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South Shore of Long Island, New York Regional Sediment Management Investigation: An Overview of Challenges and Opportunities

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PURPOSE: The US Army Corps of Engineers (USACE) is conducting the "South Shore of Long Island, New York Regional Sediment Management Investigation" to further understand sediment dynamics and to develop a comprehensive regional sediment management plan for the south shore of Long Island, New York. Regional sediment management is a systems approach using best management practices for more efficient and effective use of sediments in coastal, estuarine, and inland environments. This investigation seeks to characterize sediment movement on the south shore of Long Island as a holistic system across the entire study area. It focuses on the regional system post-Hurricane Sandy (October 2012) as the storm significantly altered the physical landscape with severe shoreline erosion, which resulted in the construction of projects to reduce the risk of future storms and stakeholder priorities with a new emphasis on bay-side sediment dynamics, such as channel shoaling and disappearing wetlands. Despite the fact the storm caused severe erosion, the equilibrium beach profile, depth of closure, and general shoreline orientation seem to be unaffected.

Previous studies have characterized sediment movement at specific sections of the south shore, but these data have not been incorporated to create a system-wide perspective. Coordinating sediment management across the six Atlantic Ocean inlets, Great South Bay Channel, Intracoastal Waterway, and coastal storm risk management (CSRM) projects could save the federal government millions of dollars in dredging and sand placement actions. This technical note presents the progress the investigation has made to date and will be followed with a more in-depth technical report titled *South Shore of Long Island, New York Regional Sediment Management Investigation: A Post-Hurricane Sandy Shoreline Evaluation,* currently in preparation.

REGIONAL OVERVIEW: Both the longest and the largest island in the contiguous United States, Long Island extends 125 miles eastward from New York Harbor (New York City) to Montauk Point (Suffolk County). The south shore of Long Island is geographically diverse and includes barrier islands, headlands, bays, coastal plains, and urban, suburban, and rural areas. It is densely developed with large federal investments in navigation channels, CSRM projects, and ecosystem restoration projects. Sediment here is a valuable resource; it is used for CSRM, erosion control, and habitat restoration. A diverse group of stakeholders, including federal agencies, New York State, New York City, Nassau County, Suffolk County, local towns, villages, academic institutions, and non-profit organizations, have expressed the need for coordinated, thoughtful sediment management to maximize the use of sediment for these purposes.

Most sediment used for federal and local CSRM and ecosystem projects is dredged from federal and local navigation channels and offshore borrow sites. USACE has been an instrumental player in the movement and management of sediment in the system since the early twentieth century, as it maintains eight regionally important federal navigation channels. Individual USACE navigation and CSRM projects have analyzed sediment needs in specific areas on the south shore, but a compilation of existing studies along the entire south shore of Long Island has yet to be completed. The region could benefit from an overarching regional sediment management plan.

EXISTING CONDITIONS

South Shore of Long Island Sediment Dynamics. There has been a long history of scientific study on the continental shelf south of Long Island. Relative to the rest of the mid-Atlantic and southeastern US coasts, the Long Island continental shelf is sediment rich. The shelf south of Long Island covers approximately 21,044 km^2 (5.2 million acres), but only a fraction of it is within the reach of present-day dredging technology. Only sediment within 30 m* of the water surface is currently reachable. Sediments within this depth range cover 2,630 km^2 (650 acres) (Bokuniewicz and Tanski 2010). Based on sediment samples by Foster et al. (1999), we can expect that there are 7.6 billion m^3 of sand (99% sand with 1% other clast sizes) to be accessible on the shelf. On average, sand dredged from inlets alone amounts to approximately 1.0 million m^3 per year (Bokuniewicz and Tanski 2010). In the future, this study will seek to update these quantities.

Erosion of the bluffs at Montauk Point has been shown, at least partially, to contribute to the sand on the beach farther west (Williams and Morgan 1988). Separate studies suggest that anywhere between 6,100 m^3 (Bokuniewicz 1999) and 110,000 m^3 (Kana 1995) of sand could be delivered annually by bluff erosion of the Montauk bluffs. A more recent study published in 2005 by Buonaiuto and Bokuniewicz indicates the total sediment supply is 34,500 m^3 per year with 21,700 m^3 per year being beach suitable. The balance of the sediment is thought to come from longshore transport from the east, stream input, the reworking of glacial outwash sand, the reworking of tidal ebb shoals, and onshore transport along shoreface-attached sand ridges. Panuzio (1969) and Rosati et al. (1999) indicated that the apparent deficit in their budgets could be explained by various factors including updrift beach nourishment and erosion as well as the uncertainty in the data. Especially as sea level rises, sand will be added to the littoral system by the excavation of the outwash plain and reworking of relic glacial overwash lobes or stranded flood tidal shoals.

There is geologic evidence that sand is being transported into the system from beyond the surf zone. Offshore sources of sand have long been hypothesized to account for the apparent increases in the longshore transport rates at Fire Island Inlet. William (1976) suggested offshore glacial outwash lobes as a source of littoral material. Kana (1995), however, proposed that relict ebb tidal shoals contributed to the beach system, arguing an offshore source may be needed to support spit growth at the terminus of Fire Island (Democrat Point). Historically, Fire Island has been migrating westward since 1834, leaving trailing ebb shoals that have been estimated to contain between 31 million m^3 (Moffatt and Nichol 2009) and 38 million m^3 (Walton and Adams 1976) of sand. The eventual stranding of ebb shoals, as inlets migrate westward and sea level rises, has been postulated to be the origin of oblique ridges (McBride and Moslow 1991). Sand from the

* For a full list of the spelled-out forms of the units of measure used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office 2016), 248-52, https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

inner shelf also contributes to south shore Long Island beaches. It is unknown how much onshore sediment transport supplies the south shore of Long Island sediment budget.

The topography of the Middle Atlantic Continental Shelf both in New York and New Jersey is dominated by the shore-subparallel ridges and swales, approximately northwest to southeast in orientation (e.g., Stubblefield et al. 1984; Swift et al. 1979. They are superimposed on large-scale, shoal-retreat massifs left by the Holocene transgression (e.g., Stubblefield and Swift 1976). The ridges are composed of very well to moderately sorted, medium to fine sand, compatible with beach-type sand found along the south shore (e.g., William 1976). The origin of these features has been the topic of considerable debate. Several lines of evidence suggest the oblique sand ridges have relic origins, as ridges from paleo (sub-aerial) drainage (McKinney and Friedman 1970), abandoned ebb shoals (McBride and Moslow 1991), relic barrier islands (Stubblefield et al. 1984), or drowned shorelines or drowned shoal-retreat massifs (e.g., Swift et al. 1979). Based on radiocarbon dating of shells recovered in cores on the ridges, it appears the shelf ridges evolved between 8,000 and 14,000 years BP during one of the sea level still-stands (Stubblefield et al. 1983). The understanding of the sand ridges' origins, the processes that maintain them, and their potential role in onshore transport of material is poor. Incomplete knowledge regarding sediment transport and the interactions between the shelf and nearshore system pose significant challenges in managing and possibly utilizing this resource. If there is onshore transport, the use of sand from offshore borrow areas for beach nourishment could be accelerating the natural process, akin to sand bypassing at inlets. However, artificial manipulation of the system could alter the rates of transport and, to a certain extent, the specific pathways possibly causing unforeseen impacts (Bokuniewicz and Tanski 2010).

Federal Navigation Channels. The south shore of Long Island includes eight federal navigation channels: Jamaica Bay (Rockaway Inlet), East Rockaway Inlet, Jones Inlet, Fire Island Inlet, Moriches Inlet, Shinnecock Inlet, the South Bay Channel, and the Long Island Intracoastal Waterway (Figure 1). All the on-going inlet channel dredging and sand placement activities serve to bypass sediment.

USACE Civil Works Studies and Projects. Constructed USACE CSRM projects on the south shore of Long Island include Coney Island; Coney Island T-Groins; Rockaway Inlet to East Rockaway Inlet; Plumb Beach, Jones Inlet Point Lookout Shoreline; Fire Island Inlet and Shore Westerly to Jones Inlet; sections of Fire Island Interim Stabilization; Long Beach, Westhampton Interim project, West of Shinnecock Inlet; and Downtown Montauk (Figure 2). Additionally, Jones Inlet to East Rockaway Inlet (Long Beach) project and the balance of the Fire Island Interim Stabilization project are currently under construction.

Figure 1. Federal navigation channels on the south shore of Long Island.

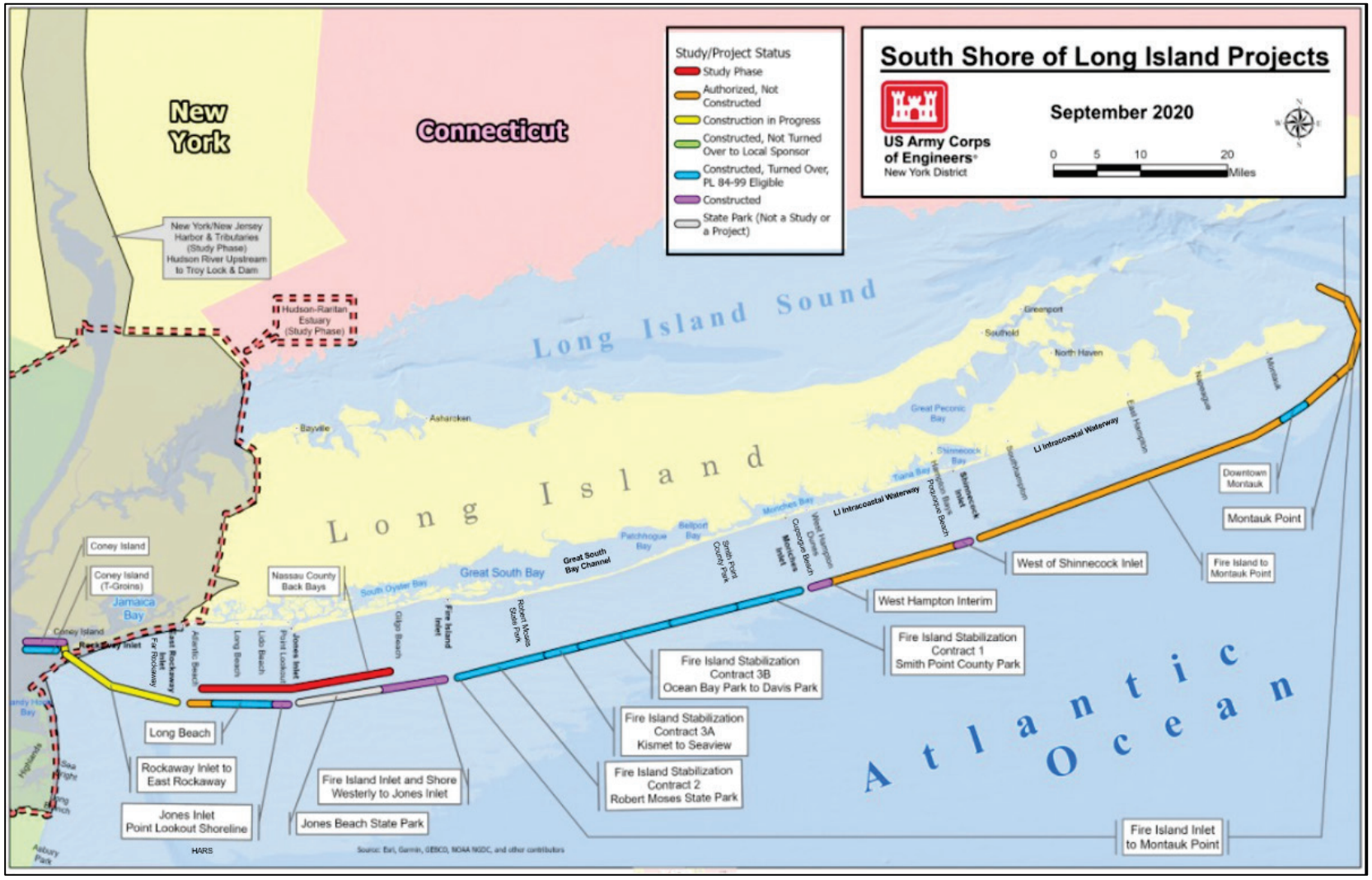

Figure 2. USACE projects on the south shore of Long Island.

There are three ongoing USACE feasibility studies in the region that recommend the construction of projects within the next 15 years. These in-progress studies include Hudson Raritan Estuary, East Rockaway Inlet to Rockaway Inlet, and Fire Island to Montauk Point. There are two additional USACE studies planned that may recommend CSRM features on the south shore: New York-New Jersey Harbors and Tributaries and Nassau County Back Bays. These studies are still in the early formulation stages, so their final recommendations are unknown currently.

Hurricane Sandy: Effects and USACE Response. Hurricane Sandy devastated the region in October 2012. This event caused major erosion that resulted in three breaches through Fire Island at the eastern end of Great South Bay in the areas of Old Inlet, Smith Point, and Moriches Inlet. Two breaches were quickly filled in and repaired, and one breach in the Wilderness Area of Fire Island National Seashore (Old Inlet), remains open to the Atlantic Ocean (New York Sea Grant 2016).

USACE undertook emergency PL 84-99 response actions immediately after Hurricane Sandy, and since their completion, USACE has constructed several additional CSRM projects in the region. It was emphasized during planning and construction of these projects that their future renourishment needs may not be met by current sediment sources. The problem is not just technical in nature but is also complicated by permitting, jurisdictional, and funding challenges regarding sediment resources.

CURRENT PROJECTS AND PRACTICES: Presently, the eight federal navigation channels are dredged periodically by USACE. The actual post-Hurricane Sandy maintenance is as follows: Jamaica Bay (Rockaway Inlet) has historically been dredged every 3–5 years, and the sand has been placed in the Historic Area Remediation Site (HARS) located approximately 3.5 nautical miles east of Sandy Hook, New Jersey, and 7.7 nautical miles south of Rockaway, New York, or on the nearby adjacent beaches. East Rockaway Inlet has been dredged every 2 – 5 years, and the sand has been placed at Far Rockaway Beach. Jones Inlet has been dredged every 7 – 12 years with its sand placed in Point Lookout. Fire Island Inlet has been dredged every 4 – 5 years, and the sand has been placed at Gilgo Beach. Moriches Inlet has been dredged every 6 years, and the sand has been placed on Fire Island at Smith Point County Park. Shinnecock Inlet has been dredged every 3 – 6 years with its sand placed at Poquogue Beach. The Great South Bay Channel has historically been dredged every 6 – 39 years, and the sand has been placed at Robert Moses State Park. The Long Island Intracoastal Waterway has typically been dredged every 2 – 9 years, and the sand has been placed in Smith Point County Park or Cupsogue Beach County Park. The historic dredge frequencies are often less than their authorized dredge frequency, which is what is needed to maintain navigation in the channel. The channels need to be dredged more frequently than they are, but funding is the limiting variable. Table 1 summarizes dredging frequency and sand placement areas for the federal navigation channels.

Table 1. Dredge frequency and sand placement areas for each federal navigation channel on the South Shore of Long Island.

Inlet/Channel Name	Observed Dredge Frequency	Sand Placement Area	Authorized Dredge Frequency
Jamaica Bay (Rockaway Inlet)	3 – 5 years	HARS	2 years
East Rockaway Inlet	2 – 5 years	Far Rockaway Beach	2 years
Jones Inlet	7 – 12 years	Point Lookout	3-5 years
Fire Island Inlet	4 – 5 years	Gilgo Beach	2 years
Moriches Inlet	6 years	Fire Island/Smith Point County Park	1 year
Shinnecock Inlet	3 – 6 years	Poquogue Beach	2 years
Great South Bay Channel	6 – 39 years	Robert Moses State Park	Unspecified
Long Island Intracoastal Waterway	2 – 9 years	Smith Point County Park or Cupsogue Beach County Park	Unspecified

PREVIOUS USACE INVESTIGATIONS: As part of this Regional Sediment Management (RSM) sponsored investigation, the Project Delivery Team (PDT) conducted a literature search of existing reports to understand the history of sediment management in the region and the problems that have been studied and addressed. The following is a summary of known information produced by USACE. Other agencies and institutions have completed similar studies, which are being used as part of the investigation but are not listed here for brevity.

In 2011, the USACE New York District carried out an RSM investigation for East Rockaway Inlet that utilized the USACE Coastal Modeling System. This investigation addressed that dredging data at that time showed that the shoaling rate of the East Rockaway Inlet was increasing. Hydrodynamic and sediment transport models showed that the shoal/inlet system is supplied by sand from a variety of sources, including longshore transport from the east; onshore transport during storm wave conditions; reworked material from the ebb shoal on the west side that circulates around to re-enter the system through the seaward edge of the ebb shoal; longshore transport from the west; and transport into the system from the bay area. Sediment transport from the west and the bay system is relatively weak compared to the other three sources. The investigation recommended a deposition basin that would accumulate approximately 76,455 m^3 of sediment annually that could be used for periodic nourishment. This deposition basin would provide a reliable borrow source for periodic nourishment while enhancing the natural bypassing and reduce net loss of the regional sediment.

In 2015, the USACE New York District conducted a re-analysis of the Long Beach Island Feasibility Study that was originally conducted in 1995. Based on the results of circulation and sediment transport modeling during the reanalysis, the recommended plan consisted of seven groins combined with beach fill.

Since the 1950s, the USACE New York District has been executing the Fire Island to Montauk Point Storm Damage Reduction Study. In 2007, a reformulation effort began on inlet modifications. The vision for the Fire Island to Montauk Point Reformulation Study is to prepare an implementable, comprehensive, and long-term regional strategy for the 133 km portion of the south shore of Suffolk County, Long Island, New York, that will reduce risks to human life and property while maintaining, enhancing, and restoring ecosystem integrity and coastal biodiversity. The Recommended Plan includes a combination of (1) inlet modifications (continuation of

authorized navigation projects, dredging, downdrift placement of dredged material, placement of dune and berm, and monitoring); (2) non-structural measures (primarily building retrofits, with limited relocations and buy-outs); (3) breach response for barrier islands; (4) beach and dune fill with renourishment: up to 30 years, approximately every 4 years; (5) sediment management; (6) groin modifications; (7) coastal process features; (8) adaptive management; and (9) integration of local land use regulations and management.

From 2006 to 2010, the USACE New York District conducted an RSM investigation called the Long Island Coastal Planning Project. The purpose of this project was to recommend ways to broaden the New York District RSM Program. The congressional direction was to (1) collect and inventory sediment resources and related coastal process data, (2) identify gaps in data, (3) develop a regional sediment budget, and (4) develop an inventory of existing sediment borrow areas. The study produced a draft white paper on sediment resources and related coastal processes (Bokuniewicz and Tanski 2010), developed a Cascade model (inlet morphology) for the Fire Island to Montauk Point project, inventoried existing sediment borrow areas, compiled existing inlet and shoreline sediment budgets, conducted sediment monitoring at Jones Inlet, and further developed the Long Island Sediment Needs Assessment database.

PROBLEMS AND NEEDS: Sustainable sediment management on the south shore of Long Island is complex. There is a need to re-envision traditional sediment management in the region due to cost and a lack of usable sand for an array of purposes. This was underscored by the recent literature search as well as a May 2019 stakeholder meeting held in Mineola, NY (USACE NAN 2019). The meeting was attended by federal, state, and local agencies as well as academic institutions. Specifically, the problems affecting USACE are that the inlets are not dredged as frequently as needed and there is not enough sand for ongoing USACE beach nourishment projects.

USACE Projects. Some longstanding problems identified by local stakeholders at the federal navigation channels of Shinnecock, Moriches, and Fire Island Inlet include navigation reliability, beach erosion immediately downdrift of the inlets, and erosion of the beach west of the ebb-shoal reattachment (USACE NAN 2019). Another need emphasized at the stakeholder meeting is more frequent dredging of federal and local inlets and channels. According to stakeholders, current maintenance practices dredge less frequently than what is required to keep the inlets navigable. The Fire Island ferries transiting the Great South Bay are affected by shoaled-in channels. This is particularly a problem for stakeholders at Jones Inlet (USACE NAN 2019). Many CSRM projects and recreational beaches will require sand resources in the future. USACE is looking for the most cost-effective method to meet ongoing and future project needs.

Additional Needs. An important finding that came out of the May 2019 stakeholder meeting is that sediment is needed for different reasons on the ocean side than on the bay side. On the ocean side, the sediment is needed for coastal storm risk management to maintain barrier islands. The barrier islands act as a buffer against storm surges for mainland Long Island, protecting the dense residential areas there from coastal storms. More people live on the western barrier islands (Long Beach, Rockaway, and Coney Island) than the eastern barrier islands. Sediment on the barrier island beach acts as a coastal storm risk management feature for the buildings on the barrier islands. Storm waves erode the barrier islands, and if enough sand is removed, buildings become endangered by wave attack, inundation, and storm-induced erosion.

Conversely, on the bay side, sediment is needed for ecological restoration and health. The western end of the bay side historically had marsh islands that were important habitat for native plants and animals. For at least 100 years these marsh islands have been eroding. The marsh islands have been reducing in size, thus losing critical habitat in this densely developed area (USACE NAN 2019). More sediment is needed to replace the sand that is lost on the marsh islands. It is not fully understood why the marsh islands are eroding, but one hypothesis is that the navigation channels in the bays increase water velocity during tidal flow; the higher tidal velocity may erode sediments on the marsh islands and carry them away (USACE NAN 2019). Another hypothesis is that the inland sediment source for the bays (the streams that drain Long Island) have been almost completely halted by development on the western end of Long Island (USACE NAN 2019). Most of the ground surface in this area has been paved over, and runoff is discharged directly into the bay from storm sewers without being able to pick up any sediment along the way. The need for more sediment is complicated by the related, but opposite, need to dredge the bay channels more frequently. The local channels in this area have filled in substantially since Hurricane Sandy, making them difficult to navigate. Several stakeholders voiced this need to dredge the bay channels at the meeting.

Further Study. The PDT learned that the stakeholder community is greatly interested in sediment management in the bays on the south shore of Long Island (USACE NAN 2019). This RSM investigation, along with most previous USACE investigations, focuses on the Atlantic Ocean side of the barrier islands on the south shore. The May 2019 stakeholder meeting participants voiced that many studies have been completed for the ocean side of the barrier islands but relatively very little has been done to understand sediment management on the bay side (USACE NAN 2019). Undertaking a regional sediment management investigation of the bays is not within the scope of this investigation. The stakeholders are keenly interested in this topic, so the bays of the south shore of Long Island may be a good subject for future RSM investigation.

OPPORUNITIES: This study can address the actual dredge frequency needs of federal channels, locate more sediment sources for ongoing USACE beach nourishment projects, and address competing needs for sediment in the study area. One aspect of this could be to implement a strategic monitoring plan. The purpose of this would be to observe and record how sediment moves through the system once it is placed on the beach. Currently, after-placement surveys are conducted after dredging, but there is no mechanism to monitor how the placed sand behaves outside of current project areas. Also, this investigation could identify areas for the beneficial use of dredged materials from the inlets. The marsh islands need sediment, and the federal navigation inlets need to be dredged. Additionally, data management plan and collaboration with local stakeholders is also needed.

Another opportunity could be to update the region's GenCade model. GenCade is a combination of the GENESIS and Cascade models. It calculates shoreline change, wave-induced long-shore sand transport, and morphology change at inlets on a local to regional scale and can be applied as a planning or engineering tool (Frey et al. 2012). The study area has an existing model, but it has not been updated in more than a decade. The New York District could use this model to predict sediment movement once it is updated to reflect the current post-Hurricane Sandy conditions of the region. Other numerical models may be used as part of the investigation as appropriate.

CONSTRAINTS: Any changes in federal navigation channels will need congressional authorization before the changes can occur. Any recommendation from this investigation that involves changing the size or depth of federal navigation channels will require a feasibility report and environmental assessment or environmental impact statement and chief's report for congressional authorization.

This investigation does not have authority to recommend dredging of locally owned navigation channels in the bays, but during the stakeholder meeting, concerns about municipalities being able to do this type of dredging were raised. Local municipalities could partner with USACE to do a Section 204 CAP project to address these sediment issues (Schrader 2019).

CONSIDERATIONS: If USACE changes the locations where sand dredged from the navigation channels is placed, the public may have concerns. If this investigation recommends different placement sites, additional stakeholder outreach will be required. Collaboration is essential as this study moves forward.

INTERAGENCY COORDINATION: During the May 2019 stakeholder meeting, USACE coordinated with the National Oceanic and Atmospheric Administration, National Park Service – Fire Island National Seashore, United States Coast Guard, United States Fish and Wildlife Service, New York Sea Grant, New York State Office of Parks, Recreation and Historic Preservation, Nassau County, Town of Babylon, Town of Brookhaven, Town of Hempstead, Florida Institute of Technology, and Stony Brook University. The workshop participants formalized themselves as the Long Island Regional Sediment Management Working Group. The Working Group will provide a forum for interagency coordination throughout the investigation and beyond.

ADDITIONAL INFORMATION: This technical note was prepared by Anna Jansson, Archeologist and Planner, USACE New York District; Arun Heer, Coastal Engineer, USACE New York District; Frank Buonaiuto, Oceanographer, USACE New York District; Suzie Rice, Senior Coastal Engineer, USACE New York District; Danielle Tommaso, Planner, USACE New York District; Lynn Bocamazo, Deputy Chief of Engineering, USACE New York District; Stephen Couch, Deputy Chief of Planning, USACE New York District; and Jodi McDonald, Deputy Chief of Operations, USACE New York District. The investigation was conducted as an activity of the RSM Program, a Navigation Research, Development, and Technology portfolio program administered by Headquarters, USACE. For information on the RSM Program, please consult *http://rsm.usace.army.mil* or contact the Program Manager, Dr. Katherine E. Brutsché, at *Katherine.E.Brutsche@usace.army.mil*. For information regarding this RSM-TN, please contact Ms. Danielle Tommaso at *danielle.m.tommaso@usace.army.mil*.

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