not entirely acceptable.
4. Today, the City is presenting a new preservation concept for discussion and potential inclusion of it as an alternative going forward.

II. PRESERVATION GOALS (Adriane)

A. Meeting Goal

1. To develop an alternative that is acceptable to the historic preservation stakeholders and meets the other challenges (such as regulatory and feasibility hurdles)
2. Seek input on what could be referred to as the proposed alternative

B. Understanding of Terms & Ground Rules

1. Preservation v. rehabilitation. The concept is currently described as “preservation” alternative, but technically it is “rehabilitation.” Working title; what should it be called?
2. Comments will be recorded.
3. Flipchart will be used for “parking lot” for issues, questions, and actions.
4. Large scale maps and flipchart will be used to take comments and notes.

C. Exercise

1. Participants were asked to identify the following on sticky notes:
   a) 3 highest priorities
   b) 1 top concern
2. Kevin collected and summarized the participant notes
3. Findings from Exercise (Kevin)
   Priorities: public use, historic integration of structures, historic uses of structures/site (swimming), viable engineering solution.
   Concerns: neglect and deferred maintenance, fairness by City (i.e., give preservation a “fair shake”)
   Discussion
   a) Donna stated concerns with waves in the swim basin and the desire to have a calm swim basin.
   b) Other concerns included site interpretation, transparency and fairness from the city with its approach to this project.

D. Preservation Terms

1. Adriane reviewed the preservation terms – guidelines and standards – and the Natatorium’s character defining features. She noted that the concept alternative is an example of the working preservation term of “Rehabilitation”. See meeting handout side 1 for contents of review.

a) The Waikiki War Memorial Natatorium's National Register nomination form was written in the 1980s so is somewhat dated; e.g., it does not address some aspects of significance outside of architectural such as social history, significance to swimming community.

b) Kiersten pointed out the WWII training use and that there is a movement to recognize historically significant uses, not just architectural style.

c) Jessica recognized that historically significant uses may be hard to identify in terms of character-defining features - they are still largely architectural, when it comes to rehabilitation or preservation of the structure.

d) Lansing asked about other historical functions/uses of the Natatorium. Donna added that there were many, including the 1946 Inaugural Keaokana Invitational, training for six national championships teams, and Amateur Athletic Union (AAU), Department of Education keiki swim lessons, and practice for the University of Hawaii swim team (this was back in the 1950s).

e) People may be associated with specific features, including war veterans. The functionality of a living memorial, swimming facility, and use by veterans was emphasized. It was noted that the Memorial is very much a product of its time, during the post-WWI era. During this time, memorials were changing from the traditional "hero on a horse" statue to functional structures. The Natatorium was about commemorating the veterans with a living memorial.

E. Rehabilitation Examples (Brian)

1. Brian presented examples of other completed historic rehabilitation projects at similar historic public pool facilities that the National Trust has been involved with in the past. Handouts were provided. All projects are award-winning and located in California.

a) Annenberg Beach House – funding was a concern after damage from an earthquake. Project received a $27M gift from Annenberg Foundation.

b) Roman Plunge in Monterey -part of Del Monte complex, same architect as Honolulu Natatorium - Louis Hobart. Universal accessibility and asbestos were issues in the renovation.

c) Richmond Pool and Bathhouse – renovation came to $250 per square foot. $8.5M effort – deck was expanded. Seismic retrofit. Solar installed.

III. REQUIREMENTS (Lesley)

A. Requirements were presenting to underscore that to move forward, the successful alternative would be designed to avoid requirements that involve discretionary approval. For those that we can't avoid, minimize their involvement by minimizing impacts.

B. In the case of historic preservation, the National Historic Preservation Act (NHPA) Section 106 consultation process cannot be initiated until the lead federal agency, anticipated to be the U.S. Army Corps of Engineers, becomes involved. Therefore, the Section 106 process cannot occur until the permitting phase. To the extent possible, the City is seeking NHPA Section 106/HRS 6E consulting parties' input now to avoid new developments late in the project. USACE has been consistent in its involvement and messaging in projects. For the Natatorium project, it recently stated that the USACE is a permitting agency, not a planning agency.

C. DOH pool regulations require agency opinions and determinations. Moreover, the monitoring requirements provide a high bar for demonstrating compliance. To avoid that process and forward movement, a design that avoids the DOH pool rules will increase the likelihood of moving forward.

D. The 8 September 2000 Stipulated Judgement also presents a high bar to overcome for the City's previous 1995 design.

E. Environmental requirements are numerous, especially with in-water work. Lesley explained that impacts on coral can result in consultation with many agencies, requests for additional studies, e.g., for coral transplantation location, which all increase costs and lengthen schedule.

F. Being able to design the location of piles to avoid negatively impacting the marine environment would minimize the potential for further delays in the permitting stage. The Magnuson-Stevens Act and specifically the Essential Fish Habitat consultation process will require an assessment of impacts to corals. If there are impacts, offsets would need to be identified and could involve the transplanting of coral and studies at the proposed transplantation location. In the case of ESA Section 7, construction materials and methods matter as NOAA will require quantitative analysis of the potential impacts of underwater noise on protect marine species such as the monk seal at neighboring Kaimana Beach.

G. Impacts to the marine substrate were discussed. It was agreed that it would make sense to pursue a preservation alternative designed to take the permitting path of least resistance.

H. Donna noted that while the City maintains the structure, the State owns the submerged lands under the site, which will add another layer of review. Donna discussed the previous EIS and the issues associated with DLNR's concerns over impacts to the coastal areas and the issuance of the SMA permit as construction outside the existing Natatorium footprint proved controversial. Donna cautioned that DLNR only allowed new construction in the Marine Conservation District because it was to preserve an existing structure.

IV. PRESERVATION ALTERNATIVE CONCEPT

A. Mark provided an overview of the preservation alternative, referring to figures on meeting handout side 2, including:

1. Reconstruction of the deck would keep the visible and useable form of the Natatorium structure, but without being a full pool. This was an idea that came up in comments during the 6E meetings in 2016 and reflects those comments. Additionally, it is not a completely new concept as it is similar to an idea previously identified by Sea Engineering Inc.
2. The design falls outside the DOH pool rules so is not considered a “pool”.
3. Retention of the Ewa groin would likely lead to deposition of sand in that corner of the basin.
4. The safety grates (a new concept) would be designed to prevent swimmers from accessing the pool from under the pier

supported piles. The grating would have a four-inch gap between bars and could be aesthetically designed to minimize any visual impacts.

B. Discussion:

1. Donna noted that rough seas takes away from the use of the pool for swimming.
2. Clifford mentioned that, in the past, structural fiberglass without cross-bars were considered for the grate. Also, the gaps were less than 4 inches.
3. Donna expressed concerned about the silt bottom and that the previous plan proposed engineered silica sand, which is heavier than beach sand and would likely stay in place better.
4. Kiersten would like to see a prioritization of preservation values in the analysis of the alternatives. She expressed concern that this had not been addressed in the City's 6E efforts to date. She noted priorities for historic preservation are to retain what is visible above the waterline; functional and "hidden" structures are not the priority, if they need to be modified to support continuing or returning to function. The bottom of the basin is not a concern from historical perspective.
5. Kiersten offered that the safety requirements need to be identified and weighed against good aesthetics. She shared that if is something is essentially functional and not visible, "whatever works," and the grates would likely fall under such a category. Mark noted that the grates might be slightly visible from the Ewa side. The group consensus was that in the case of a safety related functional feature, strive to make it unobtrusive.
6. Jessica clarified that retaining the structure could mean some changes to make it stronger or more resilient, which would be considered positive, as those would extend the existence of the historic property and support its use and longevity. For example, if the deck was reconstructed slightly elevated from the current one's position to accommodate sea level rise.
7. Pile placement
   a) Mark noted that the current pilings are 12 feet on center. The existing groins are not particularly stable and they

are sinking as they were never imbedded down to solid ocean floor bed.

b) New piles would have to go through the existing groin (Diamond Head side). Mark will try to minimize the number of pilings as the design is refined.

c) Clifford offered that the concrete pilings will not rust like steel, the existing piles below the water line are in satisfactory condition, and the portion of the old pilings below the mud line are wood (redwood). He also stated that structural engineers do not want to consider re-using existing piles because they cannot be load-tested. He also mentioned that a pre-cast block system was considered in the past.

d) Clifford suggested looking at the original construction plan.

e) Group consensus: there is flexibility as to how the structural piles are designed (to avoid impacting marine environment).

8. Wave energy

a) If possible, find a way to engineer the swim basin to calm refractive waves, which make swimming difficult.

b) Donna emphasized reviewing the previous USACE study, showing the groin configurations and various wave analyses, and sand accumulation.

c) Perhaps the reconstructed seawall proposed under the bleachers be designed to be a wave dissipater/splash absorbing feature.

V. CLOSING THOUGHTS

A. Scott Wilson—Encouraged. Architecturally, this works as far as AIA is concerned. Pleasantly surprised by the new alternative and gave the design his blessing. He has concerns related to the pool basin filling up with sand and the water remaining clean. He looks forward to seeing details when further developed.

B. Jessica Puff (observer from SHPD)—SHPD is against re-interpretation of the arch (e.g. the beach alternative). She noted that at a the SHPD meeting between DDC, SHPD and AECOM on 16 June 2017, everyone agreed that SHPD sees this preservation alternative concept as going in the right direction. She looks forward to seeing details when developed further.

C. Mo Radke—Will need to discuss the preservation alternative with the Friends of Natatorium's Board. Envisions a disabled vet getting off the bus, wheeling him/herself to the Natatorium, and entering the pool – ideal scenario.

D. Brian Turner—He is concerned that the city's preferred alternative is still demolition of the Natatorium. He likes that the communication is open and appreciates this meeting taking place. This proposed alternative is different from the Krock Pool, but NTHP could support it as it achieves the primary goals. He would like to see it developed to consider resiliency and climate change. Recommends that the group strive for one solution supported by the historical stakeholders. Appreciates range of perspectives offered. Showing functionality is good. Deferred maintenance has gone on too long.

E. Kiersten to Brian – How does this fit with the National Trust's alternative?
Brian indicated that the wave modeling they are working on currently could potentially be applied to the new alternative, if the City is interested, and noted that the Trust has enlisted UH to do the modeling. Brian Turner noted that the Krock pool design was intended to start a dialogue and it is preferable to the NTHP that the City not adopt the Krock pool design as is, but develop its own preservation-driven alternative.

F. Regarding sea level rise, Mark asked about raising the deck one foot. Jessica Puff suggested a design to "shed water," which is in line with allowing the resource to continue and are allowable modifications. Kiersten noted NPS is headed in this direction, and that adaptions and alterations to make the design more resilient should be supported. The deck can be raised and other technically appropriate modern solutions should be considered. Scott cautioned that where the 12" rise occurs can be a concern; suggesting that it be incorporated on the 3 sides.

G. Mo to Mark – What is the status of the modeling that is currently being done? Mark believes that there is enough information from Sea Engineering, but that more modeling would be needed for future design.

H. Adrian to Brian – Where are you in your design? Brian wanted to know how they can help. Mark indicated that, potentially, with UH modeling.

I. Kiersten—Previous alternatives were inadequate in the EISPN. This is step in the right direction; very promising. Addresses preservation concerns; however, needs to be developed further to address functionality (support swimming use).

J. Donna asked about the timeframe. Clifford Lau stated that an exact schedule has not been determined.

   1. Donna noted that there are important considerations per scheduling. WW I memorial commemorations and celebrations are occurring next year and there is a term limited mayor who would politically like to see some progress on this site prior to the end of his term. There is a huge opportunity and incentive, as well as existing momentum for a preservation alternative. Many individuals and groups are prepared to fundraise and financially support a plan to rejuvenate the Natatorium, should the City decide to rehabilitate the property. And “no one is going to donate for the demolition of a war memorial.”
   2. Donna continued that her general concern is that this alternative does not bring forward the legacy of the swim history, due to potentially choppy wave action in the swim basin by opening the makai and Ewa walls. If the wave action can be addressed, Donna will support this option.
   3. Donna suggested that application be made to DOH for permits, immediately. She recommended that we apply for multiple permits (for various alternatives) to get a read from DOH. Lesley offered that obtaining an opinion or determination from DOH would likely result in delay.

K. Donna supports this alternative in the EIS. She asked about what degree of the walls/length of the walls triggers the DOH pool definition. She suggested this be discussed and confirmed with a meeting with DOH.

L. A question was asked if an economic feasibility is a factor in determining preferred alternative (proposed action). The City responded that it will, and information will be made part of the EIS process. Additionally, any ideas for use of PPV and non-City fundraising need to be substantiated and provided for them to be considered in the EIS.

M. Brian noted a concern that if the grate is designed in a way that causes an issue with DOH regarding enclosure of the space, it may impede progress for this alternative. Mark noted that the grate can be designed in a variety of ways and could likely be worked around that issue.

N. Scott Wilson talked about the value of the promenade and the benefit it brings.

O. Adriane acknowledged that the landside plan is not being addressed currently, primarily because no significant changes are proposed in this alternative concept.

P. Clifford shared that the architect envisioned use of the Hau Arbor and main arch for access to the Natatorium, not the Aquarium side entrance to the deck.

Q. Mark asked participants to think about what depth the pool basin should be and what is to be done with the muck currently on the bottom. Minimizing disturbance to the basin bottom is preferred. The basin is currently 8 feet at the shallowest end and 15 feet at the deepest end. Discussion and flow of ideas followed and included:

1. Disturbance during construction/reconfiguration of the groins will result in turbidity levels being elevated and this will be a concern to DOH.
2. Donna advised against dredging and suggested the depth should be approximately 6 feet.
3. Kiersten indicated a preference for a shallow side for entering and a gentle slope for handicapped and children. Removeable features can be used for ADA.
4. A non-permanent or removable solution for access would be ideal from a preservation perspective, such as floating platforms with simple tie-downs along the deck. This would have to be developed further but the group agreed that such a concept may be considered as an option in the future.

R. Brian asked what it will take for the City to change its existing preferred alternative from the beach alternative to the preservation alternative. Lansing indicated that community interests and costs would help drive that decision.

VI. NEXT STEPS

A. A follow-up update meeting was proposed in about 2 weeks. Adriane asked if a Webex would work for the group and they concurred.

B. The goal is to conclude development of the preservation alternative in August to enable the EIS to move forward.

C. Everyone agreed on the need for timely completion and to move this alternative forward into the EIS.

Enclosure E

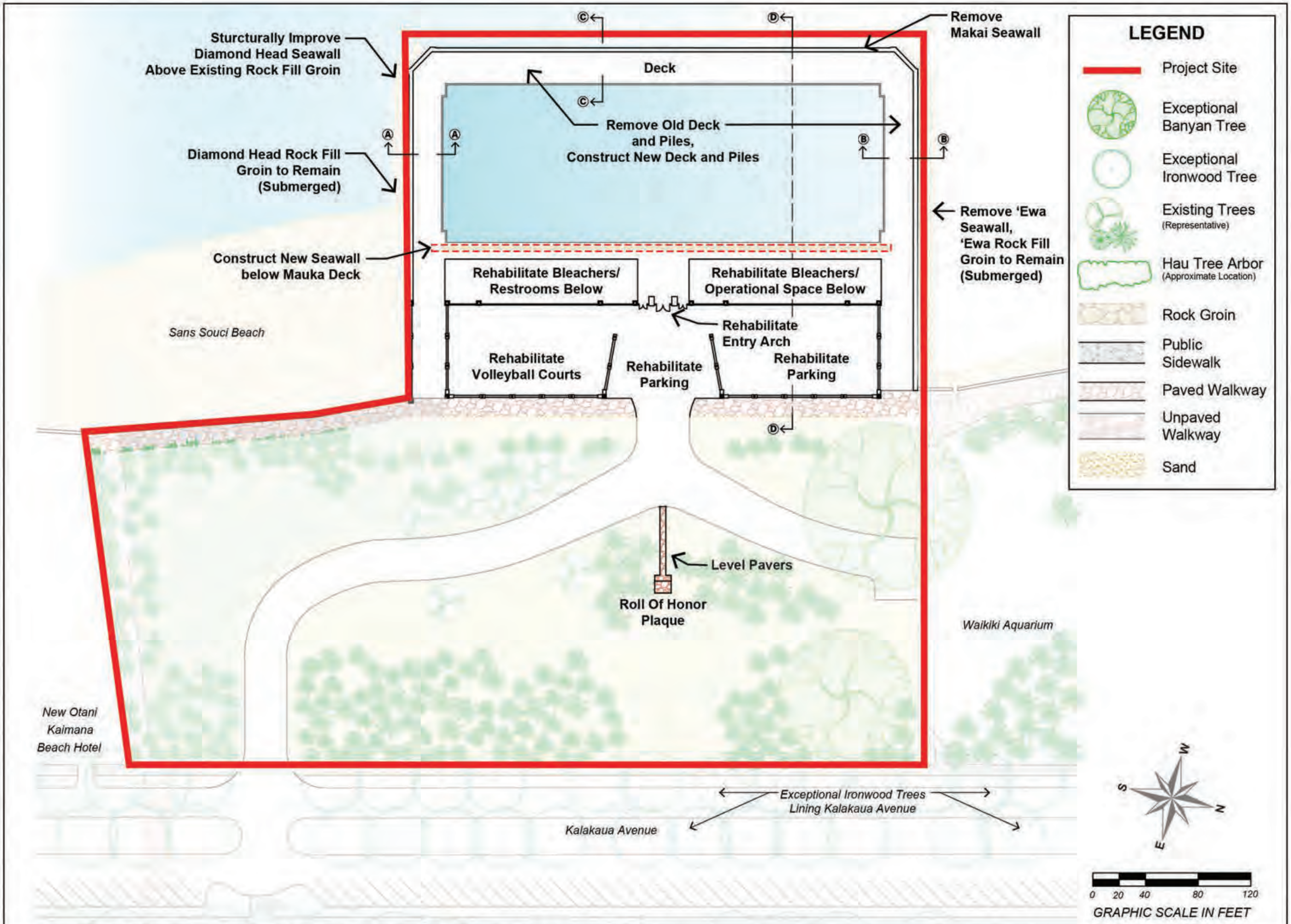


FIGURE 3.2-1: PERIMETER DECK – PROPOSED CHANGES (PLAN VIEW)

Waikiki War Memorial Complex EIS

Source: AECOM, August 2018
WCP, June 2014 (base)

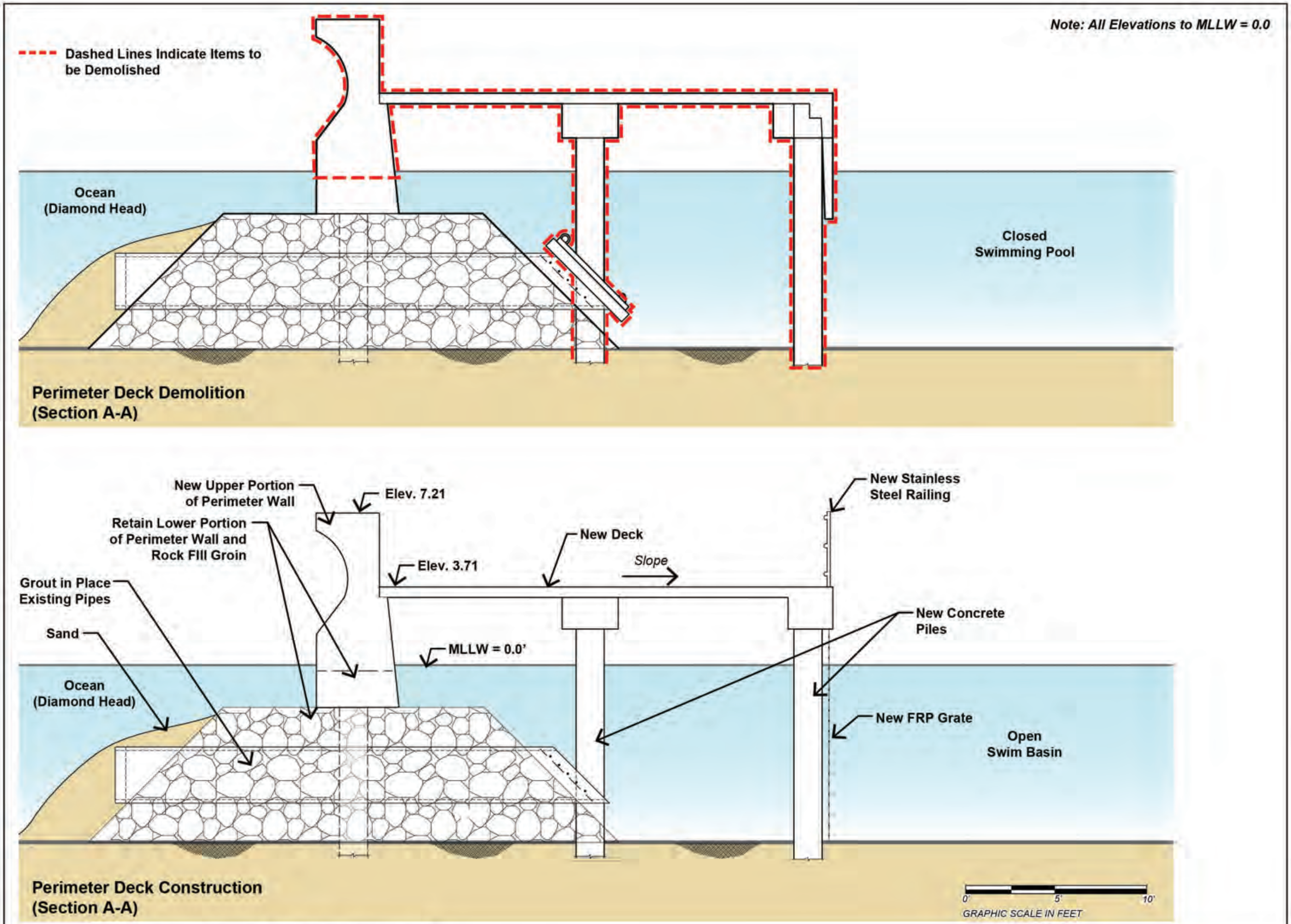


FIGURE 3.2-2: PERIMETER DECK SECTION A-A

Waikiki War Memorial Complex EIS

Source: AECOM, August 2018

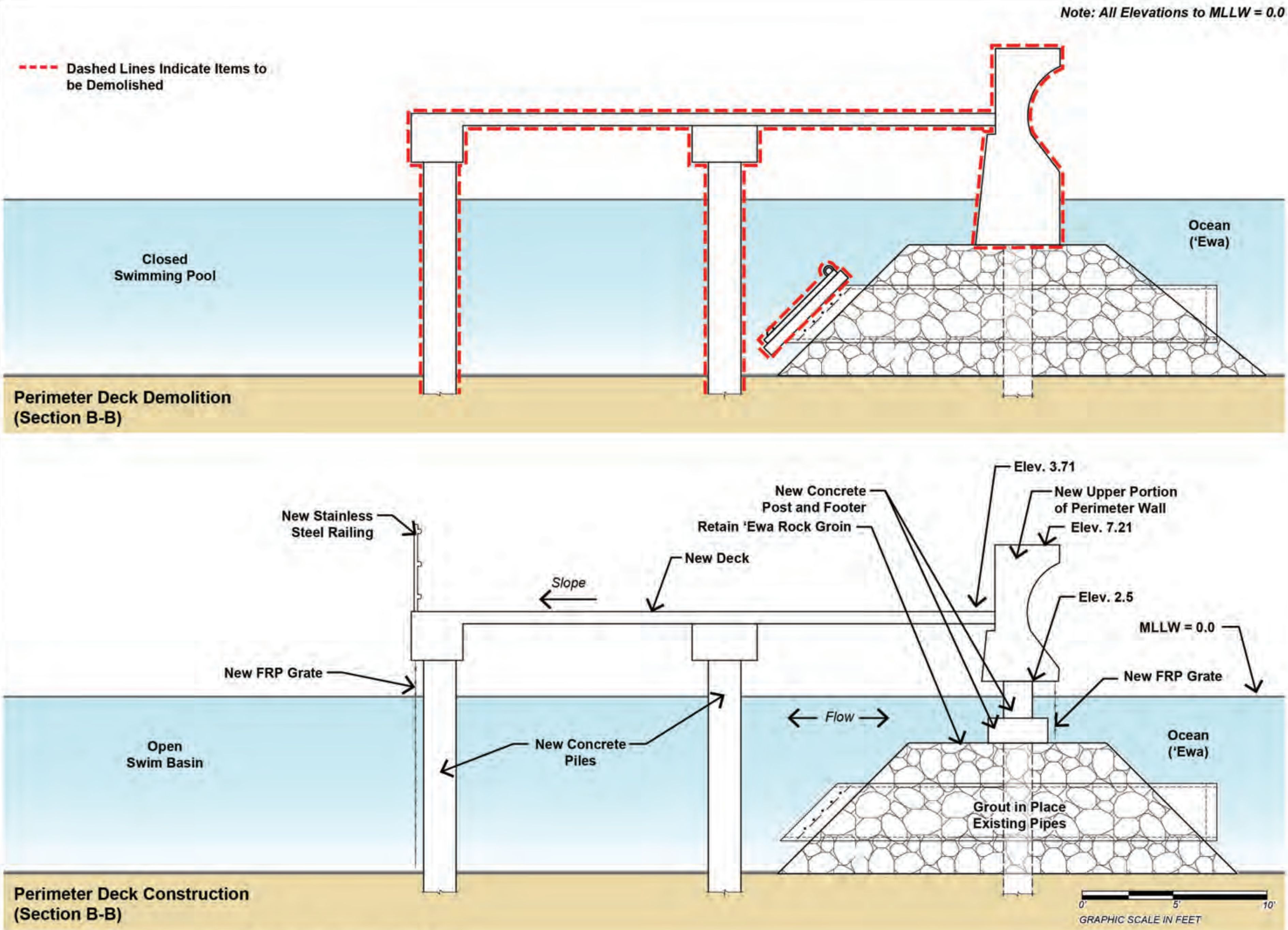


FIGURE 3.2-3: PERIMETER DECK SECTION B-B

Waikiki War Memorial Complex EIS

Source: AECOM, August 2018

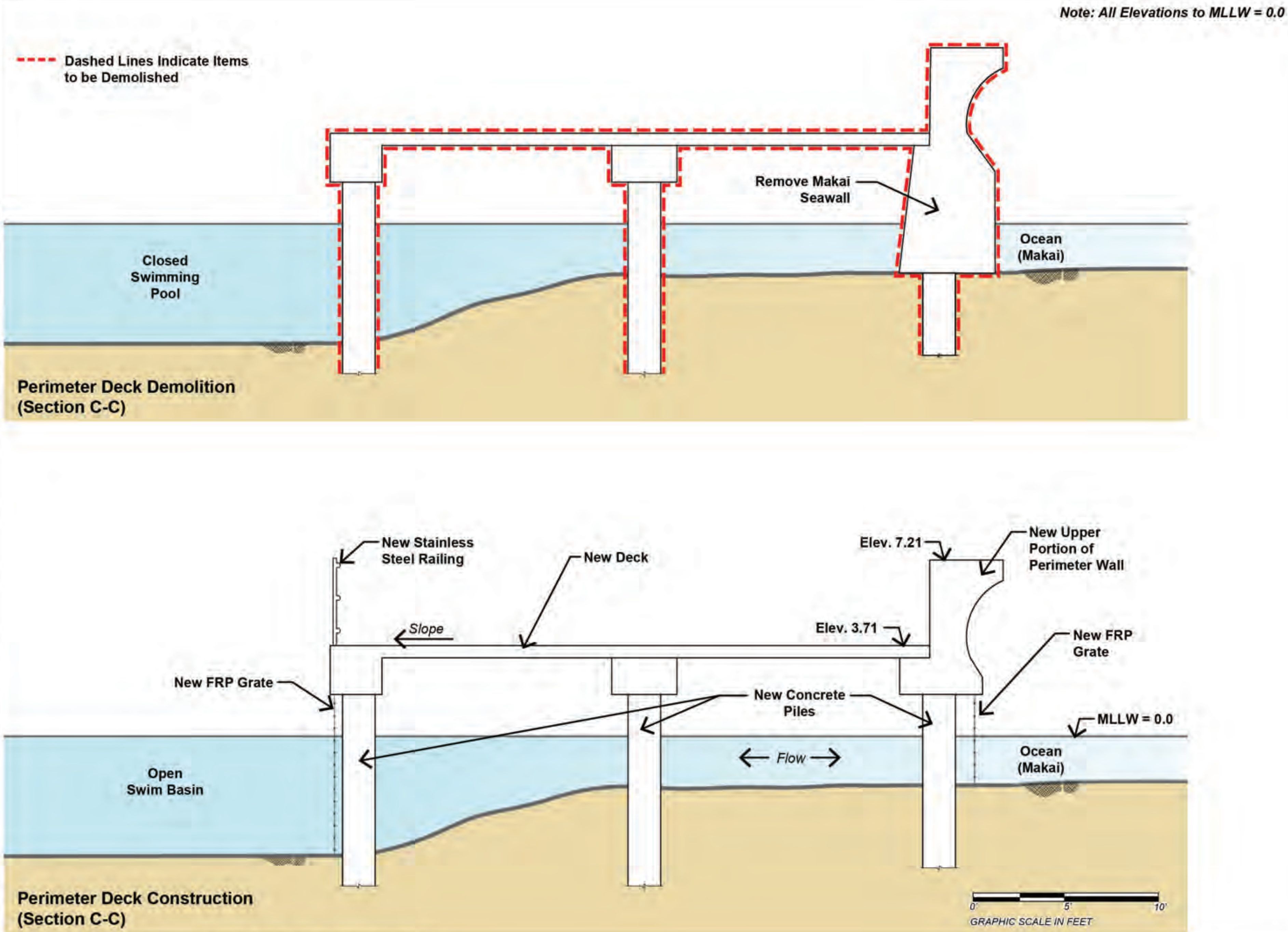


FIGURE 3.2-4: PERIMETER DECK SECTION C-C

Waikiki War Memorial Complex EIS

Source: AECOM, August 2018

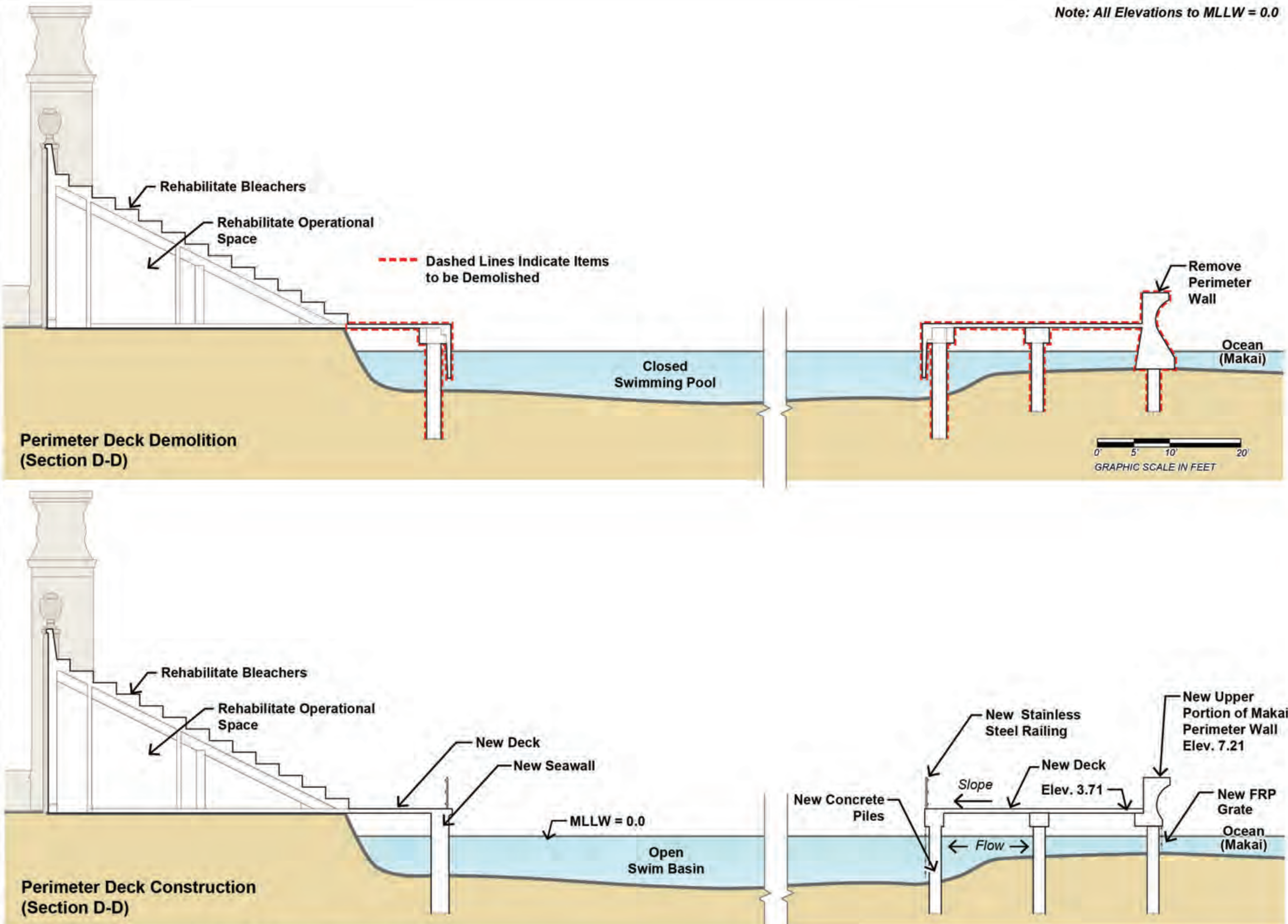


FIGURE 3.2-5: PERIMETER DECK SECTION D-D

Waikiki War Memorial Complex EIS

Source: AECOM, August 2018

Enclosure F

FIGURE 2.2-1: EXISTING CONDITIONS SHOWING DETERIORATED CONDITIONS

Source: Aerial Imagery - Google Earth, January 2013

Waikiki War Memorial Complex EIS

Site Photos Key - Page 1 of 3

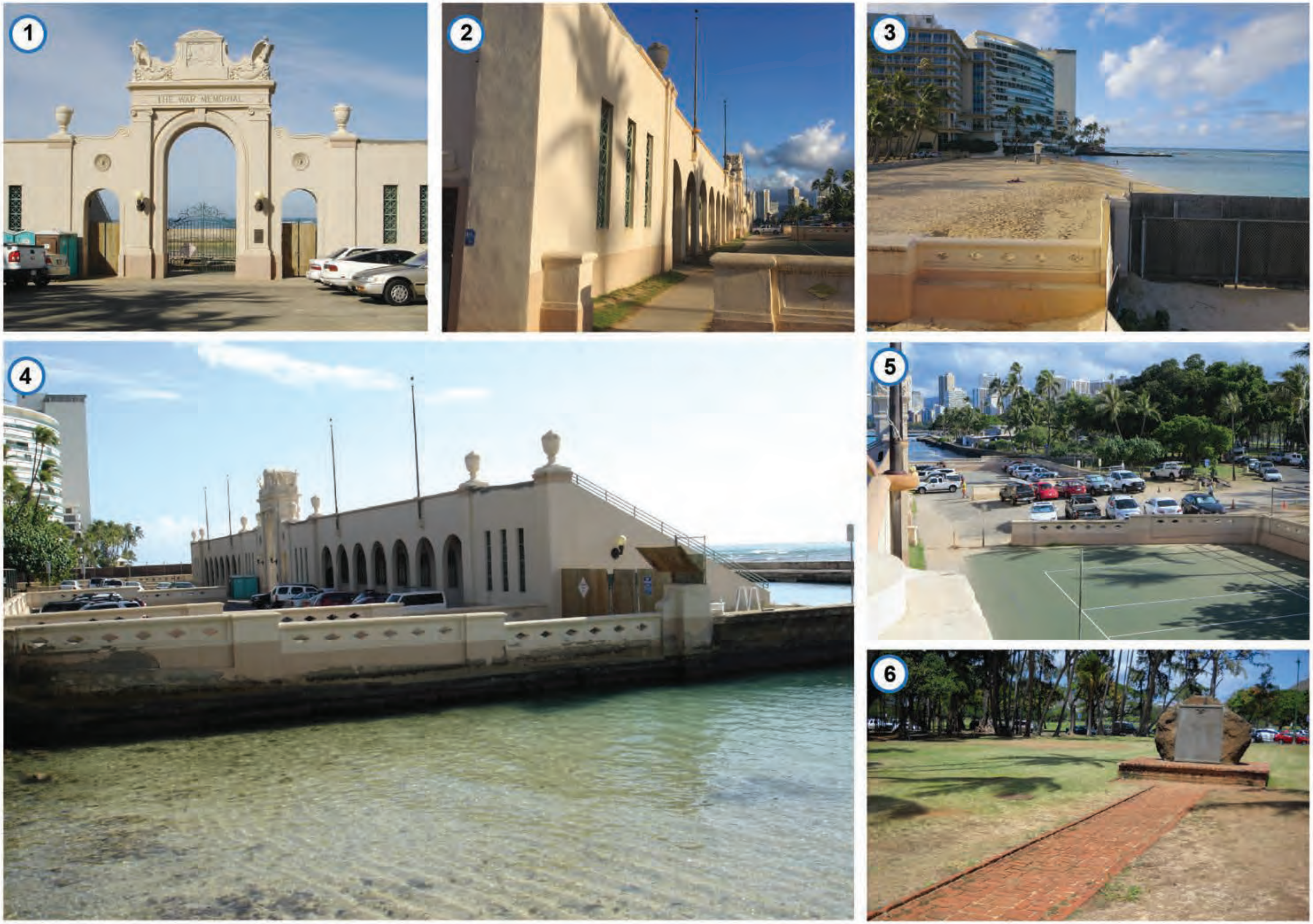


FIGURE 2.2-1: EXISTING CONDITIONS SHOWING DETERIORATED CONDITIONS

FIGURE 2.2-1: EXISTING CONDITIONS SHOWING DETERIORATED CONDITIONS

Enclosure G

Pacific Legacy

Historic Preservation

Cultural Resources Consultants

Hawai‘i Offices:
Kailua, O‘ahu
Hilo, Hawai‘i

California Offices:
Arnold
Berkeley
El Dorado Hills
Lancaster

DRAFT

ARCHAEOLOGICAL INVENTORY SURVEY AT THE WAIKĪKĪ WAR MEMORIAL COMPLEX, AHUPUA‘A OF WAIKĪKĪ, KONA DISTRICT, ISLAND OF O‘AHU, HAWAI‘I

[TMK (1) 3-1-031]

Pacific Legacy: Exploring the past, informing the present, enriching the future.

DRAFT

ARCHAEOLOGICAL INVENTORY SURVEY AT THE WAIKĪKĪ WAR MEMORIAL COMPLEX, AHUPUA‘A OF WAIKĪKĪ, KONA DISTRICT, ISLAND OF O‘AHU, HAWAI‘I

[TMK (1) 3-1-031]

Prepared by:
James McIntosh, B.A.
and
Paul L. Cleghorn, Ph.D.

Pacific Legacy, Inc.
30 Aulike Street, Suite 301
Kailua, HI 96734
(808) 263-4800

Prepared for:
WCP, Inc.
99-061 Koaha Way,
Aiea, HI 96701

March 2019

ABSTRACT

Pacific Legacy Inc., under contract to WCP Inc., conducted an archaeological inventory survey at the Waikīkī War Memorial Complex in the *ahupua*ʻ*a* of Waikīkī, island of Oʻahu, Hawaiʻi [TMK (1) 3-1-031]. Specifically, the project area is situated within Kapiʻolani Beach Park, in the area of Sans Souci Beach. The archaeological investigations were conducted as part of an Environmental Impact Statement for the Waikīkī War Memorial Complex.

During the course of the project two different archaeological testing episodes were conducted: first in 2011 and again in 2018. The second episode was the result of changes to the Project Area boundary and consultations with the State Historic Preservation Division.

In all, 22 shovel test pits and 12 backhoe trenches were excavated during the course of the project. Seven subsurface features were identified within the trenches and a discontinuous cultural layer was also identified. Several traditional artifacts were recovered along with historic vestiges documented throughout the project area. A single marine shell fishhook was identified in Shovel Test Pit 5 (60 cmbs) and an associated charcoal sample returned a date of AD 1460 to 1650. This layer and associated features have been designated as Site 50-80-14-7211.

Further testing was conducted in 2018 to further clarify the boundaries of Site 7211. During this episode, a coral abrader was recovered within STP 15 along with marine shell midden (50 cmbs). This deposit is attributed to the same cultural deposit identified in 2011. This layer and associated features have been designated as Site 50-80-14-7211. No human remains were observed during the subsurface testing.

It is recommended that preservation be undertaken for Site 50-80-14-7211, a significant cultural deposit within the Project Area. In addition, archaeological monitoring is recommended for any excavations within this portion of Kapiʻolani Park deeper than 50 cm below surface.

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Cover: The arch of the War Memorial Waikīkī (2011).

1.0 INTRODUCTION

Pacific Legacy Inc., under contract to WCP, Inc., conducted an archaeological inventory survey (AIS) at the Waikīkī War Memorial Complex (WWMC) in the *ahupua'a* of Waikīkī, island of O'ahu, Hawai'i. (TMK: (1) 3-1-31). Specifically, the project area is situated within Kapi'olani Beach Park, in the area located *makai* of Kalākaua Avenue often referred to as Sans Souci Beach (Figure 1). The archaeological investigations were conducted as part of an Environmental Impact Statement (EIS) (in prep.) for the WWMC. The boundary of the Project Area is shown in Figure 2.

1.1 BACKGROUND

Officially opened on 24 August 1927, the Waikīkī War Memorial Natatorium was constructed as "a memorial dedicated to the men and women of Hawai'i who served in World War I" (NRHP Nomination Form 1980) (Appendix A). The open air salt-water swimming pool measures 100 meters in length and is fed directly from the ocean. A series of concrete bleachers overlook the pool and could seat ca. 2,500 spectators. The main entry into the Natatorium is via a large triumphal arch inscribed with the words "The War Memorial" (see cover). Constructed at a cost of $250,000.00 maintenance was a constant problem at the structure, which has undergone several facelifts over the years. Many of the main decks around the pool have collapsed and have become a danger to the general public. The Natatorium was last opened to the public in 1978 and has been locked and boarded up since, because of its deteriorating condition and danger to the public.

Today, the "War Memorial Natatorium" is on the State of Hawai'i as site 50-80-14-9701 and the National Register of Historic Places (NRIS No. 80001283).

1.2 PROJECT HISTORY

In 2009, the City and County of Honolulu looked into proposed changes for the WWMC. During the process, it was determined that the preferred course of action was to:

> *create a war memorial beach between constructed groins, fronted by a replica memorial arch in alignment with the existing Roll of Honor plaque and hau tree arbor. The entire Natatorium structure – everything built seaward of the 1927 shoreline – would be removed. This alternative – removal of the Natatorium and creation of a new beach – was the recommendation made to the City and County of Honolulu by the Task Force in September 2009.*

In support of this proposed action, Pacific Legacy, Inc. conducted archaeological testing in the proposed Project Area for this alternative (the current Alternative 2: War Memorial Beach alternative). Archaeological subsurface testing was conducted on two different occasions. Initial testing was conducted between August 29 and September 2, 2011, 10 shovel test pits (STPs) and 12 backhoe trenches were excavated within the then Project Area.

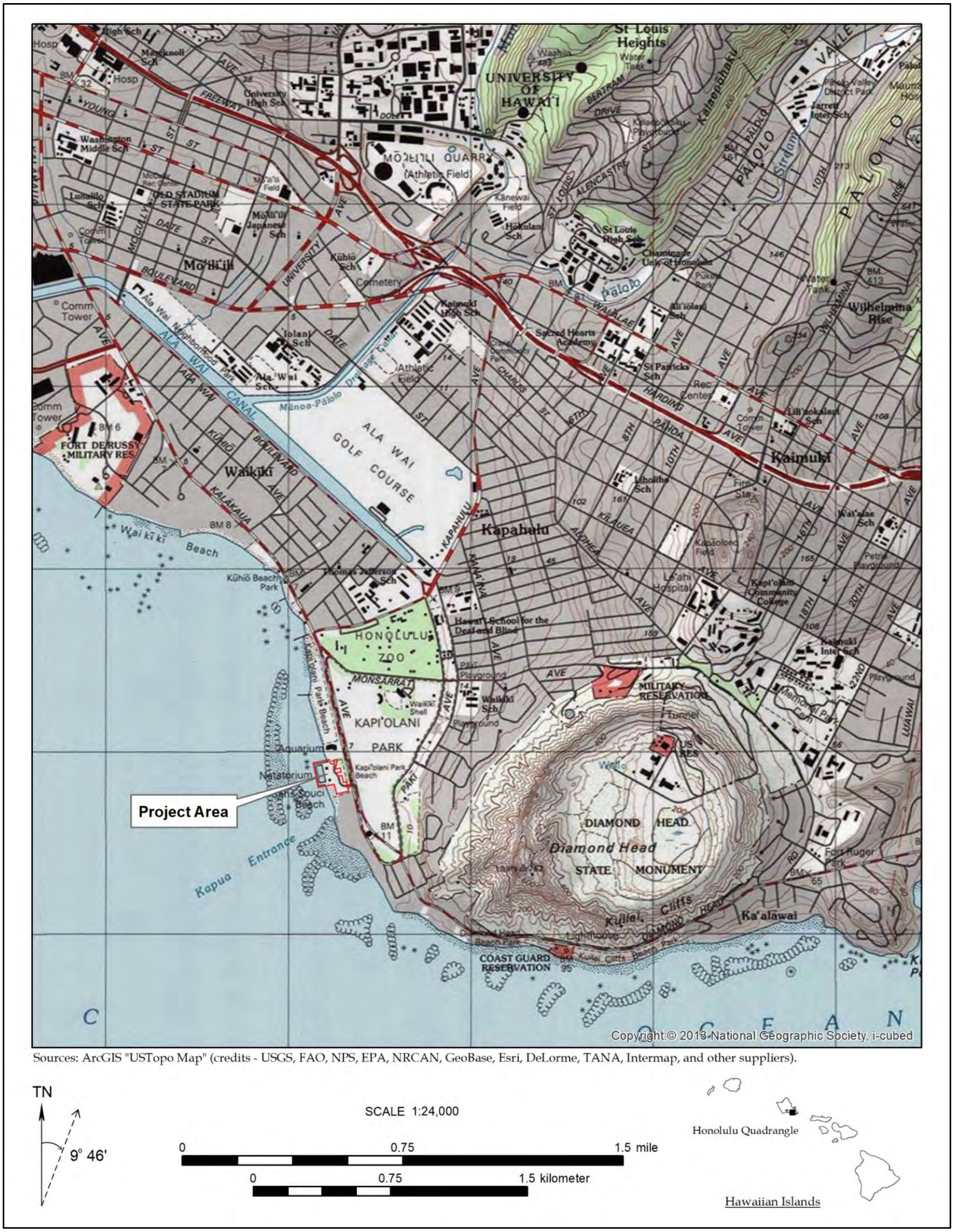


Figure 1 Project location.

Figure 2. Project area boundary.

Subsequently, through consultations with the State Historic Preservation Division and changes to the preferred alternative and an adjustment to the Project Area, additional archaeological testing was warranted. As a result, Pacific Legacy, Inc., undertook additional testing within the revised and current Project Area in August 2018. The results of both of the testing episodes are presented within the AIS.

1.3 Environment

The WWMC is located on the south shore within Kapiʻolani Park, on the island of Oʻahu. Located just to the east of Waikīkī proper, the park serves as a major outdoor venue for events, activities and recreational sports.

This area of Waikīkī receives less than 20 inches of rainfall annually (Juvik and Juvik 1998: 56) with the dominant trade winds coming from the northeast. Vegetation within Kapiʻolani Park is ornamental in nature and consists of ironwood trees (*Casuarina equisetifolia*) coconut trees (*Cocos nucifera*), *hau* (*Hibiscus tiliaceus*), *milo* trees (*Thespesia populnea*), banyan trees (*Ficus benghalensis*), shower trees (*Cassia*) and various shrubs and grasses.

Soils within the project area are derived from two sources: Jaucas Series and Beaches.

Jaucas Series

> Jaucas series consists of excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean…They develop in wind- and water deposited sand from coral and seashells (Foote et al 1972: 48).

Beaches

> Beaches occur as sandy, gravelly, or cobbly areas on all islands…They are washed and rewashed by ocean waves. The beaches consist mainly of light-colored sands derived from coral and seashells (Foote et al. 1972: 28).

1.4 Environmental Impact Statement Alternatives

Presented below are four brief summaries of project alternatives from the EIS for the WWMC. The archaeological testing discussed in this report addresses the needs of the alternatives, especially Alternative 1 (Perimeter Deck) and Alternative 2 (War Memorial Beach). For more details or specific information regarding these alternatives, the reader is referred to the EIS for the WWMC.

Alternative 1 - Perimeter Deck

The Perimeter Deck is illustrated in Figure 3. This alternative would retain the bleachers and arches, and rehabilitate the deck around the Natatorium, while removing the less visible submerged structures (such as the makai and ʻEwa seawalls) which block the free flow of water between the swim basin and open ocean. This alternative would expose the entire pool to the coastal waters. The Perimeter Deck would result in the demolition of the makai and ʻEwa side seawalls of the swim basin and reconstruction of the deck on support piles, allowing for the free flow of water between the ocean and a swim basin area. The shape, configuration, and size of the decking would be retained, resulting in the structure's appearance emulating the original facility when seen from above. The Diamond Head groin would remain and be structurally improved to ensure the retention of Kaimana Beach. The bleachers arch, and other existing elements of the Natatorium structure would also remain and be restored to their historic appearance.

The Perimeter Deck proposes minimal land-side improvements. Existing land-side conditions including landscaping, parking, access, and drainage would remain as they currently exist at the site. Construction of a new paved walkway that extends the existing Kapiʻolani Regional Park shoreline promenade to Kaimana Beach. The promenade currently ends near the boundary between the Waikīkī Aquarium and the project site. Restore level surface leading to the Roll of Honor plaque (limited to universal access).

Alternative 2 - War Memorial Beach

The War Memorial Beach is illustrated in Figure 4. This alternative would create a beach between constructed groins, fronted by a replica memorial arch in alignment with the existing Roll of Honor plaque and hau tree arbor. The entire Natatorium structure, i.e., everything built seaward of the 1927 shoreline, would be removed. Various landside improvements would also be undertaken. As noted, this alternative (removal of the Natatorium and creation of a new beach) was the recommendation made to the City by the Task Force in September 2009 and corresponds to the City's "proposed action" at the time of the 2014 FEA-EISPN. The 2011 archaeological investigations were focused on this alternative.

The War Memorial Beach alternative would relocate the memorial arch, demolish other elements of the Complex, and construct a public beach and lagoon in place of the existing saltwater pool. This alternative would use portions of the existing seawall combined with new rock, concrete walls and groins to create a protected beach and swimming area within the Natatorium footprint that would remain stable while still providing for active flushing of the water. The existing hau trees, trellises, coconut trees, and three large trees on site would be maintained, as well as the exceptional and historic trees along Kalākaua Avenue. Additional plantings would conform to a master tree and shrub planting plan. Lawn areas would be rehabilitated and the irrigation systems upgraded and automated.

The War Memorial Beach landside park improvements and changes include:
Construction of a new bathhouse and outdoor shower facility on City park lands mauka of the Complex. Replacement of the internal road/parallel parking that bisects the site with a consolidated lot at the park's south side. The capacity of the new parking lot would be sufficient to retain the same number of stalls (77) currently at the park. The existing curb cut on Kalākaua Avenue would be reused to access the new parking lot.

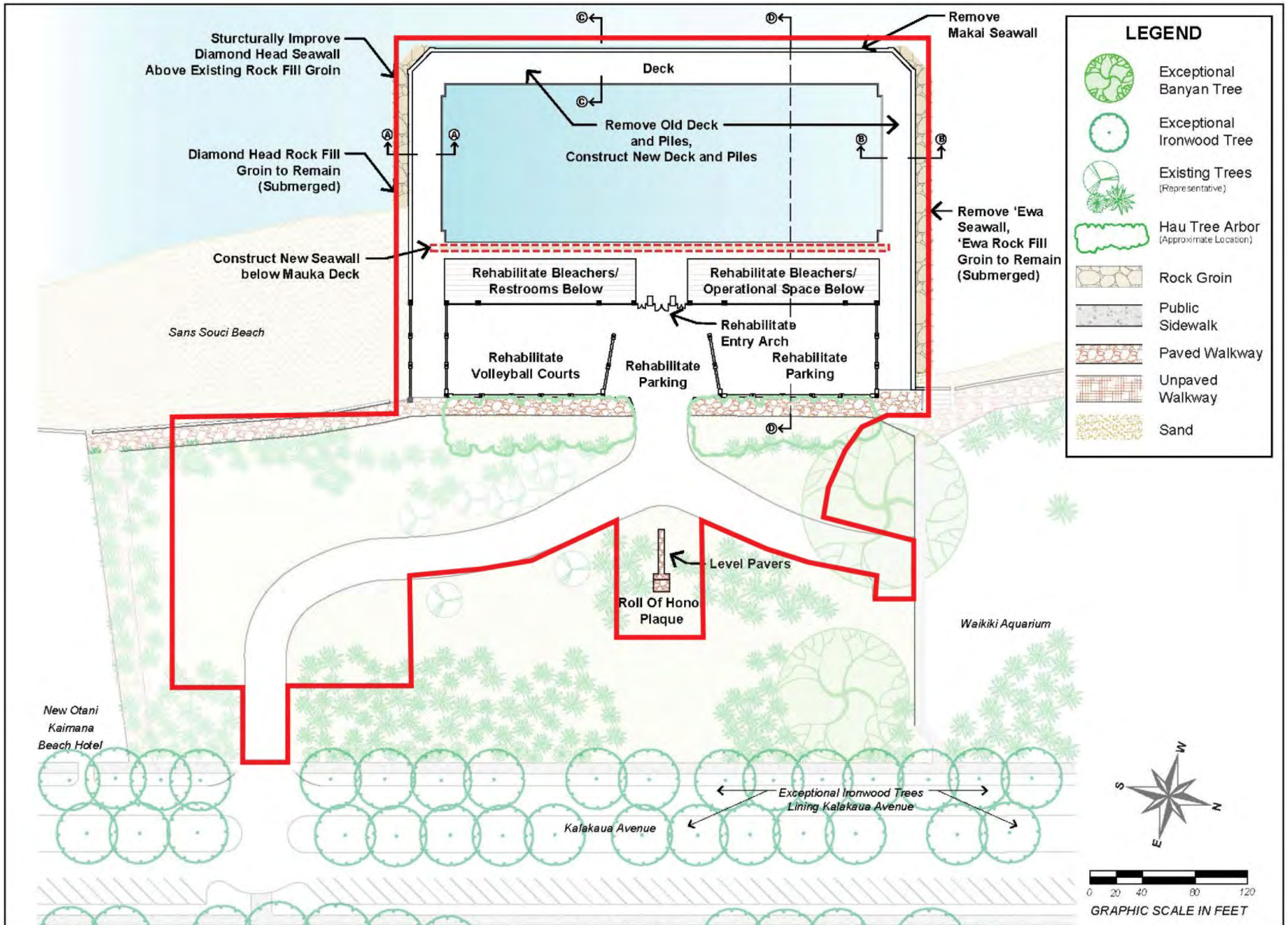


FIGURE 3.2.1-1: PERIMETER DECK – PROPOSED CHANGES (PLAN VIEW)
Waikiki War Memorial Complex EIS

Source: AECOM, August 2018
WCP, June 2014 (base)

Figure 3. The Perimeter Deck Option.

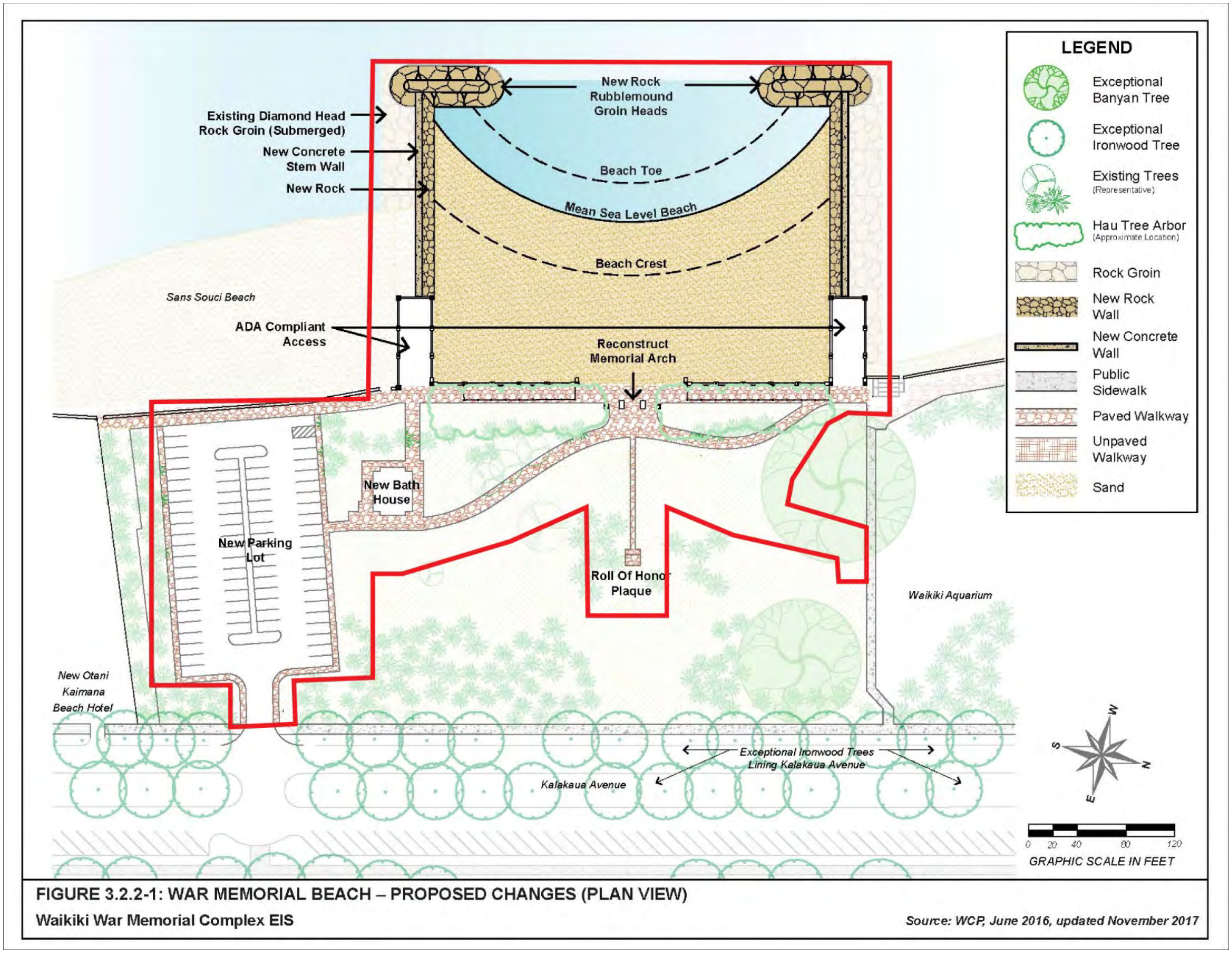


Figure 4. The War Memorial Beach Option.

Alternative 3 - Closed System Pool (previously "Reconstruction and Restoration of the Natatorium")

The intent of the Closed System Pool is to renovate the Complex to its historic character. This alternative involves maintaining the Natatorium structures while constructing a concrete lined fresh water swimming pool in place of the saltwater pool (Figure 5). In addition to the pool, other challenges to the land-side mechanical facilities would need to be considered. The spaces beneath the bleachers may not be able to accommodate the required mechanical equipment, the office space currently used by the Ocean Safety and Lifeguard Services Division office, and the existing restroom facilities. Due to its historic status, and to avoid compromising its historic integrity, a new adjacent building to house the mechanical equipment (e.g., pumps, filters, and surge tanks) would need to be carefully accommodated within the site, likely in the volleyball court area.

Under this alternative, the entire Natatorium structure would be maintained. Presently, the bleacher structure continues to deteriorate, requiring emergency work to remove loose concrete and perform limited patching that allows continued use of the bathroom facilities. A repair project and other improvements would have to be implemented to ensure continued use of the bleacher structure and spaces below. Repair work would include, among other things, waterproofing and new plasterwork for the bleachers, addressing areas that have spalled and cracked, and possible localized reconstruction in targeted areas. Due to the lifecycle costs of continual monitoring and maintenance, the option of reconstructing the bleacher structure, as originally planned, should be explored. This alternative assumes that the bleacher structure would be repaired and would require continual monitoring and maintenance.

The Closed System Pool does not propose any land-side improvements. Existing land-side conditions including landscaping, parking, access, and drainage would remain as they currently exist at the site.

Alternative 4 - No Action
No action represents the baseline conditions for which the action alternatives are evaluated. Under No Action, the WWMC would remain in its current dilapidated condition and the pool and bleachers would remain closed to the public. There would be no change to the land use or facilities that currently exist at the site. This alternative would maintain the status quo and all structures would remain in place and continue to deteriorate.

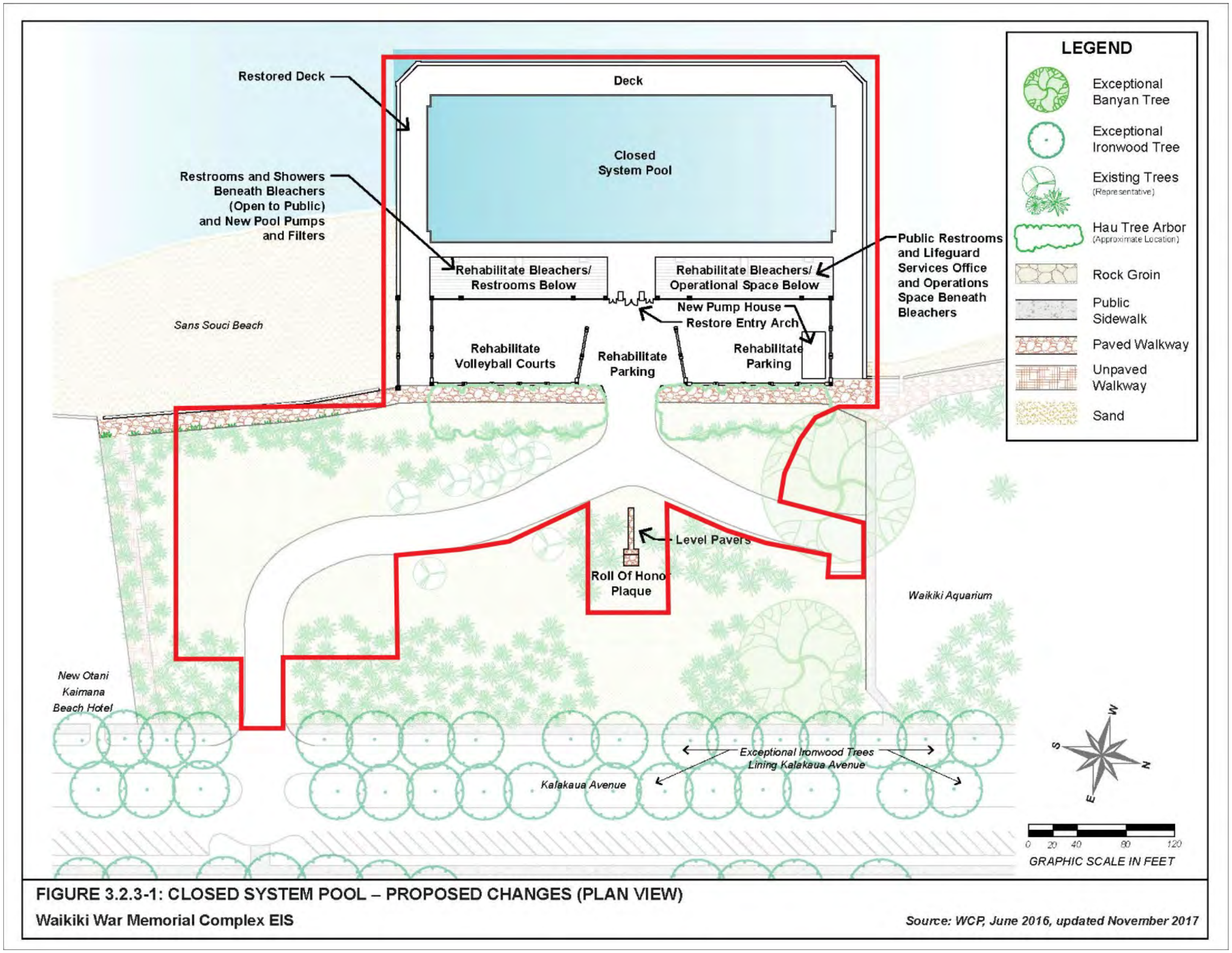


Figure 5. The Closed System Pool Option.

2.0 METHODS

Archaeological subsurface testing was conducted within the Project Area on two different occasions, first in 2011 when a different Project Area was proposed. Subsequently, the Project Area was modified requiring a second period of testing in 2018. The archaeological testing conducted in 2011 consisted of both shovel test pits (STPs) and trench excavations while the 2018 excavations consisted only of STPs. During both testing episodes, the archaeological field investigations were conducted by James McIntosh, B.A. and Caleb C. Fechner, B.A., under the overall direction of Dr. Paul L. Cleghorn, Ph.D.

Archaeological testing was limited to the terrestrial areas of the park and Natatorium. No underwater archaeological investigations were conducted during either testing episode.

2.1 2011 ARCHAEOLOGICAL TESTING

Initial testing was conducted between August 29 and September 2, 2011, 10 STPs and 12 backhoe trenches were excavated within the then Project Area. Prior to trench excavations, the eastern section of the park proposed for new parking stalls and new bath house presented in Alternative #2. This area was first surveyed with Ground Penetrating Radar (GPR) (Figure 6). The GPR was utilized in a large open area of the park to aid in the identification of potentially significant subsurface deposits, specifically human remains and to locate and identify utilities that maybe encountered during trenching. The GPR identified a number of "anomalies" which were interpreted as buried utility lines of miscellaneous metal debris. No "voids" were identified during the GPR. A "void" is interpreted as a feature that might contain human remains.

A total of 12 trenches were excavated using a backhoe. Several factors determined the placement of the trenches: the locations of subsurface utility lines and the request from Kapi‘olani Park personnel to stay a safe distance away from trees to avoid damaging roots. Work areas were secured using moveable barricades and caution tape. Each trench was closely monitored while excavation occurred; soil material was inspected as it was removed from the trenches. Soils were visually screened as they were slowly emptied from the backhoe bucket.

The walls of each trench were cleaned and straightened using a flat nose shovel and trowel in order to better see the soil stratigraphy. The stratigraphy was recorded for each trench. Profiles were drawn of at least one sidewall and all soils were recorded using standard United States Department of Agriculture nomenclature and Munsell Soil Color designations (2000). All trenches were backfilled at the end of each day.

The STPs were placed in two areas within the park where there was a probability of encountering subsurface utility lines or in areas where mechanical excavations would damage trees roots. The STPs were carefully hand excavated with round nosed shovels and all soil was screened through ¼″ and ⅛″ mesh screen. All soils were recorded using standard United States Department of Agriculture nomenclature and Munsell Soil Color designations (2000).

No profiles were drawn for any of the shovel test units, because the profiles in the STPs were redundant with those recorded in the backhoe trenches.

Figure 6. GPR was used to survey the area prior to the commencement of trenching in 2011.

2.2 2018 ARCHAEOLOGICAL TESTING

After consultations with the State Historic Preservation Division (SHPD) and changes in the Project Area additional subsurface testing was warranted. Further testing was conducted between August 7 and 10, 2018 when an additional 12 STPs were excavated with the purpose of more thoroughly testing within the amended Project Area (Figure 1 and Figure 2). No mechanical testing backhoe testing or GPR was employed during the second series of excavations.

The 12 STPs were excavated by hand and all soil was screened through nested ¼″ and ⅛″ mesh screens. All of the units were excavated to between 85-100 centimeters below surface (cmbs). At that point a hand held auger equipped with a sand head was employed to excavate the remainder of the unit to 160 cmbs. All 12 of the recent STPs were excavated to a total depth 160 cmbs.

All soils were recorded using standard United States Department of Agriculture nomenclature and Munsell Soil Color designations (2000). All STPs were backfilled at the end of the day. No human remains were encountered during testing.

All collected materials (artifacts and midden) were transported to the Pacific Legacy laboratory in Kailua, where they were cleaned, sorted and identified. All material will be curated at this facility. The location of each STP and backhoe trench was recorded with a Trimble GeoXH and processed through ESRI software.

3.0 HISTORIC BACKGROUND

3.1 Land Commission Awards

Private land ownership was introduced into Hawai‘i during the Mahele ‘Āina (the division of Hawaiian lands) of 1848. Crown and *ali‘i* lands were awarded in 1848 and *kuleana* titles were awarded to the general populace in 1850 (Chinen 1958). The awarded lands are called Land Commission Awards (LCA's). In reviewing the LCA's we are also able to determine previous land use within and around the project area. Thus we are able to determine how Native Hawaiians lived and worked in this area of Hawai‘i and possibly indicate how the current project area was traditionally used.

A review of the LCA's for the current project determined that only a single LCA has been awarded in the vicinity of the current project area. LCA 5593:1 was awarded to an individual named Pehu (Figure 7). The land was given to Pehu in 1823 by King Liholiho.

3.2 Kapi‘olani Park

The land comprising Kapi‘olani Park was obtained primarily from Crown Lands provided by King David Kalākaua and established the park as a charitable trust in 1896 (Weyeneth 2002: 7). "Kapi‘olani Park was established in Honolulu by a private corporation as a preserve for the few, the rich, and the well-born, but it has developed into a public recreation ground" (Weyenth 1991: 2). The Park was designed by Archibald S. Cleghorn, resident of the nearby family estate of ‘Āinahau and brother-in-law to King Kalākaua and father of Princess Ka‘iulani. Cleghorn served as Vice President and later President of the Kapi‘olani Park Association.

The appearance and use of the park has undergone many changes throughout its history. The large open space of Kapi‘olani Park was used previously as a horse racing track while the ponds and wetlands allowed park goers the opportunity to boat in calm waters.

The Kodak Hula Show began operating on the grass area behind Sans Souci Beach (adjacent to the War Memorial) in 1937. The flat grassy area with the palm trees and ocean background proved to be the perfect location for the hula show that operated on that spot until 1969 when the show was moved to the Waikīkī Shell. In 1992, Kapi‘olani Park was placed on the Hawai‘i Register of Historic Places.

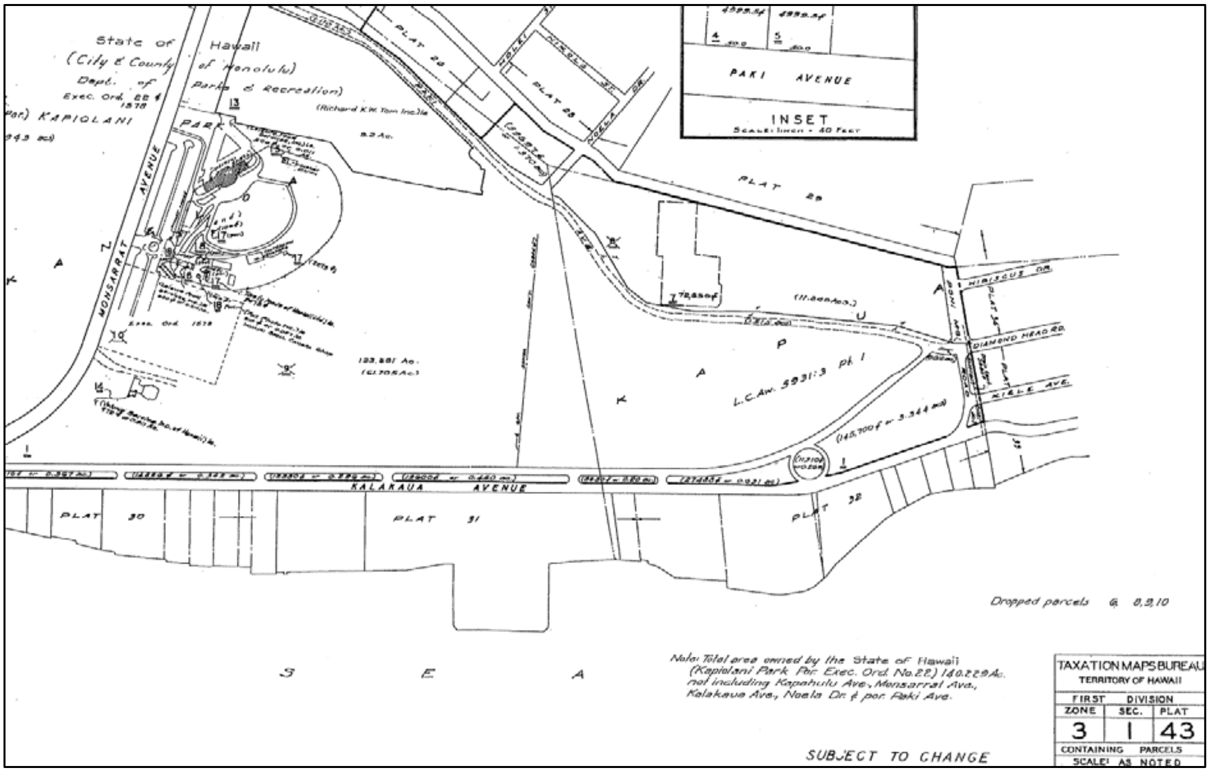
Today the park contains tennis courts, baseball and soccer fields, the Waikīkī Aquarium and much abundant space for the public to enjoy. The significance of Kapi‘olani Park was recognized by listing it as a historic property (SIHP No. 50-80-14-9758) in the Hawai‘i Register of Historic Places in 1992.

3.3 WILLIAM G. IRWIN RESIDENCE

In 1899, the renowned architect C. W. Dickey designed a "stately mansion" for the sugar industry magnate William G Irwin (Hibbard and Franzen 1986). The Irwin residence was located on the site of the present War Memorial Natatorium, and was one of the earliest Spanish Mission Revival style house in Hawaiʻi (Figure 8). It featured a verandah that wrapped completely around the house and opened into large airy rooms. The Irwin residence was demolished by 1921 for the construction of the War Memorial Natatorium (War Memorial Natatorium Nation Register of Historic Places nomination form; see Appendix A).

3.4 WAR MEMORIAL NATATORIUM

In 1921, the Hawaiʻi Territorial Legislature authorized the issuance of bonds to raise $250,000 for the construction of a War Memorial Natatorium on the former Irwin property. Construction of the Natatorium was completed in 1927 as the first "living" war memorial in the United Stated This memorial was dedicated to the men and women who served and sacrificed their lives in World War I (1914-1919). The Natatorium has been listed as a historic building in the Hawaiʻi Register of Historic Places in 1973 (SIHP #84-14-9701) and in the National Register of Historic Places in 1980 *NRHP #800001283). The Natatorium is a reinforced concrete structure that contains an open air ocean water swimming pool (Figure 9). The pool is surrounded on three sides by 20-foot wide deck. On the *mauka* side, 13 levels of bleachers provide spectator seating. The major architectural feature of the Natatorium is the Beaux-Arts inspired main entry with its triumphal arch flanked by two lesser arches (Cover and Figure 10).



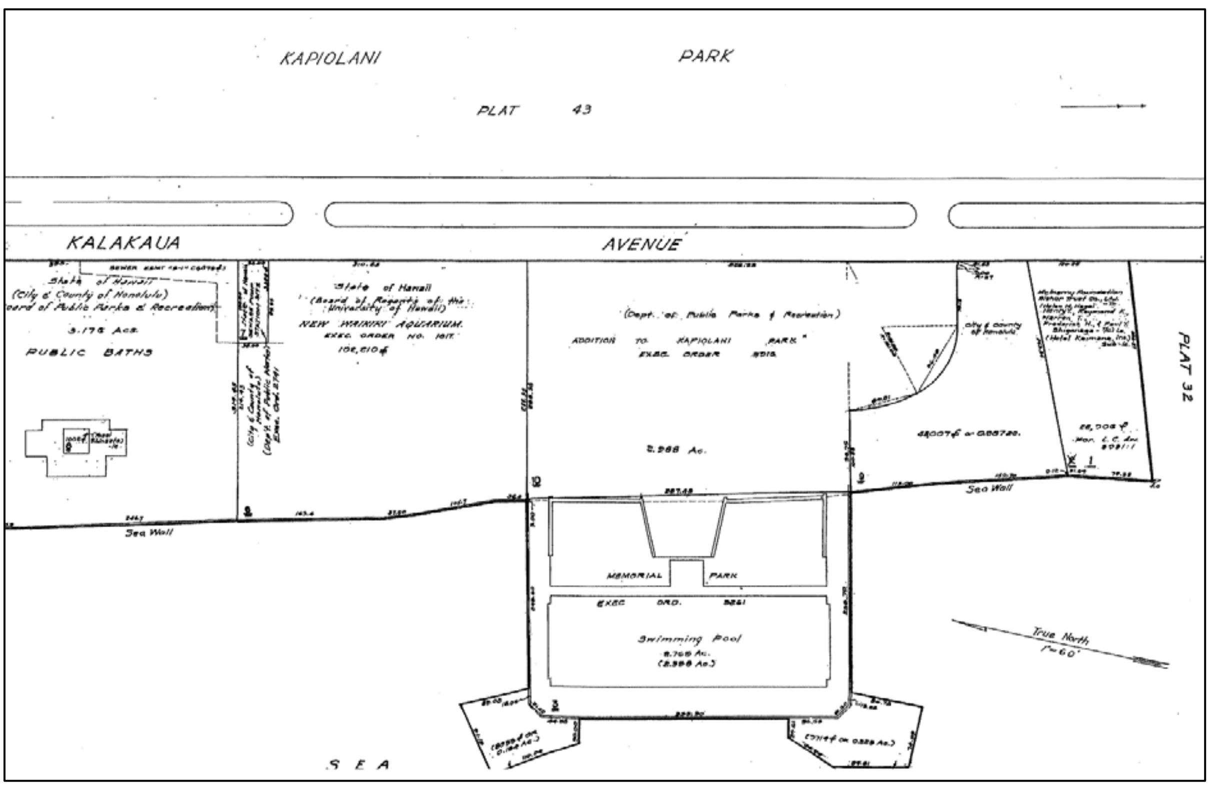


Figure 7. TMK maps showing the project area.

Figure 8. The Irwin Residence (1907) formerly located on the site of the Natatorium (photo from Weyeneth 1991: Plate 16).

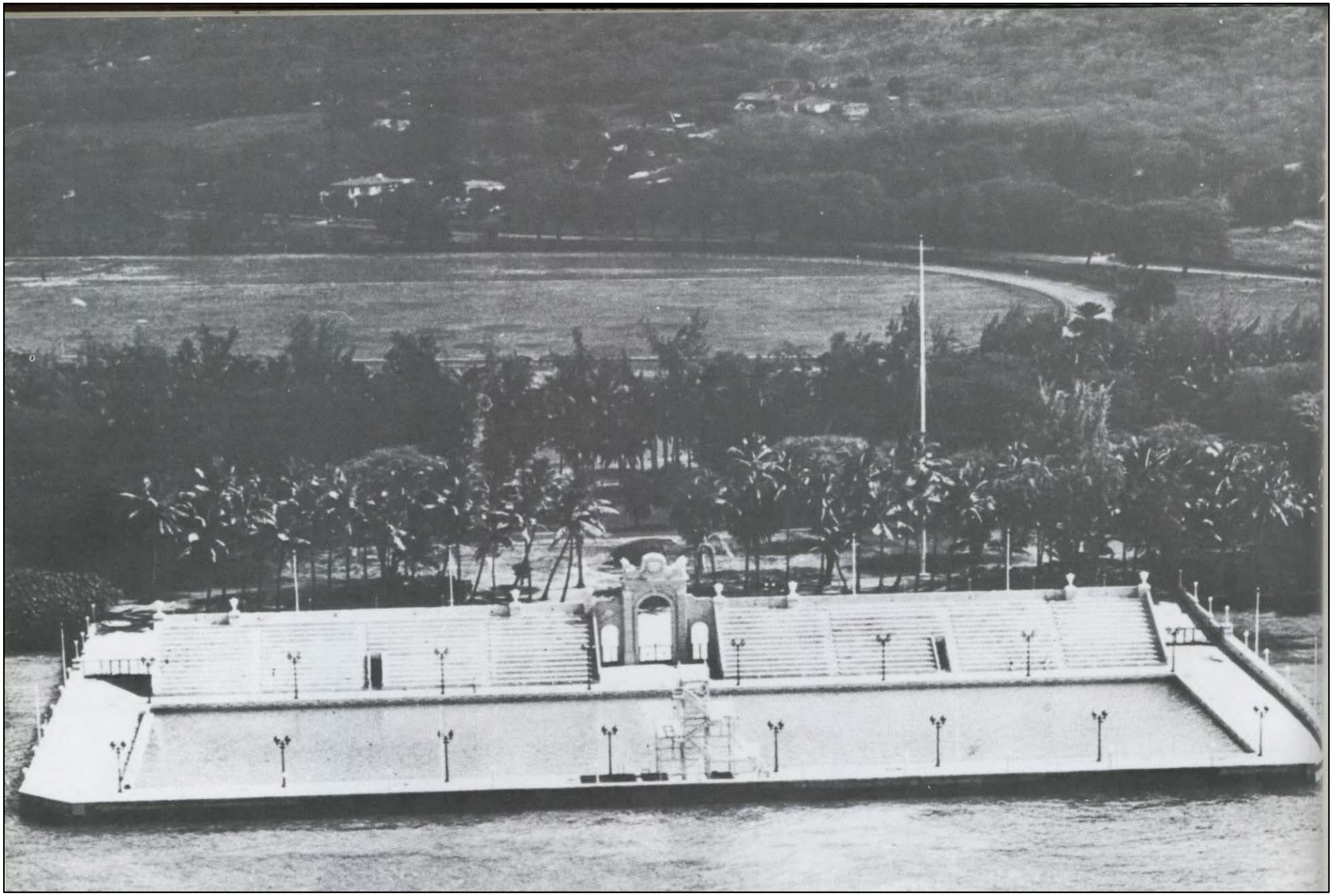


Figure 9. Aerial view of the Natatorium (from Hibbard and Frazen 1986:50).

4.0 PREVIOUS ARCHAEOLOGY

The greater *ahupua*ʻ*a* of Waikīkī has been the location of many archaeological investigations which have resulted in the identification of many buried subsurface archaeological features, sites and human burials (*iwi kūpuna*). The vicinity between the Hilton Hawaiian Village to the west and Kapahulu Avenue to the east contains numerous subsurface features and human burials. According to Mintmier and Collins (2009: 13) "no less than 63 [human burials] were reported between 2000 and 2002 [in Waikiki]."

The Fort DeRussy/Hale Koa Hotel area contains buried fishponds long filled in to reclaim the precious land. Evidence of these ponds has been uncovered during several development projects (Davis 1989, Carlson et al. 1994, Denham and Pantaleo 1997). Also associated with these fishponds are human burials, pits and post holes which is evidence of the intense use of the Waikīkī area in traditional Hawaiʻi.

The current investigations are located on the east end of the Waikīkī *ahupua*ʻ*a* on the far end of Kapiʻolani Park. As a result, the summary of previous archaeological investigations will be focused on the area east of Kapahulu Avenue between the Honolulu Zoo and Diamond Head (see Figure 1).

The first discovery to be treated as an archaeological site is that recorded by N.B. Emerson in 1901. During the 1901 excavation of trenches for the installation of water lines at the home of James B. Castle (near what is today the Elks Club), the remains of at least four individuals were exposed. The individuals were buried in white sands (Jaucus sands). Found with the burials were a variety of goods, including conical whale teeth, large, round, glass beads, and a small *niho-palaoa,* an ornament commonly worn by *ali*ʻ*i*. (Emerson 1902:19).

J.G. McAllister (1933) recorded four *heiau* (temple) in Waikīkī, three in lower Mānoa Valley, and the fourth (*Papa*ʻ*ena*ʻ*ena*) being at the foot of Diamond Head crater.

In April of 2000, Cultural Surveys Hawaiʻi (CSH; Perzinski and Hammatt 2002) conducted archaeological monitoring for excavations associated with the Waikīkī Bandstand and associated ponds. CSH identified a charcoal layer in several areas of the park and recovered a broken basalt stone lamp on the *makai* side of the bandstand.

In early 2001 CSH (Perzinski and Hammatt 2001a) conducted archaeological monitoring for a lighting improvement project along Kalākaua Avenue between the Natatorium and Ponimōʻī Road (TMK: [1] 3-1-031, 032 and 043). The monitoring documented a single historic trash pit which yielded glass bottles dating to the early 20th century. Two traditional artifacts (an adze perform and a cowry shell octopus perform) were recovered from a backdirt pile. No traditional cultural deposits or human remains were identified.

Also in April 2001, CSH (Perzinski and Hammatt 2001b) conducted archaeological monitoring for the re-interment facility for the Waikīkī *iwi kūpuna* located on the *mauka* corner of Kalākaua and Kapahulu Avenues fronting the Honolulu Zoo. The excavations did not exceed 60 cm in depth and only a single fragment of bottle glass was identified.

In mid-2001, CSH (Bush et al. 2002) conducted archaeological monitoring for the Queen Surf Promenade improvements located north of the current project area. No traditional or historic artifacts or deposits were uncovered, however, given the presence of burials in the Waikīkī area, archaeological monitoring for any future work was recommended.

Between July 2002 and May 2003, CSH (Bush et al. 2004) conducted archaeological monitoring for the proposed improvements to the Honolulu Zoo located north of the current project area. The monitoring focused on three areas on the west side of the zoo. In most excavations, remnants of previous zoo structures and fill deposits were encountered. Natural sand deposits were observed in on area near the Elephant Exhibit, however no cultural material was encountered. Given the presence of burials in the Waikīkī area, archaeological monitoring for any future work was recommended.

In May 2004, CSH conducted archaeological monitoring (CSH 2004) associated with a new sewer pump station near the Waikīkī Aquarium (TMK [1] 3-1-031:006). The excavations consisted of two electrical trenches totaling ca. 80 meters in length. A single historic trash pit was uncovered (Site 50-80-14-6704). The pit contained items including butchered animal bone, ceramic pieces and glass bottles that dated between 1880 and the 1920s.

In October 2004, Scientific Consulting Services (Tome and Spear 2005) conducted archaeological monitoring associated with the Public Baths Pump Station Modification Improvements Project located adjacent to the Waikīkī Aquarium (TMK: [1] 3-1-31:07), situated just northwest of the current project area. The monitoring identified a single archaeological site (50-80-14-6702) consisting of a single subsurface trash pit containing glass bottles manufactured between the 1870s and the 1920s. The site was assessed as significant under Criteria D with no further work recommended at the site. Archaeological monitoring was suggested for work conducted along the coastal areas.

In 2006, Cultural Surveys Hawaiʻi (Whitman et al. 2008) conducted archaeological monitoring for a 12-inch water installation along Kalākaua Avenue and Ponimōʻī Road, located just to the south of the current project area. The investigations uncovered a single fully articulated human burial (Site 50-80-14-6946) interred in a flexed position. The burial was disinterred and was identified as a young adult of Native Hawaiian ancestry. Archaeological monitoring within the area was recommended for any future work.

In 2008, Archaeological Consultants of the Pacific, Inc. (Liebhardt and Kennedy 2008) conducted archaeological monitoring at the Waikīkī Aquarium (TMK [1] 3-1-31:06) located on the opposite end of the Waikīkī Natatorium from the current project area as part of an electrical system upgrade to the aquarium. The investigations focused on several tranches excavated from Kalākaua Avenue and entering the aquarium property. They excavations uncovered various fill layers overlaying Jaucus sand deposits. No cultural remains were encountered.

4.1 Site Predictability

Based on previous archaeological investigations in the vicinity of the project area and the location of the project area adjacent to ocean resources and inland marshes in the Kapiʻolani Park area, it seems very likely that this area would have been traditionally utilized. We would expect to find habitation features such as living floors, fire hearths and ovens (*imu*), and activity areas where traditional artifacts were made. It also seems that this area has the potential to contain human burials. The area may also contain historic remnant of the Irwin residence and construction of the Natatorium.

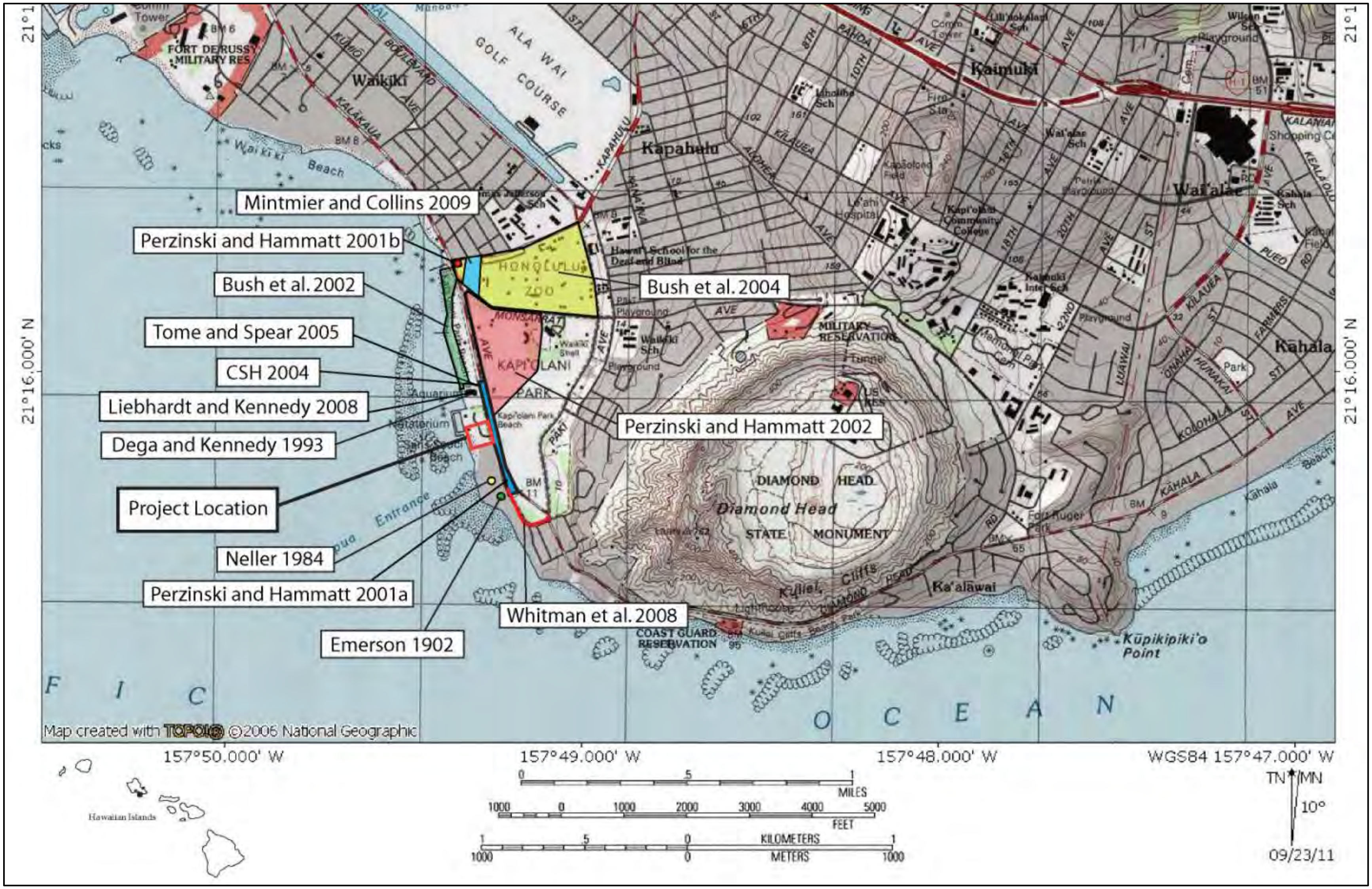


Figure 10. Locations of previous archaeological investigations near the project area.

5.0 FIELD INVESTIGATIONS

5.1 ARCHAEOLOGICAL EXCAVATIONS

A total of 22 shovel test pits (STPs) and 12 backhoe trenches were excavated during the course of the project (Figure 111 through 13). The locations of each were excavation was determined by the locations of existing utilities and vegetation. The intent was to spread out the test excavations as evenly as possible to determine if significant cultural deposits were present within this area of the park.

The excavations within the park identified a fairly even cultural layer throughout the area beginning at approximately 50 cm below the existing ground surface. This cultural layer was overlaid by various fill episodes which were employed undoubtedly by the parks department to raise and level the park grounds. The depth of the cultural layer varies within the park with the shallowest depth being 50 cm below surface and extending to a depth of approximately 110 cm below surface. Tisa cultural layer was assigned the SIHP Site number 50-80-14-7211.

The cultural layer (SIHP No. 7211) was initially identified in STP 5, at 60 cm below surface (Layer III). This layer contained dark gray sand and charcoal. A marine shell fishhook and a charcoal sample was collected from the screen in this layer. The charcoal sample was subsequently identified as to species and then radiocarbon dated (see Section 5.5).

Subsequent testing in the area further demarcated the area of the site. Cultural material was also identified within Layer III (50-75 cmbs) in STP 14 and 15. This material consisted of a coral abrader and midden within STP 14 and midden within STP 15. A possible posthole was also identified within Layer III of STP 14 between 50-75 cmbs.

Seven features were identified during test trenching (Figure 13). Feature 1 was thought to be a tree root- ball, and Feature 6 contained historic materials from the 20th century.
The remaining five features are likely traditional in nature comprising a post hole (Feature 2) and several fire pits. Before providing descriptions of the subsurface features identified (Section 5.3), descriptions of the 22 shovel test probes (Section 5.1) and the 12 backhoe trenches (Section 5.2) are presented

Figure 11. Backhoe excavations were closely monitored.

Figure 12. Location of shovel test pits and backhoe trenches on ESRI aerial image.

Figure 13. Location of identified subsurface features.

5.2 Shovel Test Pits

Shovel Test 1 (Figure 14)

Layer I	0-40 cmbs	Very dark grayish brown (10YR 3/2) silt; mixed with volcanic cinder, granular structure, slightly sticky, non-plastic; abrupt smooth boundary.
Layer II	40-65 cmbs	Dark yellowish brown (10YR 3/6) loam; platy structure, non sticky, non-plastic; contains glass bottle fragments; abrupt smooth boundary.
Layer III	65-70 cmbs	Light brownish gray (10YR 6/2) sand; sine grain structureless, non-sticky, non-plastic ; abrupt smooth boundary; no charcoal present.
Layer IV	70-100 cmbs	Very pale (10YR 7/4) sand; fine grain; structureless; beach sand.

Figure 14. STP 1 at conclusion of excavation.

Shovel Test 2 (Figure 15)

Layer I	0-6 cmbs	Dark yellowish brown (10YR 3 /4) silty loam; contains cinder; loose, fine grain, non-sticky, non-plastic; "A" Horizon.
Layer II	6-34 cmbs	Strong brown (7.5YR 4/4) silt loam; contains cinder; loose, blocky; non-sticky, non-plastic.
Layer III	34-64 cmbs	Reddish brown (5YR 4/4) clay; platy, sticky, Plastic; contains glass and metal wires.
Layer IV	64-80 cmbs	Light gray (7.5YR 7/1) sand; loose, fine grain, non-sticky, non-plastic. Beach sand.

Figure 15. STP 2 at conclusion of excavations.

Shovel Test 3

Layer I	0-40 cmbs	Very dark brown (10YR 2/2) silty clay; contains cinder, strong, non-sticky, non-plastic; medium granular, abrupt smooth boundary.
Layer II	40-60 cmbs	Dark yellowish brown (10YR 3/ 4) silt loam; platy, slightly sticky, slightly plastic; abrupt smooth boundary; contained fragments of amber glass bottle.
Layer III	60-67 cmbs	Brown (10YR 5/3) sand; structureless, fine grain; non-sticky, non-plastic; abrupt smooth boundary; brown color likely from leaching, no cultural material.
Layer IV	67-100 cmbs	Light yellowish brown (10YR 6/4) sand; structureless, fine grained; non-sticky, non-plastic; abrupt smooth boundary; beach sand containing marine shell and coral.

Shovel Test 4

Layer I	0-6 cmbs	Dark yellow brown (10YR 3/ 4) silt loam; loose; non-sticky, non-plastic; abrupt smooth boundary; contains rootlets.
Layer II	6-40 cmbs	Strong brown (7.5YR 4/4) silt loam; loose blocky, non-sticky, non-plastic; abrupt smooth boundary. Contains pockets of cinder and rootlets.
Layer III	40-75 cmbs	Gray (5YR 6/1) silt; fine grain; non-sticky, non-plastic; gradual boundary; ash-like soil with large concrete chunk, glass and metal.
Layer IV	75-85 cmbs	Light gray (7.5YR 7/1) sand; loose, fine grain; non-sticky, non-plastic; beach sand.

Shovel Test 5 (Figure 166)

Layer I	0-40 cmbs	Dark yellowish brown (10YR 3/ 4) silt; weak, medium grain; non-sticky, non-plastic; abrupt smooth boundary; contains cinder.
Layer II	40-60 cmbs	Dark brown (10YR 3/3) loam; moderate medium, platy; non-sticky, non-plastic; abrupt smooth boundary.
Layer III	60-85 cmbs	Very dark gray (10YR 3/1) sand; structureless, fine grain; non-sticky, non-plastic; gradual, wavy boundary; cultural layer containing charcoal, midden and a marine shell fishhook; charcoal identification and radiocarbon sample submitted from this layer.
Layer IV	85-100 cmbs	Very pale brown (10YR 7/4) sand; structureless, fine granular; non-sticky, non-plastic; beach sand containing marine shell and coral; no cultural material.

Figure 16. STP 5 view to west. Note pit-like feature near photo stick.

Shovel Test 6

Layer I	0-30 cmbs	Dark brown (10YR 3/3) loam; moderate medium granular; slightly sticky, slightly plastic; abrupt smooth boundary. Fill.
Layer II	30-42 cmbs	Very dark gray (10YR 3/1) cinder; structureless, medium, granular; non-sticky, non-plastic; abrupt smooth boundary. Fill.
Layer III	42-57 cmbs	Dark yellowish brown (10YR 3/ 4) loam; moderate, blocky, medium; slightly sticky, slightly plastic; contains gravel; possible base course for old driveway.
Layer IV	57-100 cmbs	Pale brown (10YR 6/3) sand; structureless, fine, granular; non-sticky, non-plastic; beach sand, no cultural material.

Shovel Test 7

Layer I	0-8 cmbs	Dark brown (10YR 3/3) loam; fine granular; non-sticky, non-plastic; abrupt smooth boundary; contains rootlets and modern glass fragments.
Layer II	8-28 cmbs	Yellowish brown (10YR 5/6) cinder; medium crumb; non-sticky, non-plastic; abrupt smooth boundary. Irrigation line in layer; fill.
Layer III	28-37 cmbs	Strong brown (7.5YR 4/6) sandy loam; fine granular, non-sticky, non-plastic; clear boundary; contains glass fragments.
Layer IV	37-60 cmbs	Grayish brown (10YR 5/2) sand; fine granular, non-sticky, non-plastic; gradual boundary; contains some charcoal flecking.
Layer V	60-80 cmbs	Dark gray brown (10YR 4/2) sand; fine granular; non-sticky, non-plastic; gradual boundary; contains midden and charcoal flecking, cultural layer.
Layer VI	80-100 cmbs	Light gray (10YR 7/2) sand; fine granular; non-sticky, non-plastic; beach sand.

Shovel Test 8

Layer I	0-35 cmbs	Very dark grayish brown (10YR 3/2) loam; moderate, medium, granular; slightly sticky, slightly plastic; fill.
Layer II	35-100 cmbs	Very pale brown (10YR 8/2) sand; structureless, fine, granular; non-sticky, non-plastic; beach sand, contains no cultural material.

Shovel Test 9

Layer I	0-40 cmbs	Dark yellowish brown (10YR 4/4) silty clay loam; moderate, medium, granular; non-sticky, non-plastic; abrupt smooth boundary; contains cinder.
Layer II	40-60 cmbs	Dark brown (10YR 3/3) loam; moderate, medium, platy; non-sticky, non-plastic; abrupt, smooth boundary; fill.
Layer III	60-85 cmbs	Dark grayish brown (10YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual, wavy boundary; contains charcoal and marine shell midden.
Layer IV	85-100 cmbs	Very pale brown (10YR 8/3) sand; structureless, fine granular; non-sticky, non-plastic; beach sand, no cultural material.

Shovel Test 10

Layer I	0-9 cmbs	Dark brown (10YR 3/3) loam; fine granular; non-sticky, non-plastic; abrupt smooth boundary; contains rootlets.
Layer II	9-34 cmbs	Yellowish brown (10YR 5/6) cinder; crumb; non-sticky, non-plastic; abrupt smooth boundary; few roots.
Layer III	34-42 cmbs	Dark yellowish brown (10YR 3/ 4) sandy loam; fine granular; non-sticky, non-plastic; clear smooth boundary; compacted hard.
Layer IV	42-90 cmbs	Light gray (10YR 7/2) sand; fine granular; non-sticky, non-plastic; beach sand.

Shovel Test 11

Layer I	0-60 cmbs	Dark brown (10YR 3/3) silt loam; weak fine crumb, mixed with volcanic cinder, friable, non-sticky, non-plastic; abrupt irregular boundary. Contains tree roots.
Layer II	26-55 cmbs	Light brown grey (10YR 6/2) loamy sand; structureless, very fine, granular; loose, non-coherent, non-sticky, non-plastic; abrupt, smooth boundary.
Layer III	60-75 cmbs	Very dark grayish brown (10YR 3/2) loam; moderate fine grain crumb; friable, non-sticky, non-plastic; abrupt smooth boundary.
Layer IV	55-160 cmbs	Very pale (10YR 7/4) sand; structureless, very fine grain; loose, non-coherent, non-sticky, non-plastic; beach sand.

Shovel Test 12

Layer I	0-20 cmbs	Very dark brown (10YR 2/2) silt loam; moderate, fine crumb; friable, non-sticky, non-plastic; abrupt irregular boundary. Contains cinder.
Layer II	20-30 cmbs	Dark brown (10YR 3/3) clay loam; moderate, medium platy; friable, non-sticky, non-plastic; abrupt smooth boundary.
Layer III	30-130 cmbs	Light grey (10YR 7/2) sand; structureless, very fine grain; loose, non-coherent, non-sticky, non-plastic. Beach sand.

Shovel Test 13

Layer I	0-30 cmbs	Very dark brown (10YR 2/2) clay loam; moderate, fine crumb; friable, slightly-sticky, slightly-plastic; abrupt irregular boundary. Contains cinder.
Layer II	30-45 cmbs	Very dark grayish brown (10YR 3/2) loamy sand; structureless, fine granular; loose, non-coherent, non-sticky, non-plastic; abrupt smooth boundary.
Layer III	25-85 cmbs	Dark grayish brown (10YR 4/2) sandy loam; structureless, fine grain; loose, non-coherent, non-sticky, non-plastic; abrupt smooth boundary. Heavily mottled.
Layer IV	55-150 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 14

Layer I	0-40 cmbs	Very dark grayish brown (10YR 3/2) silt loam; moderate, medium crumb; firm, non-sticky, non-plastic; abrupt smooth boundary. Contains cinder.
Layer II	40-50 cmbs	Dark brown (10YR 3/3) sandy clay loam; weak, fine crumb; friable, slightly sticky, slightly plastic; abrupt smooth boundary.
Layer III	50-75 cmbs	Grayish brown (10YR 5/2) loamy sand; structureless, fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt wavy boundary. Contains, marine shell midden, charcoal flecking, coral abrader, and a possible posthole.
Layer IV	75-160 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic. Beach sand.

Shovel Test 15

Layer I	0-25 cmbs	Very dark grayish brown (10YR 3/2) silt loam; moderate, medium crumb; firm, non-sticky, non-plastic; abrupt smooth boundary.
Layer II	25-37 cmbs	Dark yellowish brown (10YR 3/4) loam; weak, fine crumb; firm, non-sticky, non-plastic; abrupt smooth boundary.
Layer III	37-100 cmbs	Grayish brown (10YR 5/2) loamy sand; structureless, fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt wavy boundary. Contains, charcoal flecking, non-human bone and marine shell midden.
Layer IV	70-160 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic. Beach sand.

Shovel Test 16

Layer I	0-25 cmbs	Brown (10YR 4/3) loam; moderate, fine crumb; firm, non-sticky, non-plastic; abrupt smooth boundary. Contains cinder.
Layer II	25-85 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt smooth boundary.
Layer II	85-160 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt smooth boundary. Beach sand.

Shovel Test 17

Layer I	0-6 cmbs	Brown (10YR 4/3) silt loam; weak, fine, subangular blocky; very firm, non-sticky, non-plastic; abrupt smooth boundary.
Layer II	6-16 cmbs	Light grey (10YR 7/2) crushed coral. Abrupt smooth boundary.
Layer III	16-40 cmbs	Very dark grayish brown (10YR 3/3) silt loam; weak, fine crumb; firm, non-sticky, non-plastic; abrupt smooth boundary. Contains cinder metal and fragments.
Layer IV	40-50 cmbs	Very dark brown (10YR 2/2) clay loam; weak fine crumb; firm, slightly sticky, slightly plastic; abrupt smooth boundary. Contains abundant roots, root burn, charcoal flecking, metal and glass.
Layer V	50-70 cmbs	Dark brown (7.5 YR 3/3) clay; weak, medium, platy; friable, sticky, plastic; abrupt smooth boundary.
Layer VI	70-160 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 18

Layer I	0-6 cmbs	Brown (10YR 4/3) silt loam; weak, fine, subangular blocky; very firm, non-sticky, non-plastic; abrupt smooth boundary. Contains bottle glass.
Layer II	6-10 cmbs	Light grey (10YR 7/2) crushed coral. Abrupt smooth boundary.
Layer III	10-30 cmbs	Very dark grayish brown (10YR 3/2) loamy sand; weak, fine granular; friable, non-sticky, non-plastic; abrupt smooth boundary. Contains concrete and tree roots.
Layer IV	30-50 cmbs	Dark yellowish brown (10YR 4/4) loamy sand; structureless, fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt smooth boundary. Contains concrete.
Layer V	50-80 cmbs	Black (10 YR 2/2) sandy clay loam; weak, fine crumb; friable, slightly sticky, slightly plastic; abrupt smooth boundary. Contains metal, glass, ceramic, and concrete. Backfill material.
Layer VI	80-160 cmbs	Very pale brown (10YR 8/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 19

Layer I	0-30 cmbs	Very dark grayish brown (10YR 3/2) silt loam; weak, fine, crumb; firm, non-sticky, non-plastic; abrupt, smooth boundary. Contains cinder.
Layer II	30-60 cmbs	Brown (10 YR 4/3)clay loam; weak, fine crumb; firm, slightly sticky, slightly plastic; abrupt wavy boundary.
Layer III	60-85 cmbs	Light grey (10YR 7/2) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt, smooth boundary. Contains charcoal flecking but no cultural material.
Layer IV	85-160 cmbs	Very pale brown (10YR 8/2) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 20

Layer I	0-3 cmbs	Brown (10YR 3/2) sandy loam; weak, very fine, crumb; firm, non-sticky, non-plastic; abrupt, smooth boundary.
Layer II	3-30 cmbs	light grey (10 YR 7/1) crushed coral. Abrupt, smooth boundary. Contains glass and concrete.
Layer III	30-65 cmbs	Dark brown (10YR 7/2) clay loam; weak, fine crumb; friable, sticky, plastic; abrupt, smooth boundary.
Layer IV	65-160 cmbs	Very pale brown (10YR 8/4) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 21

Layer I	0-6 cmbs	Brown (10YR 4/3) sandy loam; weak, very fine, crumb; firm, non-sticky, non-plastic; abrupt, smooth boundary. Contains glass.
Layer II	6-38 cmbs	White (10 YR 8/1) crushed coral. Abrupt, smooth boundary. Contains concrete and rusted metal.
Layer III	38-53 cmbs	Very pale brown (10YR 7/3) sand; structureless, fine, single grain; loose, non-coherent, non-sticky, non-plastic; abrupt, smooth boundary. Contains metal, concrete and glass.
Layer IV	42-63 cmbs	Dark grey (10YR 4/1) silt loam; moderate, medium grain; firm, non-sticky, non-plastic; abrupt, smooth boundary.
Layer V	63-75 cmbs	Yellow brown (10YR 5/4) sandy loam; weak, fine granular; loose, non-coherent, non-sticky, non-plastic; abrupt, wavy boundary.
Layer VI	70-160 cmbs	Very pale brown (10YR 7/3) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

Shovel Test 22

Layer I	0-8 cmbs	Dark yellow brown (10YR 3/4) silty clay loam; moderate, fine, sub-angular blocky; firm, slightly sticky, slightly plastic; abrupt, smooth boundary. Contains glass.
Layer II	8-40 cmbs	Dark brown (10 YR 3/3) silt loam; moderate, fine crumb; very firm, slightly sticky, slightly plastic; abrupt, smooth boundary. Contains cinder, a sprinkler head and pipe, bottle glass and red brick fragments.
Layer III	40-70 cmbs	Grayish brown (10YR 5/2) loamy sand; structureless, fine single grain; loose, non-coherent, non-sticky, non-plastic; abrupt wavy. Contains metal, pipe fragments and red brick fragments.
Layer VI	70-160 cmbs	Very pale brown (10YR 8/2) sand; structureless, very fine, single grain; loose, non-coherent, non-sticky, non-plastic.

5.3 TRENCHES

Trench 1 (Figure 17)

Layer I	0-10 cmbs	Very dark brown (10YR 2/2) silty loam; moderate medium granular; slightly sticky, slightly plastic; gradual smooth boundary; contains cinder.
Layer II	10-40 cmbs	Very dark brown (10YR 2/2) cinder; structureless, medium granular; non-sticky, non-plastic; abrupt smooth boundary.
Layer III	40-45 cmbs	Very dark brown (10YR 2/2) loam; moderate fine granular; slightly sticky, slightly plastic; abrupt wavy boundary; contains cinder.
Layer IIIA	67-72 cmbs	Very dark brown (10YR 2/2) loam; moderate fine granular; slightly sticky, slightly plastic; abrupt wavy boundary; contains cinder.
Layer IV	45-67 cmbs	Dark grayish brown (10YR 4/2) sandy loam; weak fine granular; slightly sticky, slightly plastic; gradual smooth boundary; contains concrete rubble, fill layer.
Layer V	72-78 cmbs	Very pale brown (10YR 7/4) sand; structureless, fine granular; non-sticky, non-plastic; abrupt wavy boundary; beach sand.
Layer VI	78-109 cmbs	Very dark grayish brown (10YR 3/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual smooth boundary; cultural layer with charcoal and firecracked rock.
Layer VII	109-124 cmbs	Very pale brown (10YR 8/3) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.

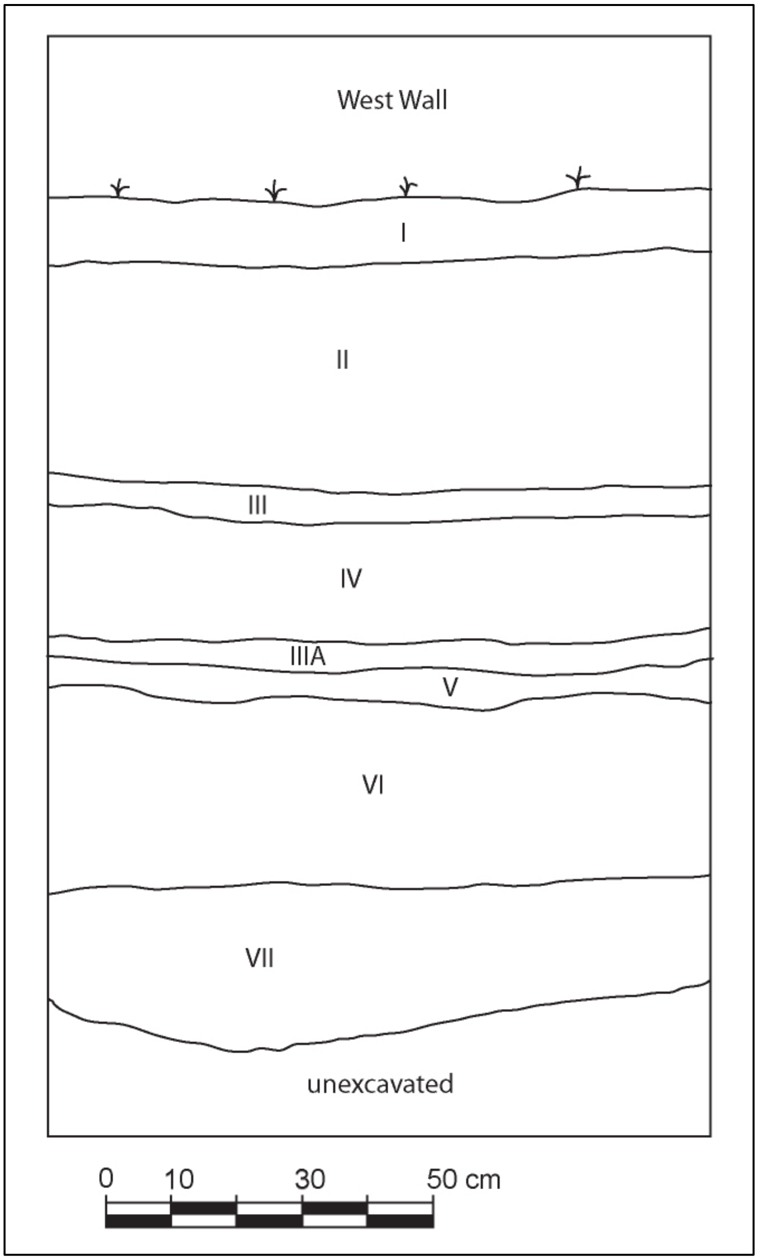


Figure 17. Profile of Trench 1, West Wall.

Trench 2 (Figure 18)

Layer I	0-9 cmbs	Very dark brown (10YR 2/2) loam; moderate medium granular; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer II	9-40 cmbs	Brown (10YR 4/3) silty loam; moderate medium granular; slightly sticky, slightly plastic; gradual smooth boundary.
Layer III	40-55 cmbs	Very dark brown (10YR 2/2) silty clay loam; structureless, medium granular; non-sticky, non-plastic; gradual smooth boundary; contains cinder.
Layer IV	55-67 cmbs	Dark brown (10YR 3/3) silty clay loam; slightly sticky, slightly plastic; moderate, medium platy; abrupt smooth boundary; contains a band of charcoal, fill.
Layer V	67-75 cmbs	Very pale brown (10YR 8/4) sand; structureless, fine granular; non-sticky, non-plastic; gradual, smooth boundary; beach sand.
Layer VI	75-109 cmbs	Very dark grayish brown (10YR 3/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual smooth boundary; contains charcoal, cultural layer.
Layer VII	109-130 cmbs	Very pale brown (10YR8/3) sand; structureless, fine granular, non-sticky, non-plastic; beach sand.

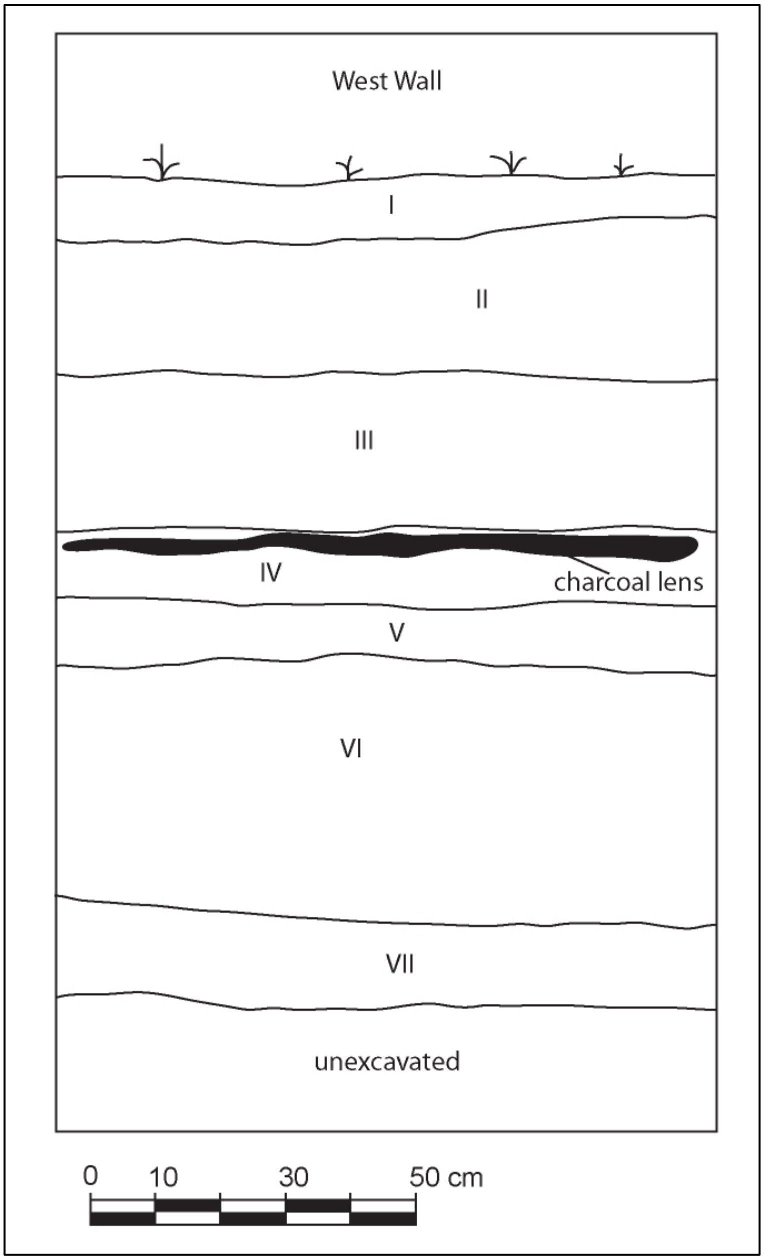


Figure 18. Profile of Trench 2, West Wall.

Trench 3 (Figure 19)

Layer I	0-10 cmbs	Very dark brown (10YR 2/2) loam; Weak medium blocky; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer II	10-35 cmbs	Very dark grayish brown (10YR 3/2) silty clay loam; moderate medium, granular; slightly sticky, slightly plastic; gradual smooth boundary; contains cinder.
Layer III	35-60 cmbs	Dark brown (10YR 3/3) silty clay loam; slightly sticky, slightly plastic; moderate, medium granular; abrupt smooth boundary; contains cinder.
Layer IV	60-69 cmbs	Grayish brown (10YR 5/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt smooth boundary; beach sand.
Layer IVA	60-69 cmbs	Dark reddish brown (2.5YR 2.5/4) clay; moderate medium blocky; sticky, plastic; abrupt, broken boundary; fill.
Layer V	69-81 cmbs	Dark brown (10YR 3/3) clay loam; moderate medium platy; slightly sticky, slightly plastic; abrupt smooth boundary; fill.
Layer VI	81-139 cmbs	Very dark grayish brown (10 YR 3/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual, wavy boundary; cultural layer containing charcoal.
Layer VII	139-150 cmbs	Pale brown (10YR 6/3) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.

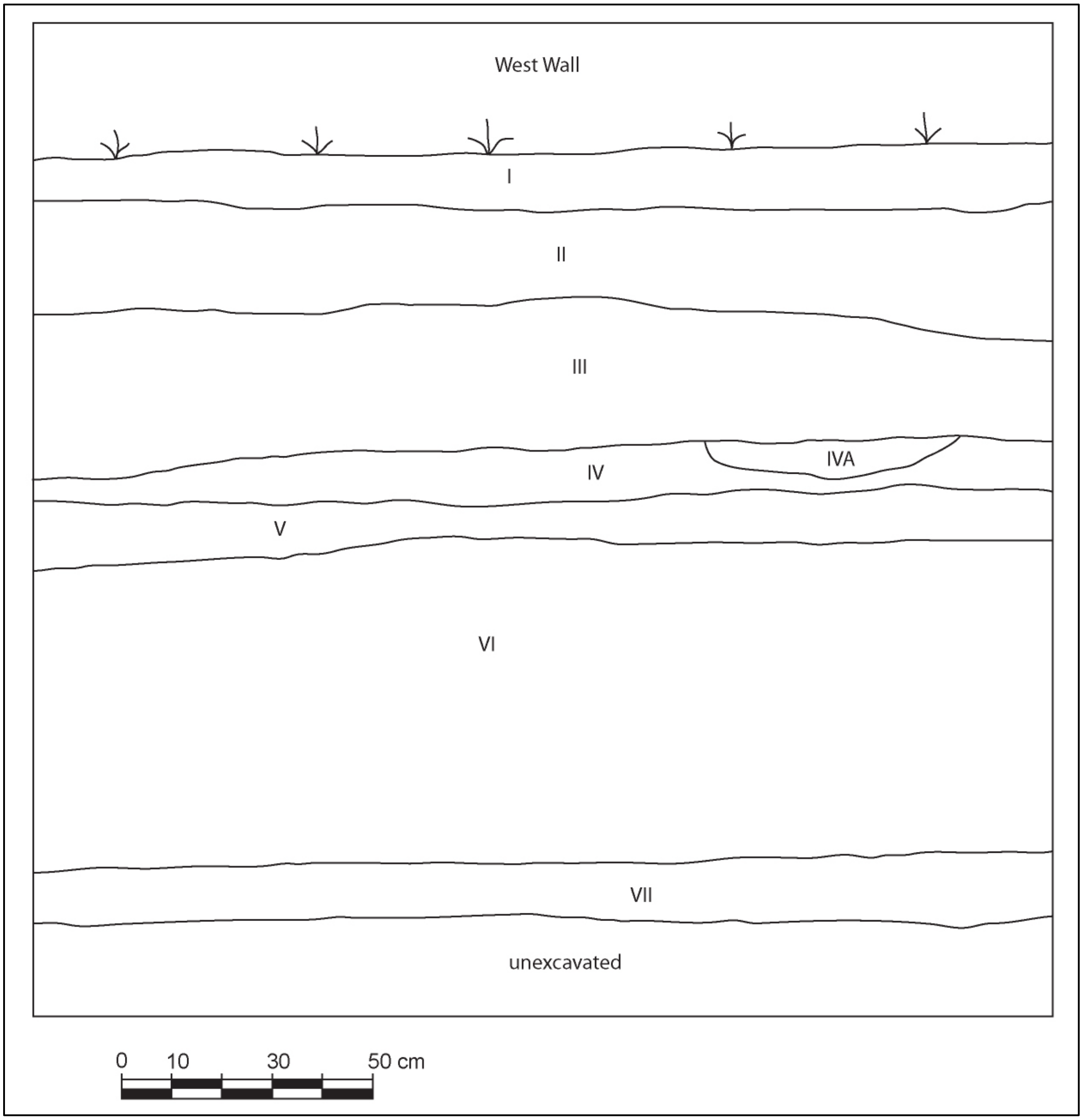


Figure 19. Trench 3, West Wall.

Trench 4 (Figure 20)

Layer I	0-10 cmbs	Very dark brown (10YR 2/2) loam; Weak medium blocky; slightly sticky, slightly plastic; abrupt smooth boundary
Layer II	10-29 cmbs	Very dark grayish brown (10YR 3/2) silty clay loam; moderate medium, granular; slightly sticky, slightly plastic; gradual smooth boundary; contains cinder.
Layer III	29-40 cmbs	Black (10YR 2/1) cinder; structureless, medium granular; non-sticky, non-plastic; abrupt, smooth boundary.
Layer IV	40-63 cmbs	Dark grayish brown (10YR 4/2) sandy loam; moderate medium granular; slightly sticky, slightly plastic; abrupt smooth boundary; contained concentration of ceramic tiles and basalt cobbles.
Layer V	63-74 cmbs	Dark brown (10 YR 3/3) loam; moderate medium platy; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer VI	74-112 cmbs	Very dark grayish brown (10YR3/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt smooth boundary; cultural layer containing charcoal and shell midden.
Layer VII	112-120 cmbs	Very pale brown (10YR 8/2) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.

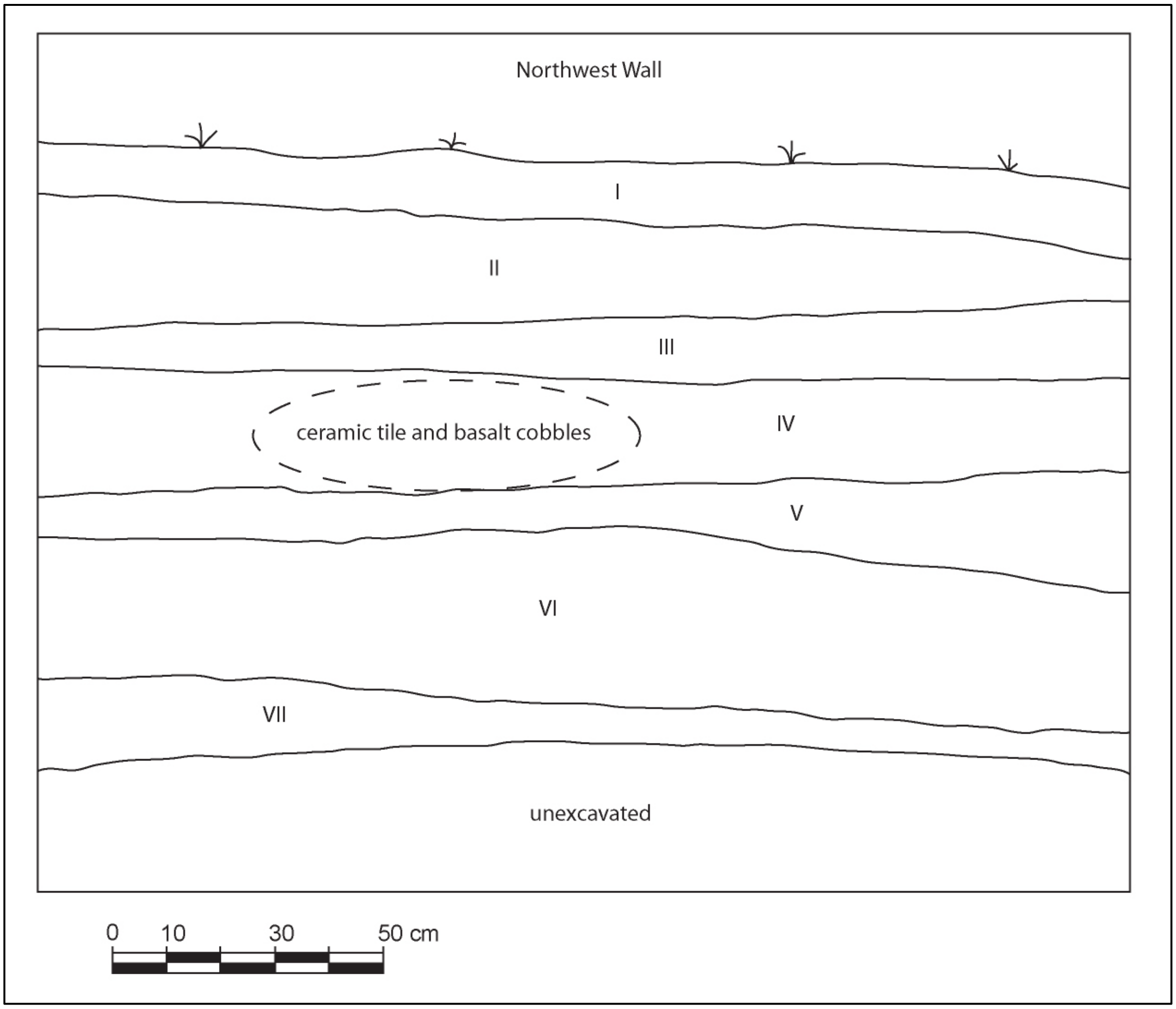


Figure 20. Profile of Trench 4, Northwest Wall.

Trench 5 (Figure 21)

Layer I	0-10 cmbs	Very dark brown (10YR 2/2) loam; weak medium blocky; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer II	10-44 cmbs	Dark brown (10YR 3/3) silt; structureless, medium, granular; non-sticky, non-plastic; abrupt smooth boundary; contains cinder.
Layer III	44-49 cmbs	Light gray (10YR7/1) sandy silt; moderate fine platy; non-sticky, non-plastic; abrupt smooth boundary; contains glass fragments.
Layer IV	49-54 cmbs	Brown (10YR 4/3) silty loam; moderate medium platy; non-sticky, non-plastic; abrupt wavy boundary.

Layer V	54-84 cmbs	Dark grayish brown (10YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual irregular boundary; cultural layer containing features and charcoal staining.
Layer VA	87-97 cmbs	Dark grayish brown (10YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual smooth boundary; cultural layer with charcoal staining.
Layer VI	80-87 cmbs	Vary pale brown (10YR 7/3) sand; structureless, fine granular; non-sticky, non-plastic; gradual smooth boundary; beach sand.
Layer VII	97-130 cmbs	Very pale brown (10YR 8/3) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.
Feature 1	87-120 cmbs	Grayish brown (10 YR 5/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt, irregular boundary; pit containing some charcoal staining, roots; probably a tree root-ball.
Feature 2	60-95 cmbs	Brown (10YR 5/3) sand; structureless, fine granular; non-sticky, non-plastic; possible post hole containing charcoal flecking.
Feature 3	50-65 cmbs	Dark grayish brown (10 YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt smooth boundary; pit containing charcoal and midden.

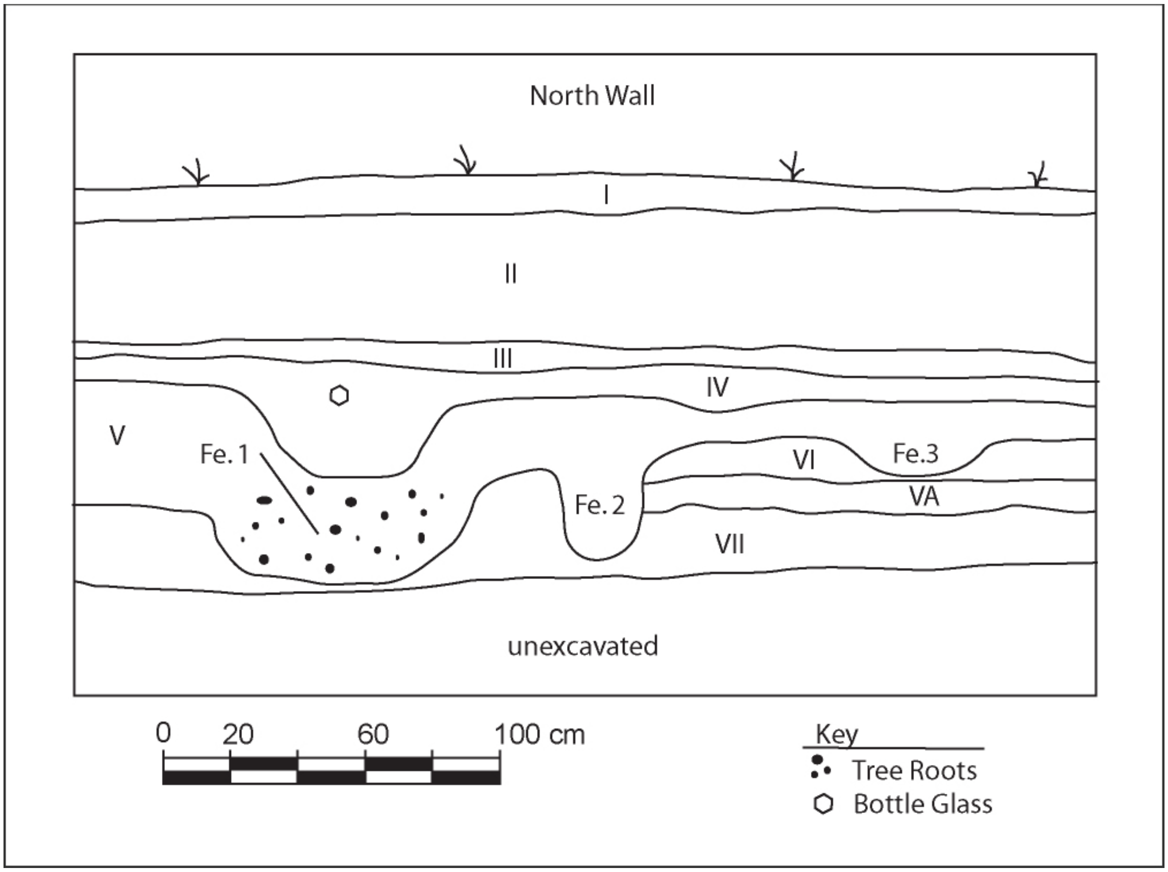


Figure 21. Profile of Trench 5, North Wall.

Trench 6 (Figure 22)

Layer I	0-10 cmbs	Brown (10YR 4/3) sandy loam; weak, fine granular; non-sticky, non-plastic; abrupt, smooth boundary.
Layer II	10-42 cmbs	Dark yellowish brown (10YR 3/ 4) sandy silt; weak medium granular; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer III	42-50 cmbs	Dark yellowish brown (10YR 3/ 4) loam; moderate medium, platy; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer IV	50-80 cmbs	Dark grayish brown (10YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt wavy boundary; cultural layer containing features and charcoal staining.
Layer V	80-107 cmbs	Very pale brown (10YR 8/3) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.
Feature 4	80-95 cmbs	Dark grayish brown (10 YR 4/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt irregular boundary; pit containing charcoal staining and flecking.
Feature 5	79-100 cmbs	Grayish brown (10 YR 5/2) sand; structureless, fine granular; non-sticky, non-plastic; gradual irregular boundary; pit containing charcoal staining and flecking.

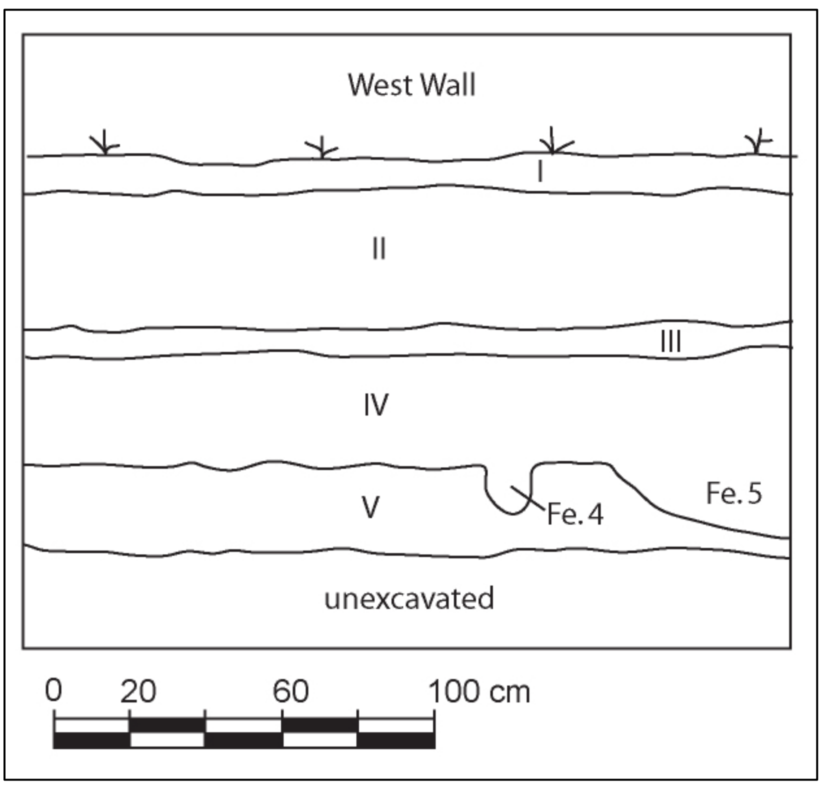


Figure 22. Profile of Trench 6, West Wall.

Trench 7 (Figure 23)

Layer I	0-9 cmbs	Brown (10YR 4/3) sandy loam; weak, fine granular; non-sticky, non-plastic; abrupt, smooth boundary.
Layer II	9-52 cmbs	Very dark grayish brown (10YR 3/2) silty loam, moderate medium, blocky; non-sticky, non-plastic; clear smooth boundary; fill with cinder.
Layer III	52-60 cmbs	Brown (10YR 4/3) clay loam; moderate medium, platy; non-sticky, non-plastic; abrupt smooth boundary.
Layer IV	60-95 cmbs	Very pale brown (10YR 7/4) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.

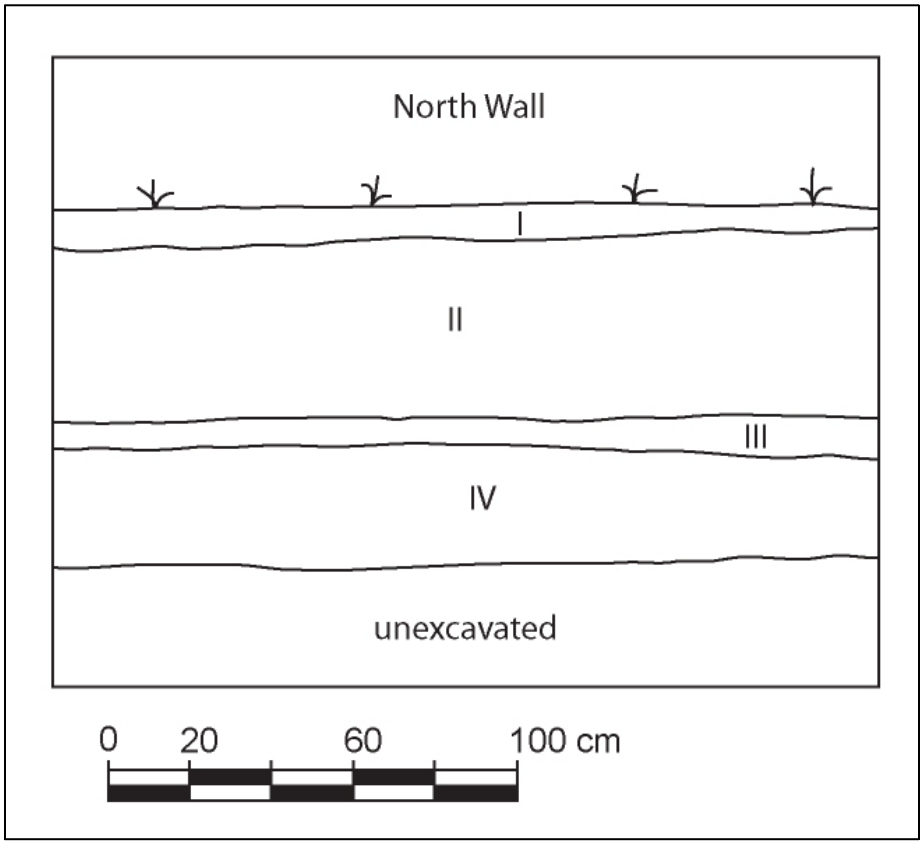


Figure 23. Profile of Trench 7, North Wall.

Trench 8 (Figure 24)

Layer I	0-10 cmbs	Very dark brown (10YR 2/2) sandy loam; structureless, fine granular; non-sticky, non-plastic; abrupt, smooth boundary.
Layer II	10-35 cmbs	Dark brown (10YR 3/3) silty clay; weak medium granular; slightly sticky, slightly plastic; abrupt smooth boundary; contains some cinder.
Layer III	35-58 cmbs	Yellowish brown (10YR 5/4) sandy loam; structureless, fine granular; non-sticky, non-plastic; clear smooth boundary; fill.
Layer IV	58-65 cmbs	Dark yellowish brown (10YR 3/ 4) silty loam; strong, medium, blocky; sticky, plastic; clear smooth boundary; contains some charcoal flecking.
Layer V	65-75 cmbs	Yellowish brown (10YR 5/4) sandy silt; weak, fine granular; non-sticky, non-plastic; abrupt smooth boundary.
Layer VI	75-110 cmbs	Very dark gray (10YR 3/1) sand; structureless, fine granular; non-sticky, non-plastic; gradual, wavy boundary; cultural layer containing charcoal staining and marine shell midden.
Layer VII	100-130 cmbs	Very pale brown (10YR 8/4) sand; structureless, fine granular, non-sticky, non-plastic; beach sand.

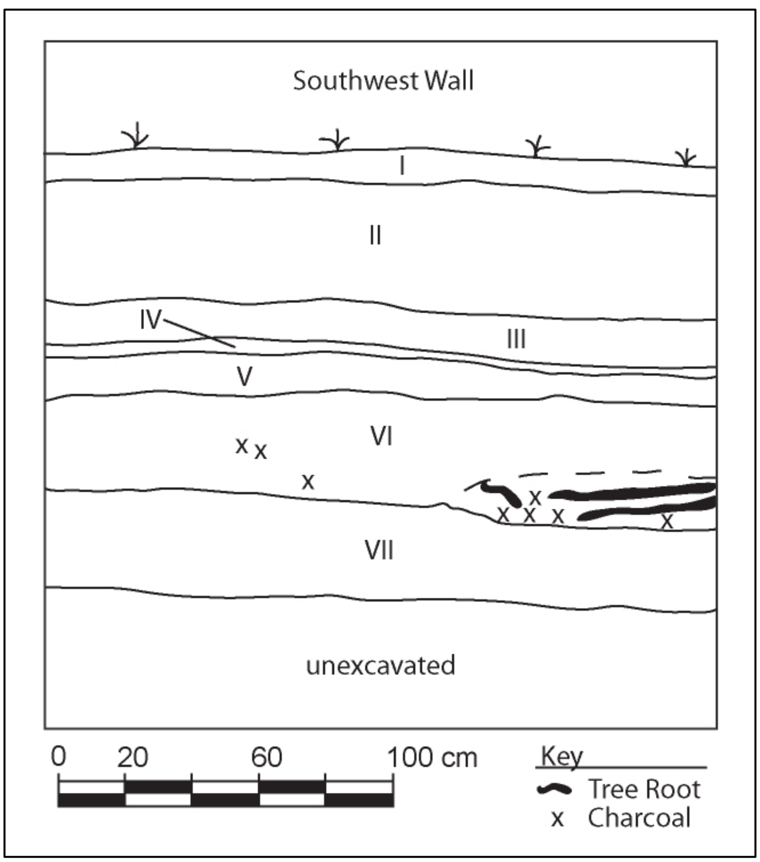


Figure 24. Trench 8 profile.

Trench 9 (Figure 25)

Layer I	0-10 cmbs	Dark yellowish brown (10YR 4/4) silty sand; weak fine granular; non-sticky, non-plastic; clear smooth boundary.
Layer II	10-67 cmbs	Very dark grayish brown (10YR 3/2) sandy silt; structureless, medium granular; non-sticky, non-plastic; clear smooth boundary.
Layer III	36-59 cmbs	Dark yellowish brown (10YR 4/4) silty loam; weak, medium platy; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer IV	53-75 cmbs	Very dark brown (10YR 2/2) sandy silt; structureless, fine granular; non-sticky, non-plastic; abrupt smooth.
Layer V	75-120 cmbs	Very pale brown (10YR 8/2) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.
Feature 6	75-102 cmbs	Very dark brown (10YR 2/2) sandy silt; structureless, fine granular; non-sticky, non-plastic; historic pit feature containing bottle glass, and ceramic earthenware.

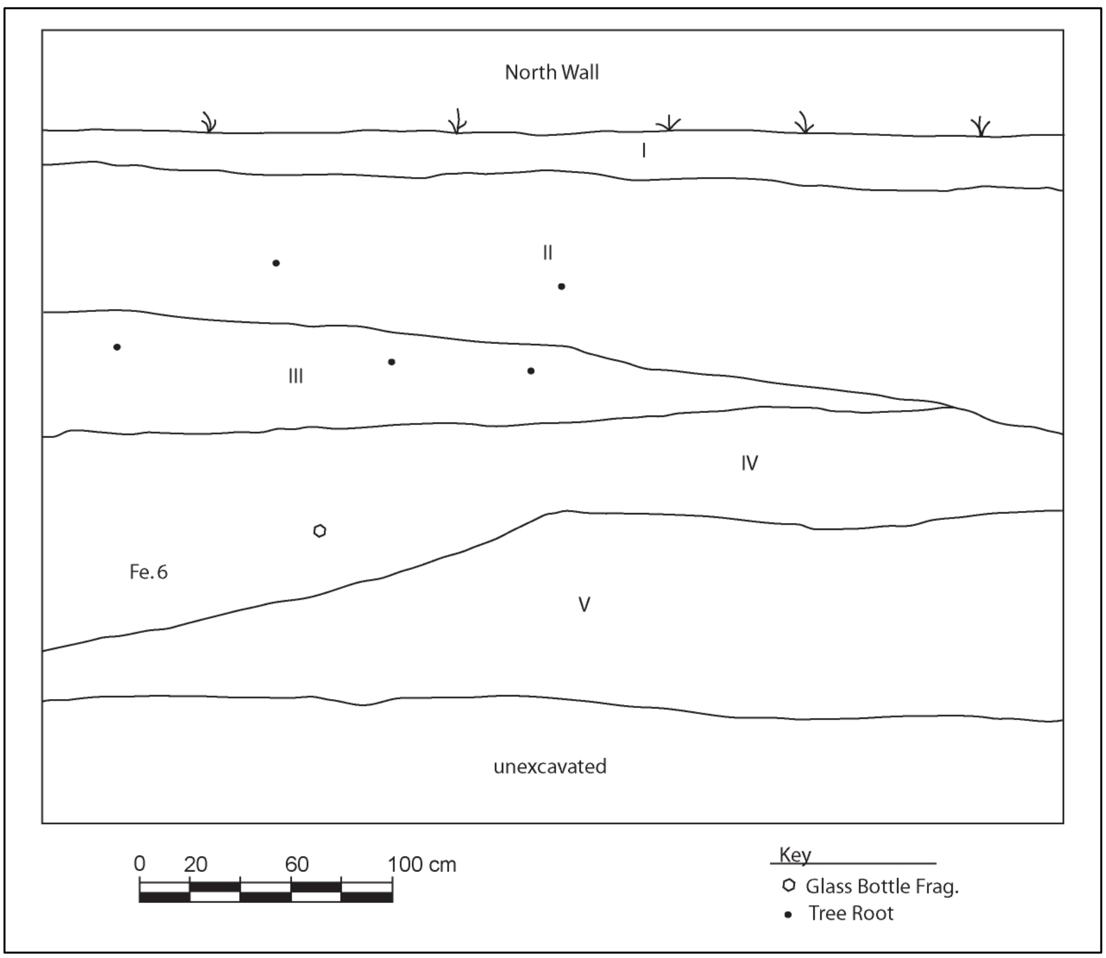


Figure 25. Trench 9 profile.

Trench 10 (Figure 26)

Layer I	0-18 cmbs	Yellowish brown (10 YR5/4) silty sand; structureless, fine granular; non-sticky, non-plastic; clear smooth boundary.
Layer II	18-58 cmbs	Dark brown (10YR 3/3) silty clay loam; weak medium granular; slightly sticky, slightly plastic; clear smooth boundary.
Layer III	58-70 cmbs	Dark yellowish brown (10YR 4/6) silty loam; moderate, medium platy; slightly sticky, slightly plastic; abrupt smooth boundary.
Layer IV	70-90 cmbs	Very pale brown (10YR 8/2) sand; structureless, fine granular; non-sticky, non-plastic; clear smooth boundary; beach sand.
Layer IVA	90-95 cmbs	Very pale brown (10 YR 8/2) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.
Layer V	90-100 cmbs	Light brownish gray (10YR 6/2) sand; structureless, fine granular; non-sticky, non-plastic.

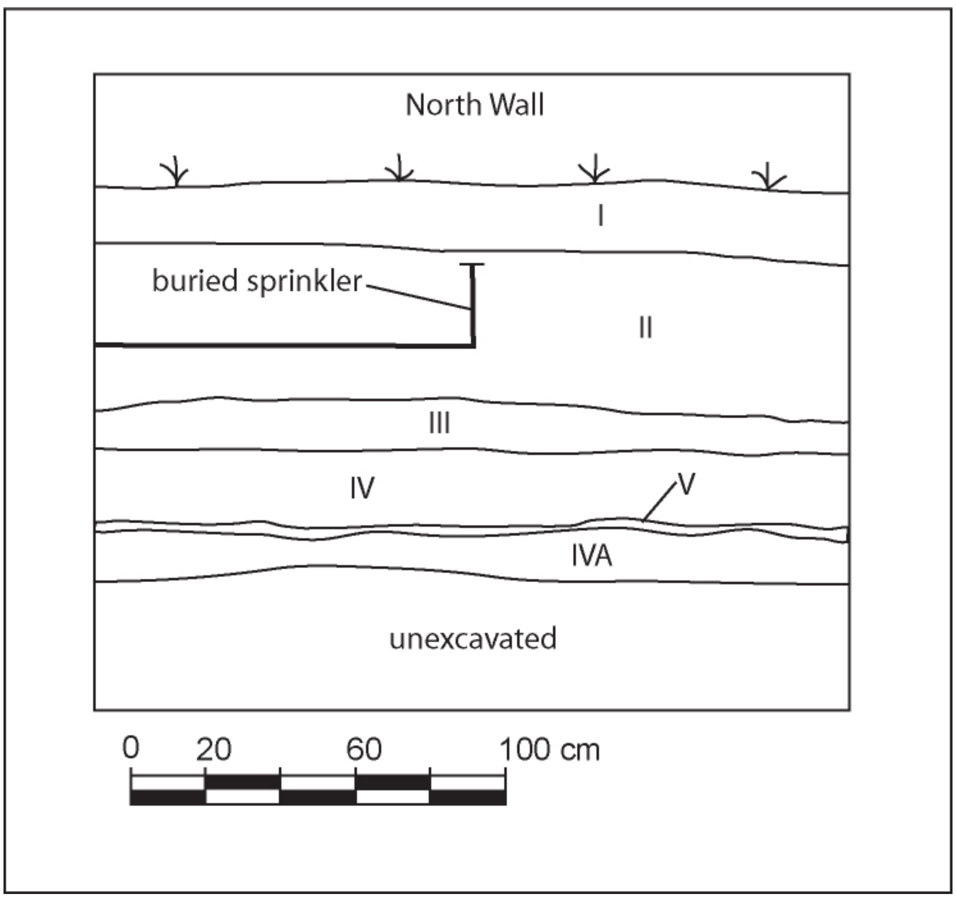


Figure 26. Trench 10 profile.

Trench 11 (Figure 27)

Layer I	0-21 cmbs	Dark brown (10 YR 3/3) clay loam; moderate medium platy; slightly sticky, slightly plastic; clear smooth boundary.
Layer II	21-60 cmbs	Very dark brown (10 YR 2/2) silty clay; weak, medium blocky; slightly sticky, slightly plastic; abrupt smooth boundary; contains cinder.
Layer III	58-105 cmbs	Pale brown (10 YR 6/3) sand; structureless, fine granular; non-sticky, non-plastic; clear smooth boundary; slightly stained but not cultural in nature.
Layer IV	65-120 cmbs	Very pale brown (10 YR 8/5) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.

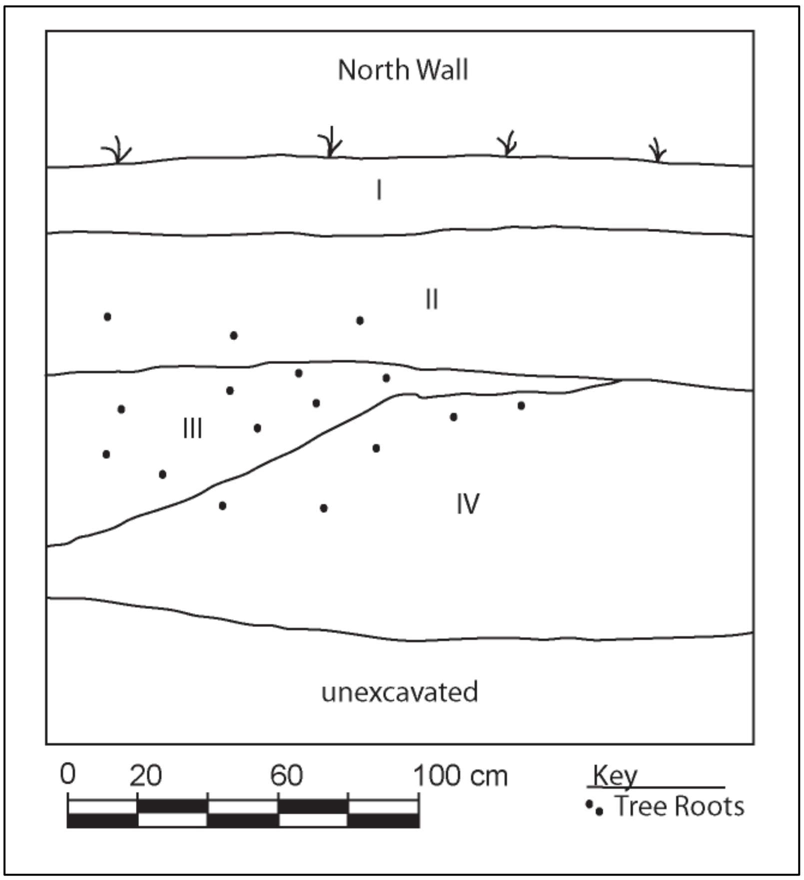


Figure 27. Profile of Trench 11.

Trench 12 (Figure 28)

Layer I	0-15 cmbs	Very dark brown (10 YR 2/2) clay loam; moderate medium platy; slightly sticky, slightly plastic; clear smooth boundary.
Layer II	10-70 cmbs	Dark brown (10YR 3/3) silty clay; weak, medium granular; slightly sticky, slightly plastic; clear smooth boundary.
Layer III	70-80 cmbs	Dark yellowish brown (10 YR 3/6) clay loam; moderate medium platy; sticky, plastic; abrupt smooth boundary.
Layer IV	76-100 cmbs	Grayish brown (10 YR 5/2) sand; structureless, fine granular; non-sticky, non-plastic; abrupt, smooth boundary; no cultural material preset.
Layer V	90-110 cmbs	Black (10 YR 2/1) sand; structureless, fine granular, non-sticky, non-plastic; clear wavy boundary; cultural layer containing feature, charcoal, and midden.
Layer VI	110-14 cmbs	Very pale brown (10 YR 8/2) sand; structureless, fine granular; non-sticky, non-plastic; beach sand.
Feature 7	95-122 cmbs	Black (10 YR 2/1) sand; structureless, fine granular; non-sticky, non-plastic; pit containing charcoal, midden and fish scales.

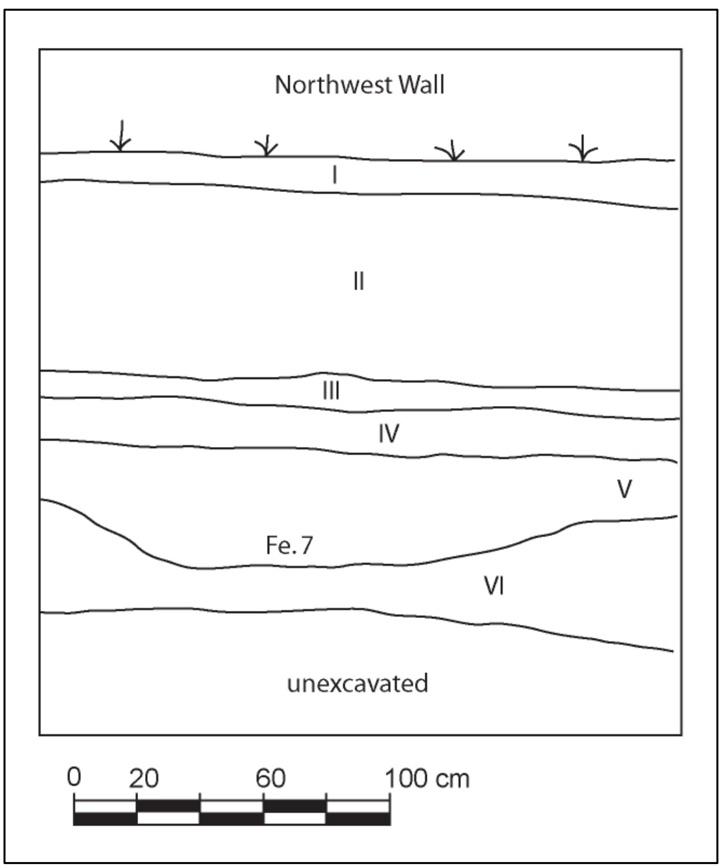


Figure 28. Trench 12 profile.

5.4 FEATURE DESCRIPTIONS

The seven features identified as being associated with SIHP Site No. 7211 are described below, Tabulated in Table 1, and their spatial distribution is shown in Figure 13.

Feature 1
Feature 1 was located within Trench 5 and was present within both the North and South walls of the trench. This pit feature measured 80 cm wide and 33 cm thick. The top of the feature began 87 cm below surface and extended to 120 cm below surface. Numerous tree roots were present within the feature. The pit-like shape contained a grayish brown soil but no cultural material. Feature 1 is located within Layer V and is overlaid by the Layer IV fill. This is likely the remains of a tree root ball.

Feature 2
Feature 2 (Figure 29) was located within Trench 5 and present in the North wall. This feature originated in Layer V and measured 22 cm wide and 35 cm thick. The top of the feature was at 80 cm below surface and extended to 110 cm below surface. The pit contained brown sand with charcoal flecking. No midden or historic materials were observed within the feature. Feature 2 may have functioned as a posthole.

Feature 3
Feature 3 (Figure 29) was located within Trench 5 and present within the North wall. It measured 43 cm wide and 15 cm thick and originated in Layer V, 70 cm below surface and extended to 85 cm below surface. This shallow pit contained charcoal staining, charcoal and midden. No historic material was observed within the pit.

Feature 4
Feature 4 is a small pit located within Trench 6. This feature measured 15 cm wide and 15 cm deep. Originating within Layer IV the top of the feature was 80 cm below surface and extended to 95 cm below surface. The feature, which was observed only in the West wall, contained charcoal staining and flecking but no midden or artifacts. The function of this pit is undetermined.

Feature 5
Feature 5 is a shallow pit located within the West wall of Trench 6. The northern portion of the feature extended into the unexcavated portion of the trench. As a result, Feature 5 measured at least 44 cm wide and 21 cm thick. Originating within Layer IV the top of the feature was 80 cm below surface extending to 101 cm below surface. This feature contained charcoal staining and flecking but no midden or artifacts. This feature appears to have been a firepit.

Table 1. Summary of Features Identified

Feature Number	Trench Location	Feature Type
1	5	Probably the remains of a tree root ball. No midden or artifacts found
2	5	Possibly a post mold. No midden or artifacts found
3	5	Possible fire pit. Contained charcoal staining, charcoal, midden, no artifacts.
4	6	Small pit of undetermined function. Contained charcoal staining and flecking but no midden or artifacts.
5	6	Possible fire pit. Contained charcoal flecking and staining, but no midden or artifacts.
6	9	Probably a historic trash pit. Contained a glass bottle fragment and several earthenware ceramic fragments.
7	12	Probable firepit. Contained charcoal staining, charcoal. shell midden, fish scales, non-human mammal bone. Also collected from the backdirt but not necessarily associated directly with this feature was a broken basalt hammerstone.

Figure 29. Trench 5, Features 2 (left) and 3 (right).

Feature 6
Feature 6 (Figure 30) was located within Trench 9 and observed only in the North wall. The west end of the feature extended into the unexcavated portion of the trench. This feature originated in Layer IV with the top beginning at 78 cm below surface and the base extending to 103 cm below surface. Overall, the feature measured at least 100 cm wide and 27 cm deep. A glass bottle fragment was observed in the pit along with several earthenware ceramic fragments. This feature likely functioned as a historic trash pit.

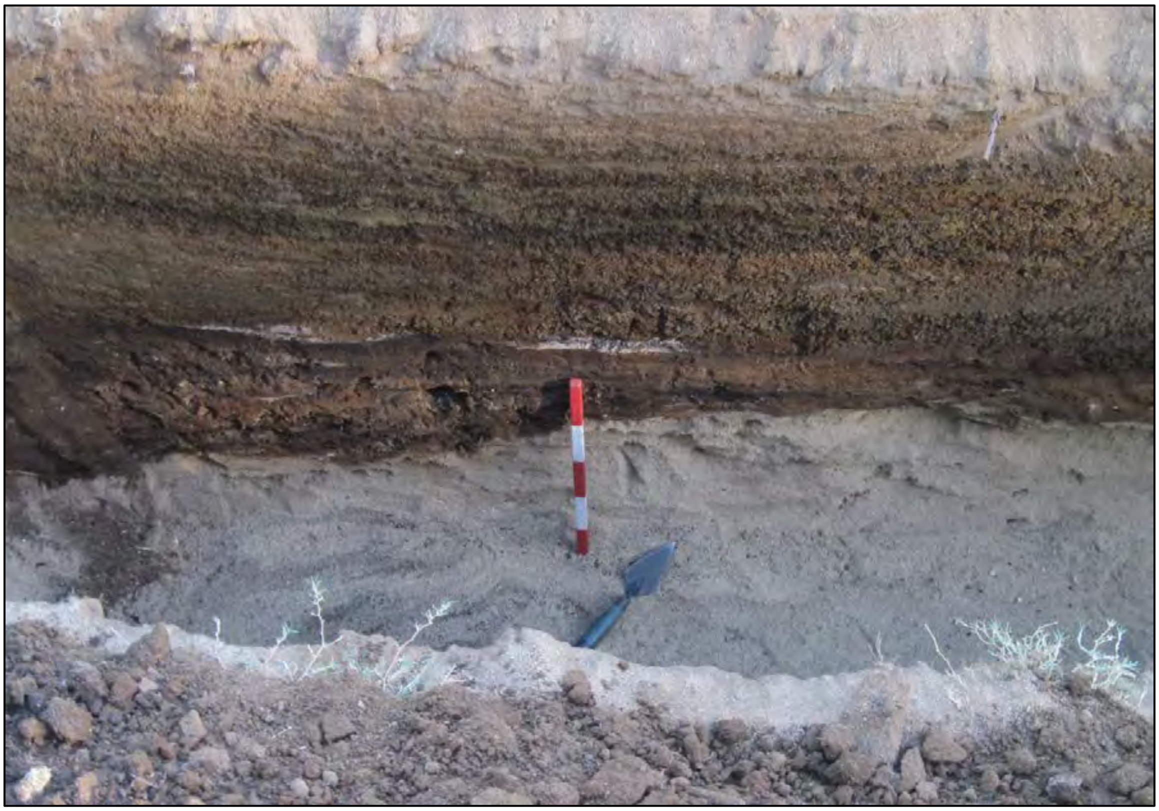


Figure 30. Trench 9, Feature 6.

Feature 7

Feature 7 (Figure 31) was located within Trench 12 and observed in both the West and East walls. This feature originated within Layer V with the top of the feature 98 cm below surface and extending to 125 cm below surface. The feature consisted of black sand with charcoal, marine shell midden and fish scales. Fire-cracked rock and a medium mammal (non-human) long bone were present within the feature. Also collected from the backdirt pile but not associated directly with this feature was a broken basalt hammerstone. No historic material was observed. Feature 7 is believed to be a traditional firepit.

Figure 31. Trench 12, Feature 7.

6.0 LABORATORY ANALYSES

6.1 ARTIFACT ANALYSES

Three traditional artifacts were recovered during the excavations along with several historic glass and nail fragments. The traditional artifacts included a small jabbing pearlshell fishhook recovered from STP 5, Layer III and measures 1.2 cm long, 0.8 cm wide and weighs 0.1 grams (Figure 32). Also identified in the same STP were four volcanic glass flakes and a single basalt flake (Table 2).

A coral abrader (Figure 33) was recovered from Layer III in STP 14. The abrader measures 4.6 cm long, 3.2 cm wide, 2.7 cm thick and weighs 30.7 grams. The artifact is rounded on one end and was likely used to sharpen or finish fishhooks like the pearl fishhook recovered from STP 5.

A third traditional artifact, a basalt hammerstone fragment (Figure 34), was identified during trenching activities but was recovered from the backdirt pile. Thus no provenience can be established for it. The hammerstone fragment measures 5.5 cm long, 5 cm wide and weighs 141 grams (Table 3).

A single historic artifact (a glass perfume bottle) was recovered from Trench 9, Feature 6 (Figure 35). This ornate clear glass and measures 5.8 cm long and 4.2 cm wide (Table 3). A series of ridges extend vertically up the side of the bottle and exhibit some grinding and cutting. The base is flat with no footing or makers marks. The bottle was likely made between the late 1800's and early 1900s.

Artifactual material such as metal nails, window and bottle glass fragments were also dispersed throughout the project area but were mainly identified in STP's 1-4. These remains are tied to the use of the area during the early 20th century.

Concrete and metal debris was recovered from STPs 17, 18, 20 and 21. These items were consistent with the concrete and metal used in the construction of the Natatorium itself and appear to have been deposited as fill fronting the wall making up the promenade. These deposits are associated with the Natatorium itself as are designated part of site 50-80-15-9701

Figure 32. A jabbing pearlshell fishhook recovered from STP 5.

Figure 33. Coral abrader recovered from STP 14.

Figure 34. Hammerstone fragment recovered from backdirt at Trench 12.

Figure 35. Decorative perfume bottle recovered from Feature 6, Trench 9.

Table 2. Artifacts Recovered From the Shovel Test Pits

Cat. #	Location	Layer/ Feature	CMBS	Category/ Material	Manufacture Style	Description	Qty	L (cm)	W (cm)	Wt. (g)	Condition	Comments
1	STP 1	II	60	Glass	Historic	Bottle, fragment	1			2.4	Poor	Clear glass bottle base fragment. Outside is very worn.
2 (A)	STP 2	III	57	Glass	Historic	Bottle, fragment	1			1.4	Poor	Amber glass bottle finish fragment. Likely from a beer bottle.
2 (B)	STP 2	III	57	Metal	Historic	Nail, Wire, fragments	1,1			5.6	Poor	Rusted metal nail and wire.
3	STP 3	II	50	Glass	Historic	Bottle, fragment	1			3.1	Poor	Amber glass bottle fragment.
4 (A)	STP 4	III	60	Glass	Historic	Window, fragment	1			0.7	Fair	Clear glass fragment. Likely window pane.
4 (B)	STP 4	III	60	Metal	Historic	Nail, fragment	1			1.3	Poor	Rusted metal nail fragment.
5	STP 4	III	70 - 80	Volcanic Glass	Traditional	Volcanic Glass, fragment	1			0.7	Fair	Volcanic glass fragment.
6	STP 4	III	70 - 80	Glass	Historic	Window, fragments	2			1.4	Fair	Clear glass fragments. Likely window pane.
7	STP 4	III	70 - 80	Lava	Natural	Lava Drip	1			2	Fair	Lava drip.
8	STP 4	III	70 - 80	Metal	Historic	Nail, fragments	5			10.8	Poor	Rusted metal nail fragments.
10	STP 5	III	80 - 90	Stone (Basalt)	Traditional	Basalt, flake	1			8.3	Fair	Basalt flake.
11 (A)	STP 5	III	80 - 90	Volcanic Glass	Traditional	Volcanic Glass, flake	1			0.6	Fair	Volcanic glass flake.
11 (B)	STP 5	III	80 - 90	Volcanic Glass	Traditional	Volcanic Glass, flake	1			0.2	Fair	Volcanic glass flake.
12	STP 5	III	80 - 90	Shell	Traditional	Shell, fish hook	1	1.2	0.8	0.1	Good	One piece, point slightly curved, unbarbed shell fish hook. IA(1).
13 (A)	STP 5	III	80 - 90	Volcanic Glass	Traditional	Volcanic Glass, flake	1			0.7	Fair	Volcanic glass flake.
13 (B)	STP 5	III	80 - 90	Volcanic Glass	Traditional	Volcanic Glass, flake	1			0.3	Fair	Volcanic glass flake.
17	STP 7	V	60-80	Glass	Historic	Bottle fragments	2			1.7	Poor	
19	STP 10	II	15	Button	Modern	Shell	2			0.4	Fair	
37	STP 14	III	50-75	Coral	Traditional	Abrader	1	4.6	3.2	30.7	Fair	Coral Abrader

Table 3. Artifacts Recovered From Test Trenches

Cat. #	Location	Layer/ Feature	CMBS	Category/ Material	Manufacture Style	Description	Qty	L (cm)	W (cm)	Wt. (g)	Condition	Comments
34	TR 9	IV / Fe. 6	95	Glass	Historic	Decorative Fragment	1	5.8	4.2	46	Fair	Possible perfume bottle
36	TR 12	-	-	Basalt	Traditional	Hammerstone	1	6	5	141	Fair	Collected from the backdirt pile

6.2 RADIOCARBON DATING

A charcoal sample collected from STP 5 (80-90 cm below surface) was submitted to the Wood Identification Laboratory at the International Archaeological Research Institute, Inc. for charcoal identification. This sample was collected from the screen and directly associated with the pearlshell fishhook recovered in the same screen-full of soil. The sample contained four different types of wood --three native species from Hawaiʻi and a Polynesian introduction (Table 4 and Appendix B). The sample of *ʻaʻaliʻi* was submitted to Beta Analytic, Inc. for radiocarbon dating because this short lived species would provide the most accurate radiocarbon date.

Table 4. Taxa Identified During Wood Identification

WIDL No.	Scientific Name	Common/Hawaiian Name	Origin/Habit	Part	Count/ Weight (g)
1125-1	*Aleurites moluccana*	Kukui, candlenut tree	Polynesian introduction/Tree	Nutshell	1/0.06
1125-2	cf. *Rauvolfia sandwicensis*	*Hao*	Native/Tree	Wood	3/0.18
1125-3	cf. *Osteomeles anthyllidifolia*	*ʻŪlei*	Native/Shrub	Wood	2/0.18
1125-4	cf. *Dodonaea viscosa*	*ʻAʻaliʻi*	Native/Shrub	Wood	3/0.07

The carbon sample was quite small so that accelerator mass spectrometry (AMS) radiocarbon dating was necessary. AMS dating at Beta Analytic includes $^{13}C/^{12}C$ analysis, so all samples were adjusted based on the ^{13}C / ^{12}C ratio.

The pretreatment for the AMS dating charred material samples consisted of acid/alkali/acid washes where the sample was first gently crushed and dispersed in deionized water. It was then given hot acid washes to eliminate carbonates, then alkali washes to remove secondary organic acids, then a final acid rinse to neutralize the solution prior to drying. During these serial rinses, mechanical contaminants such as associated sediments and rootlets were eliminated.

The results of the radiocarbon dating are summarized in Table 5; Appendix C presents the data sheets. The sample returned a date of 330 $\pm$ 30 and calibrated at 2 standard deviations to AD 1460 to 1650. This places the date of the layer within the mid to late pre-Contact period of Hawaiʻi.

Table 5. Radiocarbon Dating Results

Sample No.	SIHP No. (50-50-xx-xxxx) & Provenience	Material	Measured Radiocarbon Age	$^{13}C/^{12}C$ Ratio	^{13}C Conventional Age B.P.	Calibrated Age[1] (one sigma)	Calibrated Age[2] (two sigma)
Beta 3308137	Site 7211 STP 5; III 80-90 cm bs	Charred material cf. *Dodonaea viscose; ʻAʻali*ʻ	340 $\pm$ 30 BP	-25.5 o/oo	330 $\pm$ 30	AD 1490 - 1600 AD 1610 – 1640	AD 1460 – 1650

6.3 Midden Analysis

A small quantity marine midden (158.1 g) was recovered from four STPs (5, 7, 14 and 15) and from Trench 12, Feature 7 (Tables 6 – 10). The midden from all three units was derived from shallow offshore waters as well as inland march areas. These were varieties of marine resources that were traditionally collected and consumed by the Native Hawaiians. By far the largest collection of midden was represented by Gastropods. These were collected along the rocky shore line and were a common staple in the Native Hawaiian diet. Bivalves are also minimally represented in the collections and could be collected just offshore in the sandy substrates or in slightly brackish waters which were located within the marsh lands of Kapiʻolani Park.

Table 6. Midden Identified from STP 5, Layer III

SAMPLE	WEIGHT (g)
Bivalvia	
Isognomonidae spp.	2.0
Lucinidae spp.	0.2
Mytilidae spp.	1.2
Tellinidae spp.	2.2
Echinodermata	
Unidentified Echinodermata	0.4
Gastropoda	
Conidae spp.	2.5
Cypreaidae spp.	6.2
Nerita polita	0.5
Patellidae spp.	0.1
Turbinidae spp. w/operculum	17.5
Unidentified Gastropoda	0.3
TOTAL WEIGHT	**33.1 grams**

Table 7. Midden identified from STP 7, Layer V

SAMPLE	WEIGHT (g)
Bivalvia	
Lucinidae spp.	0.7
Mytilidae spp.	3.6
Tellinidae spp.	1.5
Echinodermata	
Unidentified Echinodermata	1.2
Gastropoda	
Conidae spp.	0.5
Turbinidae spp.	4.3
Fissurellidae spp.	3.4
TOTAL WEIGHT	**16.7 grams**

Table 8. Midden identified from STP 14, Layer III

SAMPLE	WEIGHT (g)
Bivalvia	
Lucinidae spp.	0.4
Gastropoda	
Conidae spp.	9.7
Nerita polita	0.8
Patellidae spp.	0.4
Turbinidae spp. w/operculum	22.1
Unidentified Gastropoda	0.8
TOTAL WEIGHT	**34.2 grams**

Table 9. Midden recovered from STP 15, Layer III

SAMPLE	WEIGHT (g)
Bivalvia	
Isognomonidae spp.	1.3
Lucinidae spp.	0.5
Mytilidae spp.	1.4
Tellinidae spp.	
Echinodermata	
Unidentified Echinodermata	1.8
Gastropoda	
Conidae spp.	18.3
Cypreaidae spp.	2.8
Nerita polita	0.3
Patellidae spp.	6.9
Turbinidae spp. w/operculum	16.1
Unidentified	11.8
TOTAL WEIGHT	**61.2 grams**

Table 10. Midden Identified from Trench 12, Feature 7

SAMPLE	WEIGHT (g)
Gastropoda	
Cypreaidae spp.	3.0
Nerita picea	0.2
Patellidae spp.	0.2
Turbinidae spp.	5.3
Unidentified Gastropoda, operculum	1.4
Unidentified Shell	2.5
TOTAL SHELL WEIGHT	**12.6 grams**
Fish Scales	0.3
TOTAL WEIGHT	**12.9 grams**

7.0 SIGNIFICANCE

The State of Hawaiʻi has developed a system for evaluating significance of historic properties under Hawaiʻi Administrative Rules Title 13 Chapter 284 (HAR §13-275-6, Rules Governing Procedures for Historic Preservation Review for Governmental Projects covered under sections 6E-7 and 6E-8). This system is patterned after Federal Regulations 36 CFR §60.4 and is meant to provide a framework for the evaluation of significance.

> To be significant, a historic property shall possess integrity of location, design, setting, materials, workmanship, feeling, and association and shall meet one or more of the following criteria as defined in HAR §13-275-6:
>
> Criterion "a" Be associated with events that have made an important contribution to the broad patterns of our history;
>
> Criterion "b" Be associated with the lives of persons important in our past;
>
> Criterion "c" Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;
>
> Criterion "d" Have yielded, or is likely to yield, information important for research on prehistory or history; or
>
> Criterion "e" Have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts--these associations being important to the group's history and cultural identity.

7.1 ASSESSMENTS OF INTEGRITY

While the War Memorial Natatorium (50-80-14-9701) continues to become extremely deteriorated, it still retains may aspects of integrity. The Natatorium retains its integrity of location as it is still in the place where it was constructed and where important social and recreational events took place. The Natatorium also retains its integrity of design; the original design of the structure has been maintained, though some aspects are now deteriorated. The Natatorium also retains integrity of setting, materials, workmanship, feeling, and association.

Evaluating the integrity of a buried Pre-Contact cultural deposit (Site 50-80-14-7211 is a little more difficult. Site 7211 does retain integrity aspects of materials and association as it contains faunal (marine shell) and floral (charcoal) remains in association with artifacts (shell fishhook).

It also retains its integrity of location, as it the deposit remains in the area where it was originally developed. This site does not maintain it integrity of design, setting, materials, workmanship, feeling, and association.

7.2 Assessments of Significance

7.2.1 War Memorial Natatorium (Site 50-80-14-9701)

The significance of the War Memorial Natatorium has been recognized by it listing in both the Hawaiʻi Register of Historic Places and the National Register of Historic Places. However, the NRHP nomination form that was filled out in 1979 did not specify the qualifying significance criteria. The Natatorium is currently assessed as significant under the following criteria:

Criterion "a" It is associated with events that have made an important contribution to the broad patterns of our history. This structure was constructed as a "living memorial" to Hawaiʻi men and women who participated in World War I. Annual ceremonies are held to commemorate this. The Natatorium was also the site of national swimming competitions that were important to the social and recreations aspects of Hawaiʻi's citizenry.

Criterion "b" The Natatorium is associated with the lives of persons important in our past. World-renowned swimmers swam and competed in the Natatorium pool, including Duke Kahanamoku, Johnny Weissmuller, and "Buster" Crabbe.

Criterion "c" The Natatorium was rendered in a Beaux-Arts style, which was typical of the period when it was constructed. It presents a striking monumental image within an open lawn, beach, and ocean settling.

Criterion "e" The War Memorial Natatorium has value to all Americans and especially those form Hawaiʻi, as well as the descendants of World War I participants from Hawaiʻi. This value is manifested in two annual ceremonies – Veteran's Day and Memorial Day

7.2.2 Pre-Contact Cultural Deposit (Site 50-80-14-7221)

Site 50-80-14-7211 is assessed as significance based on the following criteria:

Criterion "d" This cultural deposit has already yielded information important to our history. It has yielded artifactual, faunal, and floral remains that have provided a glimpse into the Pre-Contact life in this portion of Waikiki. The cultural deposit is in a relatively intact condition, thus having the potential to yield additional important information.

Criterion "e" This site is important to Native Hawaiians as a remnant of their ancient history in the Waikiki. I provides an appreciation and admiration for their forbearers.

8.0 SUMMARY, DISCUSSION, AND RECOMMENDATIONS

Pacific Legacy Inc., under contract to WCP Inc., conducted an AIS at the WWMC in the *ahupuaʻa* of Waikīkī, island of Oʻahu, Hawaiʻi. (TMK: (1) 3-1-31). The archaeological investigations were conducted to support the EIS for the proposed changes to the WWMC.

The use of the area during the early 20th century has been well documented. Nearly the entire coastline from Diamond Head to the present day aquarium contained a residence of some sort. As we see today, people have always enjoyed living near the ocean and the Kapiʻolani Park area provided a beautiful landscape for those who lived there.

During historic times, the project area was initially extensively modified in 1899 with the construction of the W. G. Irwin residence. This mansion was demolished in 1921 for the construction of the War Memorial Natatorium, which still exists today, albeit in deteriorated condition.

At the initiation of the subsurface archaeological survey, the areas to be tested were first investigated using Ground Penetrating Radar (GPR) to identify voids that might have been interpreted as human burials. It should be noted again that the entire area grass area of the Waikīkī War Memorial Complex was not surveyed using the GPR. Only the sections where subsurface survey was conducted was investigated. Although no voids that might contain human remains were noted during the GPR survey and none were found during the subsurface archaeological survey, there is still the possibility that human remains could be present within the project area.

Ten shovel test pits and 12 backhoe trenches were excavated during 2011 excavations. Seven subsurface features were identified within the trenches and a discontinuous cultural layer was also documented in most of the excavations. A single marine shell fishhook was identified in STP 5. A charcoal sample from the layer returned a calibrated date of AD 1460 to 1650. The cultural layer and features has been designated as Site 50-80-14-7211.

The cultural layer is discontinuous and does not appear in all of the trenches. Interestingly, the cultural layer is not present in Trenches 7, 10 and 11 which were all located in the area where the Kodak Hula Show was formerly located. This area was probably filled and leveled to provide a surface for the hula dancers. Any remnants of the cultural layer that may have been present were likely removed during these activities.

The 2018 excavations focused on further defining the boundary of Site 7211. STPs 14 and 15 revealed the cultural deposit, midden, a coral abrader and a possible posthole. These resources are part of the 2011 Site 7211, thus the boundary of Site 7211 was extended ca. 20 meters further to the north including the locations of STPs 14 and 15.

There is no doubt that the project area was settled during the pre-Contact period and provided a Native Hawaiian population a fine location in which to thrive.

The data uncovered during current investigations indicates the importance and use of the area by the Native Hawaiians as documented by the radiocarbon date, shell fishhook and marine shell midden obtained from STP 5 along with the midden and coral abrader from STPs 14 and 15. The numerous pits and substantial cultural layer identified throughout the project area further highlights the intense use of the site during the pre-Contact period; this use undoubtedly extended into the early post-Contact period.

Historic artifactual remains consisting mostly of metal nails window and bottle glass were recovered within several of the shovel test pits. The majority of these remains were concentrated within STPs 1-4. These remains were recovered from above 60 cm below surface and were likely brought in with the fill that was used to flatten and level the park. The single glass perfume bottle recovered from Feature 6 in Trench 9 is evidence of the project area being developed for western residences during the early 20th century. It is probable that additional historic resources and artifactual remains from the time period are present within the park.

The resources documented herein are significant and provide a unique window into the pre-Contact lifestyle within the Kapiʻolani Park area and the Waikīkī Ahupuaʻa. The current investigations identified the presence and context of the deposit as well as determined the size and scale of the cultural resources within the proposed Project Area.

In addition, the concrete and metal debris identified within STPs 17, 18, 20 and 21 are associated with the construction and backfilling of the promenade area fronting the WWMC. These deposits are associated with the Natatorium itself as are designated part of site 50-80-15-9701.

8.1 RECOMMENDATIONS

Given the significant cultural deposit documented during the current investigation along with the presence of subsurface features both traditional and historic in nature, it is recommended that Site 50-80-14-7211 be preserved.

In addition, although no human remains were uncovered during test excavations, there is still a possibility that human remains could be encountered during excavations within the park. Thus it is recommended that any excavations deeper than 50 cm below surface within this area of Kapiʻolani Park should be archaeologically monitored in the event these remains may be encountered.

9.0 REFERENCES

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APPENDIX A

WAR MEMORIAL NATATORIUM

NATIONAL REGISTER FORMS
AND
PHOTOGRAPHS

Form No. 10-300 (Rev. 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

FOR NPS USE ONLY
RECEIVED JUN 5 1980
DATE ENTERED AUG 11 1980

SEE INSTRUCTIONS IN *HOW TO COMPLETE NATIONAL REGISTER FORMS*
TYPE ALL ENTRIES -- COMPLETE APPLICABLE SECTIONS

1 NAME

HISTORIC War Memorial Natatorium

AND/OR COMMON

2 LOCATION

STREET & NUMBER Kalakaua Avenue
__NOT FOR PUBLICATION

CITY, TOWN Honolulu __ VICINITY OF
CONGRESSIONAL DISTRICT First

STATE Hawaii CODE 15 COUNTY Honolulu CODE 03

3 CLASSIFICATION

CATEGORY	OWNERSHIP	STATUS	PRESENT USE	
__DISTRICT	X PUBLIC	__OCCUPIED	__AGRICULTURE	__MUSEUM
__BUILDING(S)	__PRIVATE	X UNOCCUPIED	__COMMERCIAL	X PARK
X STRUCTURE	__BOTH	__WORK IN PROGRESS	__EDUCATIONAL	__PRIVATE RESIDENCE
__SITE	**PUBLIC ACQUISITION**	**ACCESSIBLE**	__ENTERTAINMENT	__RELIGIOUS
__OBJECT	__IN PROCESS	__YES: RESTRICTED	__GOVERNMENT	__SCIENTIFIC
	__BEING CONSIDERED	X YES: UNRESTRICTED	__INDUSTRIAL	__TRANSPORTATION
		__NO	__MILITARY	__OTHER:

4 OWNER OF PROPERTY

NAME State of Hawaii

STREET & NUMBER 1151 Punchbowl Street

CITY, TOWN Honolulu __ VICINITY OF STATE Hawaii

5 LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC. Bureau of Conveyances

STREET & NUMBER 1151 Punchbowl Street

CITY, TOWN Honolulu STATE Hawaii

6 REPRESENTATION IN EXISTING SURVEYS

TITLE Hawaii Register of Historic Places 80-14-9701

DATE 1973 __FEDERAL X STATE __COUNTY __LOCAL

DEPOSITORY FOR SURVEY RECORDS Department of Land and Natural Resources

CITY, TOWN Honolulu STATE Hawaii

7 DESCRIPTION

CONDITION		CHECK ONE	CHECK ONE
__EXCELLENT	X DETERIORATED	X UNALTERED	X ORIGINAL SITE
__GOOD	__RUINS	__ALTERED	__MOVED DATE______
__FAIR	__UNEXPOSED		

DESCRIBE THE PRESENT AND ORIGINAL (IF KNOWN) PHYSICAL APPEARANCE

The War Memorial Natatorium is a reinforced concrete structure which contains an open air 100 meter by 50 foot swimming pool which is fed by ocean water through a series of coffered locks.

The pool is surrounded on four sides by a twenty-foot wide deck which is enclosed on the three ocean sides by a three-foot high wall. On the fourth, mauka (mountain) side, concrete bleachers rise thirteen levels in height and provide seating for approximately 2,500 people. The bleachers are divided into two parts, each with four sections, with a central entry space separating the two parts.

The Beaux-Arts inspired main entry, with its triumphal arch flanked by two lesser round arches, is the major architectural feature of the Natatorium. A pair of Ionic pilasters support the triumphal arch's entablature which has the words, "The War Memorial" inscribed in its frieze. An elaborate sculpture rises from the entablature. It consists of a garlanded base with an American eagle perched at each corner and the Hawaiian motto and seal in the center. The triumphal arch itself, has a paneled ceiling decorated with hexagonal floral designs. Flanking the triumphal arch, and above the two lower arches, is a medallion with floral patterns and a woman's face in the center in relief. The ocean and mountain sides of the entry are similar.

To either side of the main entrance, the bleacher's rear walls extend approximately 100 feet. Locker rooms are below the bleachers and inset behind centered round arched arcades of seven bays each. Round arched windows, which correspond to the arcade openings, provide the locker rooms with ventilation and illumination. A pair of simple pilasters flank the arcade and support large concrete urns, which project above the bleacher walls and demarcate the end sections of each bleacher. A flagpole with a ball finial is located above the second and sixth openings of each arcade. The bays on either side of the arcade contain office and restroom spaces and are distinguished by rectangular windows with grills.

A ramp leads to the main entry; to either side of this ramp are a volleyball and basketball court. A concrete wall with an incised diamond pattern, encloses these courts. The end walls are stepped, and two bays long at the main entry end and three bays long at the other end. The front walls are five bays long and a tapered concrete column, which originally supported a light globe, is at each pier. At the corners of the entry ramp, these columns are fluted metal and support spotlights which illuminated the triumphal arch entry. A hau arbor, supported by pipes, is adjacent to the front walls.

The War Memorial is situated on the ocean in Kapiolani Park and is surrounded by expansive lawns with a large number of tall coconut trees, a few banyans and other varieties of vegetation.

The basic structure is in poor condition and presently is officially closed, although people still use the facility. There have been no additions, and the only alterations have been the removal of a free-standing clock and diving platform from the deck area, and the removal of several light fixtures.

8 SIGNIFICANCE

PERIOD	AREAS OF SIGNIFICANCE -- CHECK AND JUSTIFY BELOW			
_PREHISTORIC	_ARCHEOLOGY-PREHISTORIC	_COMMUNITY PLANNING	_LANDSCAPE ARCHITECTURE	_RELIGION
_1400-1499	_ARCHEOLOGY-HISTORIC	_CONSERVATION	_LAW	_SCIENCE
_1500-1599	_AGRICULTURE	_ECONOMICS	_LITERATURE	_SCULPTURE
_1600-1699	X ARCHITECTURE	_EDUCATION	_MILITARY	X SOCIAL/HUMANITARIAN
_1700-1799	_ART	_ENGINEERING	_MUSIC	_THEATER
_1800-1899	_COMMERCE	_EXPLORATION/SETTLEMENT	_PHILOSOPHY	_TRANSPORTATION
X 1900-	_COMMUNICATIONS	_INDUSTRY	_POLITICS/GOVERNMENT	_OTHER (SPECIFY)
		_INVENTION		

SPECIFIC DATES 1927 BUILDER/ARCHITECT Lewis P. Hobart

STATEMENT OF SIGNIFICANCE

The War Memorial Natatorium is significant as a major landmark along the Kapiolani Park stretch of Kalakaua Avenue. Rendered in a Beaux-Arts style, which is typical of its period, it presents a striking image of monumentality within its setting of open lawn, beach and ocean.

In 1921, the Territorial Legislature authorized the issuance of bonds to produce $250,000 for the construction, on the former Irwin property, of a memorial dedicated to the men and women of Hawaii who served in World War I. The legislature further provided for the appointment of a Territorial War Memorial Commission to decide upon the form the memorial was to take. The legislature stipulated that a swimming pool of at least 100 meter length be included and a competition be held to determine the most appropriate design. The competition was held under the general rules of the American Institute of Architects. Three architects, Bernard Maybeck of San Francisco, Ellis F. Lawrence of Portland, and W.R.B. Willcox of Seattle, were selected to judge the competition, and Louis P. Hobart of San Francisco won the first prize. Hobart's plans, however, had to be twice modified before they could be implemented in accordance with the budgetary parameters. Thus it was not until 1927 that Mr. T.L. Cliff started construction.

The Natatorium was completed in the summer of 1927, the first "living" war memorial in the United States. The opening ceremonies were held on August 24, and were the major social event of the year. The feelings of the populace were expressed in an editorial appearing in the Advertiser that day: "Tonight the Hawaii War Memorial Opens. It is highly appropriate that this Memorial to the heroes of the World War should be a public natatorium. America went to war to assure safety and independence and the privileges and rights of a free people to all her citizens, and a part of the birthright of a free people is sound health and the opportunity for wholesome recreation. The Natatorium epitomizes Hawaii's prominence in one of the world's great sports. Situated at Waikiki, it looks upon and is part of the ocean, whereof Hawaii is the "crossroad"... No such galaxy of swimming stars has ever been gathered together since the last Olympic Games. The opening of the natatorium will be signalized by the greatest competitive swimming ever seen anywhere in the Pacific, once more giving Hawaii a place of honor and distinction."

The actual ceremonies were colorful and dignified. "Duke" Kahanamoku--who traveled from Los Angeles to open the pool on his birthday--made the first swim, emerging at the end of the 100 meters to a thunderous ovation. It was an unforgettable moment--the man who symbolized the Hawaiian people to the rest of the world opening a memorial whose design captured so well the character of the Territory and its relationship to the sea.

An AAU National championship swimming meet, with swimmers from Japan and South America participating, capped the opening activities. Olympic champion, Johnny Weissmuller, was

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10 GEOGRAPHICAL DATA

UTM NOT VERIFIED

ACREAGE OF NOMINATED PROPERTY 5.347

UTM REFERENCES

ACREAGE NOT VERIFIED

	ZONE	EASTING	NORTHING		ZONE	EASTING	NORTHING
A	0 4	6 2 1 8 8 5	2 3 5 2 2 5 0	B			
C				D			

VERBAL BOUNDARY DESCRIPTION

This nomination includes the War Memorial Natatorium and Memorial Park which is designated in 1979 by the Tax Map Key: 3:1:31:3

LIST ALL STATES AND COUNTIES FOR PROPERTIES OVERLAPPING STATE OR COUNTY BOUNDARIES

STATE	CODE	COUNTY	CODE
STATE	CODE	COUNTY	CODE

11 FORM PREPARED BY

NAME / TITLE
Don Hibbard and Gary Cummins, architectural historian and historian

ORGANIZATION
State Historic Preservation Office

DATE
November 1, 1979

STREET & NUMBER
1151 Punchbowl Street

TELEPHONE
548-6408

CITY OR TOWN
Honolulu

STATE
Hawaii

12 STATE HISTORIC PRESERVATION OFFICER CERTIFICATION

THE EVALUATED SIGNIFICANCE OF THIS PROPERTY WITHIN THE STATE IS:

NATIONAL ___ STATE X LOCAL ___

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

STATE HISTORIC PRESERVATION OFFICER SIGNATURE Susumu Ono

TITLE

DATE May 28, 1980

FOR NPS USE ONLY
I HEREBY CERTIFY THAT THIS PROPERTY IS INCLUDED IN THE NATIONAL REGISTER

W. Ray Luce for KEEPER OF THE NATIONAL REGISTER DATE 8/11/80

~~DIRECTOR, OFFICE OF ARCHEOLOGY AND HISTORIC PRESERVATION~~

ATTEST: DATE 8-4-80

~~KEEPER OF THE NATIONAL REGISTER~~

GPO 892-453

Form No. 10-300a
(Rev. 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

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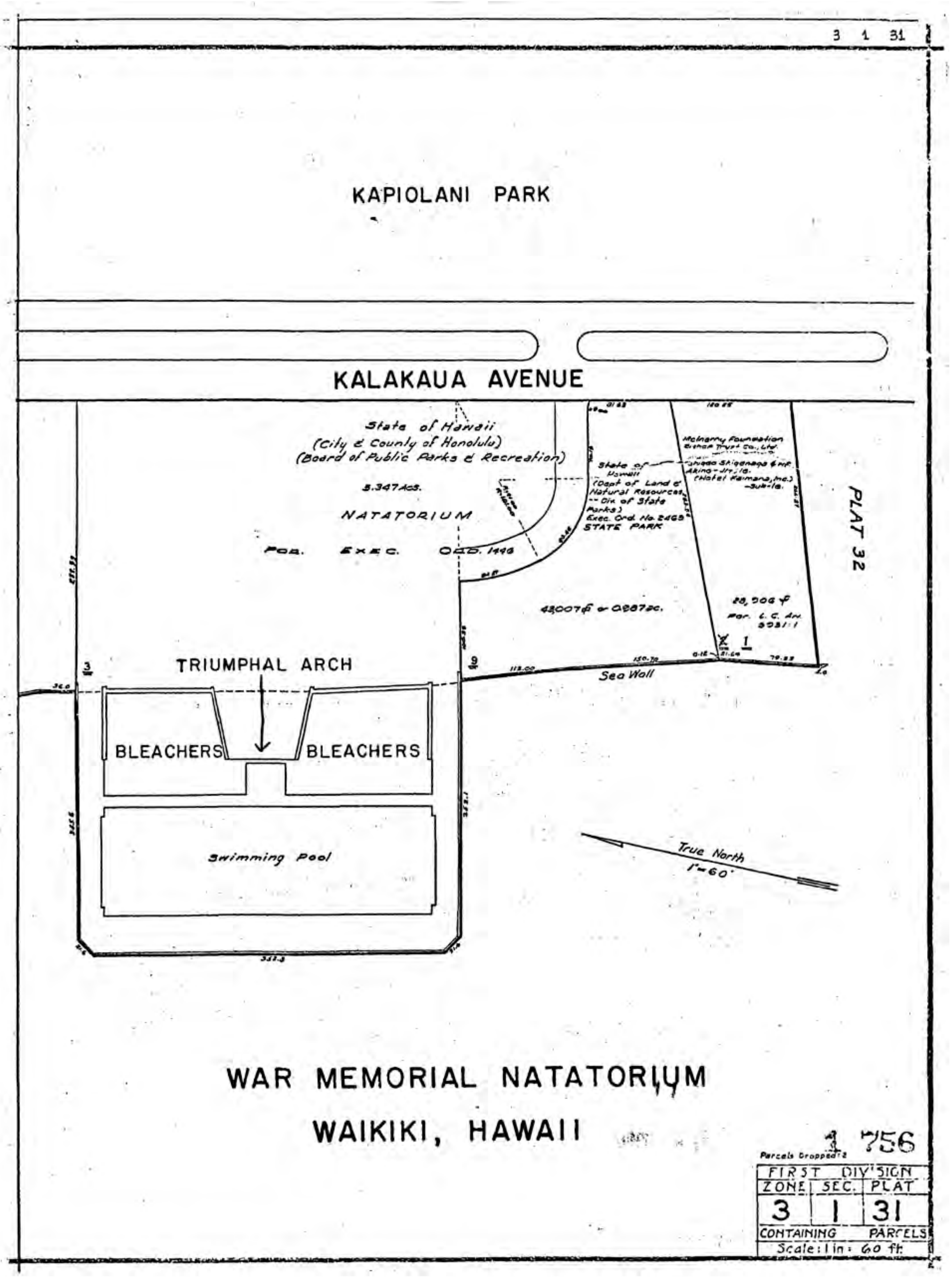
CONTINUATION SHEET ITEM NUMBER 8 PAGE 2

in excellent form, managing to break the world's record for the 100-meter freestyle swim, and in the following three days of competition, set new world's records for the 440 and 880-meter freestyles, cutting more than ten seconds off the previous world marks for these events. Clarence "Buster" Crabbe, a local swimmer, who was later to replace Weissmuller in the famous "Tarzan" series, won the 1500-meter contest.

The natatorium became a social-recreational center for local people immediately, and many important international and national swimming meets were held there. It became a factor in moves toward a "Pan-Pacific" philosophy, at least in the area of athletics.

There were, however, problems. Maintenance gradually became less and less efficient. The job of superintendent of the natatorium was awarded by the Territorial government more on the basis of political loyalty than expertise. Gradually, deterioration set in.

After Pearl Harbor, the natatorium was taken over by the army until 1943, and used for training purposes. Its physical condition continued to deteriorate, and began to take on the proportions of a scandal. In 1949, the natatorium was rehabilitated by the Territorial government at a cost of $82,000 and subsequently turned over to the City and County of Honolulu on July 1. The sporadic and inefficient maintenance of the memorial continued, however, and today, the natatorium is once again in need of extensive rehabilitation, if it is to continue to serve as a major social-recreational center. Although officially closed, the pool still attracts its share of visitors: local swimmers, people seeking to experience the ocean-park-beach scene from a unique space, and spectators who gather nightly to view a serene sunset.


KAPIOLANI PARK
KALAKAUA AVENUE
State of Hawaii
(City & County of Honolulu)
(Board of Public Parks & Recreation)
NATATORIUM
STATE PARK
PLAT 32
TRIUMPHAL ARCH
BLEACHERS
BLEACHERS
Swimming Pool
Sea Wall
True North
WAR MEMORIAL NATATORIUM
WAIKIKI, HAWAII
FIRST DIVISION
ZONE SEC. PLAT
3 1 31
CONTAINING PARCELS
Scale: 1 in = 60 ft.

Honolulu co.

War Memorial Natatorium

JUN 5 1980

Waikiki, Hawaii

Photographer: Unknown, 1979

Neg. in State Historic Preservation Office

Looking North

AUG 11 1980

Photo #1 of 5

War Memorial Natatorium Honolulu Co.
Waikiki, Hawaii
Photographer: Nathan Napoka, 1980
Neg. in State Hist. Pres. Office
Looking North at South Wall
JUN 5 1980
AUG 11 1980 Photo #2 of 5

Honolulu Co.

War Memorial Natatorium

Waikiki, Hawaii JUN 5 1980

Photographer: Nathan Napoka, 1980

Neg. in State Hist. Pres. Office

Looking Southeast at Swimming Pool

AUG 11 1980 Photo #3 of 5

War Memorial Natatorium Honolulu Co.

Waikiki, Hawaii JUN 5 1980

Photographer: Nathan Napoka, 1980

Neg. in State Hist. Pres. Office

Looking South at Entry Elevation

AUG 11 1980 Photo #4of 5

War Memorial Natatorium Honolulu co
Waikiki, Hawaii JUN 5 1980
Photographer: Nathan Napoka, 1980
Neg. in State Hist. Pres. Office
Looking West at Triumphal Arch
AUG 11 1980 Photo #5 of 5

APPENDIX B

WOOD IDENTIFICATION
GAIL MURAKAMI (IARII)

CHARCOAL TAXA IDENTIFICATION IN A SAMPLE FROM THE WAIKIKI NATATORIUM, O‘AHU ISLAND

By

Gail M. Murakami

October 13, 2011

INTRODUCTION

This report presents the results of taxa identification in one charcoal sample from the Waikiki Natatorium, O‘ahu, performed at the request of Pacific Legacy. Identification of charcoal found in archaeological context can give insight into the vegetation of the surrounding area at the time that the woods were burned. This information can then be used to interpret the environment as well as possible cultural use of specific plants. In this way charcoal samples may be viewed as partial records of the environmental and cultural history of an area.

METHODS

The freshly fractured transverse and tangential facets of the charcoal pieces were viewed under magnification of a dissecting microscope. Taxa identifications were made by comparing the anatomical characteristics seen during examination against those of known woods in the Pacific Islands Wood Collection at the Department of Botany, University of Hawai‘i, and published descriptions.

RESULTS

Examination of the charred wood in the sample resulted in the identification of four taxa (Table 1). Descriptions of the taxa identified are presented below.

Table 1. Taxa Identified in STP 5, 80-90 cm bs, from the Waikiki Natatorium.

WIDL No.	Scientific Name	Common/Hawaiian Name	Origin/Habit	Part	Count/ Weight, g
1125-1	*Aleurites moluccana*	Kukui, candlenut tree	Polynesian introduction/Tree	Nutshell	1/0.06
1125-2	cf. *Rauvolfia sandwicensis*	*Hao*	Native/Tree	Wood	3/0.18
1125-3	cf. *Osteomeles anthyllidifolia*	*‘Ūlei*	Native/Shrub	Wood	2/0.18
1125-4	cf. *Dodonaea viscosa*	*‘A‘ali‘i*	Native/Shrub	Wood	3/0.07

REVIEW OF TAXA

APOCYNACEAE

Rauvolfia sandwicensis A. DC (*Hao*)

This endemic species is a tree or shrub, 3 to 10 m tall, found primarily in mesic forests but also in dry forest or dry shrubland and on lava flows, on all the main Hawaiian islands except Kaho‘olawe at 100 to 800 m elevations (Wagner et al.:1990: 220).

EUPHORBIACEAE

Aleurites moluccana (L.) Wild. (*Kukui*)

Once cultivated, this Polynesian introduction has escaped into the native forest, where the pale foliage of the 10 to 20 m trees (Wagner et al. 1990:598) can be seen in abundance in moist gulches and valleys. Dyes were once extracted from the bark and roots (Buck 1957:187), the oily kernel was burned for light (Buck 1957:107) or eaten as a relish after baking (Buck 1957:48), and net floats and dugout canoes were made from the soft wood (Buck 1957:297).

ROSACEAE

Osteomeles anthyllidifolia Lindl. (‘*Ūlei*)

This indigenous plant can often be found sprawling among the rocks along the coasts but may become an erect shrub up to 3 m tall in other environments. *Osteomeles* is found on all the main islands except Ni‘ihau and Kaho‘olawe and ranges in distribution from sea level to 2300 m in elevation (Wagner et al. 1990:1104-1105). In the past, the hard wood was used to make digging sticks (‘*ō*‘*ō*, fishing spears, carrying poles (‘*auamo*), and a musical bow (‘*ukeke*) (Buck 1957:12, 357, 14, 388). The flexible smaller branches were bent into hoops for fishnets (Neal 1965:387).

SAPINDACEAE

Dodonaea viscosa Jacq. (‘*A*‘*ali*‘*i*)

These indigenous shrubs or small trees are 2 to 8 m tall and range in distribution from coastal dunes to dry, mesic, and wet forest, at 3 to 2,350 m elevations on all of the main Hawaiian Islands except Kaho‘olawe (Wagner et al. 1990:1227-1228). The red papery fruit capsule clusters and leaves of some varieties were made into *lei* (Pukui and Elbert 1986:3).

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APPENDIX C

RADIOCARBON DATING
BETA ANALYTIC, INC.

BETA

Consistent Accuracy . . .
. . . Delivered On-time

Beta Analytic Inc.
4985 SW 74 Court
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Beta@radiocarbon.com
www.radiocarbon.com

Darden Hood
President

Ronald Hatfield
Christopher Patrick
Deputy Directors

November 1, 2011

Dr. Paul Cleghorn
Pacific Legacy, Incorporated
30 Aulike Street
#301
Kailua, HI 96734
USA

RE: Radiocarbon Dating Result For Sample NAT-STP-5

Dear Dr. Cleghorn:

Enclosed is the radiocarbon dating result for one sample recently sent to us. It provided plenty of carbon for an accurate measurement and the analysis proceeded normally. As usual, the method of analysis is listed on the report sheet and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analysis. It was analyzed with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

The cost of the analysis was charged to the VISA card provided. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood
Digital signature on file

BETA ANALYTIC INC.
DR. M.A. TAMERS and MR. D.G. HOOD
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305-667-5167 FAX:305-663-0964
beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Dr. Paul Cleghorn — Report Date: 11/1/2011

Pacific Legacy, Incorporated — Material Received: 10/24/2011

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 308137	340 +/- 30 BP	-25.5 o/oo	330 +/- 30 BP

SAMPLE : NAT-STP-5
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1460 to 1650 (Cal BP 490 to 300)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

Page 2 of 3

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.5:lab. mult=1)

Laboratory number: **Beta-308137**

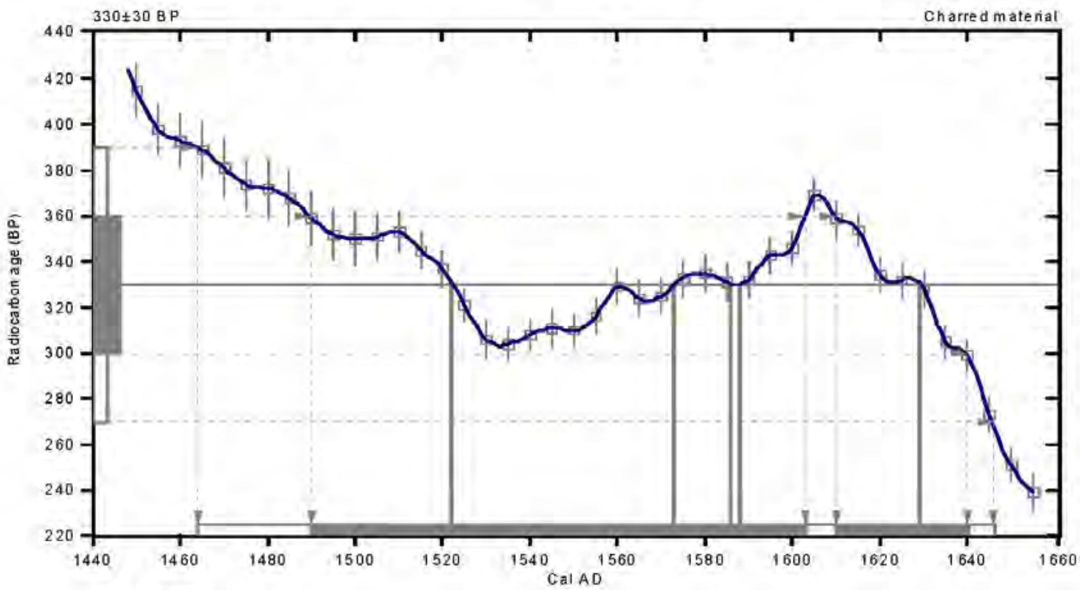
Conventional radiocarbon age: **330±30 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1460 to 1650 (Cal BP 490 to 300)**

Intercept data

Intercepts of radiocarbon age with calibration curve:
Cal AD 1520 (Cal BP 430) and
Cal AD 1570 (Cal BP 380) and
Cal AD 1590 (Cal BP 360) and
Cal AD 1590 (Cal BP 360) and
Cal AD 1630 (Cal BP 320)

1 Sigma calibrated results: (68% probability)
Cal AD 1490 to 1600 (Cal BP 460 to 350) and
Cal AD 1610 to 1640 (Cal BP 340 to 310)



References:

Database used
INTCAL09

References to INTCAL09 database
Heaton,et.al.,2009, Radiocarbon 51(4):1151-1164, Reimer,et.al, 2009, Radiocarbon 51(4):1111-1150, Stuiver,et.al,1993, Radiocarbon 35(1):137-189, Oeschger,et.al.,1975,Tellus 27:168-192

Mathematics used for calibration scenario
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

Beta Analytic Radiocarbon Dating Laboratory

4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

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Appendix J:
Revised Planning Cost Estimates

Construction Costs Rough Order of Magnitude (ROM), Including Dredge and Fill Actions, October 2019

Perimeter Deck

Item	Description	Quantity	Units	Unit Cost	Total
	Mobilization for in-water demolition	1	LS	$ 200,000.00	$200,000
	Mobilization for in-water construction	1	LS	$ 500,000.00	$500,000
	Grout Diamond Head pipes	1	LS	$ 8,000.00	$8,000
Sediment Removal Option[1,2]	Construct and set up structurally sound load-in and load-out section of basin	600	SF	$ 445.00	$267,000
Sediment Removal Option[1,2]	Dredging of basin material, including overdredged quantitities (1)	10,000	CY	$ 261.00	$2,610,000
Sediment Removal Option[1,2]	Load-out and disposal of dredged materials	833	LOADS	$ 3,506.00	$2,920,498
	Demo and dispose pool deck	1635	CY	$ 650.00	$1,062,750
	Demo and dispose top half of seawall	280	CY	$ 650.00	$182,000
	Demo and dispose bottom half of Ewa and makai seawall	600	CY	$ 900.00	$540,000
	Demo and dispose piles above mudline	130	EA	$ 1,600.00	$208,000
	Demo portion of Ewa rock fill	64	CY	$ 900.00	$57,600
	Demo portion of DH rock fill	16	CY	$ 2,500.00	$40,000
	Replace select portion of DH rock fill	16	CY	$ 950.00	$15,200
	Temporary sheet piles @ Sans Souci Beach	2000	SF	$ 42.00	$84,000
	Mobilization for pile construction	1	LS	$ 100,000.00	$100,000
	Pre-drill to -20'	129	EA	$ 900.00	$116,100
	Install 24" concrete iles to -65'	129	EA	$ 20,500.00	$2,644,500
	Cutoff piles @+2.0'	129	EA	$ 700.00	$90,300
	Construct new deck	27745	SF	$ 65.00	$1,803,425
	Construct top half of seawall	280	CY	$ 3,200.00	$896,000
	Construct new mauka seawall	220	CY	$ 3,200.00	$704,000
	Provide and install FRP grates and frames	3655	SF	$ 80.00	$292,400
	Install floating deck	800	SF	$ 225.00	$180,000
	Install pool railings & ladders	1	LS	$ 60,000.00	$60,000
	Install seawall diving barrier around deck	800	LF	$ 225.00	$180,000
	Repair Bleachers, Arches, Offices, Bathrooms	11500	SF	$ 450.00	$5,175,000
	Restore Memorial Arch	1	LS	$ 900,000.00	$900,000

Landscape Improvements	1	LS	$ 520,000.00	$520,000
Outdoor Lighting	1	LS	$ 400,000.00	$400,000
Vollyball Court	1	EA	$ 30,000.00	$30,000
Repave Existing Parking Lot	14400	SF	$ 4.80	$69,120
Water Service	1	LS	$ 50,000.00	$50,000
Sanitary Sewer	1	LS	$ 120,000.00	$120,000
Storm Drain System	1	LS	$ 80,000.00	$80,000
Electrical Utility & Distribution	1	LS	$ 60,000.00	$60,000
Erosion Control	1	LS	$ 500,000.00	$500,000
Site Restoration	1	LS	$ 250,000.00	$250,000
Demobilization	1	LS	$ 200,000.00	$200,000
SUBTOTAL				$24,115,893
Contingency, 20%		LS		$4,823,179
Engineering/Design, 12%		LS		$2,893,907
Subtotal				$31,832,979

(1) Based on depth of sediment estimated at 55 grid points over pool area, CY based on average depth of sediment. Because probes frequently did not reach hard refusal (hard substrate), this factor alone may suggest that volume may be greater than estimated.

(2) Source: Sea Engineering, Inc., via email on September 9, 2019.

Note: Cost for any recovery of sand from the existing pool is not included.

War Memorial Beach

Item	Description	Quantity	Units	Unit Cost	Total
	Mobilization for in-water demolition	1	LS	$ 200,000.00	$200,000
	Mobilization for in-water construction	1	LS	$ 500,000.00	$500,000
	Mobilization for landside demolition	1	LS	$ 150,000.00	$150,000
	Mobilization for landside construction	1	LS	$ 200,000.00	$200,000
	Grout Diamond Head pipes	1	LS	$ 8,000.00	$8,000
	Grout Ewa pipes	1	LS	$ 8,000.00	$8,000
	Demo and dispose pool deck	1635	CY	$ 650.00	$1,062,750
	Demo and dispose top half of seawall	280	CY	$ 650.00	$182,000
	Demo and dispose bottom half of Ewa and makai seawall	600	CY	$ 900.00	$540,000
	Demo and dispose piles above mudline	130	EA	$ 1,600.00	$208,000
	Demo and dispose bleachers, parking lot, volleyball court	1490	CY	$ 450.00	$670,500
Sediment Removal Option[1,2]	Construct and set up structurally sound load-in and load-out section of basin	2,560	SF	$ 295.00	$755,200
	Dredging of basin material, including overdredged quantitities	10,000	CY	$ 82.00	$820,000
	Load-out and disposal of dredged materials	833	LOADS	$ 2,093.00	$1,743,469
	Provide and place rock fill	16,000	CY	$ 204.00	$3,264,000
	Geotextile fabric[3]	45,000	SF	$ 7.00	$315,000
	Provide and place sand fill	10,000	CY	$ 220.00	$2,200,000
	Construct concrete w/rip-rap DH & Ewa groin stems	344	LF	$ 12,500.00	$4,300,000
	Construct DH & Ewa groin heads	2,140	CY	$ 720.00	$1,540,800
	Rebuild memorial arch	1	LS	$ 2,500,000.00	$2,500,000
	Construct bath house	1,250	SF	$ 1,200.00	$1,500,000
	Landscape improvements	1	LS	$ 520,000.00	$520,000
	Construct new parking lot	26,450	SF	$ 16.00	$423,200
	Replace ocean safety office	4,000	SF	$ 450.00	$1,800,000
	Water service	1	LS	$ 50,000.00	$50,000
	Sanitary sewer	1	LS	$ 120,000.00	$120,000
	Storm drain system	1	LS	$ 80,000.00	$80,000
	Electrical utility & distribution	1	LS	$ 60,000.00	$60,000
	Erosion Control	1	LS	$ 500,000.00	$500,000
	Site restoration	1	LS	$ 250,000.00	$250,000

Demobilization	1	LS	$ 200,000.00	$200,000
SUBTOTAL				$26,670,919
Contingency, 20%		LS		$5,334,184
Engineering/Design, 12%		LS		$3,200,510
Subtotal				$35,205,613

(1) Presumes dredge depth of -14.2' MSL and rock fill to -7.0' MSL

(2) Source: Sea Engineering, Inc., via email on September 9, 2019.

(3) Excludes anchor design and construction; cost for fabric only

Note: Cost for any recovery of sand from the existing pool is not included.

Operations and Maintenance Estimated Costs Per Year
Waikiki War Memorial Complex
DEIS 2018 (supporting details used in Section 3.4)

Description	Perimeter Deck		War Memorial Beach		Closed Pool		No Action	
	$223,740		$279,675					
Life Safety	$55,935	*	$55,935	*	$55,935	*	$0	
Additional Life Safety	$167,805	3	$223,740	4	$167,805	3	$0	
Groundskeeping	$46,033	*	$46,033	*	$46,033	*	$46,033	*
Structural Upkeep	$41,618	*	$0		$41,618	*	$0	
Water/Sewer	$5,000		$5,000		$10,000		$5,000	
Electric - exterior lighting	$25,185	**	$0		$25,185	**	$5,000	
Electric - pumps/filters	$0		$0		$60,444	***	$0	
Beach Nourishment	$0		$15,000	****	$0		$0	
Total O&M, per year	$341,576		$345,708		$407,020		$56,033	
Say:	**$342,000**		**$346,000**		**$407,000**		**$56,000**	

* Final EIS for the Waikīkī War Memorial Park and Natatorium (Leo A Daly 1995) in 1994 dollars. Escalated at 2% per year to 2018.

** Assume: $0.23 /kwh, 0.5 w/sqft, approx. 50,000 sqft, 12 hr/day = $69/day

*** Assume: $0.23 /kwh, total 30 kw pumps, 24 hr/day = $166/day

**** Annual allowance for 100 cubic yards @ $150 each

Operations and Maintenance Estimated Costs Per Year
Waikiki War Memorial Complex
Revised Cost Estimate for FEIS, October 2019

Description	Perimeter Deck [(a)]		War Memorial Beach [(b)]		Closed Pool [(c)]		No Action	
FTE for Existing Natatorium Area	$839,025	15	$279,675	5	$839,025	15	$0	
Groundskeeping	$46,033	*	$46,033	*	$46,033	*	$46,033	*
Structural Upkeep	$41,618	*	$0		$41,618	*	$0	
Restrooms	$10,405	*****	$10,405	*****	$10,405	*****	$10,405	*****
Water/Sewer	$5,000		$5,000		$10,000		$5,000	
Electric - exterior lighting	$25,185	**	$0		$25,185	**	$5,000	
Electric - pumps/filters	$0		$0		$60,444	***	$0	
Annual Cost for Capital Budget	$0		$15,000	****	$100,000	****	$0	
Total O&M, per year	$967,266		$356,113		$1,132,710		$66,438	
Say:	**$967,000**		**$356,000**		**$1,133,000**		**$66,000**	

Cost per FTE* $55,935

* Final EIS for the Waikīkī War Memorial Park and Natatorium (Leo A Daly 1995) in 1994 dollars. Escalated at 2% per year to 2018.

** Assume: $0.23 /kwh, 0.5 w/sqft, approx. 50,000 sqft, 12 hr/day = $69/day

*** Assume: $0.23 /kwh, total 30 kw pumps, 24 hr/day = $166/day

**** War Memorial Beach: Annual allowance for 100 cubic yards sand for beach nourishment @ $150 each.
Closed System Pool: Annual allowance for $100,000, based on $1M cost to construct pool pumps (plumbing) and over 10 years.

*****0.25 FTE, FTE is $41,618. Presumed for restroom maintenance. Should have been included in DEIS.

FTE for Existing Natatorium Area

[(a)] Full time equivalent (FTE) staffing estimates for the Perimeter Deck with no lights: 3 maintenance from DPR (FRP maintenance acknowldged and will be identified later when design and operational conditions can be assessed), per DDC on October 22, 2019. Additional staff from HESD would include 3 lifeguards at any one time. Presuming 7 days/week, 12 FTE from HESD (Meeting with the City Department of Parks and Recreation, Honolulu Emergency Services Department, and City Department of Design and Construction, February 4, 2019). 12 FTE HESD presumed for 6 days/week. HESD staff cost for 12 is based on $55,935/yr x 12 staff=$671,220/yr. DPR staff cost for 3 is based on $55,935/yr x 3 staff=$167,805/yr. Total staff=$671,220/yr+$167,805/yr=$839,025.

[(b)] FTE staffing estimates for the War Memorial Beach with no lights presumes 5 lifeguards based on 9:00 a.m. to 5:30 p.m. (8-hr shift), 7 days per week (Personal communication between City Department of Parks and Recreation, Honolulu Emergency Services Department, and City Department of Design and Construction, February 4, 2019). HESD staff cost for 5 is based on $55,935/yr x 5=$839,025/yr.

[(c)] FTE staffing estimates for a closed pool with no lights: 8 lifeguard, 6 maintenance, and 1 pool manager. Presumes operating hours of 8 hours per day, 6 days per week. Actual hours would be dependent on the needs of the public (Meeting with City Department of Parks and Recreation and City Department of Design and Construction, September 18, 2019). DPR staff cost for 15 is based on $55,935/yr x 15 staff=$839,025/yr.

Appendix K:
FRP Hazard Evaluation

Sea Engineering, Inc.
Makai Research Pier 41-305 Kalanianaole Hwy.
Waimanalo, Hawaii 96795
Ph: (808) 259-7966
Website: www.seaengineering.com

Report

DATE:	October 24, 2019
TO:	Lesley Matsumoto, AECOM
FROM:	David Smith
PROJECT:	Natatorium Security Bar Report (Job No. 25704)

BACKGROUND

A Draft Environment Impact Statement (DEIS) for the proposed improvements to the Waikiki War Memorial Natatorium ("Natatorium") was published on November 8, 2018.

The Perimeter Deck, as presented in the draft EIS, would have security bars oriented vertically across openings in the makai and Ewa walls. Sea Engineering, Inc. and ARCCA, Inc. were hired to perform a desktop study to assess the possible hazards due to a wave pressing a human against those bars. Sea Engineering was responsible for determining the oceanographic conditions for the study and biomechanist Dr. Calum McRae of ARCCA, Inc. was responsible for interpreting the hydrodynamic driving forces and discussing the possible effects on a human body. Dr. McRae has prepared the attached draft report assessing the potential injuries to a person impacting the Natatorium walls or proposed security bars.

This report presents an initial, preliminary assessment of possible injuries due to the bars. The purpose of the study is to identify if there is reason to believe that the bars could be a threat to public health and safety. This desktop study was performed for a commonly occurring wave condition at the makai wall of the Natatorium and is not intended to identify and assess all possible hazards.

SECURITY BAR CONFIGURATION

The security bar configuration from the 1995 Natatorium renovation plan (shown as Figure 1) was suggested by the City for this project. The bars are vertically oriented, have diameter 1.75 inches, and are placed 5.75 inches apart on center. This configuration results in an opening of 4 inches.

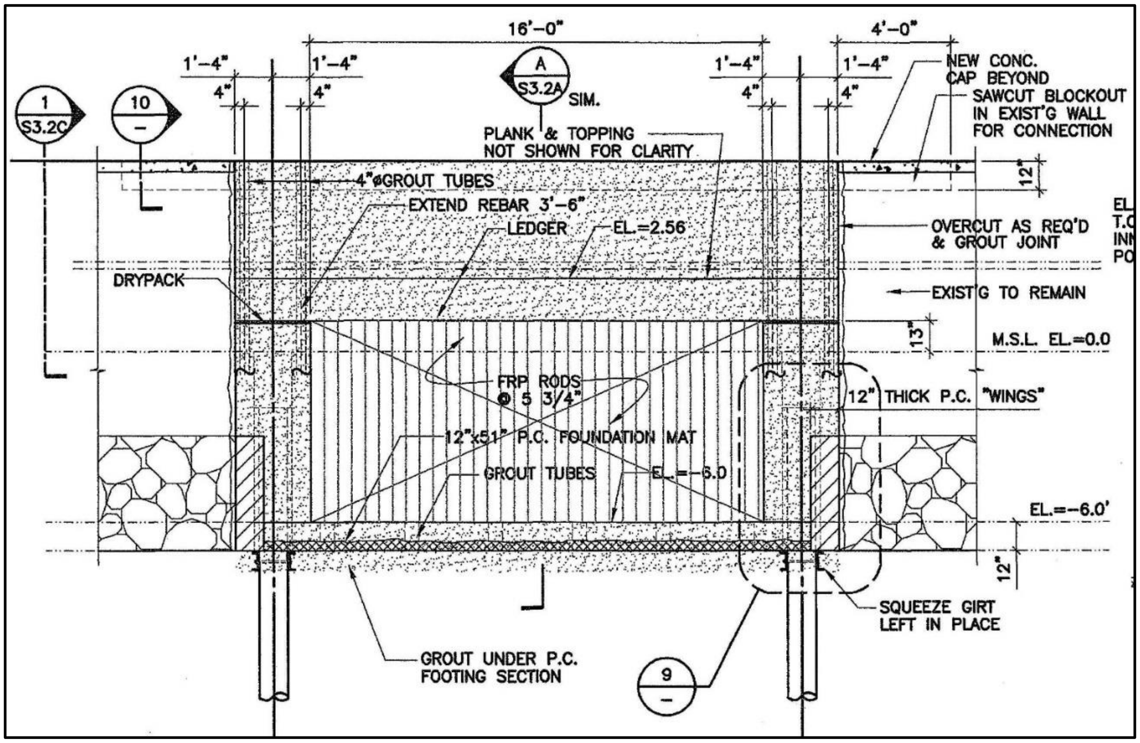


Figure 1. Elevation view of security bar configuration from the 1995 plan

OCEANOGRAPHIC CONDITIONS

Deepwater wave statistics have been performed for coastal projects on the south shore of Oahu for many years. The wave data sets have become increasingly accessible and analysis techniques have become very sophisticated over the last 5 to 10 years. These data sets can be analyzed to show the likelihood of occurrence of a given offshore wave condition, and this analysis was performed previously for the Natatorium project. The offshore wave statistics, however, cannot be directly transferred to the nearshore. As waves break, reform, and propagate over the shallow reef, the maximum wave height becomes a function of the water depth, a condition referred to as "depth limited". Thus, a range of deepwater conditions can produce a certain wave height at the Natatorium.

A commonly-occurring wave height of 1.4 feet was selected for use in this study. This wave produced a maximum horizontal orbital velocity of 5.5 ft/sec (3.7 mph), which was advanced to ARCCA for analysis. The horizontal orbital length of the wave at the offshore wall of the Natatorium was determined to be 4 feet, i.e., a particle of water moves onshore-offshore over a total excursion of about 4 feet. That means that a human moving as a particle of water would impact the security bars if that person were within 4 feet of the bars when the wave crest approached. An analysis of velocities and accelerations shows that the maximum impact would occur if the human began half the orbital distance from the security bars.

Additional hazards identified are entrapment between bars, hair entanglement in the bars, and panic if a user is pinned against the security bars.

ASSESSMENT

The ARCCA "Preliminary Biomechanical Assessment of Proposed Natatorium Security Bars" is attached and key findings are summarized below.

Impact

ARCCA reported that a human impacting the security bars or concrete wall would likely suffer only minor injuries, such as contusions and abrasions, under most body orientations. The most severe injury, however, would occur when a human was projected head-first into the security bars or the wall. While the speed of the wave is only a fast walking speed (3.7 mph), the serious injury would not be a concussion or other head injury. The serious injury would be to the cervical spine (i.e., neck) and would result from the momentum of the body exerting force on the neck following impact. Though ARCCA reports that this has a low likelihood of occurrence, such an impact could result in complete paralysis.

The impact hazard is expected to be essentially the same whether a user hits the security bars or the concrete wall. Presently, the wall hazard exists and the City had indicated that there have been no reported incidents of injury. The openings in the deck, however, may draw people close to the security bars, increasing their risk. Assessing this risk is beyond the scope of the present study.

Entrapment

Entrapment refers to a human having his head caught between security bars due to the opening size. Entrapment could occur accidentally or voluntarily. Building code prohibits openings of 3.5 to 9 inches in public spaces, relating to the human head size. ARCCA states in the attached report that security bar spacing of 4 inches presents an entrapment concern for young children.

Hair entanglement

ARCCA reported that this hazard exists for users with long hair that can flow past the security bars and potentially become entangled due to turbulence on the opposite side of the bar.

Panic

ARCCA noted that there is potential for a swimmer to panic if they were held underwater against the security bars, even for a short period of time. The wave duration of 4 seconds was reported to be sufficient for this to occur.

LIMITATIONS

The purpose of this desktop study was to perform a preliminary assessment of possible injuries due to the proposed security bars. Those hazards presented in this report and in the ARCCA report have been identified based on a single wave case and anticipated usage. Other hazards not presented in these reports might exist. While hazards have been identified, the likelihood of occurrence has not been assessed at this stage.

ARCCA, INCORPORATED
2288 SECOND STREET PIKE
P.O. BOX 78
PENNS PARK, PA 18943
PHONE 215-598-9750 **FAX** 215-598-9751
www.arcca.com

October 14, 2019

David Smith and Ian Hardy
Sea Engineering, Inc.
Makai Research Pier
41-305 Kalanianaole Hwy.
Waimanalo, Hawaii 96795

Re: *Preliminary Biomechanical Assessment of Proposed Natatorium Security Bars*

Dear Dr. Smith and Mr. Hardy:

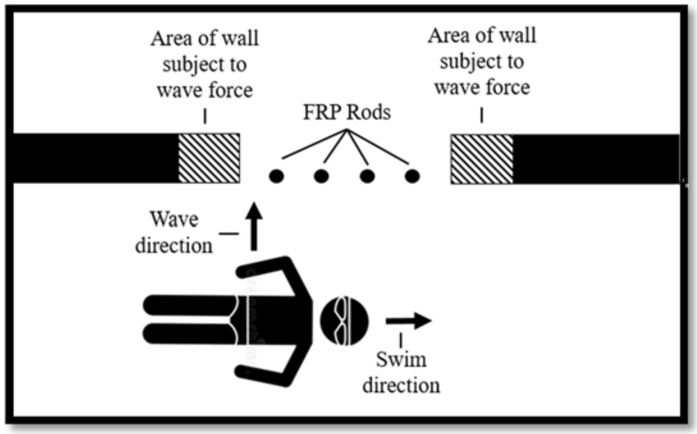
Thank you for the opportunity to participate in the above-referenced matter. Your firm retained ARCCA, Incorporated to conduct a preliminary biomechanical analysis of the proposed security bars for the Natatorium. Specifically, our analysis considers the potential for injury to swimmers due to interaction with the security bars and surrounding structures while being propelled by waves. As provided by Sea Engineering Inc., the following parameters are used in our assessment:

- The design condition outside the Natatorium is an incident wave crest approaching from offshore with a maximum horizontal velocity of 5.46 feet per second (ft/s) or 3.7 miles per hour (mph).
- The design condition inside the Natatorium is a reflected wave crest approaching from land with a maximum horizontal velocity of 2.04 ft/s or 1.4 mph.
- The fiberglass reinforced plastic (FRP) bars are 1.75 inches in diameter, vertically oriented (from the sea floor to the facility's deck), spaced 5.75 inches (on center), and providing 4-inch-wide openings for water flow. The spacing is assumed to not affect the water flow.

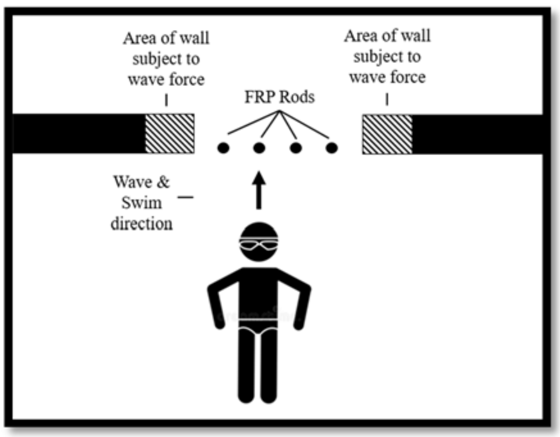
Two hazards are identified and evaluated: 1) impact and 2) entrapment.

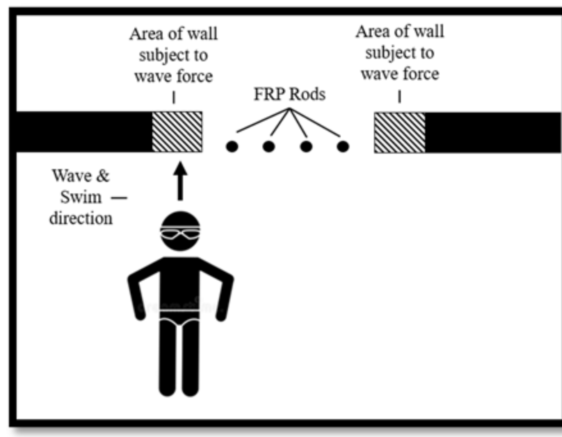
<u>Impact Hazard</u>:

The wave velocities both outside and inside the facility are relatively low (the highest expected velocity of 3.7 mph is comparable to an average walking speed). Assuming the wave velocity is equal to the impact velocity, lateral impacts at that velocity, where a swimmer's body is forced against the bars or surrounding wall while swimming parallel to those structures (Figure 1(a)), are unlikely to produce significant injuries. This is primarily because forces would be spread out across the swimmer's body. Minor injuries such as bruises (or cuts / lacerations in the case of contact to the wall) are possible. Note that if the corners of the wall opening in which the bars are mounted are pointed or sharp, those corners may present an unfriendly contact surface and exacerbate the aforementioned minor injuries.



(a) Lateral impact.





(b) Head first impact into FRP bars. **(c) Head first into surrounding wall.**

Figure 1 – Examples of potential contact between a swimmer and the security bars or surrounding wall structures (plan view).

The low energy of the expected waves is also unlikely to result in significant head injuries following head impact as a result of the wave action itself.[1,2,3] As with any swimming pool, however, it is possible for an individual to sustain head injuries from contact with the surrounding hard surfaces through their own volitional actions (for example, a misjudged dive or a fall).

Although much less likely to occur, the greatest likelihood of significant injury is anticipated when the wave and swim direction are the same and contact occurs head first (Figure 1(b)). Under these conditions, the swimmer's body weight would be behind him and that weight would load into the head and neck following contact (the total impact velocity would be greater when the swimmer is swimming in the direction of the wave). Despite the relatively low velocity of the presumed wave, there is potential for significant, and even fatal, injury because (1) the longitudinal orientation of the

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1 Gennarelli, T.A., Pintar, F.A., Yoganandan, N. (2003). Biomechanical Tolerances for Diffuse Brain Injury and a Hypothesis for Genotypic Variability in Response to Trauma. 47th Annual Proceedings – Association for the Advancement of Automotive Medicine.

2 Rowson, S. and Duma, S. (2013). Brain Injury Prediction: Assessing the Combined Probability of Concussion Using Linear and Rotational Head Acceleration. Annals of Biomedical Engineering. 41(5):873-882.

3 Funk, J.R., Cormier, J.M., Bain, C.E.et al. (2008). Relationship Between Linear and Rotational Head Acceleration in Various Activities. Rocky Mountain Bioengineering Symposium & International ISA Biomedical Sciences Instrumentation Symposium, 2008.

swimmer is aligned with the direction of the wave upon impact and (2) the force is imparted on an area of the body, such as the cervical spine (neck), where injury can result in catastrophic long term effects. From an impact energy perspective, a wave-induced head-first impact into the security bars or wall from outside the Natatorium could be comparable to a person falling upside down and head first into the ground from a height of 5.5 inches. From inside the Natatorium, the impact energy could be comparable to a person falling head first from 0.8 inches. In these scenarios, it is the weight of the following body mass which has the potential to force the cervical spine into an injurious position.

During such an impact, the cervical spine could be forced into hyperflexion (where the head is bent forward into the chest), hyperextension (where the head is bent backwards) or direct compression / axial loading (where the head and neck are compressed into the torso) which could potentially result in significant injuries including, but not limited to, vertebral fractures, ligament ruptures and spinal cord injuries resulting in complete paralysis.[4,5,6,7,8,9]

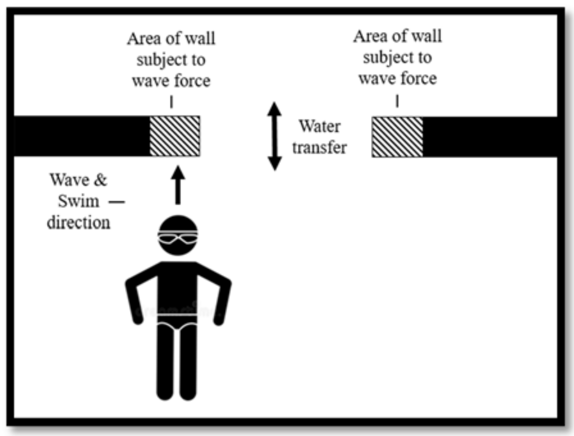

Figure 2 – Examples of potential contact between a swimmer and the surrounding wall structures in the absence of the security bars (plan view).

The potential for head first impacts (and subsequent injury) into hard surfaces is present in any swimming pool (for example, swimmers can still volitionally swim into a side wall or dive in shallow water). The difference in the proposed environment is the potential for wave-induced uncontrolled / unexpected motion into a hard surface. The wall and FRP bars are rigid with hard surfaces and both are likely to exhibit similar impact characteristics during the aforementioned scenarios. As such, they have a similar level of risk associated with the potential for impact-induced injury. Because the primary force generator is the transfer of water in and out of the swimming pool, even in the absence of the security bars, the areas of the wall adjacent to the opening would still pose a similar hazard (Figure 2).

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4 McElhaney, J., Snyder, R.G., States, J.D. et al. (1979). Biomechanical Analysis of Swimming Pool Injuries. (SAE 790137). Warrendale, PA, Society of Automotive Engineers.

5 White III, A. A., Panjabi, M. M. (1990). Clinical Biomechanics of the Spine. Philadelphia, J.B. Lippincott Company.

6 Crowell, R.R., Shea, M., et al. (1993) "Cervical Injuries Under Flexion and Compression Loading" Journal of Spinal Disorders 6(2): 175-181.

7 Roberts, C. and Kerrigan, J.R. (2015). Injuries and Kinematics: Response of the Cervical Spine in Inverted Impacts. 24th International Technical Conference on the Enhanced Safety of Vehicles.

8 Yoganandan, N., Pintar, F., Sances, A. et al. (1991). Strength and Kinematic Response of Dynamic Cervical Spine Injuries. Spine. 16(10S):S511-S517.

9 Maiman, D.J., Sances Jr., A., et al. (1983) "Compression Injuries of the Cervical Spine: A Biomechanical Analysis" Neurosurgery 13(3): 254-260.

As previously described, a head-first impact is much less likely to occur than other types of impacts. However, wave-induced cervical spine injuries following head impact in shallow water have been documented in the literature, so the possibility of them occurring cannot be ruled out. [10]

Note that the aforementioned opinions are also based on the assumption that the partially or fully-submerged body impacts have similar characteristics to body impacts out of water. The effects of buoyancy or drag may affect the impact pulse characteristics. This potential impedance effect from water is not well known and would have to be further assessed through further research and/or testing.

Signage, lifeguards and impact attenuation are potential strategies that can be used to mitigate the hazard if proven to exist as the design process continues.

Entrapment:

According to the U.S. Consumer Safety Product Commission (CSPC), certain openings can present an entrapment hazard if the distance between any interior opposing surface is greater than 3.5 inches and less than 9 inches.[11] Because the FRP bar spacing presumed in this analysis is 4 inches, the bars present a potential entrapment hazard for young children (Figure 3). Head entrapment can occur when a child enters an opening either feet first or head first, and head entrapment has the potential to lead to strangulation and death. There is potential for this to happen either volitionally (children trying to squeeze through the bars themselves) or as a result of being pushed into the opening while propelled by a wave. The spacing guidelines are a generally-accepted practice for all playground equipment because the equipment is intended for children. However, the spacing guidelines are also consistent with accepted, and required, building codes which require openings to be less than 4 inches on guard systems (for example, balcony or stair railings) which are designed to protect occupants from falling or climbing through open sided areas.[12]

Figure 3 – Example of head entrapment. [13]

A potential second entrapment hazard is that of a submerged swimmer being held in place against either the security bars or surrounding wall structure due to drag forces from the wave. As with the potential impact hazard, this would likely be much more significant for a swimmer on the outside of

[10] Robles, L.A. (2006). Cervical Spine Injuries in Ocean Bathers: Wave-Related Accidents. Spine. 58(5):920-923.
[11] U.S. Consumer Safety Product Commission. (2010). Public Playground Safety Handbook.
[12] International Code Council. (2018). International Building Code (IBC).
[13] U.S. Consumer Safety Product Commission. (2010). Public Playground Safety Handbook.

the facility (who could be exposed to the higher energy wave) than one on the inside. While the drag forces themselves would not be likely to cause significant injury and would be relatively short in duration (based on the initial wave force assessment, approximately 4 seconds), they would have the potential to hold an individual in place. Although the time period would be short, this could induce panic in a submerged swimmer (which could be further exacerbated by limbs becoming temporarily entrapped between the bars while the drag forces are being applied) and increase the risk of drowning.

The FRP bar spacing (4 inches) is large enough that entrapment of hair between them would not be expected (note that entrapment would also not be expected should the spacing be reduced to meet the aforementioned building code standards or CSPC guidelines). However, there is potential for hair to become entangled around the FRP bars due to the forces produced by the waves and subsequent turbulence generated from the water passing though the bars. The mechanism for entanglement often involves individuals with long, fine hair, who are underwater with their head near a suction outlet. The water flow through the outlet, sweeps the hair into and around the outlet grate, if equipped, and the hair becomes entangled. Testing in a hydraulic laboratory could be performed to assess the potential for hair entanglement and to guide the appropriate design to mitigate such entanglement.

If you have any questions or require additional assistance, please do not hesitate to call.

Sincerely,

Calum G. A. McRae, Ph.D.
Senior Biomechanist

Michael L. Markushewski,
Vice President and Chief Technical Officer, ARCCA Incorporated