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Hawaii RSM: Advance Planning for the Beneficial Reuse of Dredged Material at Haleiwa Harbor, Island of Oahu, Hawaii

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PURPOSE: This U.S. Army Corps of Engineers (USACE) Regional Sediment Management Technical Note (RSM-TN) brings together the information necessary to prepare for the next maintenance dredging event at Haleiwa Small Boat Harbor (HSBH), located on the north shore of the Island of Oahu, State of Hawaii. Through the National RSM Program, the USACE Honolulu District (POH) is working toward beneficial reuse of suitable quality dredged sediment rather than disposing of it upland or offshore, as is typically done. For that purpose, this RSM-TN reviews previous work in the region including maintenance dredging and sediment budgets, evaluates sediment quality data, and projects future sediment volumes and shoaling rates. Additionally, this RSM-TN identifies environmental coordination requirements and permits and documents discussions with the non-federal sponsors and other stakeholders to identify stockpile, beneficial reuse, and disposal options. The non-federal sponsors of this RSM initiative are the State of Hawaii Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands (OCCL), and the Division of Boating and Ocean Recreation (DBOR). The City and County of Honolulu (C&C) is one of several project stakeholders.

BACKGROUND: Regional sediment management (RSM) refers to the effective use of littoral, estuarine, and riverine sediment resources in an environmentally sensitive and economical efficient manner. RSM changes the focus of engineering activities from the local or project-specific scale to a broader scale defined by natural sediment processes. A prime motivator for the implementation of RSM principles and practices is the potential for reducing construction, maintenance, and operation costs of federally authorized projects. Implementing RSM principles also has the potential to positively impact multiple projects in their ability to accomplish authorized purposes.

The RSM program was implemented at POH in 2004. The Haleiwa region on the north shore of Oahu (Figure 1) was previously studied in 2013. There are two federally authorized projects in this region: (1) the HSBH and (2) the Haleiwa Beach Shore Protection Project (HBSPP). For the FY13 RSM study, numerical models and a shoreline change analysis were used to identify sediment pathways and to develop a sediment budget for the Haleiwa region (Podoski 2014). With this understanding of the regional processes, several potential RSM projects were proposed with input from stakeholders. The following projects were identified as being implementable, practicable, and environmentally acceptable (Smith 2014):

1. Reduce sediment transport into the HSBH from Ali`i Beach due to waves overtopping the state outer breakwater.
2. Facilitate beneficial use of dredged material from the HSBH.

3. Identify sustainable sand sources to maintain the region's beaches.
4. Sand tighten the Haleiwa Beach Park (HBP) groin.
5. Restore the HBP by renourishing the beach fill project.
6. Construct additional shore protection structures at the HBP.

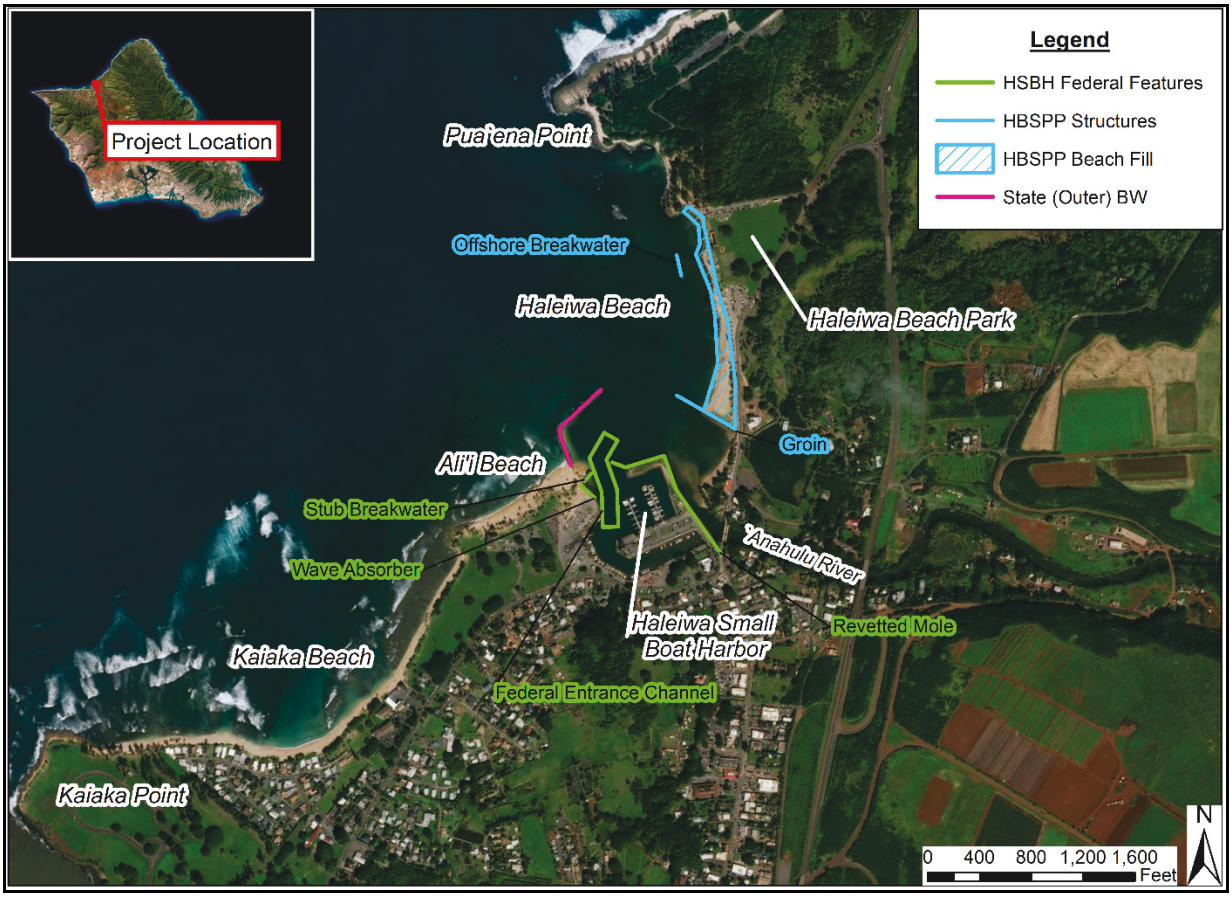

Figure 1. Map of the Haleiwa region, Island of Oahu, Hawaii.

Actions needed to implement potential RSM project Number 2 from the above list (beneficial use of dredged material) are described in further detail in this RSM-TN.

FEDERAL PROJECT HISTORIES AND PRIOR DREDGING

Haleiwa Small Boat Harbor (HSBH). Prior to the construction of the HSBH, the `Anahulu River emptied where the harbor is presently located. The State of Hawaii constructed what is now the outer breakwater for the harbor in 1955. The HSBH was authorized on 26 March 1964 and 25 October 1974 under Section 107 of the River and Harbor Act of 1960, as amended. The project was the first joint federal-state harbor constructed on Oahu. The original federal project, which was completed in November 1966, consisted of the entrance channel and revetted mole. The stub breakwater and wave absorber were added in 1975. The current federal general navigation features of Haleiwa Harbor consist of an entrance channel 740 feet (ft) long, 100–120 ft wide, and 12 ft deep; a revetted mole that is 1,310 ft long; a stub breakwater that is 80 ft long; and a wave absorber that is 140 ft long (Figure 1). Non-federal project features include 64

berths, 26 moorings, 2 loading docks, and 3 ramps. The non-federal sponsor for the harbor is the State of Hawaii, DLNR and DBOR.

Haleiwa Harbor has been dredged twice since initial construction: (1) 7,214 cubic yards (cy) in 1999 and (2) approximately 6,500 cy in 2009 (Table 1). Both times, the material was disposed upland. Some of the clean, sandy material from the 2009 dredging was used at the HBP for repair work, and some was made into concrete. At the time, placing suitable dredged material on Haleiwa Beach was identified as a potential beneficial reuse option. The necessary environmental permits were not in place, however, and the maintenance dredging schedule and budget did not allow for them to be acquired at that time.

Table 1. USACE dredging history of Haleiwa Harbor.

Year	Type of Work	Type of Disposal	Volume (cy)	Total Cost	Unit Cost
1999	Maintenance	Upland	7,214	$208,100	$28.85
2009	Maintenance	Upland	6,500	$1,150,000	$176.92

Prior to the 2009 maintenance dredging, shoaled areas were sampled for both grain size and chemicals of concern by Marine Research Consultants, Inc. (MRCI) in 2008. MRCI conducted two rounds of sampling (Figure 2): the first for grain size analysis (Samples H1-H6) and the second for chemicals of concern (Samples H1-H5, and H7). Composite Sample H123 was in the interior non-federal berthing area, which is the state's dredging responsibility. Composite Sample H45 and discrete Sample H6 are in the federal channel. Table 2 shows the grain size results.

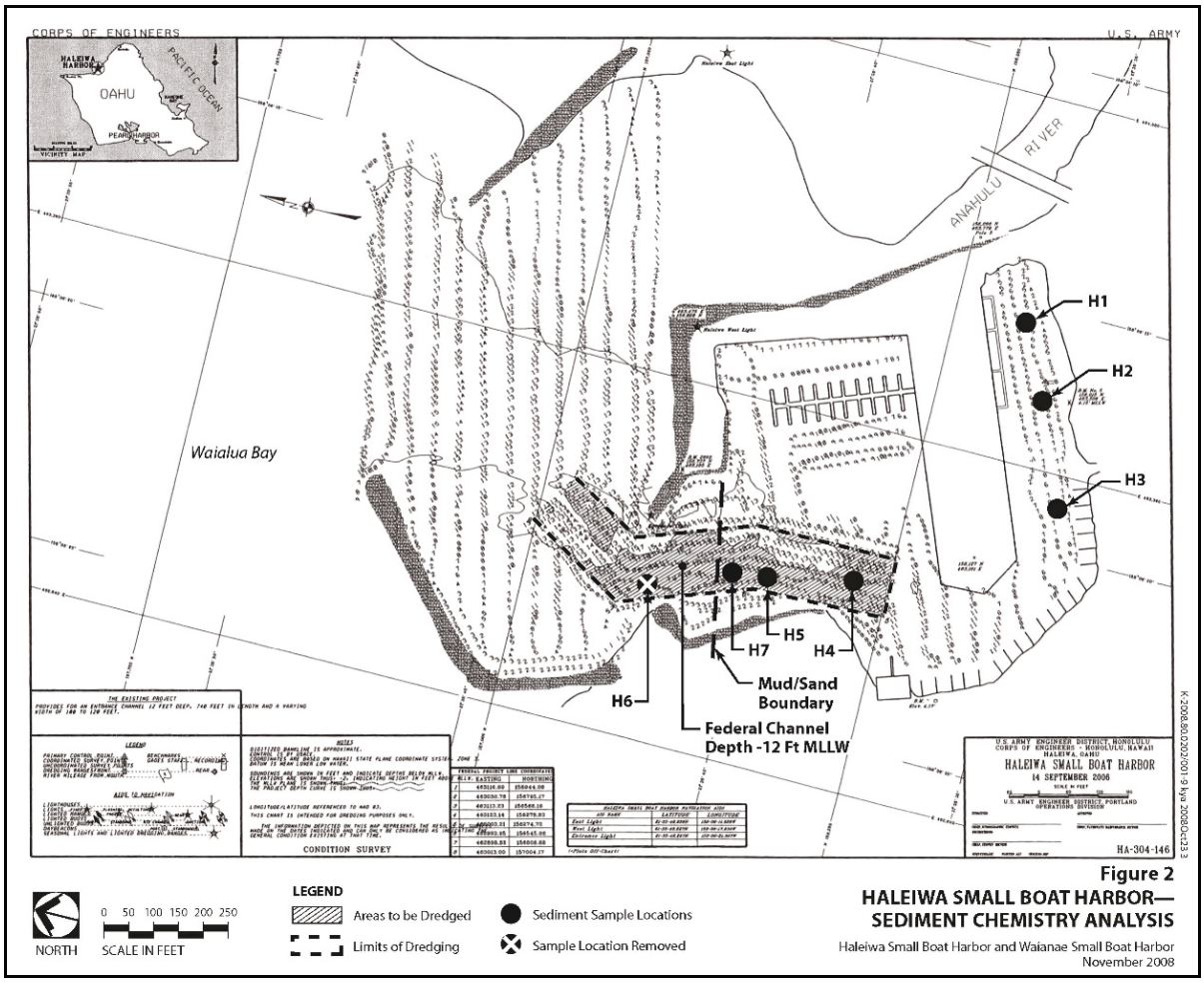

Figure 2. Haleiwa Harbor with sediment sampling locations and estimated sand/mud boundary (MRCI 2008).

Table 2. Particle size distribution by sample (MRCI 2008).

Sample	H123 (%)	H45 (%)	H6 (%)
Gravel (>2 mm*)	1.63	1.74	7.29
Sand (>63 µm**)	8.11	43.67	92.35
Silt/Clay (<63 µm)	91.89	54.59	0.37

*mm = millimeter
**µm = micron

These data show the gradation from very fine-grained material in the berthing area (Sample H123), to clean, well-sorted coarse-grained sand in the outer channel (Sample H6). Based on these results, Figure 2 shows the approximate boundary between the sand/silt areas in the entrance channel. Since Sample H6 was found to be <1% fines (silt/clay), it was not used for the second round of testing, which was a chemical analysis on material with greater than 15% fines. Instead, another sample location (Sample H7) was added to create composite Sample H457 as shown in Figure 2. Although chemical concentrations were detected in Sample H457, they were determined to be below the Department of Health Environmental Action Limits for unrestricted uses. They were

also below the criteria for landfill acceptance. Thus, contaminates will not restrict disposal options. Though the amount of dredge material suitable for beach placement was not quantified in 2009, based on the sample data and observations during dewatering, an assumption was made that approximately 60% (3,900 cy) of the material dredged from this section of the federal channel (dashed box in Figure 2) was sand similar to that found in Sample H6.

Haleiwa Beach Shore Protection Project (HBSPP). Haleiwa Beach is just north of Haleiwa Harbor and the `Anahulu River mouth. In December 1949, the HBP was fronted by a beach ranging from 90 to 130 ft wide. It steadily eroded over the next several years, however. In March 1957, a tsunami washed away a large volume of sand. At one point, a section of the existing seawall fronting the HBP comfort station collapsed due to the lack of beach in front of it (USACE 1973). The HBSPP was authorized by the River and Harbor Act of 1965 and was constructed in 1965. It consists of an offshore breakwater 160 ft long, a 520 ft long terminal groin at the southern end of the project, and a beach fill 1,600 ft long and 140–265 ft wide (Figure 1). In the 1970s, it was repaired several times due to storm damages. In December 1969, USACE conducted emergency repairs on the groin and offshore breakwater in response to damages caused by severe storms and placed approximately 12,000 cy of sand on the beach. Storms in January 1974 and November 1976 again caused damages requiring emergency repairs for the project, in 1975 and 1978, respectively. The project authorization states that the non-federal sponsor is responsible for ongoing maintenance of the project and that USACE may conduct emergency repairs to the project in accordance with Public Law (PL) 84-99. The non-federal sponsor for the HBSPP is the State of Hawaii, Department of Transportation.

Regular maintenance of the HBSPP has been limited; thus, portions of the beach are severely eroded. During a site visit in March 2017, it was observed that the most northern section directly in front of the seawall protecting the comfort station at the HBP was completely gone (Figure 3A). At that time, the seawall was undermined, and the fill behind the wall was being washed out. The seawall itself was at risk of collapsing (Figure 3B) as it had done previously, most recently in the 2000s before being reset but not repaired substantially[1]. The beach fronting the remaining length of seawall ranges in width from 10 to 30 ft.

[1] Sea Engineering, Inc. Draft Report. *Concept Designs for Selected Beach Parks, Volume 1—Haleiwa Beach Park*. Prepared for the City and County of Honolulu, Department of Design and Construction.

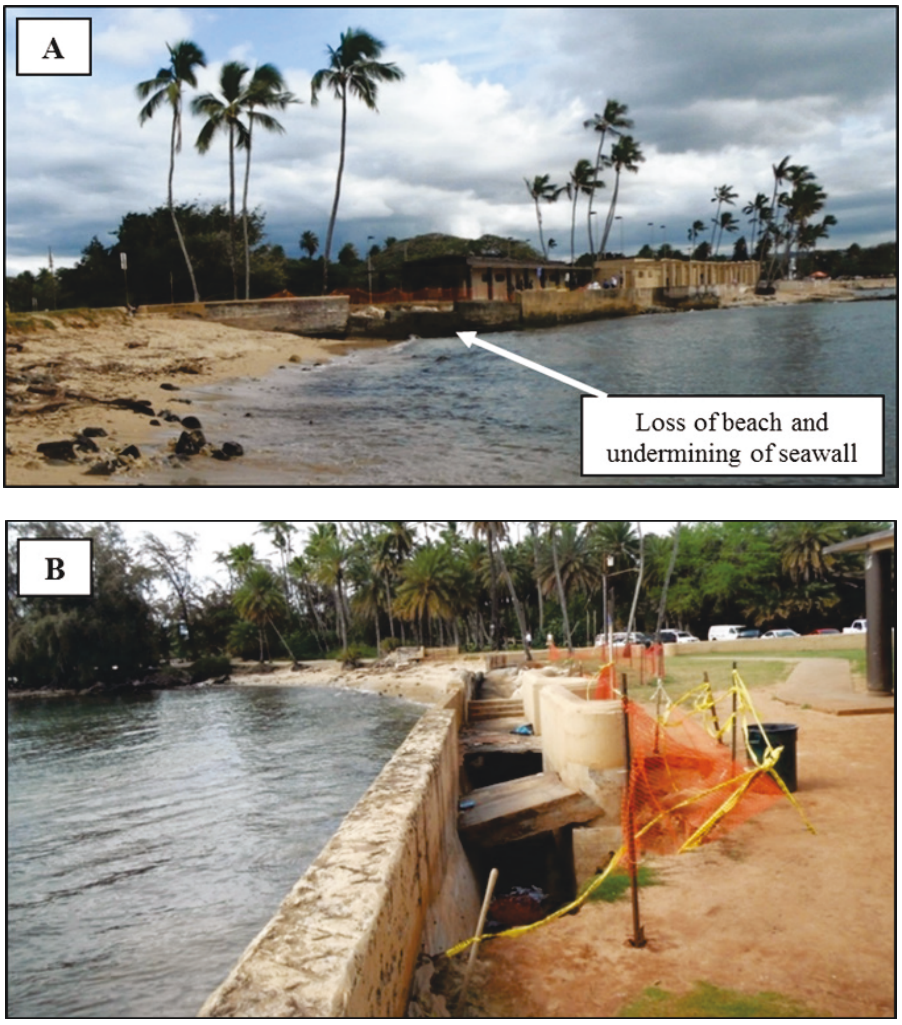

Figure 3. Pictures from the March 2017 site visit showing the severe erosion of the beach at the northern section of the Haleiwa Beach Project (A) and the washed out area behind the seawall (B).

The majority of sand in the littoral cell has been transported alongshore toward the groin at the southern end of the project. The C&C maintains the HBP and thus are highly concerned about the state of the shore protection project and its impact on the HBP facilities. During recent years, the C&C has only repaired the wall when it failed. A limited repair was constructed around 2013, for example. Limits in funding and jurisdiction prevent C&C from taking further immediate action. C&C hired Sea Engineering Inc. to conduct a study and develop conceptual plans to address the erosion issues at the HBP[1]. While the potential quantity of dredged material in the harbor is not enough to renourish the entire beach fill, USACE may be able to place recovered sand in the area of greatest need to prevent complete collapse of the seawall and continue protection of the structures. Details of such actions will be discussed below.

REGIONAL COASTAL PROCESSES: The coastal region of Haleiwa containing the aforementioned projects is bounded by two rocky headlands — Pua`ena Point to the north and Kaiaka Point to the south. In the 2013 RSM study, numerical modeling of waves and currents was used to identify dominant sediment pathways and to inform the development of a regional

sediment budget (Podoski 2014). Currents were observed to flow along the shoreline and then offshore at the relic stream channels.

Along the Haleiwa Beach shoreline, there is strong transport from north to south, as evidenced by the wide beach at the terminal groin (Figure 1), which allows some sand to leak through. This process leaves the section in front of the comfort station severely eroded. Some of the sand leaving the Haleiwa Beach cell ends up in the harbor channel in the lee of the state breakwater. In addition, terrestrial sediment enters the back of the harbor from `Anahulu Stream. These observed regional processes agree with the sediment analysis described above, which identified fine-grained terrestrial sediment in the back of the harbor and coarse-grained sand in the outer harbor.

The 1967–2006 shoreline erosion map of this region produced by the University of Hawaii, Coastal Geology Group supports these findings (UH SOEST 2018; Fletcher et al. 2012). According to their calculations, the shoreline at Haleiwa Beach is retreating at an average rate of 2.2 ft/year (yr). Ali`i Beach is not experiencing erosion so severe, with its shoreline retreating at approximately 0.3 ft/yr. Kaiaka Beach has advanced at a slow rate since 1910, approximately 0.2 ft/yr on average. In this area, the highest rates of shoreline advancement were observed along the section fronting the channel, suggesting that the channel acts as a sediment source.

EVALUATION OF DISPOSAL OPTIONS AND DREDGE QUANTITY REDUCTION

Material dredged from Haleiwa Harbor was previously disposed upland. In anticipation of future maintenance dredging, different disposal options will be presented and compared. Since it is known that some of the material will be beach quality sand, the requirements for stockpiling and beach placement will be reviewed in the following section.

Estimated Shoaling Rate. Future dredging needs can be predicted by evaluating past dredging events and surveys, as summarized in Table 3. Shoaling rates are then calculated as the shoaled volume divided by the years of accumulation. Assuming that the span between the two most recent dredging events provides the best data (i.e., 6,500 cy of material shoaled between 1999 and 2009), an annual shoaling rate of 650 cy/yr can be estimated. Shoaling may also result from episodic events affecting the north shore during winter months, however. By 2022, which is the next anticipated dredging year, approximately 8,500 cy of material may need to be dredged. If the harbor needs to be dredged every 10–15 yr, over the next 20 yr (2018–2038), the harbor will be dredged twice with a total dredged volume of approximately 17,000 cy.

Table 3. Shoaling volume and rate based on dredging and hydrosurvey history.

Year	Type of Work	Shoaling Volume (cy)	Shoaling Rate (cy/yr)*
1999	Maintenance Dredging	7,214	219
2009	Maintenance Dredging	6,500	650
2011	Hydrosurvey	311	155
2014	Hydrosurvey	800	160

*Equal to the shoaled volume/year since last dredging.

Deposition Basin to Reduce Channel Dredging. To reduce the dredging needs at Haleiwa Harbor (Objective #1 in the Haleiwa Potential RSM Projects), there may be justification to authorize a deposition basin adjacent to the federal channel. A large volume of sand has accumulated between the federal stub breakwater and the state's outer breakwater. The sand is transported by wind and high waves from Ali`i Beach over the root of the state breakwater and fills in this area. That sand ultimately shoals in the channel and requires maintenance dredging. While the area between the breakwaters is outside of the federal channel limits, USACE may pursue authorization to conduct advanced maintenance, such as the construction of a deposition basin. Since sand will eventually enter the channel via this pathway, this location would be a logical choice for a deposition basin so that any sand coming over the breakwater would settle here rather than moving into the channel.

The deposition basin would also need to be maintained (using land-based equipment with a limited reach) but would reduce channel maintenance requirements (including a floating dredge plant). Based on 2013 USACE Joint Airborne Lidar Bathymetry Technical Center of Expertise lidar data, it is estimated that 1,200 cy of sand could be removed from the shoaled area to create a 100 ft long by 60 ft wide by 8 ft deep mean lower low water deposition basin, at a cost of approximately $160,000. Given the harbor's dredging history, the deposition basin would need to be excavated at 3 yr to 5 yr intervals. Assuming a reduced future channel shoaling rate, the dredging interval would increase to well beyond 10 yr. In addition, all of the material from the deposition basin would be beach quality material that could be used for beach placement.

Disposal Options. Based on projected dredging needs, four different disposal options were evaluated for the dredged material in the channel and/or deposition basin.

- **Stockpiling**. Dredged material would be stockpiled at the HBP. This material would be turned over to the C&C. Since the C&C is responsible for the maintenance of the HBP, they are interested in using the sand to address the erosion problem around the comfort station. This could be accomplished by working with the state to renourish the beach fronting the structures (using a combination of offshore sand and dredged material) or by placing sand in the cavities that have eroded behind the seawall. For this option, the C&C would be responsible for all necessary environmental requirements. The silty material would be taken to the Offshore Dredged Material Disposal Site (ODMDS) or beneficially reused.

- **Beach Placement**. For this option, POH would place clean, sandy material on Haleiwa Beach in the area of greatest erosion, which is immediately in front of the seawall by the comfort station. It is estimated to be an area of approximately 8,000 square feet. This would help to temporarily protect the seawall and the structures behind it. While the C&C and the state are interested in renourishing the whole project, the beneficial reuse of this dredged material would help protect the most critical shore side facilities before a full renourishment can take place. POH would be responsible for meeting the necessary environmental requirements to place sand on the beach for this option. The silty material would be taken to the ODMDS or beneficially reused.

- **Landfill**. Dredged sediment would be taken to a landfill in west Oahu. This landfill is the only landfill on Oahu that accepts construction and demolition material, including sediment. The dredged material could be used to cap sections of the landfill. The distance to the landfill is approximately 35 miles from the project site.

- **South Oahu ODMDS**. All dredged sediment would be taken via barge to the South Oahu ODMDS. While this site is far from Haleiwa Harbor, it is the only ODMDS for the Island of Oahu. The site is approximately 48 miles from Haleiwa Harbor and 3.3 nautical miles off the south shore of Oahu in Mamala Bay.

A rough order of magnitude cost estimate is presented in Table 4 to compare the different disposal options. For each option, it is assumed the channel will be dredged to authorized depth (total volume of 6,500 cy) and that all material will be disposed with a single disposal method (i.e., stockpile, beach placement, landfill, or ODMDS). Unit dredging costs were calculated by dividing the dredging cost only (no mobilization/demobilization costs included) by the dredging volume. The estimate shows that disposing of the material at the ODMDS is the least-cost option, at $33/cy. Taking the material to the ODMDS eliminates the need for landside equipment, as well as dewatering and trucking the material. Stockpiling and beach placement have very similar in-unit costs, as there is not much difference in construction cost between placing the material at the HBP and placing it on the beach. Trucking the material to the landfill is the most expensive option, almost double the cost of stockpile or beach placement options (i.e., $188/cy vs. $91–96/cy).

Table 4. Cost estimates for disposal options (rough order of magnitude).

Disposal Method	Mob/Demob Cost	Dredging Volume (cy)	Dredging Cost	Total Construction Cost	Dredging Unit Cost ($/cy)
Stockpile	$501,121	6500	$593,948.23	$1,095,069.34	$91
Beach Placement	$501,121	6500	$621,450.80	$1,122,571.91	$96
Landfill	$501,121	6500	$1,220,902.80	$1,722,023.91	$188
South Oahu ODMDS	$626,888	6500	$212,880.06	$839,768.54	$33

The Federal Standard. The Federal Standard (EPA and USACE 2007) is defined in USACE regulations as the least costly dredged material disposal or placement alternative (or alternatives) identified by USACE consistent with sound engineering practices and meeting all federal environmental requirements. It is also USACE policy to fully consider all aspects of the dredging and placement operations while maximizing benefits to the public. Beneficial use options for the dredged material should be given full and equal consideration with other alternatives. Based on the cost analysis above, open water placement of dredged material in the South Oahu ODMDS is the Federal Standard (or *base plan*).

Beneficial use project costs exceeding the cost of the Federal Standard option become either a shared federal and non-federal responsibility, or entirely a non-federal responsibility, depending on the type of beneficial use. Section 145 of the Water Resources Development Act (WRDA)

1976, as amended by Section 933 of WRDA 1986, Section 207 of WRDA 1992, and Section 217 of WRDA 1999, authorizes USACE to place suitable dredged material on local beaches if a state or local government requests it. Although placement for restoration purposes may be authorized, this provision is primarily used for storm damage control purposes. The incremental costs of beach nourishment are shared on a 65% federal and 35% non-federal basis.

PERMITTING AND COORDINATION FOR BENEFICIAL USE: The biggest hurdles to beneficially reusing dredged sediment (stockpiling or direct beach placement) are completing all required environmental permits and actions as well as finding a non-federal sponsor willing and able to pay the incremental costs above the Federal Standard. To facilitate this prior to the next dredging event at Haleiwa Harbor, POH discussed disposal options with several stakeholder agencies to identify concerns and to develop a timetable for all environmental coordination and permits.

POH met with members from the Hawaii regulatory agencies on 4 August 2017 to discuss the permitting requirements for disposing of dredged material from the HSBH. Agencies included the State DLNR OCCL, State Coastal Zone Management Office (CZMO), and the State Department of Health, Clean Water Branch (DOH). The State DLNR DBOR was also in attendance as the local sponsor of the harbor project. The main concern brought up during this discussion was whether the placed material would remain on the beach. USACE noted that a partial solution is to sand tighten the leaky terminal groin.

POH conducted an informational meeting with the various resource agencies that are consulted during the environmental permitting process on 3 August 2017, including the DLNR Division of Aquatic Resources (DAR), U.S. Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration, National Marine Fisheries Service Protected Resources Division. These agencies provide oversight for the Fish and Wildlife Coordination Act and the Endangered Species Act. Overall, the agencies do not have any major concerns. They see a need to evaluate and identify the resources to better understand the potential impacts. The agencies prefer an adaptive management approach to ensure that the nourished beach does not become a source for sedimentation, disrupt natural drainage, or get washed away shortly after placement.

The primary environmental permits that would be required for beneficial use of dredged material, either through stockpiling and placement by C&C or by direct beach placement by POH, are listed in Table 5 with approximate review times associated. Overall, the entire environmental coordination and permitting process is expected to take 1–2 yr, depending on the disposal options selected. For the stockpiling and landfill option, it is estimated to take up to a year at a cost of approximately $250,000. Placing sand on the beach will require more coordination and permitting, thus it is expected to take 1–2 yr at a cost of approximately $500,000. Taking the material to the ODMDS will require additional sediment testing to meet EPA standards, but the coordination is not expected to be as rigorous as beach placement. Planning for ODMDS is estimated to be $350,000 and take 12–18 months. Based on this information, a project planning timeline by fiscal year has been developed to aid in future project planning, shown in Figure 4.

Table 5. Permitting requirements and timetable.

Permit	Regulating Agency	Regulated Activity	Agency Review Time*
CDUP	DLNR OCCL	Any beach placement	180 days
Section 401 WQC	DOH Clean Water Branch	Discharge into state waters, including any beach placement below high-tide line	30 days
Section 402 NPDES	DOH Clean Water Branch	Any land disturbance greater than 1 acre (including beach placement/stockpiling)	30 days
CZM Federal Consistency Review	State Office of Planning, CZMO	USACE beach placement	60 days
CZM Special Mgmt Area Review	State Office of Planning, CZMO	C&C beach placement	60 days
DA Permit (Standard)	USACE	C&C beach placement below high-tide line	120 days
Stockpiling Permit	C&C of Honolulu, DPP	Stockpiling	

*Assumes that submitted application is complete per agency's requirements. Pre-application meetings should be scheduled with each agency once an environmental contractor is in place to ensure that all application requirements will be met.

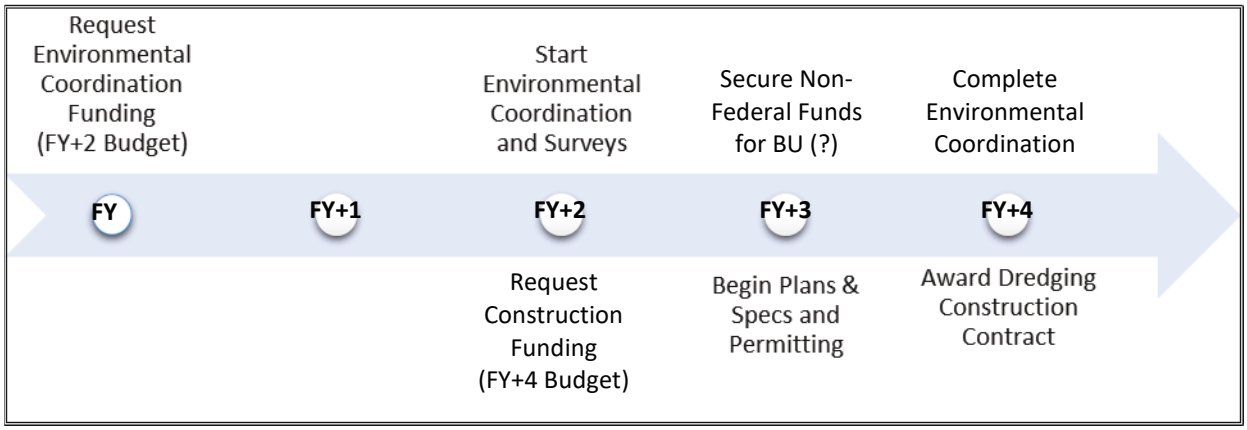

Figure 4. Project planning timeline.

RECOMMENDATIONS FOR FUTURE ACTION AT THE HALEIWA SMALL BOAT HARBOR (HSBH): Based on the analysis and information obtained as part of these RSM investigations, and in support of continued efforts toward maximizing beneficial reuse of dredged material and lowering dredging costs, recommendations for future actions for Haleiwa SBH are as follows:

1. Take next steps to intercept material before it is transported into the HSBH. Identify environmental coordination and permit requirements for a deposition basin. Secure funding for development of a deposition basin implementation plan. Coordinate plan through POD for approval and authorization. Also, identify potential methods to reduce

the amount of fine-grained terrestrial material entering the harbor through culverts in the revetted mole.

2. Utilizing available cost estimates, determine approximate non-federal costs (pre-construction and construction) for placement of dredged material at locations not covered by the Federal Standard.

3. Discuss the possibility of cost-sharing in incremental costs beyond the Federal Standard with potential stakeholders and non-federal sponsors. Identify federal authorities for cost-sharing in beneficial use of dredged material. Facilitate between agencies and stakeholders in identification of non-federal funding sources.

4. Budget for pre-construction Operation and Maintenance dredging funds at least 4 yr in advance of contract award. This will provide enough time for environmental investigations and coordination to enable non-federal cost sharing above the Federal Standard.

ADDITIONAL INFORMATION: This Regional Sediment Management Technical Note (RSM-TN) was prepared by Lauren K. Molina and Jessica H. Podoski, U.S. Army Engineer District, Honolulu (POH), HI, with input from the Hawaii RSM Project Delivery Team. The study was conducted as an activity of the USACE National RSM Program, a Navigation Research, Development, and Technology (RD&T) Portfolio program administered by Headquarters (HQ) USACE. For information on the National RSM Program, please consult *http://rsm.usace.army.mil* or contact the USACE National RSM Program Manager, Ms. Linda Lillycrop, U.S. Army Engineer Research and Development Center (ERDC), Coastal and Hydraulics Laboratory (CHL), *Linda.S.Lillycrop@usace.army.mil*. For information regarding this RSM-TN, please contact Lauren Molina *Lauren.K.Molina@usace.army.mil*.

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