Improving Aquatic Placement Practices for Beneficial Use of Dredged Material in the Great Lakes

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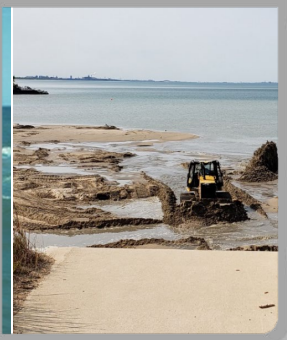
Great Lakes Dredging Team
Milwaukee, WI

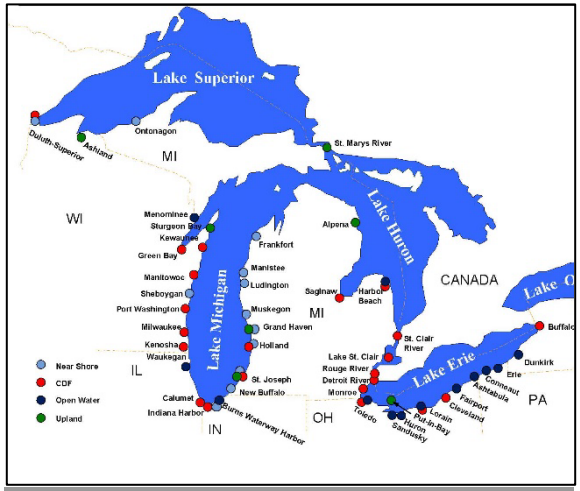
15 September, 2022



PROBLEM

- Maintenance of the Great Lakes Navigation System generates up to 5 M CY of sediments annually with associated dredging costs of up to $50M /year

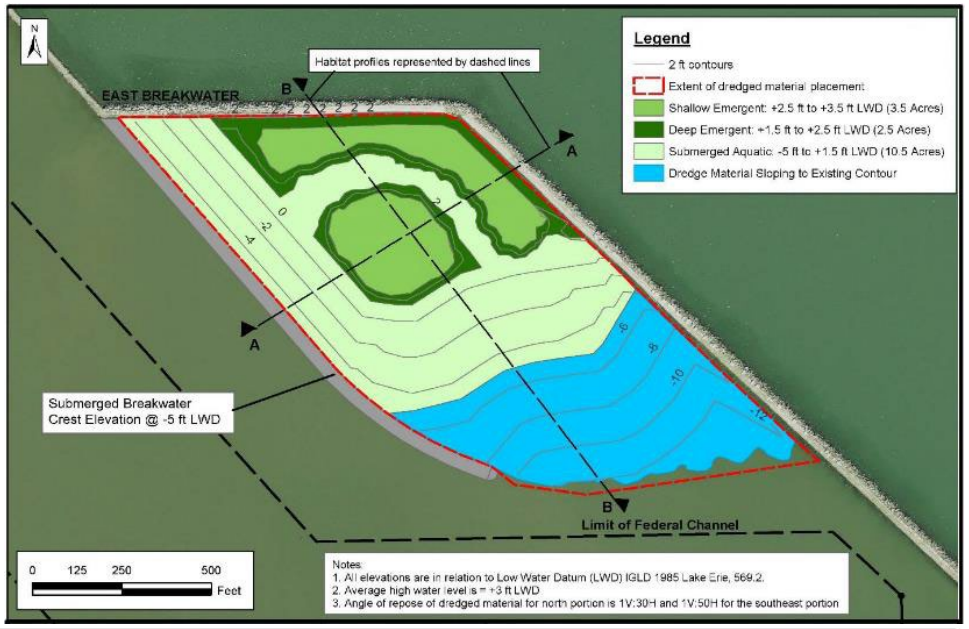
- Between 2010 – 2019, only ~ 25% of dredged sediments were beneficially used



>74 Harbors May be Eligible in Great Lakes	5 Million CY of Sediments Dredged	Need a 45% Increase in Beneficial Use

SOLUTION

- Evaluate attributes of successful aquatic beneficial use placements: including wetland and beach nourishments
- Model sediment transport of potential beneficial use projects
- Engage with district partners and state agencies to develop proof of concept design principles and implement pilot project
- Increase in sustainable dredged material management, working towards goal of 70% beneficial use by 2030



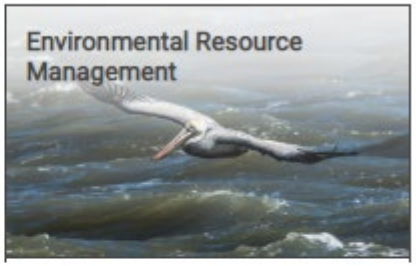
Dredging Operations and Environmental Research Program

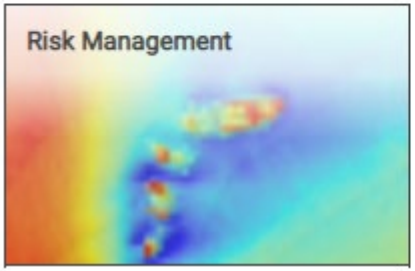
Funding for FY22 - 24

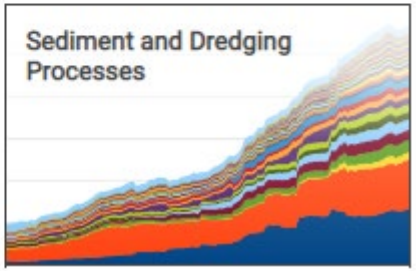
The DOER Program

The Dredging Operations and Environmental Research Program (DOER) supports the U.S. Army Corps of Engineers Operation and Maintenance Navigation Program. Research is designed to balance operational and environmental initiatives and to meet complex economic, engineering, and environmental challenges of dredging and disposal in support of the navigation mission. Research results will provide dredging project managers with knowledge and technology for cost-effective operation, evaluation or risks associated with management alternatives, and environmental compliance.

Focus Areas



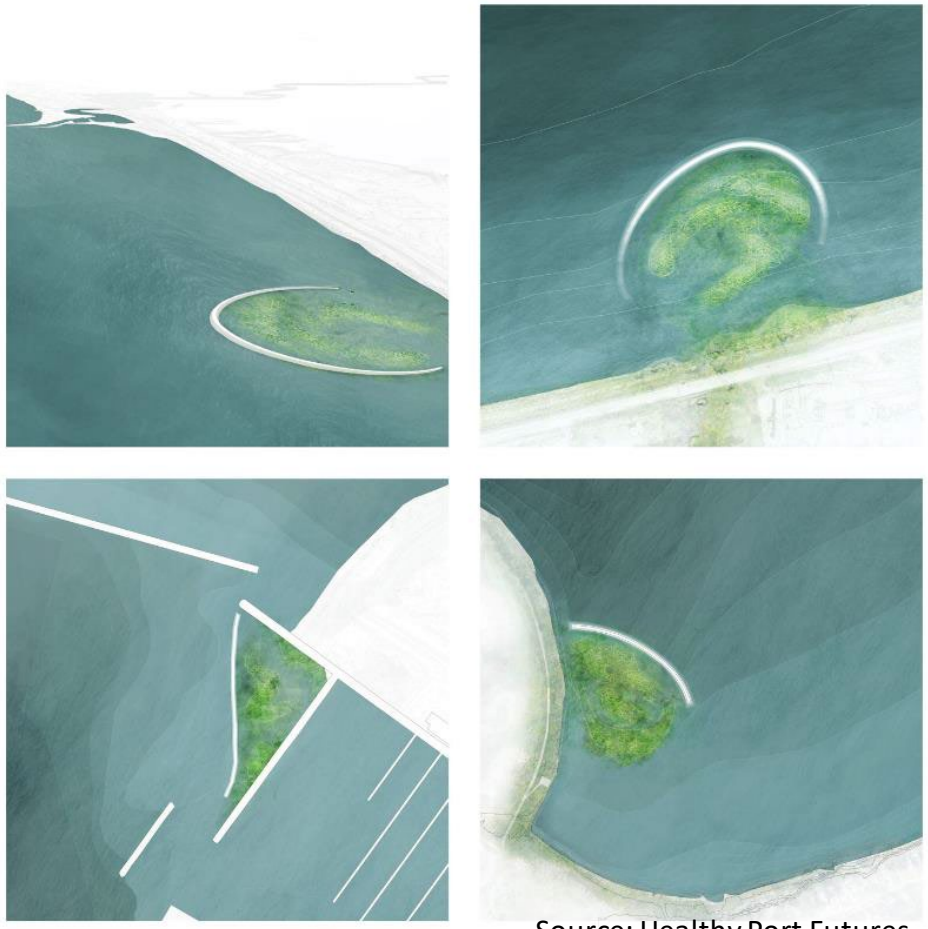




Statement of Need:

Evaluate Attributes of Nearshore Aquatic Beneficial Use Placements

- Quantify the volume and transport directions for mixed sediment placed in the nearshore based on the physical characteristics (e.g., grain size, clay content) and the hydrodynamic forcing. The transport and fate of the fine content is of particular concern to regulatory agencies.
- Identify placement techniques or dynamic containment structure techniques that are engineered as nature-based solutions to enhance benefits.
- Analyze the environmental acceptability and impacts of dynamic containment structures.



Source: Healthy Port Futures

DOER Research Task Objectives: Year 1 (FY22)

- Identify harbors where sediments greater than 10% fine sediments (measured in situ) have been used for beach nourishment, and to under-stand the transport and disposition of the fine and sandy sediments associated with these placement operations.
  - ➢ Inform monitoring, modeling, and design concepts for future beach nourishment placements

- Document innovative placement techniques, engineering designs and features used for dynamic structures to support nearshore placement operations for aquatic habitat creation which may be more appropriately performed using finer grained material
  - ➢ Inform monitoring, modeling, and design concepts for innovative structures and/or placement techniques for wetland creation

- Technical Report summarizing placement design features, modeling techniques to support placements, and case studies of aquatic beneficial use projects across the Great Lakes

DOER Research Task Objectives: Year 2 (FY23)

- Perform monitoring and/or modeling at representative aquatic beneficial use project site(s)

  - Inform design concepts for future beach nourishment placements

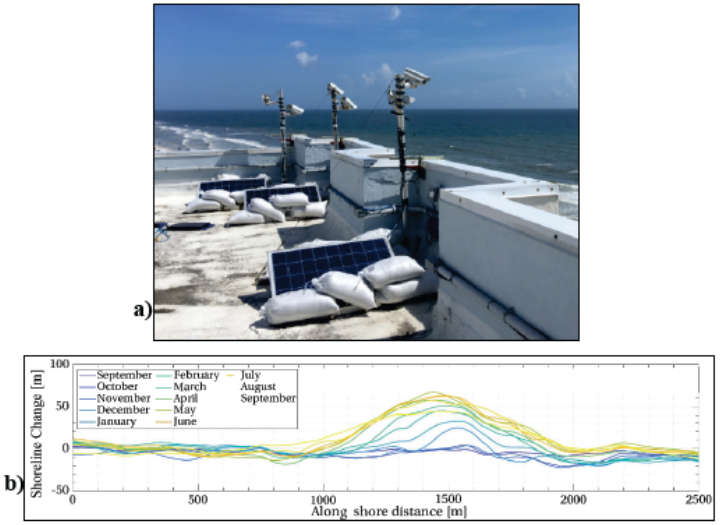
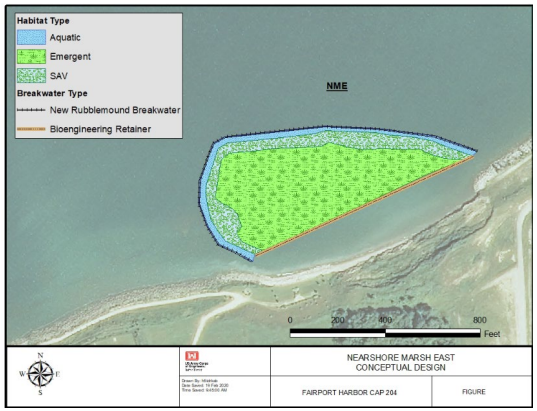


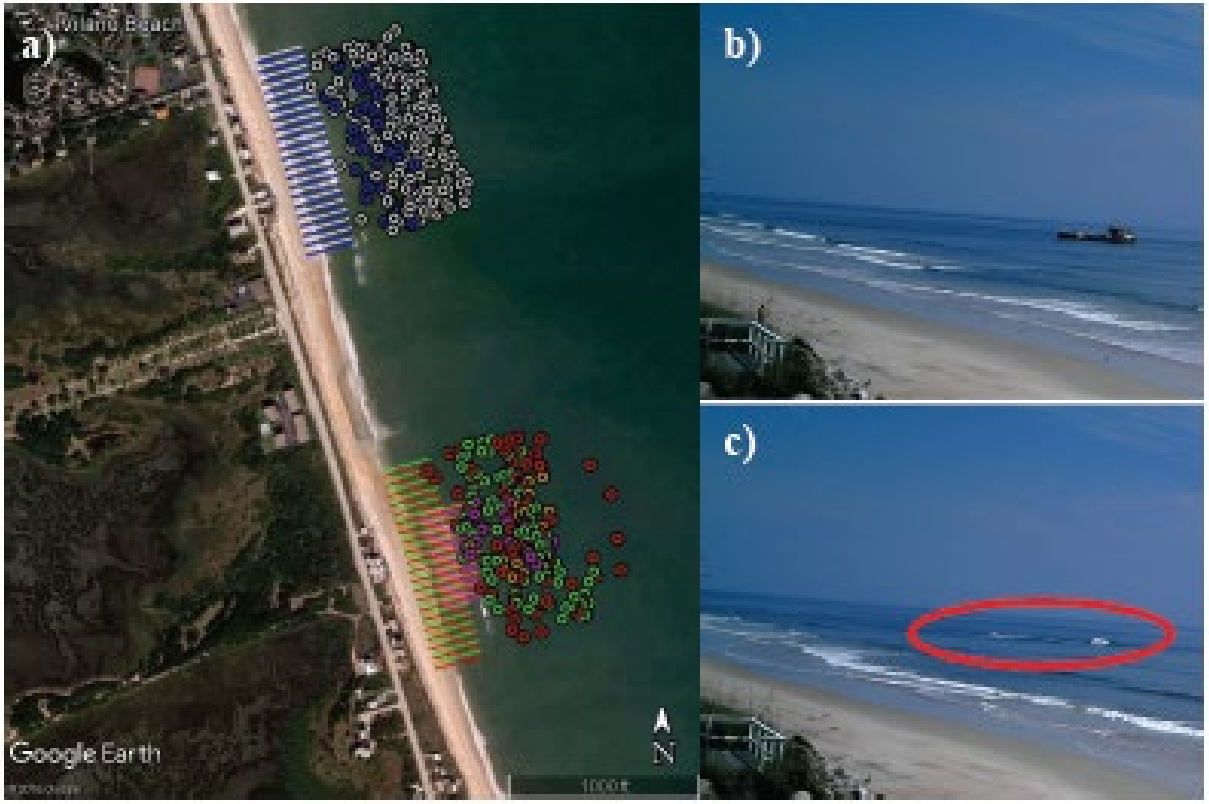
Figure 3. (a) Argus cameras installed on top of hotel and (b) shoreline change following nearshore nourishment (Onnink 2020) at New Smyrna Beach, FL.

  - Inform design concepts for future wetland creation projects

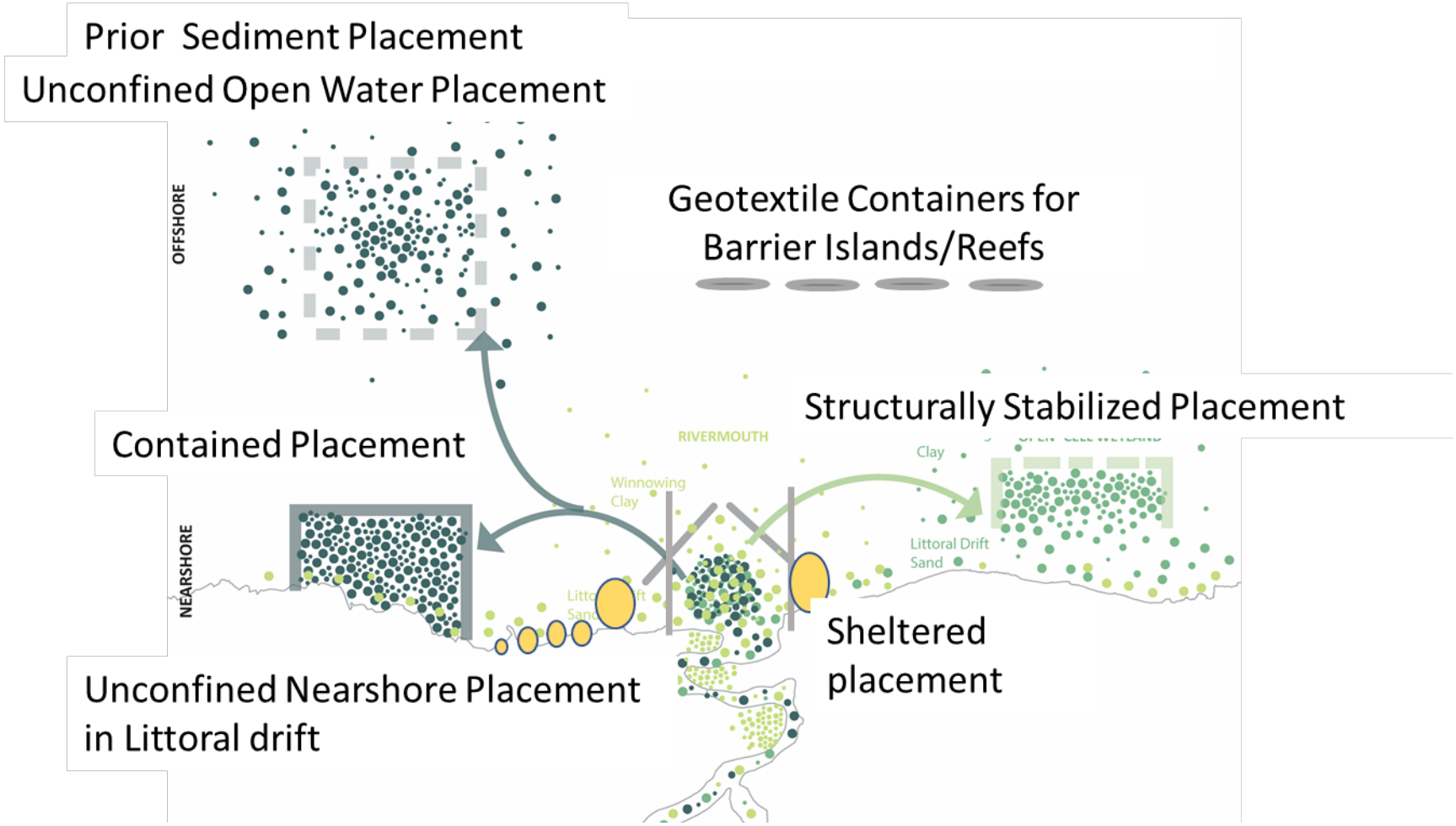


DOER Research Task Objectives: Year 3 (FY24)

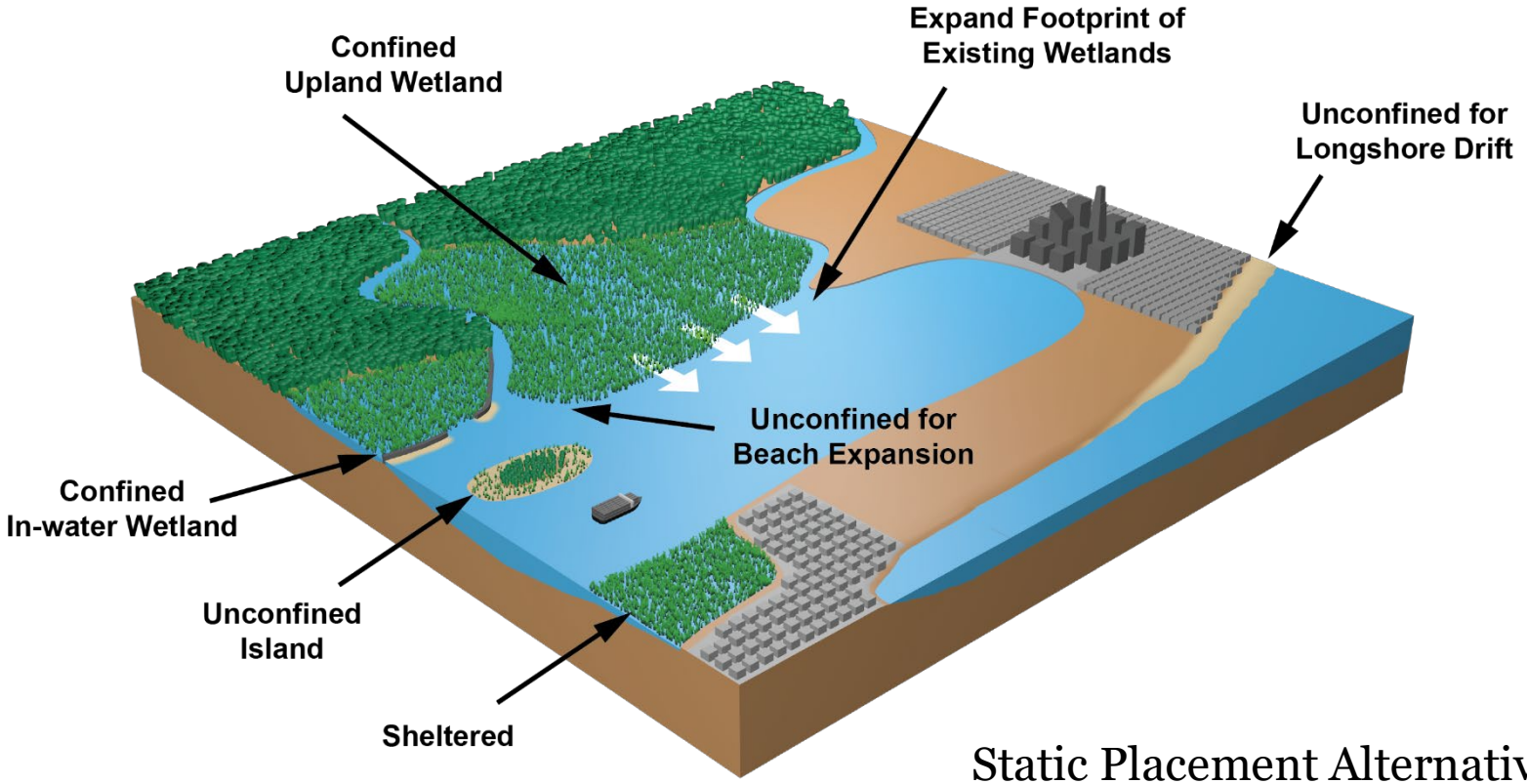
- Field-scale demonstration of design concepts



Great Lakes Sediment Management Alternatives



Adapted from Healthy Port Futures: https://healthyportfutures.com/about-us/



Dynamic Placement Alternatives

- Sediment moves via natural longshore sediment transport forces
- Renews site capacity as material is moved out of the area

Static Placement Alternatives

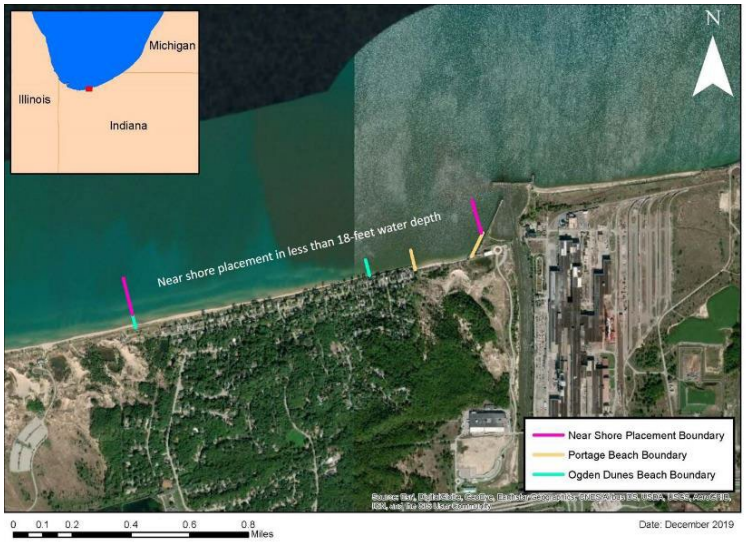
- Sediment is placed in sheltered bays or coves
- “Pocket wetlands” in the downdrift side of jetties, piers, and seawalls
- Structures of various types and size

Unconfined

Materials placed with no permanent structure or feature that would prevent the migration of sediment. This type of placement includes beach nourishment, the construction of nearshore berms, cross shore swash zone placement, and all other unconfined littoral zone placement.

Unconfined Beach Nourishment Alternatives

Burns Harbor, Lake Michigan



Burns Harbor placement site

Sheltered

Materials placed with no permanent structure or feature that would prevent the migration of sediment, but that are intentionally placed within a low energy environment to minimize sediment transport.

21st Ave West, 40th Ave West, Grassy Point, Lake Superior

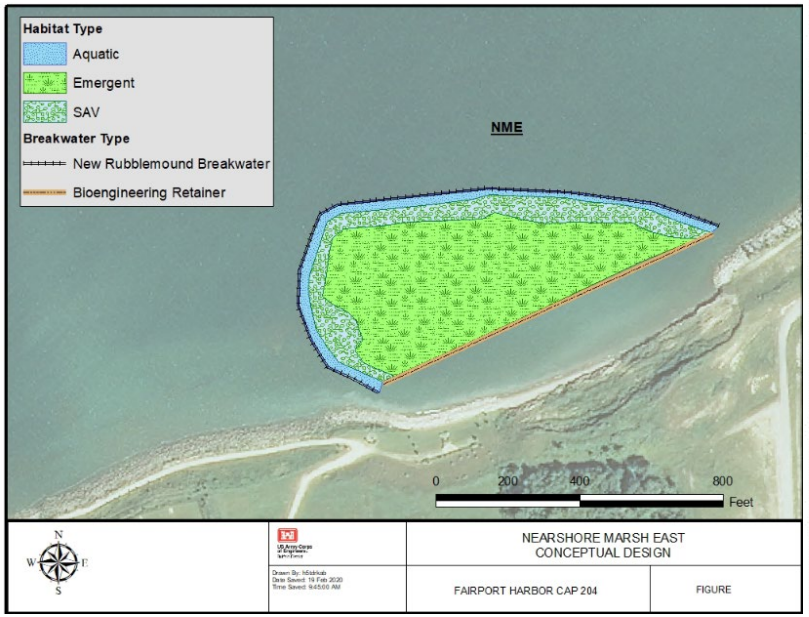
Unity Island, Niagara River

Structurally Stabilized

Materials that are placed behind a manmade structure on one or more sides; the structure is engineered to limit sediment transport and can be made from stone, logs, sheetpile or other natural or construction materials. These features are also referred to as “dynamic containment” since they allow the exchange of water and sediment in at least one direction.

Cat Island, Green Bay

Fairport Harbor, Lake Erie

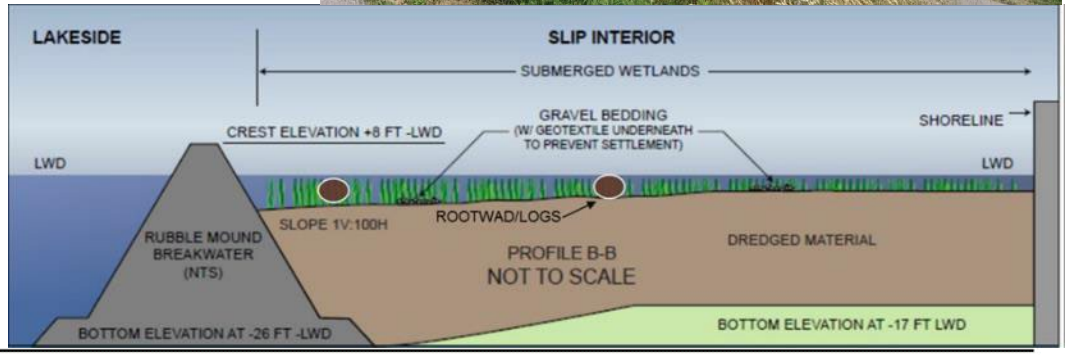


Contained or confined

Materials are placed within a structure that entirely protects the area from waves and prevents all sediment migration or loss.

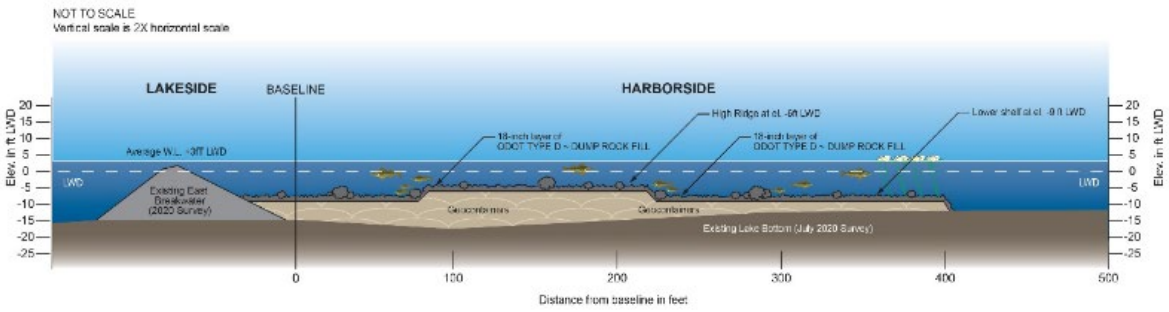
Cedar Point Wetlands, Lake Erie

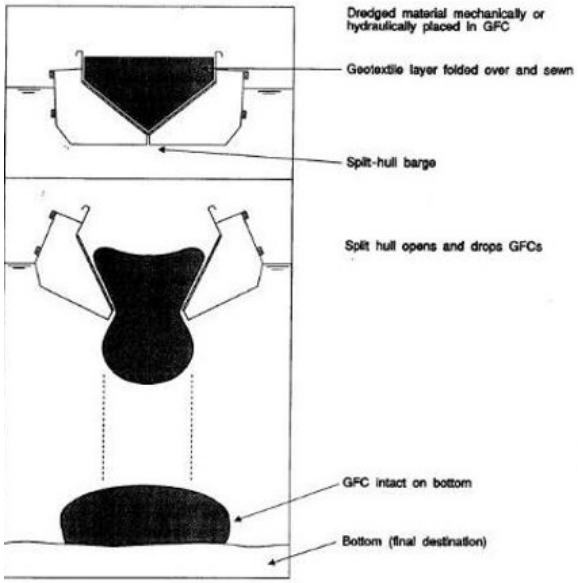
Buffalo Outer Harbor, Lake Erie



Geosynthetic Containers for Reefs, Bars, and Barrier Islands

Geosynthetic containers (GSCs) are bags, “pillows”, tubes, and other containers (Figure 7) pumped full of sediment for coastal protection and, more recently, ecosystem restoration and dredged sediment management.

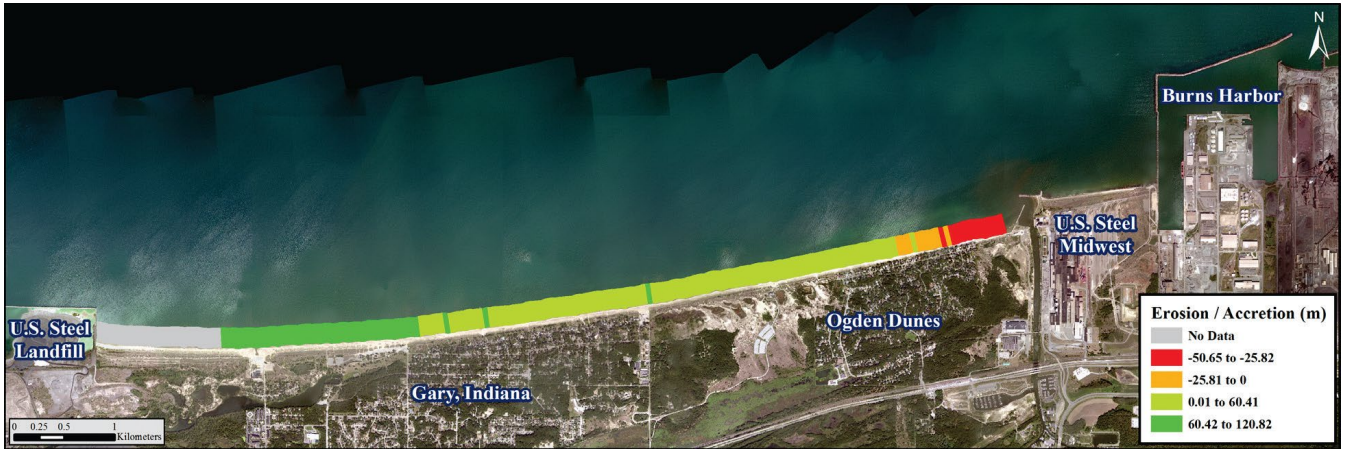




Fate of Placement

Unconfined sediment will move in a high energy environment.

- Where will the sediment (especially the fine-grained material) move?
- What are the differences in the movement of fine-grained sediment verses sandy materials?
- Is beach nourishment with dredged material with > 10% fines an acceptable dredged material management alternatives?
- Is creation of temporary (unconfined) wetlands an acceptable dredged material management alternative?



Shoreline accretion (green) and erosion (red) from 1969 to 2014 near the Port of Indiana (Arnold et al. 2018).

Fate of Placement
Sediment Mobility Tool:
Port of Indiana

Table 4. Summary of the predicted sediment mobilization frequency and sediment migration directions for various grain sizes under typical and storm wave conditions.

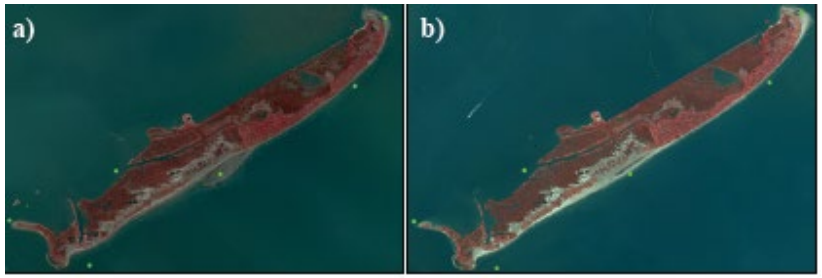
	Typical Waves		Storm Events	
d_{50} (mm)	Frequency of Mobilization	Sediment Migration	Frequency of Mobilization	Sediment Migration
0.1	41% - 54%	68% Onshore	79% - 87%	51% Offshore
0.15	37% - 48%	91% Onshore	76% - 84%	72% Offshore
0.2	34% - 44%	97% Onshore	73% - 81%	85% Onshore
0.3	30% - 38%	99% Onshore	68% - 76%	96% Onshore

Source: Arnold et al. 2018

Performance Criteria

Ancillary or regional monitoring techniques include:

- Satellite or aerial imagery to show shoreline response
- Annual topographic and bathymetric surveys
- No significant change in recreation or wildlife use in subsequent years.



Site specific monitoring techniques include:

- Project stability/evolution
- Shoreline tracking and analysis
- Bathymetric inversion monitoring
- Sediment tracer or geo-tracer monitoring.
- Turbidity

Next Steps

- Choose 1 to 3 dredged material placement sites in the Great Lakes which would benefit from additional monitoring and/or modeling support.
  - Outcome of this step would be to recommend placement design features to be implemented in a demonstration (pilot) project.

Next Steps

Specific goals of demonstration projects should include:

- Modeling sediment transport prior to sediment placement, and as a result, recommend placement designs and/or techniques.
- Monitoring turbidity before and after project implementation, to document the impact of placement methods and fine content on water quality.
- Monitoring sediment movement after placement, particularly of fines (by taking repeated samples along transects, for example).

Considerations

- A variety of placement techniques and stabilization or containment methods (if needed) should be used in the different projects, to provide data on a range of approaches to beneficial use.
- A variety of wave environments, lake conditions, locations and other site variables should be selected for demonstration projects, to capture a range of data representative of the Great Lakes.

Potential Aquatic Beneficial Use Pilot Demonstration Project Sites

A list of Great Lakes harbors which may be potential candidates for performing some of this monitoring or applying modeling techniques is being developed.

We welcome your input on the list of potential candidate sites.

Site name & State	Placement Objective	Monitoring Needs	Modeling Needs	Placement Schedule	Notes	POCs (District & State
Lake Erie						
Buffalo Harbor slip 3 NY	Wetland creation/ habitat restoration	Turbidity, settlement, and surfacesediment stability	Settlement, and surfacesediment stability	FY24, 26, and 28	Construction of containment structure in FY23	LRB –Josh Unghire NY -
Conneaut OH – Presque Isle PA	Longshoredrift	Fate of sand around Conneaut harbor (anybypass?) Disposition of fines	Depth of closure/ placement depth	FY 24 (?)	RIOS deployment planned fall 2022.	LRB –Tim Noon OH – PA –
Ashtabula Harbor OH	Coastal Wetland and Aquatic Habitat Restoration	Turbidity, Sediment scour/mobilization, rateor settlement and erosion,	Stability of material and fateof fines	FY22 –FY25	Project will conduct some monitoring surveys of placed sediment.	LRB –Josh Unghire, A. Hannes
Woodtick Peninsula MI	Wetlands restoration or protection	Turbidity and scouringat placement site	Stability of material and fateof fines		Subject of EWN project, will not beevaluated under this DOER RT22-03	LRE– Kevin Meyer LRB –Ashley Binion-Zuccaro
Lake Michigan –eastern shore						
South Haven, MI	Beach nourishment, longshoredrift	Fate of material	Fate of material	FY 23	Study looking at theplacement of material along South Beach, directly south of theFederal Structure.	LRE– Jim Selegean MI -
Burns Harbor, IN	Nearshore or beach nourishment at Portage Park/Ogden Dunes	Fate of material, follow on to previous work	Sediment mobility tool?	Annual dredging	Previous research by McFall; Geomorphic index/study available for Lake Michigan	LRC –Jen Miller IN – Marty Maupin
Burns Small Boat Harbor, IN	Nearshore or beach nourishment at Portage Park/Ogden Dunes	Fate of material, follow on to previous work	SMT?	award FY23, dredgingin FY24	Geomorphic index/study available for Lake Michigan	LRC –Jen Miller IN – Marty Maupin
Michigan City, IN	Nearshore or beach nourishment at Mt. Baldy	Fate of material	SMT	Uncertain dredging schedule	Geomorphic index/study available for Lake Michigan	LRC –Jen Miller IN – Marty Maupin
Lake Michigan –western shore						
WI harbor - Western shore Lake Michigan Suamico WI – Lake Michigan	Shoreline (coastal) resiliency / shore nourishment – habitat restoration at nearby Green Bay AOC or state natural areas	Fate of material, resilience of placement, turbidity?	Fate of material; SMT (in progress, August 2022)	award FY23, dredging likely FY24	Geomorphic index/study available for Lake Michigan	LRC –Jen Miller WI –Jim Killian
Algoma, WI	Shoreline resiliency, beach nourishment	Fate of material, resilience of placement, turbidity?	Fate of material; SMT (in progress, August 2022)	award FY23, dredging likely FY24	Geomorphic index/study available for Lake Michigan	LRC - Jen Miller WI –Jim Killian
Oconto, WI	Shoreline resiliency, beach nourishment	Fate of material, resilience of placement, turbidity?	Fate of material; SMT (in progress, August 2022)	Possible award FY24?	Geomorphic index/study available for Lake Michigan	LRC - Jen Miller WI –Jim Killian
Two Rivers, WI	Shoreline resiliency, beach nourishment	Fate of material, resilience of placement, turbidity?	Fate of material; SMT (in progress, August 2022)	Possible award FY24?	Geomorphic index/study available for Lake Michigan	LRC - Jen Miller WI –Jim Killian
Kenosha, WI	Shoreline (coastal) resiliency / shore nourishment	Fate of material, resilience of placement, turbidity?	Fate of material; SMT (in progress, August 2022)	dredging FY23	Geomorphic index/study available for Lake Michigan	LRC –Jen Miller WI –Jim Killian
Lake Superior						
Wisconsin Point, Duluth Superior Harbor, Superior, WI	WI Point Shoreline (coastal) resiliency, beach nourishment	Fate of material, resilience of placement, habitat benefits	Fate of material	FY 24 or later	WDNR currently budgeted BUDM in FA4 GLRI budget	LRE– Melissa Bosman and Jim Luke WI –Cherie Hagen
Ashland, WI	Island resiliency and open water placement	Fate of material, potential impacts on fish habitat	Fate of material	FY23 or later	Looking at 3 potential open water placement sites and island restoration	LRE– Melissa Bosman WI –Jim Killian
Deep Holes, Duluth Superior Harbor, Duluth MN	Evaluation of dredged material in deep holes to study impacts on fish that may utilize the deep holes	Impacts on fish species of concern such as Lake Sturgeon, Muskellunge.	None necessary	FY23 or later	May be difficult finding a local sponsor on this proposal as this issues controversial in Duluth Superior Harbor	LRE- Melissa Bosman MN - ?
MN Point South, Duluth Superior Harbor, Duluth MN	Shoreline resiliency, beach nourishment	Fate of material, turbidity study looking at impacts on the water intake line.	Fate of material, BMPs for limiting turbidity when placing.	FY23 or later	Would work closely with the public works department in an effort to build trust.	LRE– Melissa Bosman MN –Dan Breneman
Lake Huron						
Lexington, MI	Shoreline resiliency, evaluate impacts to water intakes	Fate of material, turbidity study looking at the impacts on the water intakeline	Fate of material, BMPs for limiting turbidity when placing.	FY23 or later	Would work closely with the public works department	LRE– Melissa Bosman MDNR – Jordan Bydlich ?
Moon Island, Sault Ste. Marie,	Habitat improvement through use of BUDM	Fate of material, vegetation growth in shallow areas, benefits to habitat (piping plover)	Fate of material,	FY23 or later	Have had challenges working with Regulatory agencies regarding the benefits of placement along moon island. Regulators would also likely require long term maintenance.	LRE Melissa Bosman MDNR - ?

Site name & State	Placement Objective	Monitoring Needs	Modeling Needs	Placement Schedule	Notes
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Ashtabula Harbor OH	Coastal Wetland and Aquatic Habitat Restoration	Turbidity, Sediment scour/mobilization, rate or settlement and erosion,	Stability of material and fate of fines	FY22, 23, FY25, FY27 (100,000 CY/ placement)	Project will conduct some monitoring surveys of placed sediment. Review of placement to optimize or increase capacity may be appropriate as adaptive management approach.
Burns Harbor, IN	Nearshore or beach nourishment at Portage Park/Ogden Dunes	Fate of material, follow on to previous work	Sediment mobility tool?	Annual dredging	Previous research by McFall; Geomorphic index/study available for Lake Michigan
Burns Small Boat Harbor, IN		Fate of material, follow on to previous work	SMT?	award FY23, dredging in FY24	Geomorphic index/study available for Lake Michigan
Wisconsin Point, Duluth Superior Harbor, Superior, WI	WI Point Shoreline (coastal) resiliency, beach nourishment	Fate of material, resilience of placement, habitat benefits	Fate of material	FY 24 or later	WDNR currently budgeted BUDM in FA4 GLRI budget
MN Point South, Duluth Superior Harbor, Duluth, MN	Shoreline resiliency, beach nourishment	Fate of material, turbidity study looking at impacts on the water intake line.	Fate of material, BMPs for limiting turbidity when placing.	FY23 or later	Would work closely with the public works department in an effort to build trust.
Moon Island, Sault Ste. Marie, MI	Habitat improvement through use of BUDM	Fate of material, vegetation growth in shallow areas, benefits to habitat (piping plover)	Fate of material,	FY23 or later	Have had challenges working with Regulatory agencies regarding the benefits of placement along moon island. Regulators would also likely require long term maintenance.

This DOER project will continue until 2024 and we will provide updates along the way.

An ERDC Technical Note will be completed in 2022 based on input from Districts and GLDT.

Field studies will be initiated in 2023 and 2024 at sites to be determined.

Kenosha Dunes, Lake Michigan

Thank You