

## SEVEN MILE ISLAND INNOVATION LABORATORY: ADVANCING BENEFICIAL USE PRACTICES TO SUPPORT COASTAL SYSTEM RESILIENCE

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**Abstract:** In 2019, the U.S. Army Corps of Engineers (USACE) Philadelphia District partnered with the State of New Jersey, The Wetlands Institute, and the USACE Engineer Research and Development Center to launch the Seven Mile Island Innovation Laboratory (SMIL). The initiative is designed to advance and improve dredging and marsh restoration techniques in coastal New Jersey through innovative research, collaboration, knowledge sharing and practical application. SMIL efforts are enhancing the science and engineering that supports dredging and beneficial use placement practices by clearing shoals from the federal New Jersey Intracoastal Waterway for navigation and innovatively placing that sediment on multiple sites described herein. Regional Sediment Management and Engineering with Nature principles and practices serve as a strong foundation for SMIL actions. Efforts are successfully evolving the practice and advancing techniques for beneficial use of dredged channel sediments with innovative placements that support coastal resilience for habitats and communities.

### Introduction

The United States Army Corps of Engineers (USACE), Philadelphia District has been participating in the national Regional Sediment Management (RSM) and Engineering with Nature (EWN) Programs with considerable lessons learned developed for channel dredging and placement activities in coastal New Jersey (NJ). Navigation managers from the Philadelphia District continue to partner with USACE's Engineering Research and Development Center (ERDC), the State of NJ's Department of Environmental Protection (NJDEP), various stakeholders such as The Wetlands Institute (TWI), and the dredging industry to utilize EWN and RSM strategies in an innovative regional approach to restore navigation and enhance coastal system resilience. Over the last decade, beneficial use of dredged material (BUDM) placements involving shoreline stabilization, natural infrastructure creation and marsh restoration and enhancement have significantly increased in the region, helping to advance practices and policies that keep dredged material in the natural sediment system as opposed to past disposal

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methods which tended to remove them from the system. In addition to the coastal navigation mission, the Philadelphia District maintains a robust beach nourishment program along the NJ and Delaware coasts and serves as an EWN Proving Ground.

Following Superstorm Sandy, USACE and NJDEP took action to restore navigation and support shoreline and ecosystem recovery. Simultaneously, long-term strategies were sought to build a more resilient coastal system using clean dredged sediment. Initial projects were constructed within NJDEP's Cape May Coastal Wetlands Wildlife Management Area using NJ Intracoastal Waterway (NJIWW) channel sediments, including thin-layer placement near Avalon using predominantly fine-grained material and habitat creation for endangered nesting birds with sand on Ring Island (Chasten et al., 2016).

The creation of the Seven Mile Island Innovation Laboratory (SMIIL) followed the initial pilots and has advanced the practice of BUDM by expanding applications, developing new tools, and increasing the acceptance of innovative projects using a science-based approach and improving our understanding of risks and benefits. Through the SMIIL, a systems approach is advancing techniques for dredging, managing and placing sediment, making the region a think tank to develop and demonstrate new methods and tools while providing a forum for sharing experience and knowledge. The concept brings technical and social domains together in a collaborative forum that advances science, practice, and innovation to preserve marsh integrity and enhance resilience for the natural resources in the region and surrounding communities.

### **Creation of the Innovation Laboratory**

In 2019, the Philadelphia District partnered with co-founders NJDEP, TWI, and ERDC to launch the Seven Mile Island Living Laboratory (Rochette et al., 2019), a concept adapted from the "Living Lab for Mud" in the Netherlands (Ecoshape, 2018). The name was changed to an "Innovation" Laboratory to reflect the expanding program. The location was chosen because: it is a marsh-dominated Atlantic back barrier system in a region rich in historic datasets, builds on ongoing collaboration and research between the Philadelphia District and ERDC, TWI is centrally located within SMIIL to provide technical expertise, field support and public outreach, federal and state navigation channels have sandy and cohesive sediment as a resource, it contains a number of historic and recent monitored innovative beneficial use projects, and a significant amount of land is managed by the State of NJ. A SMIIL Working Group creates an opportunity for practitioners and natural resource managers to provide input, learn, and share expertise, manage challenges, and bring science and practice to the SMIIL to better understand the system, tradeoffs and approaches.

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## Building Momentum through SMIL

Through collaborative partnerships, design, construction, monitoring, and adaptive management, SMIL efforts expanded with new projects that used both sand and cohesive channel sediments to trial nature-based solutions including elevated nesting habitat creation with sandy sediments (Fig. 1) and marsh elevation enhancement, marsh edge protection and intertidal shallows creation and enrichment with predominantly cohesive sediments (Fig. 2). Innovative techniques including the sediment distribution pipe (Beardsley et al., 2022) were



Fig. 1. Sandy elevated nesting habitat at Great Flats during initial construction in 2018 (left) and after adaptive management in 2021 (photos courtesy of Gary Paul).



Fig. 2 Constructed marsh restoration (A), marsh edge protection (B), and intertidal shallows enhancement (C) with fine sand and mud at Gull Island (photo courtesy of Gary Paul, 2020).

also trialed while working on building elevation on Sturgeon Island (Fig. 3). Tedesco et al., 2021 provides a summary of projects including the initial pilots at Avalon and Ring Island and the follow-on projects at Great Flats, Sturgeon and Gull Islands (Fig. 4; Table 1). Additional dredging and placements were completed at Sturgeon Island in the Fall of 2022. These projects used a fully contained placement to build marsh elevation to transitional elevations for wading bird nesting and strategically placed sandy sediments to create a sandy marsh edge protection system (Fig. 5). Additional placements are planned for the southern portion of SMILL in 2023, via dredging of the NJIWW channel and funded through the Bipartisan Infrastructure Law.



Fig. 3. Trialing techniques to build elevation and marsh edge protection with cohesive sediments at Sturgeon Island using a sediment distribution pipe.



Fig. 4. Map of BUDM projects in SMILL. Summarized in detail in Table 1.

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Table 1. Summary of BUDM projects in SMIL.

<b>Project funding (year (s))</b>	<b>Volume of Sediment (acreage)</b>	<b>Placement Methods</b>	<b>Sediment type</b>	<b>Project Goals and Outcomes</b>
<b>Sturgeon Island Restoration</b> <i>USACE (2020/2022)</i>	15,291 m <sup>3</sup> /18,349 m <sup>3</sup> (elevation: 2.43 hectares / edge protection: 1.42 hectares)	<ul style="list-style-type: none"> <li>• Split (via y-valve) direct on marsh. Distribution pipe &amp; spray. Partial then full containment.</li> <li>• Direct off marsh edge w/ distribution pipe &amp; floating discharge pipe.</li> <li>• Indirect thru tidal channels.</li> </ul>	Mixed, mud & fine sand	<ul style="list-style-type: none"> <li>• Marsh elevation enhancement for wading bird nesting habitat.</li> <li>• Tidal delta enhancement.</li> <li>• Subtidal placement berm for marsh edge protection.</li> <li>• Ongoing monitoring of elevation, site usage and vegetation establishment.</li> </ul>
<b>Gull Island Restoration</b> <i>USACE (2020)</i>	30,582 m <sup>3</sup> (elevation: 8.90 hectares/ edge protection: 2.23 hectares)	<ul style="list-style-type: none"> <li>• Split (via y-valve) direct: <ul style="list-style-type: none"> <li>– On marsh, uncontained, spray nozzle.</li> <li>– Off marsh edge, floating pipe w/ spreader plate.</li> </ul> </li> <li>• Indirect thru tidal channels.</li> </ul>	Mixed, mud & fine sand	<ul style="list-style-type: none"> <li>• Enhanced marsh elevation for high marsh nesting birds. Marsh restoration across range of elevation goals.</li> <li>• Subtidal placement berm for marsh edge protection.</li> <li>• Turbidity impacts were localized, short lived, &amp; on scale with storm levels.</li> </ul>
<b>Great Flats Nesting Habitat</b> <i>USACE (2018/2021)</i>	4,587 m <sup>3</sup> / 2,294 m <sup>3</sup> (0.49 hectares)	<ul style="list-style-type: none"> <li>• Direct on marsh to create sandy containment berm. Build to target elevation.</li> </ul>	95% fine-medium sand	<ul style="list-style-type: none"> <li>• Build transitional early successional upland habitat for colonial beach nesting birds.</li> <li>• Planned adaptive management to reestablish elevation and disturb vegetation on roughly 3-year cycle.</li> </ul>
<b>Ring Island Marsh Enhancement and Nesting Habitat</b> <i>USACE /NFWS (2015/2018)</i>	5,352 m <sup>3</sup> /917 m <sup>3</sup> (0.81 hectares)	<ul style="list-style-type: none"> <li>• Direct, spray from barge at marsh edge; no containment.</li> <li>• Direct, spray from barge at marsh edge with containment and grading for nesting habitat.</li> </ul>	95% fine-medium sand	<ul style="list-style-type: none"> <li>• Build transitional early successional upland habitat for colonial beach nesting birds.</li> <li>• Planned adaptive management to reestablish elevation and disturb vegetation on roughly 3-year cycle.</li> </ul>
<b>Avalon Marsh Enhancement Project</b> <i>USACE /NFWS (2015-2016)</i>	42,051 m <sup>3</sup> (18.21 hectares)	<ul style="list-style-type: none"> <li>• Direct pumping on marsh with spreader plate.</li> <li>• Containment with coir logs.</li> </ul>	mud & fine sand	Placement over 2 years into fully contained areas for elevation enhancement and pool infilling.

Links to Additional Information:

<https://www.nap.usace.army.mil/Missions/Civil-Works/Coastal-Dredging-Beneficial-Use/>

<https://wetlandsinstitute.org/smil-2/>



Fig. 5. Strategic placement of sandy materials to build marsh edge protection feature at Sturgeon Island.

Ongoing monitoring of the projects includes physical and geotechnical studies (elevation evolution, compaction, and dewatering; sediment transport and erosion; wave attenuation and turbidity generation {Fall et al. 2021; Fall et al., 2022}); hydrology and ecological studies (vegetation evolution, benthic community response {Reine, 2022}), focal avian species response (Collins et al. 2021) and social science aspects involving communities (Thorne, et al, 2022). Over 30 researchers from USACE, the State of NJ and various academic institutions are currently working on data collection and analyses for SMIIIL projects and related practices. Future publications from ongoing research efforts will continue to share knowledge and encourage collaboration within SMIIIL as well as regionally, nationally and internationally.

## Conclusion

Monitoring and technical advancements for channel dredging and placements continue in the Seven Mile Island Innovation Laboratory, but a primary success has been a paradigm shift leading to more BUDM implementation in NJ and the region. Challenges are overcome through trust, persistence, proactive leadership, a continual focus on the best available science, and strong community engagement. All aspects have proven to be critical to moving forward, especially facing rapidly intensifying climate change impacts to vulnerable coastal environments.



USACE is a “broker” managing sediment in federal navigation channels, a much-needed “currency” within the natural coastal system that also supports resilience of habitats and communities. SMIL efforts are documented in a series of case studies of individual projects and within a framework of a landscape approach to dredged material management for multiple habitat benefits. Monitoring has documented and informed each project, and aids in the development of research and practical lessons learned that add to the science and practice of BUDM. Knowledge sharing is a key SMIL goal and ongoing efforts will continue to produce guidance that can be used to advise practitioners and encourage collaboration. Moving forward, SMIL partners will continue to innovate and build on past successes to inform best sediment management practices, encourage natural and nature-based solutions, and promote system resilience by cost-effectively and strategically keeping valuable sediment in the natural system.

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