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Proceedings from the Soft Substrate Island Design Workshop

Alyssa J. Calomeni and Chuck Theiling

September 2023

Environmental Laboratory

Cover Photo:

Soft sediments (gray color) placed on top of sandy substrates (brown color) during construction of an island at Conway Lake in 2020. Photo provided by John Henderson (USACE–St. Paul District).

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Final report

Prepared for US Army Corps of Engineers
Washington, DC 20314-1000

Under Project 494207, "Soft Substrate Island Design Workshop"
Funding Account Code 4375538; AMSCO Code 089500

Abstract

This report summarizes the activities of the Soft Substrate Design Workshop held virtually on 08 September 2021.

The 28 participants from federal, state, local, and academic organizations discussed designing and constructing islands with soft sediments in inland waterways. They were introduced to the US Army Corps of Engineers' (USACE) Engineering With Nature® (EWN®) initiative and the vision for Tri-County Planning Commission (Peoria, Illinois). An overview of collaborative projects using landscape architecture and EWN principles was provided. The focus of discussion was on two primary waterways, the Upper Mississippi River System, and Illinois River. Participants discussed their experience associated with designing and constructing islands with and on soft sediments prior to breakout sessions to discuss specific design and contracting elements. The groups were brought together to discuss design techniques that could be implemented in the Upper Mississippi River and Illinois River systems.

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Preface

The workshop was coordinated by Dr. Chuck Theiling, Aquatic Research Ecologist, US Army Corps of Engineers (USACE), Engineer Research and Development Center (ERDC), in Vicksburg, Mississippi; Dr. Burton Suedel, research biologist, USACE ERDC in Vicksburg, Mississippi; and Mr. Ray Lees, planning program manager, Tri-County Regional Planning Commission in Peoria, Illinois. Facilitation for the meeting was provided by Ms. Chrissa Waite, public involvement specialist, USACE Charleston District in Charleston, South Carolina. Facilitation of breakout sessions was provided by Dr. Ellen Hartman, research landscape architect, USACE ERDC in Vicksburg, Mississippi, and Dr. Rob Holmes, associate professor of landscape architecture, Auburn University in Auburn, Alabama. The workshop was made possible by support offered through USACE's Engineering With Nature® (EWN®) program. Funding was provided by project number 494207, "Soft Substrate Island Design Workshop." The organizers would like to thank the workshop participants who shared their knowledge and experience.

This report was written by the Ecological Resources Branch (EE-E) of the Ecosystem Evaluation and Engineering Division (EE) and the Environmental Risk Assessment Branch (EP-R) of the Environmental Processes and Engineering Division (EP), ERDC, Environmental Laboratory (EL). At the time of publication, Mr. Joseph Minter was branch chief, and Mr. Mark Farr was division chief, EE. Mr. James Lindsay was branch chief, EP-R and Mr. Warren Lorentz was division chief, EP. Dr. Todd Bridges was the program manager of EWN. The deputy director of ERDC-EL was Dr. Brandon Lafferty, and the director was Dr. Edmund Russo.

COL Christian Patterson was the commander of ERDC, and Dr. David Pittman was the director.

Executive Summary

Large floodplain, alluvial rivers have similar sediment transport characteristics evolved through millennia of glacial scour and fill. Most US alluvial rivers are in a filling state between glacial episodes and exasperated by significant anthropogenic land use change. Soft sediments (e.g., clay and silt) are common in the backwaters and off-channel areas of the Upper Mississippi River and Illinois Waterway System (UMR-IWW) and have become a focus for ecosystem restoration efforts. It is becoming increasingly common to integrate navigation and environmental dredged material to implement Engineering With Nature (EWN®) through beneficial uses. One beneficial use of dredged material successfully implemented is inland island creation which can improve environmental quality in degraded habitats (e.g., wetlands, floodplain forests, and backwater lakes). Island construction using dredged soft sediments in inland waterways has historically been implemented with successes; this workshop explored opportunities for improvement.

This workshop arose from a need to identify island design and construction techniques that can be successfully implemented using soft sediments in inland waterways.

The four primary objectives associated with the workshop were

1. identify successes and lessons learned from prior inland island design projects that utilized soft sediments,
2. discuss opportunities and challenges of candidate island design techniques using soft sediments,
3. identify island design techniques that could be implemented for inland island design, and
4. document and publish workshop results.

The single-day virtual workshop began with introductions by all attendees and an outline of the purpose and objectives of the workshop. Next, representatives from EWN, Tri-County Planning Commission, and the Dredge Research Collaborative introduced their programs/projects. Sedimentology and land use information pertaining to the Upper Mississippi and Illinois Rivers were provided in a “Defining the System” session.

In the morning, Jon Hendrickson from USACE–St. Paul District provided an overview of island projects that had been constructed with soft sediments as part of the Upper Mississippi River Restoration Program (UMRR program). Ray Lees from Tri-County Planning Commission and John Marlin from the University of Illinois outlined the construction techniques used in the Upper Peoria (McCluggage Bridge) Island. Participants then discussed successes and limitations of prior projects with specific focus on mobility/access issues, alternative equipment, and feature and material stability as well as other considerations.

Two break-out sessions were held that afternoon. One group discussed considerations necessary for the planning of islands using soft sediments, including defining objectives/desired outcomes of the island design (e.g., habitat type), hydrodynamics, and contracting processes. The second group focused on specific island design techniques (e.g., letting river energy distribute sediment, thin layer placement, integrating environmental pool management to consolidate soft sediment). The break-out groups were then combined, and the discussion focused on contactor adaptability during construction, the contracting process, and the stability of newly constructed islands.

The final session focused on potential island design techniques that could be implemented in the Upper Peoria Lake. The group discussed placing sediment within the Upper Peoria Lake and allowing fluvial processes to carry sediments to desirable locations to establish land mass and new habitat. There was a conclusion that hydraulic models would be important to predict the movement of the placed sediments. The workshop discussion ended with an opportunity for participants to provide workshop feedback.

1 Introduction

1.1 Background

Soft sediments (i.e., clays and silt) are dominant in off-channel areas of the Upper Mississippi and Illinois River systems. Historically, fluvial processes deposited soft sediments in floodplain lakes during floods, and more recently, water management operations (e.g., dams) have resulted in increased sediment transport to these areas. Increased aquatic connectivity coincided with significant increases in soft sediment transport from upland land use changes to further exacerbate backwater sedimentation rates. Dredging soft sediments from backwater areas and using the dredged sediments to create inland islands is an ecosystem restoration measure used to restore depth to backwater lakes and create new island habitat.

Inland island design and construction uses a collaborative approach that meets the goals of the Upper Mississippi River Restoration (UMRR 2021) program implemented by the US Army Corps of Engineers (USACE) and other federal (e.g., US Fish and Wildlife Service, US geological Survey) and state (e.g., Illinois, Iowa, Minnesota, Missouri, and Wisconsin) partners. The UMRR program, authorized in 1986, was the first large river ecosystem restoration and environmental monitoring program in the US. UMRR has constructed 56 Habitat Rehabilitation and Enhancement Projects (HREP), with 20 more in planning, design, or construction. The UMRR has funded many projects utilizing key elements of the Engineering With Nature® (EWN®) program. Key elements of EWN are (1) using science and engineering to produce operational efficiencies, (2) using natural processes to maximize benefit, (3) increasing the value provided by projects to include social, environmental, and economic benefits, and (4) using collaborative processes to organize, engage, and focus interests, stakeholders and partners. Succinctly, the goal of USACE EWN Program is to align natural and engineering processes to deliver economic, environmental, and social benefits efficiently and sustainably through collaboration (Bridges et al. 2018, 2021). The UMRR and Upper Mississippi River Illinois Waterway System (UMR-IWW) navigation operations are increasingly aligning ecosystem restoration and channel maintenance activities using EWN practices to increase efficiency and manage costs. One approach that aligns ecosystem restoration and channel maintenance is island construction.

Island designs typically use historic maps to identify substrates where islands were once located (Hendrickson 2012). Historic islands should provide suitable substrates or a foundation for construction of the new island and reduces material needs. For island construction, sand and mixtures of soft sediment and sand are used to create the island base and a stable surface for construction equipment. Soft sediments are then placed on top of the base to provide topsoil dressing for vegetative plantings or natural succession. Due to the abundance of soft sediments and potential for insufficient sand in backwaters of the Upper Mississippi and Illinois River systems, there is an interest to utilize greater quantities of soft sediments during island construction.

Soft sediments are a challenging fill material and substrate for island construction due to their physical properties. Clays and silt sediments can be difficult to compact, lack stability, and result in sinking, shrinkage, and dispersion. Island construction using soft sediments may require the use of retaining structures to contain placed sediments during consolidation (O'Donnell 2018). Estimating the final island elevation may be challenging due to slow consolidation and settling rates. Additionally, sand, rock, and other construction materials can sink when placed on top of a soft sediment base or substrate. Given the interest in using soft sediments and challenges associated with the use of this material for island construction, information on how to best utilize soft sediments for island construction is needed. This information can be gathered from lessons learned during prior island construction projects. This workshop convened regional experts in river restoration planning, engineering, construction, and evaluation/monitoring to explore opportunities to learn from and improve inland soft substrate island designs.

The two primary areas of focus for this workshop were island design projects located in Peoria Lakes (Upper and Lower Peoria Lake and Goose Lake) along the Illinois River (Figure 1) and Pig's Eye Lake along the Mississippi River (Figure 2). Peoria Lakes consist of Upper and Lower Peoria Lake located along the Illinois River in Peoria, Woodford, and Tazewell counties, Illinois. Goose Lake is an Illinois Department of Natural Resources (DNR) wildlife management area located in the Northern portion of Upper Peoria Lake. Peoria Lakes were selected based on recommendations of the Peoria Lakes Comprehensive Conservation Plan (PLCCP) which was a collaboration of USACE Rock Island District and the Tri-County Regional Planning Commission (Abi-Akar et al. 2018).

This island design workshop was deemed necessary because of conflicting opinions on a recently completed island project and continued hopes for effective ecosystem restoration in Peoria Lakes. Pig's Eye Lake is a USACE Section 204 beneficial use of dredged material project located in Pool 2 below the confluence of the Minnesota River which transports sediment loads to the Upper Mississippi River reach above Lake Pepin.

Figure 1. Upper and Lower Peoria Lakes and Goose Lake wildlife management area along the Illinois River.

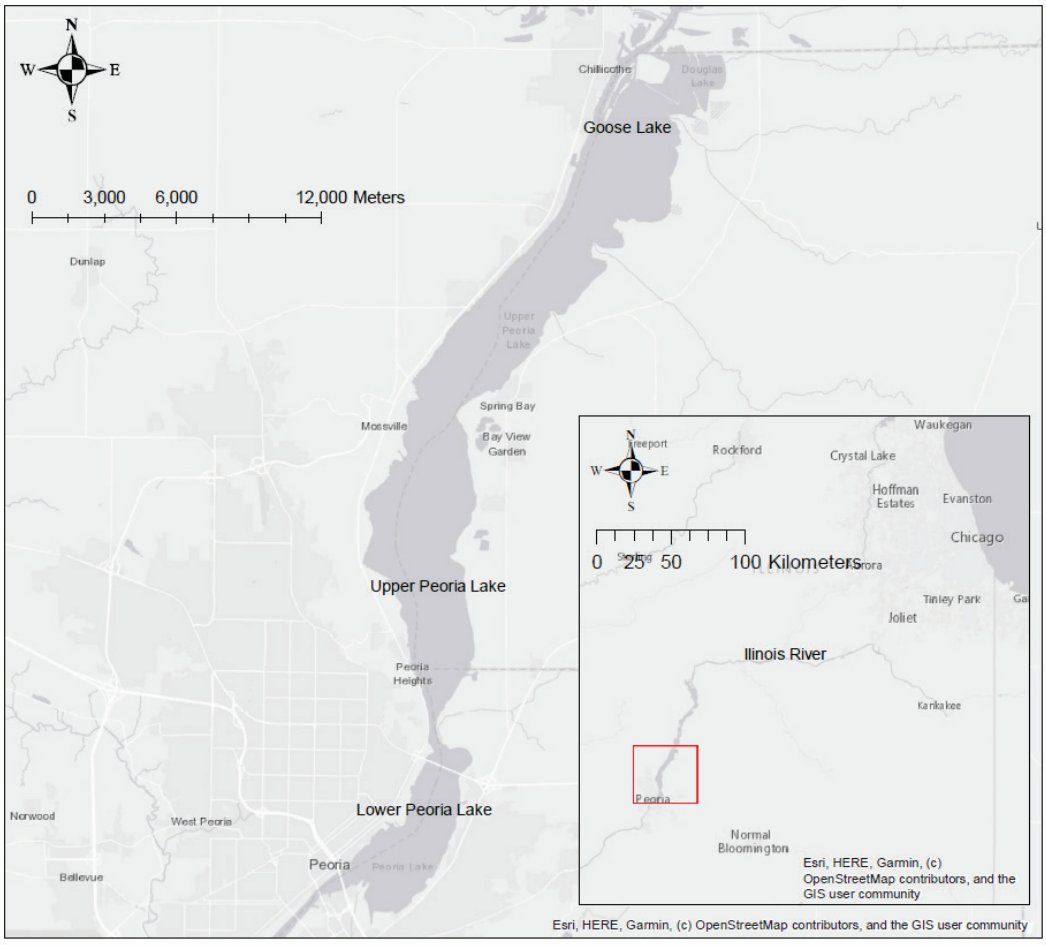
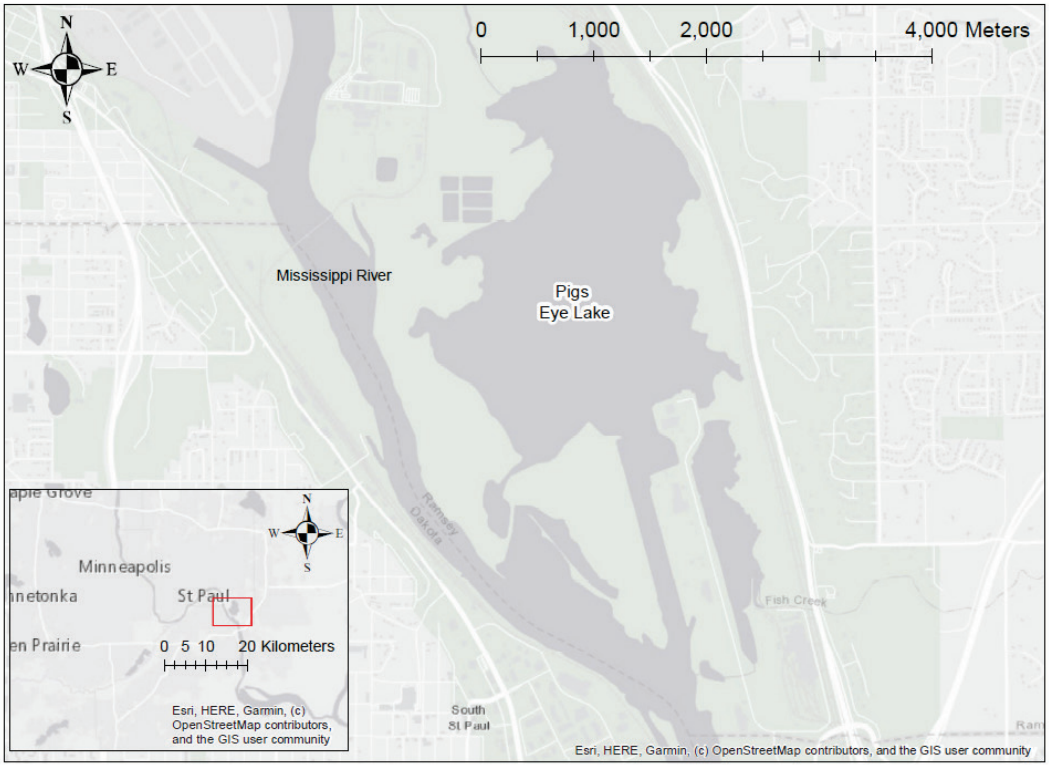


Figure 2. Pig's Eye Lake, an inland lake along the Mississippi River.



1.2 Purpose

The purpose of the workshop was to assemble subject matter experts to conceptualize research and development geared towards identifying regional EWN design questions leading to demonstration projects and research strategies to evaluate outcomes for designing and constructing islands on soft substrates in inland waterways. Prior inland island designs and methods will be reviewed with a focus on projects using soft substrate construction methods. Alternative island designs and construction methods will be identified and discussed. The results of the workshop are documented in this report.

1.3 Objectives

The four primary objectives associated with the workshop were

1. identify successes and lessons learned from prior inland island design projects that utilized soft sediments,
2. discuss opportunities and challenges of candidate island design techniques using soft sediments,

3. identify island design techniques that could be implemented for inland island design, and
4. document and publish workshop results.

2 Agenda and Workshop Structure

The full workshop agenda can be found in Appendix A.

2.1 Introduction and experience

The one-day virtual workshop began with a welcome and introductions led by Chrissa Waite of USACE–Charleston District and Chuck Theiling of USACE ERDC. Twenty-eight participants from Auburn University, USACE ERDC, USACE-Charleston District, USACE–Rock Island District, USACE-St. Louis District, USACE–St. Paul District, State of Illinois Department of Natural Resources, Tri-County Planning Commission, University of Illinois, US Fish and Wildlife Service, and Wisconsin Department of Natural Resources attended the workshop. See Appendix B for full participant list including name, affiliation, contact information, and workshop role. Introductions included name, affiliation, and level of experience related to island design using soft sediments. Participants were asked to rate their experience in island construction from "none yet, but maybe in the future" to "have been part of completed construction." Eleven participants indicated they did not have experience in this subject but may develop this experience in the future. Seven participants had studied or researched the topic prior to the workshop, six participants had been involved in the design phase, and four participants categorized their experience as "have been part of completed construction."

2.2 Purpose and objectives of workshop

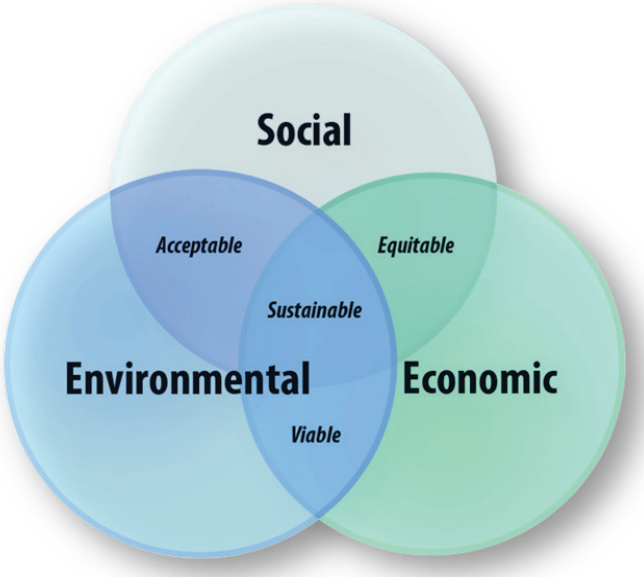
The workshop purpose (Section 1.2) was presented by Dr. Chuck Theiling (USACE ERDC). Ms. Chrissa Waite (USACE–Charleston District) outlined the objectives of the workshop, as outlined in Section 1.3, and provided an overview of the agenda. A brief morning session taught participants how to use annotation tools to facilitate discussion using the WebEx platform.

2.3 Setting the stage

An overview of EWN was provided by Dr. Burton Suedel of USACE ERDC. EWN is "the intentional alignment of natural and engineering processes to efficiently and sustainable deliver economic, environmental and social benefits through collaboration" (Figure 3). Key elements of EWN projects are (1) using science and engineering to produce operational efficiencies, (2) using natural processes to maximize benefit, (3) increasing the value

provided by projects to include social, environmental, and economic benefits, and (4) using collaborative processes to organize, engage, and focus interests, stakeholders, and partners. Through the 11-year initiative, numerous workshops (>50), publications, and projects with EWN goals have been completed. The number of proving grounds or districts committed to implementing EWN projects are growing. EWN projects have been implemented to support the USACE mission space. Examples include strategic placement of dredged material for navigation, natural and nature-based features for flood risk management, ecosystem services supporting engineering functions for ecosystem restoration, and shoreline stabilization using native plants for water operations. Multiple guidance documents have been published with support from government agencies, academic institutions, nongovernmental organizations, engineering firms, and construction companies.

Figure 3. Venn diagram presenting the three benefit categories of EWN® projects.

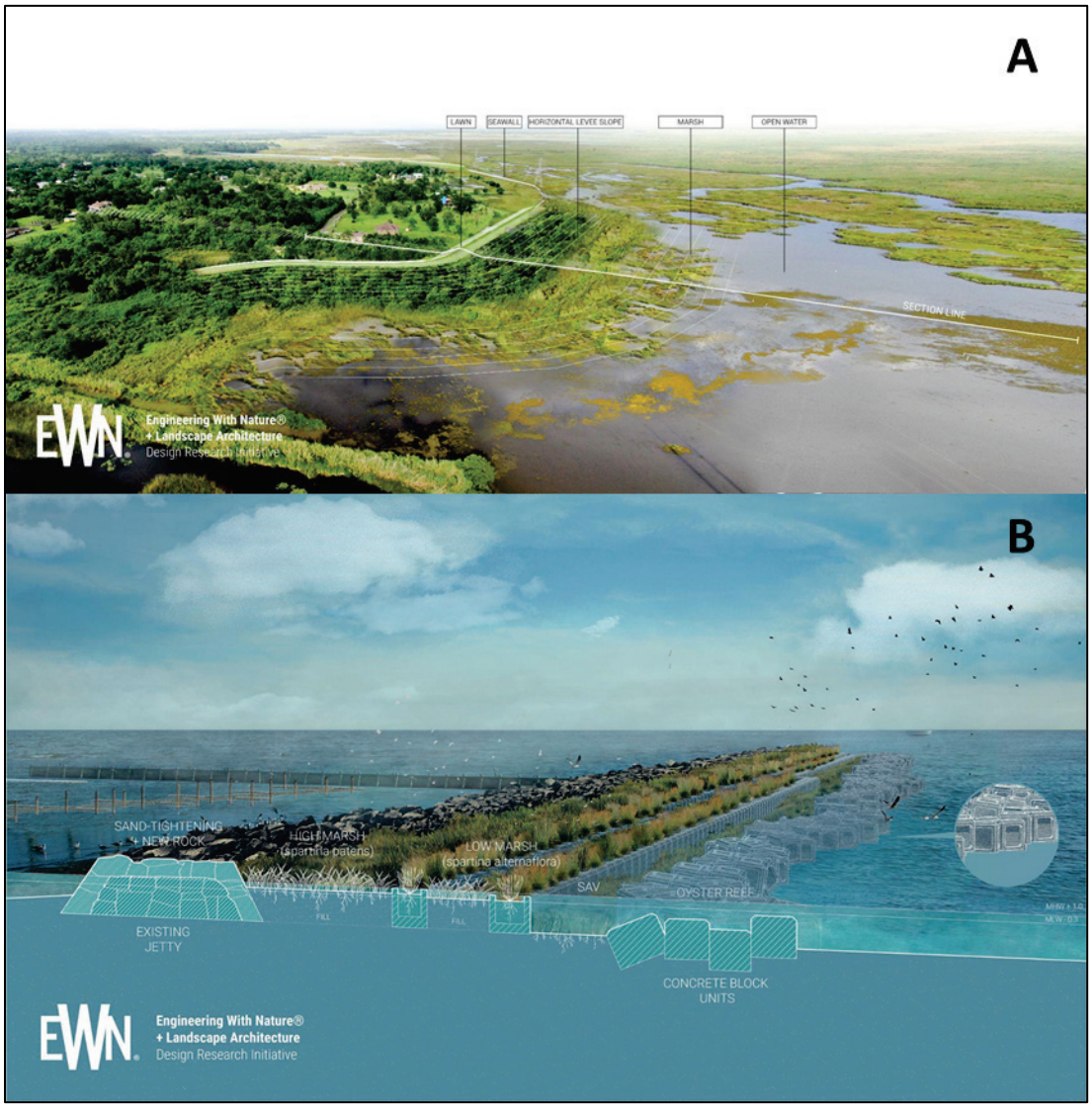


Following Dr. Suedel, Mr. Ray Lees of the Tri-County Planning Commission verbally outlined the vision for Tri-County Planning Commission to include environment, land use, and community planning as well as transportation. Tri-County has collaborated with USACE since 2015 on the Comprehensive Conservation Plan which recommended this workshop and the beneficial use of dredged material. Tri-County was a

critical partner in the formulation, planning, and execution of the workshop captured in this document.

Dr. Rob Holmes of Auburn University listed collaborative projects between EWN and landscape architects. These projects capture key elements of EWN and incorporate landscape architecture methods around shared goals. The projects listed ranged in terms of scale (Figure 4) and location (Texas to New Jersey). These projects utilized collaboration between EWN and landscape architecture to synthesize and communicate concepts to the public during engagement workshops.

Figure 4. Example EWN and landscape architecture projects that range in scale from horizontal levees (*A*) to a single jetty (*B*).



2.4 Defining the system

Sedimentology and land use information for the two river systems of interest was provided by Dr. Chuck Theiling (USACE ERDC). Primary reasons for sedimentation in these river systems are these areas are glacial alluvial systems. As glacial alluvial river systems, they exhibit a low longitudinal slope and meandering pattern resulting in slow water flows and consequently depositional zones for soft sediments. Additionally, water operations (e.g., low head dams to support commercial navigation) have changed the landscape from wetlands, forests, and prairies to open water navigation impoundments which altered sediment transport processes and induced sedimentation in the new aquatic areas.

2.5 Prior experience in island construction

2.5.1 St. Paul District construction experience

The St. Paul District's island construction experience was provided by Mr. Jon Hendrickson of USACE–St. Paul District. This district started building islands in the late 1980s. Island construction projects started at Weaver Bottoms in 1986 and between 1986 and 2016 UMRR, for which the St. Paul District is a partner, constructed 20 HREPs that included island construction. Mr. Hendrickson made the distinction that soft substrates can be used as a construction material to be placed on top of sandy substrates (Figure 5) as well as a substrate for the formation of islands. As a construction material, consolidated soft sediments (i.e., silts and clays) have cohesive properties that provide a stable island surface during flood overtopping events (Hendrickson 2012). St. Paul District has used historic maps to locate predam islands and natural levees with higher elevation and firm foundation for new construction.

Figure 5. Example of island design with sand base and soft sediment (i.e., fines) to provide substrate for vegetation and stability during overtopping.

2.5.2 Peoria Riverfront Island construction

As Peoria Lakes (Illinois River) are one of the primary focus areas of this workshop based on the excessive sedimentation and aquatic ecosystem restoration recommendations from the PLCCP, information regarding the construction of the Peoria Riverfront Island was provided. To create the Peoria Riverfront Island, soft sediments were dredged to provide deep water aquatic habitat for fish. The dredged soft sediments were used to build a terrestrial island, Peoria Riverfront Island. To date, it is the only regional example of using entirely fine sediment and geotextile containers to create project features.

Planning, design, and construction of Peoria Riverfront Island was completed through a collaboration with USACE-Rock Island District and the Illinois Department of Natural Resources as the non-Federal project sponsor under a specific Congressional authority in Section 216 of the 1970 Flood Control Act and Section 519 of the Water Resources Development Act (WRDA) 2000, which authorized restoration of the Illinois River Basin (USACE 2003). Planning was complete in 2003, construction occurred 2009–2013, and the most recent project review was completed in 2020 (USACE 2021). Details from the construction of Peoria Riverfront Island were provided by Mr. Ray Lees of Tri-County Planning Commission and John Marlin of University of Illinois (Figure 6).

A large clamshell dredge loaded dredged sediment from borrow area channels around the exterior of the Peoria Riverfront Island containment cell. The dredged sediment was loaded to a concrete pump to hydraulically transport soft sediments into geotextile tubes which were then stacked and aligned in a large kidney-shaped structure to create the perimeter of the Peoria Riverfront Island containment cell. Additional dredged sediment was then used to fill in the interior of the island. The design needed to be altered during construction due to insufficient dredged material which resulted in the height being 8 ft lower than designed and with one side of the island having a greater elevation which formed a depressional wetland below controlled pool stage. Since construction, some geotextile containers have split open, rolled, sank, or otherwise been displaced; however, a self-generated, early successional forest has developed. Given the island elevation relative to flood stage, the island is expected to evolve toward a typical floodplain forest.

Figure 6. Stages of Peoria Riverfront Island, Illinois River. (*A*) Perimeter construction from filling of geotextile tubes in 2010, (*B*) interior construction in 2012, (*C*) island completion in 2015, and (*D*) increase in vegetation cover in 2017.

2.6 Limitations and successes of prior project designs

Participants discussed successes and limitations of prior projects which are captured in Sections 2.6.1 to 2.6.5.

2.6.1 Construction and mobility/access

Access to the construction site can be a critical limitation because there are shallow aquatic areas where access channels may be required to move barges and heavy equipment and soft sediments provide an unstable surface for construction equipment. The group discussed that construction site access should be considered early in the feasibility phase. Contractors have provided critical insight regarding means to gain access to construction sites and contracting should allow flexibility for contractors to provide input. Contract packages can be developed that guide contractors to feasible construction designs while also allowing for flexibility in their methods. To provide sufficient information about the construction site in the contract package, design teams need to collect sufficient geotechnical and bathymetric data. For soft sediments that may be displaced and impacted by settlement, economic risk to the contractor may be a critical decision threshold to decide to submit a proposal. Economic risks to the contractor can be decreased by paying for borrow material at the source or in the barge since cost estimates can be more exact in contrast to paying for material based on the elevation after placement because cost estimates are impacted by settlement. This may increase the number of quality proposals received from contractors. During contracting, one construction plan can be developed for a government estimate, but flexibility can be used to allow contractors to submit independent ideas.

Contractors have used push boats and hydraulic dredges to move sediment in shallow areas. Other methods for gaining mobility and access to construction sites discussed included floating conveyors and construction pads to bridge areas between access cuts and the design feature.

2.6.2 Soft substate dredging equipment

With strong interest in Illinois River aquatic habitat and wetland restoration, the Illinois DNR investigated common construction equipment performance with soft substrates from 1998 to 2017 (Marlin and Darmody 2018). Dredging and placement for environmental

restoration typically requires mechanical methods to avoid managing high volumes of return water in hydraulic dredging. Equipment and ways to use it that have been successfully tested or used during construction with soft sediments include the following:

- Minimize excess water by heaping/overfilling buckets to displace water, letting them drain, and placing (not dropping) sediment. Pump out free water from hopper barge or use a draining deck barge (Marlin and Darmody 2018).
- A screened clamshell bucket performed best for minimizing water in Lower Peoria Lake mud. Hydraulic clamshell buckets on excavators were used to offload barges (Marlin and Darmody 2018).
- Several types of displacement pumps, or concrete pumps, were tested and shown to be useful and adaptable for soft clay substrates. The Dry Dredge™ is a unique dredge and displacement pump tested in Peoria and currently used for harbor maintenance (Marlin and Darmody 2018).
- Floating or barge-mounted conveyors for transporting soft sediments (not consolidated clays) without digging an access channel (discussed during workshop).
- Dewatering equipment (temporary filtering and dewatering bags, centrifuge, or sieves; discussed during workshop).

2.6.3 Feature stability

A challenge for feature stability identified by the group was high water elevations that overtop islands. Overtopping has caused erosion of newly constructed islands. A critically vulnerable period for new islands is during construction before a sand base is covered with topsoil and before plants have time to establish on new topsoil (e.g., during construction and within the first floods following construction). Islands remaining unvegetated through the winter are more vulnerable to erosion during spring flood overtopping.

Several island design concepts were discussed to increase feature stability during overtopping. These island design concepts have been utilized by the USACE - St. Paul or Rock Island districts during designs of different island projects. Island designs more resistant to erosion are those that have implemented the use of temporary cover crops to provide stability or coconut fiber logs to assist in the establishment of plants. Other designs have utilized capping with consolidated clay and silt to provide stability to

the island during overtopping. Constructed islands parallel to river flow have experienced less erosion relative to islands perpendicular to river flow.

Other considerations for feature stability identified by the group included

- fill material used for geotextile tubes; different density sediments can impact settling rates,
- plants as soil engineers,
- considering hydrology surrounding the proposed island, and
- using historic maps to identify suitable substrates for island construction.

2.6.4 Material stability

The group discussion related to material stability focused on subsidence as a primary limitation of soft substrate islands. Islands constructed with a soft sediment base may be particularly vulnerable to subsidence due to consolidation following placement of unconsolidated clays. To help decrease the severity of subsidence, island construction has utilized the placement of a series of layers of coarse and soft sediments.

Other techniques identified to maintain material stability included

- using borings to evaluate the chemical and physical characteristics of sediment prior to placement so consolidation can be anticipated,
- leaving a shallow buffer area (i.e., sacrificial berm) between the feature and deeper water to mitigate wave energy reaching the island,
- planting vegetation to mechanically reinforce sediment by roots,
- displace soft soils before placing granular material or riprap to avoid sinking, and
- using structures to contain soft sediments such as wetlands and sand berms to allow consolidation of soft sediments.

2.6.5 Other considerations

Another limitation of island design discussed was that natural processes will continually impact the island. High water levels and water flow can lead to erosion of an island and consequent infilling of dredged area. Due to this, island design projects should be coupled with dredging projects so sediments can be efficiently utilized. Additionally, similar to navigation maintenance dredging projects occurring at regular intervals, island

construction should be recognized as a project that requires long-term attention.

Other considerations that have led to successful island construction projects identified by the participants included

- developing the appropriate project team with qualified engineers, experienced contractors, and agency partners and
- appropriate data collection and planning prior to contracting and construction.

2.7 New design features

In the afternoon, two break-out sessions were held. One group (Group A) primarily focused on future considerations for island design and contracting. The other group (Group B) discussed potential design elements using soft sediments.

During the breakout discussion for Group A, considerations important for island design were discussed. Initially, the project team should define the project goals for island construction. These goals may include the desired ecosystem intended for the new island, for example.

Other design elements that need to be considered include river flow and flood stage. The design team should consider not just the current river flow, but also anticipate how new island construction may alter flow. Additional considerations related to water flow included anticipating where sediments will move, ensuring sediments move to desired areas and not sensitive species habitats. During the design phase, borings can be used to sample sediments for analysis of physical and chemical characteristics. This data can be used to understand sediment consolidation and potentially to mix sediments (e.g., sand with clay) to create more desirable physical and chemical soil characteristics.

Contracting was also discussed during Group A's breakout session. This conversation was a continuation from that morning related to the limitations and successes of island design and construction (section 2.6.1). Group A discussed that isolated funding streams for dredging and sediment placement can make acquiring and coordinating funding challenging. For instance, navigation dredging and environmental restoration are funded by different mechanisms, their schedules and

quantities may not match, and both programs are expected to plan, design, build, and operate under different funding sources and schedules. Savings are achieved by sharing stockpiled sediment. An economic driver for coupling navigation dredging and ecosystem restoration placement events would be to move sediment only one time in contrast to storing sediment dredged for navigation in a confined disposal facility for a period before being able to use sediment for ecosystem restoration, for example.

During the breakout discussion for Group B, design elements that could be implemented for future soft substrate islands were discussed. One concept was to integrate environmental pool management during island construction. A phase of environmental pool management includes drawdowns or the planned lowering of water levels to create a targeted habitat. Drawdowns could also be used opportunistically to consolidate sediments during island construction.

Another design element discussed in Group B was to place sediments in a location to allow water flow to "naturally" distribute sediments into desired locations. Models could be implemented to anticipate sediment movement, and training structures could be used to allow fluvial processes to distribute sediments into the desired location.

Following breakout discussions, the groups were joined to summarize the primary topics discussed during the breakout discussions and summarized in this section. After a brief summarization of primary topics, island stability during multiyear construction projects was discussed. This was a continuation of the discussion in Section 2.6.3 related to design elements that can provide stability during overtopping. Plants that may become established late in the season and provide stability during the winter include winter wheat and annual rye grass. Additionally, six to twelve inches of consolidated clays that are evenly graded can serve as a sediment cap during overtopping.

2.8 New project design concepts for Upper Mississippi and Illinois River systems

Dr. Chuck Theiling introduced Goose Lake (Upper Peoria Lake Enhancement HREP, Peoria, Illinois) and a Barrier Island Management Area environmental restoration concept. Dr. Theiling posed the question, what island design concepts could be effective for these locations?

2.8.1 Goose Lake (Upper Peoria Lake Enhancement HREP, Peoria, Illinois)

The Peoria Lake Enhancement HREP included a barrier island built to block wind through Peoria Lakes and into the Illinois Department of Natural Resources (IDNR) Goose Lake wildlife management area. Since construction was completed in 1997, sediment from the navigation channel has accumulated adjacent to the navigation channel downstream from the project. The process has formed alluvial delta mudflat wetland and terrestrial island habitat. Woody terrestrial area extends 2,000 ft farther downstream since 2005 and emergent aquatic plants occur on approximately 50 acres. The project features and subsequent accretion have created a "crab claw" island form much like islands in St. Paul District.

The concept of strategically placing more sediment in transport zones and allowing fluvial processes to carry sediment to desired locations was identified as a potential design concept to increase the rate of island formation for this location. The group discussed that models can be used to anticipate the rate of transport and where sediments will be transported. They agreed this approach would be an efficient construction approach because sediment could be gradually transported to the desired location concurrent with annual navigation dredging.

2.8.2 Barrier island management areas

Barrier island management areas were introduced in the workshop and were also presented as a concept for environmental restoration in the PLCCP as potential new design concepts that would restore ecosystems in the Upper Mississippi and Illinois River systems. Within these systems, impoundment has resulted in the creation of large open water areas. Barrier island management areas can isolate lakes, control water levels (e.g., wildlife management areas), and break up wind generated waves (e.g., barrier islands) by forming a partial barrier between stable geomorphic structures (i.e., HREP island and tributary delta). Multiple islands would form a chain to break up wind fetch, and the gaps in the chain could be periodically mechanically infilled with sediment so the interior area could be dewatered with temporary pumps like a traditional management unit. The practice of water level manipulations using fixed infrastructure is routine (e.g., Illinois River Wildlife Management Areas) and provides predictable and well-documented wetland benefits

(Fredrickson 1991). Temporarily isolating the management area provides important geomorphic and plant responses but provides fish overwintering habitat in most years.

3 Closing Session and Workshop Conclusion

Workshop participants identified numerous considerations and design features for inland islands using soft sediments. Participants were provided the opportunity to give feedback regarding their experience during the workshop where they agreed the workshop was well facilitated and enjoyed the use of virtual tools. They felt that more direction could be given to focus discussion during the breakout session and final session on specific design features for the Upper Mississippi and Illinois River systems.

4 Workshop Products and Recommendations

The next step is to synthesize information from the workshop into this report.

Recommendations for the design and construction of inland islands that resulted from the workshop discussion included the following.

- Develop project goals and collect sufficient data (e.g., physical and chemical sediment characteristics, water flow) to inform island design at the beginning of the project.
- Allow flexibility in the contracting package. Contractors have successfully utilized creative techniques to move and place soft sediments at sites that are difficult to access or have mobility limitations.
- Implement design elements (e.g., planting of cold tolerant plants, using soft sediment to cap islands) to stabilize newly constructed islands in the winter.
- Recognize that like dredge operations, island construction requires long-term attention.
- Use seed islands and strategic sediment placement and fluvial transport to distribute material into nature-based features.

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Abbreviations

SAC	United States Army Corps of Engineers - Charleston District
DNR	Department of Natural Resources
ERDC	Engineer Research and Development Center
EWN	Engineering with Nature
FEMA	Federal Emergency Management Agency
FWS	Fish and Wildlife Service
HREP	Habitat Rehabilitation and Enhancement Projects
IDNR	Illinois Department of Natural Resources
LA	Landscape Architecture
MVP	United States Army Corps of Engineers–St. Paul District
MVR	United States Army Corps of Engineers–Rock Island District
MVS	United States Army Corps of Engineers–St. Louis District
PLCCP	Peoria Lakes Comprehensive Conservation Plan
UMR-IWW	Upper Mississippi River Illinois Waterway System
UMRR	Upper Mississippi River Restoration
USACE	United States Army Corps of Engineers
WRDA	Water Resources Development Act

Appendix A: Workshop Agenda

Engineering With Nature (EWN)
Soft Substrate Island Design Workshop

Location: Virtual Workshop

Virtual Link:
https://usace1.webex.com/usace1/j.php?MTID=m132e8f270679c3397fc17a9b2b1a677a

Date: September 8, 2021

Workshop Agenda:

TIME	CONTENT/ACTIVITIES
9:00 – 9:30	**Welcome and Introduction** Meeting opening, Purpose and Objectives - Chuck Theiling. Agenda Review and How to Engage for WebEx – Chrissa Waite
9:30 – 10:00	**Setting the Stage** Present: **Engineering with Nature,** Burton Suedel (10 min) **Tri-County** Present: Ray Lees (10 min) **EWN-LA and the Dredge Research Collaborative** Present: Rob Holmes (10 min)
10:00 – 10:30	**Defining the System** Present: Chuck Theiling (30 min) Illinois River/Peoria Lake Mississippi/Minnesota Rivers above Lake Pepin
10:30 – 10:45	**BREAK**
10:45 – 11:20	**Prior Experience with island construction** Present: Jon Hendrickson, MVP UMRR (15 min) Ray Lees, MVR Peoria Riverfront/NESP (15 min) Q&A (5 min)
11:20 – 12:15	**Limitations/Problems with prior projects** Discuss • Construction mobility/access • Alternative equipment • Feature stability (sinking & rolling) • Material stability (spreading & current/wave wash)
12:15 – 12:45	**LUNCH**

TIME	CONTENT/ACTIVITIES
12:45 – 2:00	Brainstorm new design measures – 2 Break-out sessions - Facilitated by Ellen Hartman and Rob Holmes
2:00 – 2:15	BREAK
2:15 – 3:00	Report out – Discuss outcomes from break-out sessions with group
3:15 – 4:15	Brainstorm new project design concepts for Conservation Management Plan
4:15 – 4:30	Summary and Review, Next Steps
4:30	Adjourn

Appendix B: Workshop Participant List

LAST NAME	FIRST NAME	AFFILIATION	EMAIL	ROLE
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REPORT DOCUMENTATION PAGE

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED	
		START DATE	END DATE
September 2023	Final report	FY	FY

4. TITLE AND SUBTITLE

Proceedings from the Soft Substrate Island Design Workshop

5a. CONTRACT NUMBER	5b. GRANT NUMBER	5c. PROGRAM ELEMENT
5d. PROJECT NUMBER	**5e. TASK NUMBER**	**5f. WORK UNIT NUMBER**
494207		

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8. PERFORMING ORGANIZATION REPORT NUMBER

ERDC/EL SR-23-6

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)	11. SPONSOR/MONITOR'S REPORT NUMBER(S)
US Army Corps of Engineers Washington, DC 20314-1000		

12. DISTRIBUTION/AVAILABILITY STATEMENT

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Funding Account Code 4375538; AMSCO Code 089500

14. ABSTRACT

This report summarizes the activities of the Soft Substrate Design Workshop held virtually on 08 September 2021.

The 28 participants from federal, state, local, and academic organizations discussed designing and constructing islands with soft sediments in inland waterways. They were introduced to the US Army Corps of Engineers' (USACE) Engineering With Nature® (EWN®) initiative and the vision for Tri-County Planning Commission (Peoria, Illinois). An overview of collaborative projects using landscape architecture and EWN principles was provided. The focus of discussion was on two primary waterways, the Upper Mississippi River System, and Illinois River. Participants discussed their experience associated with designing and constructing islands with and on soft sediments prior to breakout sessions to discuss specific design and contracting elements. The groups were brought together to discuss design techniques that could be implemented in the Upper Mississippi River and Illinois River systems.

15. SUBJECT TERMS

Dredging spoil, Dredged material, Artificial islands—Design, Artificial islands—Construction, Restoration ecology

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES
a. REPORT	b. ABSTRACT	C. THIS PAGE		
Unclassified	Unclassified	Unclassified	SAR	37

19a. NAME OF RESPONSIBLE PERSON	19b. TELEPHONE NUMBER (include area code)