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Potential RSM Projects West Maui Region, Maui, Hawai'i

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BACKGROUND. The West Maui Region was the focus of Hawai'i Regional Sediment Management (RSM) investigations in fiscal year 2014 (FY14). The West Maui Region extends from Kaanapali through Honolua Bay. The conceptual regional sediment budget developed for West Maui as part of the FY14 RSM investigations indicates that the shoreline has been relatively stable over the past 17 years (1997 through 2014). Portions of sandy shoreline within the region, however, have been lost altogether. Critically eroding beaches in the West Maui Region have been identified by the County of Maui Planning Department and various other stakeholders. This Coastal and Hydraulics Engineering Technical Note (CHETN) identifies potential RSM projects (PRPs) that could be implemented in the region. Since the U.S. Army Corps of Engineers' (USACE's) RSM program does not provide federal funds for project implementation, the goal of this document is to identify conceptual alternatives that could be refined and implemented through acquisition of appropriate federal authorizations, by other federal, state, and/or county agencies, partnerships or the private sector.

WORKSHOP DISCUSSIONS. The following is a summary of PRPs in the West Maui Region as discussed at a 17 August 2014 RSM workshop held in Kihei, Maui. Of the three breakout sessions conducted at the workshop, one consisted of identifying PRPs in the region. The other two breakout sessions were devoted to the identification of engineering and environmental considerations associated with implementation of PRPs in the region. The following are the highlights of the various workshop breakout sessions.

Engineering Considerations
(Moderators: Jessica Podoski and Nani Shimabuku)

1. Optimize beneficial use of dredged material (both federal and non-federal operations). No pump out capability aboard the USACE's Essayons hopper dredge.
2. Most sources of offshore sand are in small sand fields located in relatively deep water. Need to quantify the volume of suitable offshore sand available and the cost associated with dredging and placing it on various beaches within the region.
3. Determine the nominal interval for beach renourishment in the region.
4. Identify the impacts of beach nourishment in the region (both economic and environmental).
5. Document lessons learned from shore protection efforts in the West Maui Region.
6. Review the Sugar Cove beach nourishment project (previous homeowner sponsored project). Approximate cost is $60,000 per year; fill material is fine sand.
7. Investigate the need for terminal structures for beach nourishment/fill on an open coast.
8. Determine the potential for hotels to share in the cost of beach nourishment projects. Tourists could contribute through assessment of a bed tax.

9. Quantify the engineering benefits of combining different shore protection alternatives. An example would be construction of a revetment and nourishment of the beach. This is a hybrid solution that has been used with some success in past projects in the region.

10. Push sand to recreate a berm is another option that has minimal cost and equipment requirements that can provide short-term protection.

11. Consider temporary placement of sand bags in the winter season. This was acceptable to the resource and permitting agencies. This alternative provides protection in the winter and can be removed at the end of the season.

12. West Maui region has many areas with erosion issues at the end of cells due to seasonality of shoreline accretion/erosion. In many areas, there is also long-term erosion that is occurring in addition to seasonal erosion. Both could be investigated in a site-specific manner through quantification of regional coastal processes.

13. BMPs for the use of upland sediment sources are needed so that proper physical and chemical characteristics are met for placement on the beach.

14. Do we want natural or engineered beaches in these areas? A bigger picture consideration. The answer to this will vary by region (West Maui vs. Waikiki).

15. Review the Napili Bay/Kapalua beach nourishment plan. This could serve as a model for beach nourishment in the West Maui Region.

16. Develop beach nourishment project designs that maximize sand retention time through use of "headland" control features. Promote regional beach project implementation (e.g. Pohailani Condos to Pohaku Beach Park beach nourishment with headland control structures).

17. Look into the possibility of moving roads inland to eliminate the need for hardened coastal structures to stabilize highways.

Environmental Considerations
(Moderators: Tom Smith and Justin Goo)

1. Determine the consequences of introducing sediment into the littoral environment. There is concern that a portion of sand placed on the beaches within the region will be transported offshore onto the reef. Impacts of the transport of sand onto the reef include but are not limited to covering (smothering) of coral and filling voids in the reef that provide habitat for various marine organisms.

2. Close the knowledge gap concerning the impacts of beach fill projects on reef systems. To date, there has been limited study of the impacts of sand on reef environments. Anecdotal indications that sand negatively impacts reef systems need to be substantiated by rigorous scientific investigation. Until that time, resource agencies along with beach nourishment proponents should not rely on broad unsubstantiated claims to promote their points of view.

3. Investigate the physical and chemical characteristic of calcium carbonate versus terrestrial sediment. Can varying percentages of these types of sediment be introduced into the littoral system with favorable results?

4. Study the impacts of fine grain sand with particular focus on the dynamics of sediment that can be resuspended into the water column by waves and currents. What is the residence time of these sediments on reefs in the West Maui Region?
5. Establish more water quality stations within the region and ensure that they accurately measure constituents of interest. There are a limited number of water quality sensors in the West Maui Region. Develop a suitable water quality network and seek funding for installation, operation and maintenance of the network.
6. Establish at least one laboratory on Maui that can process water quality samples. Currently, water quality samples from Maui are sent to off-island laboratories. Test results are oftentimes not provided soon enough to enable avoidance of the threat.
7. Ensure that beach fill material is compatible with the native beach sand. Overly fine grained sand as well as overly coarse sand could potentially be detriments to the littoral system.
8. Investigate the potential impacts of utilizing offshore sand resources for beach nourishment.
    a. Dredging operations can generate sediment plumes
    b. Exposure of clay layer or other unwanted material can release fine grained material
    c. Determine if sand sources in deeper water can be dredged with fewer impacts to the reef system
    d. Investigate whether the impacts are short-term or long-term
9. Potential Inland RSM Projects (PIRPs)
    a. Create sediment retention basin inland from the coast
    b. Redirect stream flows away from the coast
    c. Construct erosion control structures to reduce stream sedimentation
    d. Implement feral animal control to reduce the amount of barren soil
    e. Re-vegetate barren areas
    f. Post-fire restoration-response to stabilize exposed ground
10. Conduct ecological assessment of beach fills to investigate their sustainability and identify long-term impact.

Potential RSM Projects
(Moderators: Linda Lillycrop and Katherine Touzinsky)

1. Advocate for increased Environmental Protection Agency (EPA) involvement in the enforcement of the Clean Water Act (CWA). The State of Hawai‘i’s Department of Health, Environmental Management Division, Clean Water Branch implements the intent of the CWA under the stewardship of the EPA. Increased involvement and oversight from the EPA would ensure that CWA standards are carried out on a consistent basis throughout the country.
2. RSM can address brown water issues caused by agriculture and construction site runoff (an inland issue that must be addressed through enforcement and permitting processes). Runoff

from construction sites is often sediment laden and ultimately results in increased turbidity in nearshore coastal waters. Improved sediment best management practices (BMPs) at construction sites can be employed to reduce point source runoff.

3. Alternate solutions must be available when it becomes apparent that BMPs do not apply to a specific area. RSM could help with site design and BMPs for these areas. Examples: Honokahua Bay, Mahana Ridge (originally part of Kapalua Mauka permits in 2007 that promised no negative downstream effects), and Honolua Bay.

4. Offer outreach and guidance to stakeholders in the West Maui Region in the form of RSM concepts, modeling, research and coordination.

- **a.** Aid in better understanding the sediment/reef relationships through RSM principles
- **b.** Work to identify knowledge gaps, current tools, and future needs to aid in planning
- **c.** Hold a series of workshops to provide RSM guidance to the West Maui Region stakeholders

5. Hawaii RSM models inherently need to be different from mainland RSM models in order to incorporate the effects of steep offshore slopes, wide shallow reefs, incident wave climate, etc. Hawaii needs more specific data to allow for variations in beach and storm characteristics during modeling projects for RSM and sediment transport. Mainland RSM models may not accurately predict island coastal processes.

6. Conduct detailed offshore sand investigations in support of beach nourishment

- **a.** Find viable sand resources through reconnaissance sampling, geophysics, etc.
- **b.** Once viable sand resources are identified, work with communities to discuss beach nourishment logistics
- **c.** Candidate areas: Napili Bay and Kahana Bay

7. Kahana Bay Regional Beach Nourishment Project

- **a.** Nourishment project could easily tie into a potential offshore sand investigation project, as described above
- **b.** Nourishment project would focus on retention structures and monitoring/R&D to serve as alternatives to shore hardening

KAHANA BAY PRP. As discussed above, the Kahana Bay shoreline may be a good location for an RSM project. The shoreline within this reach of the West Maui Region is chronically eroding and various types of "hard" shore protection alternatives have been recommended to reduce future economic and environmental impacts. The following accounts are provided as background to the shoreline erosion issues being experienced in the area.

1. The shoreline fronting the Hololani Resort Condominiums has experienced chronic erosion at an annual average rate of about 0.8 feet per year. Since 1959, the shoreline has eroded about 40 feet and the Hololani Resort has lost about 5,000 square feet of property. The problem is at least partly due to seasonal erosion. The north swells in the winter push the sand to the southern end of the littoral cell, but south swells in the summer bring some of that sand back. Swells from the north and northeast are especially an issue because they enter the

channel and can transport large volumes of sand quickly in this area. However, historical data suggests that the entire cell is losing sand.

2. The Hololani Resort is not the only property with erosion problems in this area. There are six other hotels in this littoral cell, including the Pohailani Condominiums to the north, Royal Kahana immediately south, and the Valley Isle, Sands of Kahana and Kahana Beach Resort farther south. The Pohailani has a seawall that was recently reconstructed in 2012-2013. The Royal Kahana shoreline is also eroding and its owners have placed erosion mats along part of its coastline as a temporary measure. Other hotels have placed sandbags to help protect their properties. Primarily the properties to the north are affected, but the entire littoral cell has an erosion problem.

3. The Hololani Resort funded design of shoreline protection for their property. The current design calls of a seawall/rubblemound revetment structure along approximately 372 feet of shoreline. The crest elevation would be 6 feet for the revetment and 12 feet for the seawall. On the south end, erosion mats would be placed along the shoreline that adjoins the Royal Kahana to try to reduce impacts of end effects on the neighboring property. This was the recommended alternative because a seawall alone would reflect too much wave energy and affect coastal processes. The seawall/revetment combination reduces the footprint of the revetment. Beach nourishment alone was not recommended because the sand would probably not stay in place or provide sufficient protection to the Hololani. It was argued that groins would take too long to permit and that the Hololani needs protection soon.

4. The draft environmental assessment for the Hololani shoreline protection project was presented to the County of Maui Planning Commission in September 2012. One concern that was voiced at this meeting was the effect it would have on the neighboring properties. This structure could affect other properties, which would experience the same erosion problem as the Hololani. It was also suggested that the Pohailani seawall exacerbated the problem at Hololani and potentially affected longshore transport in the entire cell. Several people called for a regional solution such as beach nourishment. Other concerns that were expressed included the revetment being too steep, dislike of shoreline hardening in general, and the visual impact. Based on these concerns, the commission recommended looking further into other alternatives including groins, an offshore breakwater, and beach nourishment.

Coastal Modeling System

At the request of the County of Maui's Planning Division, the West Maui Region's RSM coastal numerical modeling effort was leveraged to take a closer look at the sediment transport processes within the Kahana Bay littoral cell. County personnel are interested in the potential of providing shore protection to upland property and infrastructure through "soft" alternatives such as beach nourishment. Previously modeled results of waves and current forces were utilized to drive a sediment transport visualization model under differing ocean conditions. The visualizations have the potential to enable better understanding of the sediment pathways and residence times for beach nourishment within the Kahana Bay littoral cell.

Coastal Modeling System (CMS) numerical models CMS-WAVE and CMS-FLOW were implemented to simulate wave transformation and water circulation within the West Maui Region. Prevailing (tradewind) and predominant (northwest) winds along with northwest and

south wave conditions were simulated in steering mode to capture the interdependence of waves and currents.

The regional processes influencing the West Maui Region shoreline that were considered in setting up the numerical model were complex and include the following:

1. A multi-directional wave climate with waves arriving from north, south, and occasionally west
2. Wave sheltering from the islands of Lānaʻi, Molokaʻi and Kahoʻolawe
3. A propagating tide from south to north through ʻAuʻau and Pailolo channels
4. Orographic intensification of northeast tradewinds (up to 50%) in the channels between the islands of Maui, Molokaʻi and Lānaʻi
5. Large internal tides in Hawaii
6. Complex nearshore bathymetry including coral reefs

To better understand coastal dynamics in coral reef habitats, the U.S. Geological Survey obtained wave and current data at four locations along the west coast of Maui. Data included hourly observations of waves, currents, temperature, salinity and turbidity off the West Maui coast for about 4 months between June and October 2003. All measurements were on the inner shelf in water depths of 9 to 12 meters. These wave and current data were used in the present study to calibrate and validate the CMS numerical models.

The long-term time series simulations were completed for two selected time periods. The first was for the entire year of 2003, representing an extreme storm year. The second was the 15 month period from September 2009 to December 2010, representing a typical year, including a full winter wave season.

Particle Tracking Model

The Particle Tracking Model (PTM) is a Lagrangian particle tracking model designed to allow the user to simulate suspended sediment transport processes. It provides powerful visualizations of potential pathways utilizing the results from both CMS-WAVE and CMS-FLOW. The PTM is designed to address the following processes and project needs:

- Sediment mobility
- Fate of mobilized sediment
- Source or origin location of material in areas experiencing sedimentation
- Effects of anthropogenic activity on sediment pathways
- Fate of material released during a dredging and placement operation
- Stability and fate of in-place sediment, including dredged-material mounds, sediment caps, and contaminated sediment deposits

Kahana Bay PTM

The PTM was utilized to visualize dominant sediment pathways offshore of Kahana Bay. Results from two events in the 2003 CMS time series were used in the simulations. The time periods identified for beach nourishment within the Kahana Bay littoral cell were the following:

- August 25 – September 2, 2003 (south swell)
- November 18 – 28, 2003 (northwest swell)

PTM runs simulated approximately 30,000 cubic yards of beach quality sand being placed along a 0.63 mile stretch of shoreline between Kahana Stream at the north, and "S-turns" Beach Park to the south (Figure 1). Simulations did not include any sand retention structures (such as groins or breakwaters).

PTM Results for Kahana Bay

The results of the PTM run for the 2003 south swell condition (Figure 2 and Figure 3) indicate that early in the simulation, during a period of smaller waves from the south, the nearshore current velocities were small and consistently directed to the north of the initial placement site. Without stabilizing structures, the material moved northerly along the nearshore, beyond Kahana Stream and the small headland that separates the Kahana Sunset littoral cell (Figure 2). For the first three days of the 9 day simulation, the particles remained within the extents shown in Figure 2. By day 5 of the simulation, the particles moved further offshore within relic stream channels and to some degree onto the reef (Figure 3). Real-time observations by members of the Hawaii RSM project deliver team verified the general sediment transport pathways illuminated by the PTM results shown in Figure 3. These pathways should be investigated for their potential as sustainable offshore borrow areas for beach nourishment.

The results of the PTM run for the 2003 northwest swell condition indicate that the particles were much less stable than for the south swell run. This was due to the larger wave heights associated with the northwest swell. After 1 day, the particles moved in extent similar to the south swell run after 5 days. Some particles were even transported as far north as Kapalua Point after 1 day. Towards the end of the run (day 11), the majority of the particles had moved away from the placement area to as far south as South Kaanapali. This is evidence that the PTM is based on limiting assumptions (e.g. no bed load) that preclude its use as a true indicator of volume change in high energy environments.

Is must be noted that the PTM simulates suspended transport of material specified as input to the water column. It does not represent bed load transport. Therefore, the resulting transport pathways inferred by the model must be interpreted with caution. It was noted in the Kahana Bay PTM simulations that the particles were transported rapidly from their original placement location. This trend in model results does not suggest that beach fill will not be stable if placed in the area of interest. What is important to consider relative to regional coastal processes are the pathways that the particles followed.

CONCLUSIONS. The West Maui Region extends from Kaanapali to the south through Honolua Bay to the north. Critically eroding beaches in the West Maui Region have been identified by the County of Maui Planning Department and other stakeholders. This CHETN identifies various RSM projects that could potentially be implemented through acquisition of appropriate federal authorizations, by other federal, state, and/or county agencies, partnerships or the private sector. A workshop was held on 17 August 2014 in Kihei to solicit stakeholder input on Potential RSM Projects for the region. Engineering and environmental considerations associated with implementation of PRPs are discussed in this CHETN.

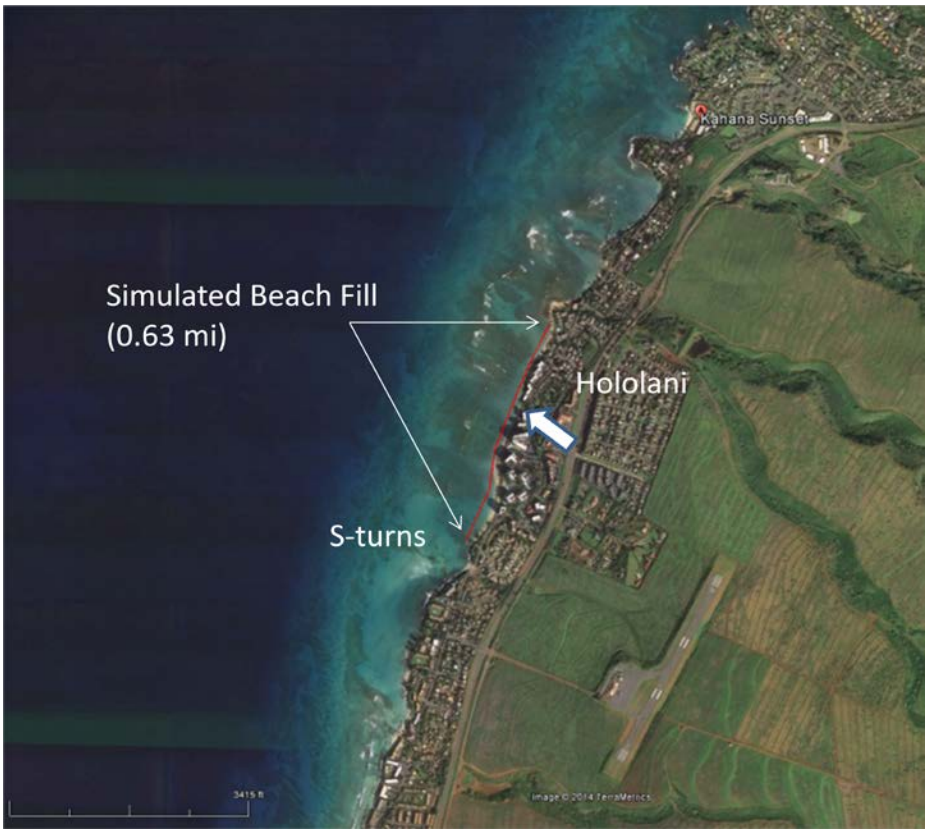

Figure 1: PTM Simulated Beach Fill Area

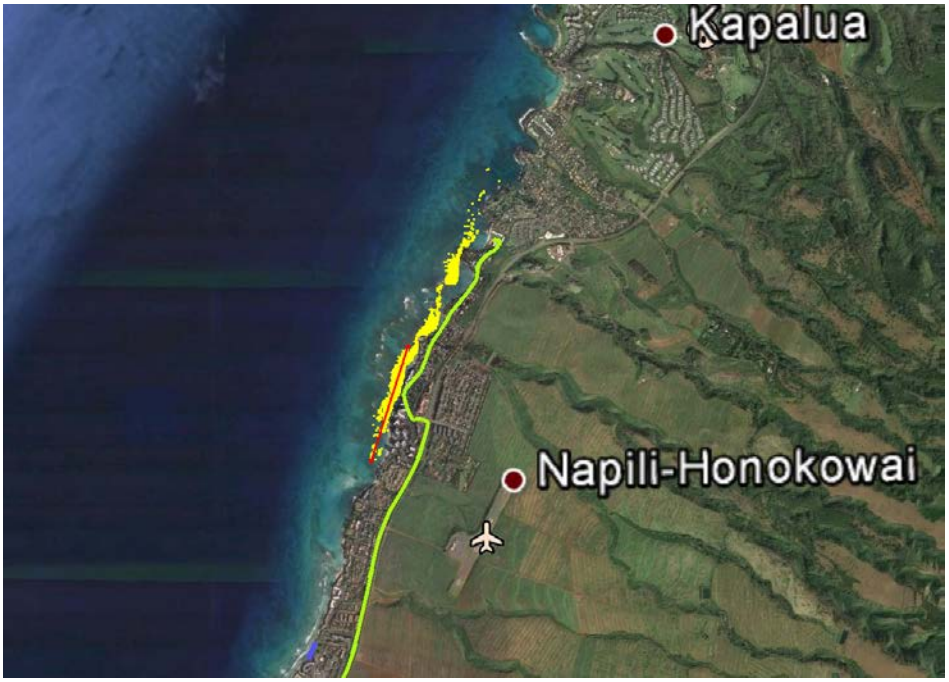

Figure 2: PTM snapshot 1 day after release of particles

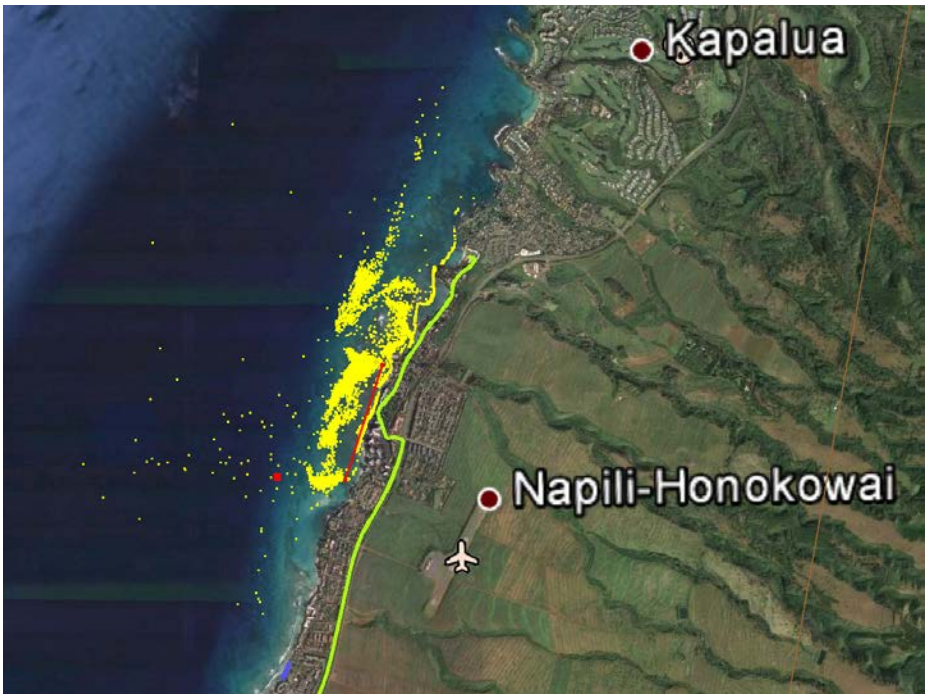

Figure 3. PTM snapshot 5 days after release of particles

The County of Maui identified Kahana Bay as its first PRP priority. Previous numerical modeling capabilities were leveraged to investigate beach nourishment performance in the Kahana Bay littoral cell through visualization of sediment transport pathways via the Particle Tracking Model. PTM results indicated that material placed on the beach would migrate offshore along relic stream channel alignments under the forcing of south swell waves. Longshore transport to approximately 0.5 miles north of the placement area was predicted over a 9 day simulation. The particle transport results for PTM simulation of a large northwest swell were similar to the south swell run in the cross shore direction, but extended much further longshore to both the north and south.

Based on the West Maui RSM workshop findings, the following engineering and environmental considerations should be incorporated into the development of an RSM project for Kahana Bay:

Kahana Bay Engineering Considerations

1. Quantify the volume of suitable offshore sand available and the cost associated with dredging and placing it on the beach.
2. Determine the nominal interval for beach renourishment.
3. Identify the impacts of beach nourishment (both economic and environmental).
4. Investigate the need for terminal structures.
5. Determine the potential for hotels to share in the cost of beach nourishment projects.
6. Quantify the engineering benefits of combining different shore protection alternatives.
7. Review the Napili Bay/Kapalua beach nourishment plan.

Kahana Bay Environmental Considerations

1. Determine the consequences of introducing sediment into the littoral environment.
2. Ensure that beach fill material is compatible with the native beach sand.
3. Investigate the potential impacts of utilizing offshore sand resources for beach nourishment.
4. Conduct ecological assessment of beach fill to investigate their sustainability and identify long-term impact.

POINTS OF CONTACT. This Coastal and Hydraulics Engineering Technical Note was prepared as part of the USACE Regional Sediment Management Program, and was written by Thomas D. Smith, US Army Corps of Engineers Honolulu District, Honolulu, HI, with input from the Hawaii RSM Product Delivery Team. David A. Lau is the USACE Pacific Ocean Division (POD) RSM Point of Contact (POC). Additional information pertaining to Hawaii RSM can be found at http://gis.poh.usace.army.mil/rsm/index.htm and at the RSM Program website http://rsm.usace.army.mil.

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