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Beneficial Use of Dredged Material: A Workshop to Explore Engineered Drainage Soils for Stormwater Management

by Chuck Theiling and Ray Lees

PURPOSE: Beneficial use of dredged material in engineered soils is an alternative to achieve environmental and economic sustainability for waterway operations. Engineered soils can combine navigation and environmental dredging with municipal and commercial waste streams to create a valuable commercial soil product while reducing public operating costs, creating economic opportunity, and creating better soil products for lower cost. The need, opportunities, and challenges to establishing an Illinois Waterway-based commercial soil industry were explored by river, highway, stormwater, environmental resource managers, and industry experts in a workshop in Peoria, IL, on 4–5 September 2019.

INTRODUCTION: Dredging occurs infrequently at many places on the Illinois Waterway (IWW) and annually at several chronic dredging locations. Deltas would build over time if the Corps did not dredge approximately 50,000 cubic yards (cy; 38,230 m³) annually at each location. These chronic dredge cuts have operated efficiently for decades under the prior dredging plan, but the confined disposal facilities (CDFs) purchased to store sand have reached the end of their life span and must be replaced or offloaded. Replacing a CDF is a significant Federal real estate action requiring much planning and coordination.

Three IWW chronic dredging site CDFs must be replaced, enlarged, or offloaded. The recently completed Mackinaw Dredged Material Management Plan recommends purchasing 133 acres (54 ha) of prime farmland and building the CDF for \$2.5 million to accommodate 20 more years of dredging. The Bull’s Island draft recommendation is \$1.3 million to expand the existing site to accommodate the 15,000 cy (11,500 m³) annual dredging for 20 yr.

Excessive sedimentation also degrades aquatic habitat, and Peoria Lakes are an extreme example of the environmental and economic degradation that can result. The shallow post dam lake rapidly filled with fine sediment and was resuspended by wind and boat waves, which blocks light to aquatic plants. Recreational boating was very popular and supported marinas and lakeside economic activity, but most recreational boating is now limited to a single marina with a long channel dredged to connect the main channel. Peoria Lakes have been the subject of much investigation and lake restoration planning to revive economic development and quality of life in the Peoria region. The most recent Peoria Lakes Comprehensive Conservation Plan (<https://tricountyrpc.org/wp-content/uploads/PLCCP-Final-Oct-2018.pdf>) made several recommendations to restore upland, bluffline, and in-lake conditions. It also envisioned a nonprofit soil manufacturing entity to help offset the cost of ecosystem restoration. The concept of integrating multiple waste streams into Peoria Lakes sediment management and restoration



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planning could potentially trap tributary sand and gravel entering the lake, dredge fine sediment from the lake, and integrate municipal wood chips or slash from upland clearing for prairie regeneration.

Investigations into IWW beneficial use opportunities began in July 2015 at a conceptual modeling workshop to share unconventional ideas and explore a different set of dredged material management alternatives at Beardstown, IL. Offloading existing CDFs to commercial engineered soil was one alternative exported for consideration at other IWW sites. The Peoria Beneficial Use of Dredged Material (BUDM) workshop was designed to maintain motivation in advancing engineered soil manufacturing to support Illinois Waterway economic and environmental sustainability.

OBJECTIVES: The objective of IWW engineered soil beneficial use investigations has been to transfer successful material management approaches and sustainability considerations (i.e., recycling) into private-public solutions. Sharing information may result in collaborations that save money and resources, so the broad objectives for the workshop were technology transfer, municipal savings, and public/private partnerships.

1. **Technology Transfer**

Sharing knowledge and introducing beneficial use practitioners to transportation and stormwater management officials for the purpose of increasing the beneficial use of dredged material for stormwater management needs in highway, roadway, and other applications to support navigation and ecosystem sustainability.

2. **Municipal Savings**

Demonstrating municipal savings by incorporating other “waste” such as yard waste (carbon source) and sewage treatment by-products (biosolids = nutrient source) into an engineered soil that meets or exceeds construction standards with lower costs for contractors/states.

3. **Public / Private Partnerships**

Promoting Illinois Waterway and Peoria Lakes environmental and economic sustainability through private-public partnerships. Government operating costs can be reduced, and economic output increased through sustainable material management.

The workshop included formal presentations, group discussion, and breakout groups to foster networking and interactions. Senior leaders in the Corps and industry presented their needs and opportunities for Illinois Waterway beneficial use. They were followed by Minnesota, Ohio, and Illinois experts sharing their experience with commercial soil manufacturing using dredged material. A discussion of a proposed nonprofit beneficial use business model emphasized a systems approach for IWW and Peoria Lake beneficial use that uses efficient inland waterway transport to connect rural sand supplies with urban markets in Chicago and St. Louis (Figure 1). The complex and variable state of the science and regulatory policy were presented by Federal and state agency representatives before breakout groups discussed (1) opportunities for using dredged material and (2) challenges to using dredged material.



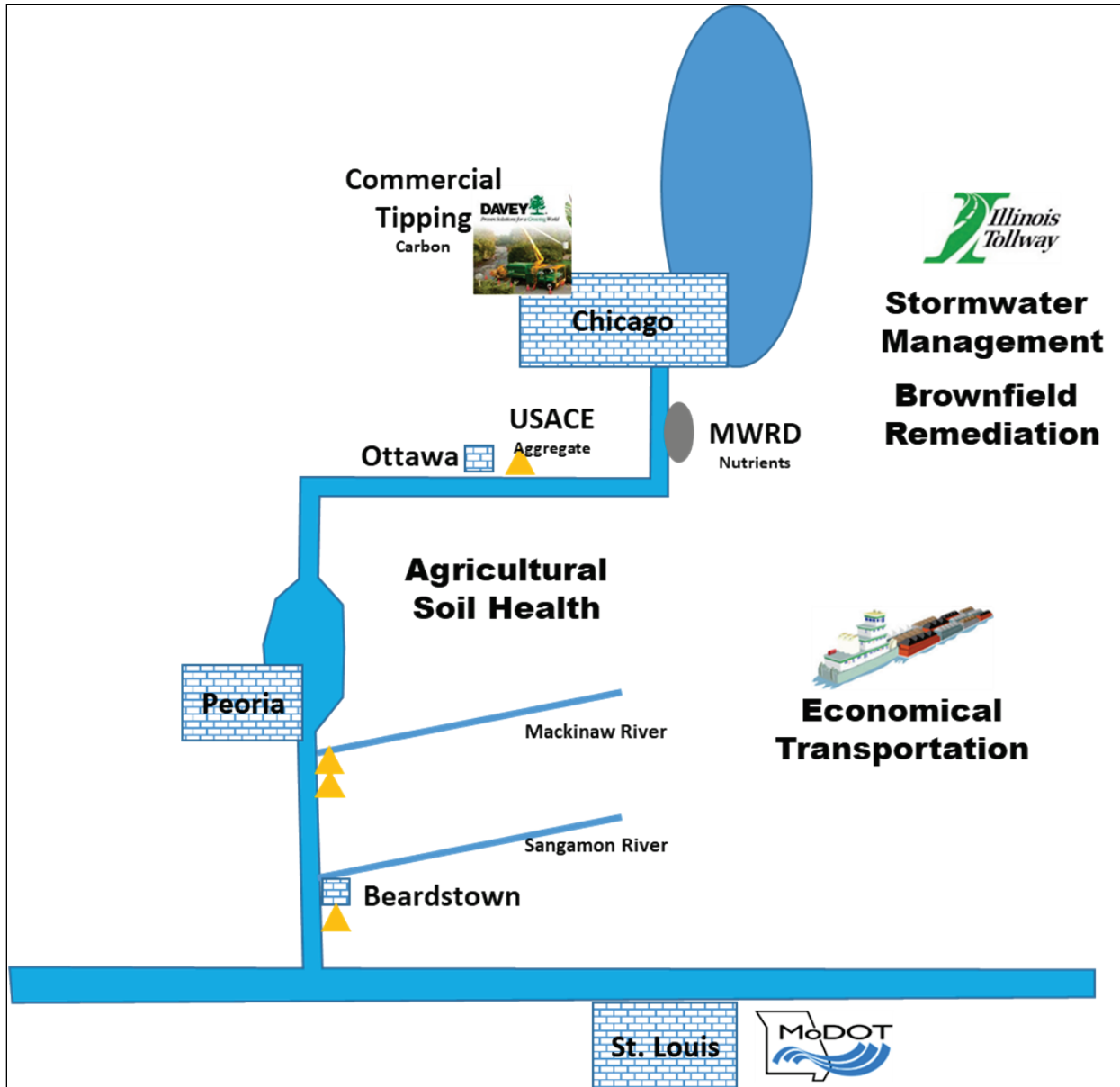


Figure 1. A conceptual model of Illinois Waterway beneficial use of dredged material considering efficient water transportation to move valuable construction products from rural dredged material stockpiles to urban markets for use in road and stormwater construction and brownfield remediation. (USACE = US Army Corps of Engineers; MWRD = Metropolitan Water Reclamation District of Greater Chicago)

OUTCOMES: This workshop was an opportunity to coordinate partners and identify leaders and champions to help grow a market for river soils. Peoria Mayor James Ardis (term 2005 – 2021) emphasized the importance of the Peoria Lakes environmental quality to the community. He also highlighted the compatibility between the engineered soil objectives and the City’s objectives to resolve combined sewer overflow problems by building stormwater infiltration into municipal drainage projects. Illinois Department of Natural Resources (DNR) Director Colleen Callahan discussed the difficulty of coordinating multiple entities for effective natural resource



management and emphasized the need for leadership and good plans to achieve long-term goals. COL Steven Sattinger, USACE Rock Island District Commander (2018 – 2021), thanked the innovators for working to support his area of operation and stated the public perspective on problems and opportunities, which was summed up as “take our sand.” Mr. Don McNeil, Caterpillar Corporation, represented the Natural Infrastructure Initiative (NII), which is an informal grouping of companies and organizations working to promote the use of natural infrastructure in public projects. The vision of the NII is to support the widespread acceptance of and increased investment in natural infrastructure projects to advance the economic vitality and environmental health and security of the Nation.

APPLICATIONS: Engineered soil and beneficial use experts from Minnesota, Ohio, and Illinois shared their experiences in changing traditional practices to increase environmental sustainability objectives. The “Minnesota Model” was described by Mr. Marty Long, CEO Minnesota Mulch and Soil, and Mr. Todd Hubmer, project manager at Wenck. The Minnesota Model is a sustainable recycling system that is profitable to manufacturers, saves government spending on waste disposal and building, creates tax revenue, and is environmentally responsible. It is a classic reduce-reuse-recycle approach developed over 20 years of collaboration among Minnesota Pollution Control Agency (PCA), Minnesota Department of Transportation (DOT), private sector, and university partners developing regulations and specifications for materials to achieve regulatory objectives. PCA identified stream flow management objectives and developed regulations to achieve them. The general model is to create a loamy topsoil with adequate sand, silt, clay, and organics for plant growth and water retention balanced with drainage. Engineered soil applications in Minnesota include road and ditch construction, large commercial landscapes, lake rehabilitation, stadium, sport, and golf turf, sewage treatment, and Superfund sites among many others.

Mr. Dave Emerman, General Counsel and Dredge Program Administrator for the Ohio Lake Erie Commission, outlined the financial justification for Great Lakes commercial navigation and harbor maintenance and reviewed recent regulatory changes. Concerns for nutrient enrichment and harmful algal blooms in Lake Erie eliminates dredged material open-water disposal in 2020, so new beneficial use or CDF alternatives are required. The Lake Erie dredging community committed to a strategy to develop alternative sediment management plans by

1. committing to mutual ownership of the challenge,
2. generating options,
3. identifying constraints and flexibility,
4. local management,
5. project scoping,
6. stakeholder outreach,
7. adaptive management and contingency planning,
8. securing funding, and
9. implementation.

A stakeholder coordination group met monthly to identify constraints and flexibilities and to add value to a range of alternatives for sediment management. The groups focused on local projects with lots of outreach to develop acceptable projects using \$10 million in state funding in 2018.



They changed sediment regulatory classifications to ease permitting and use with an “it’s just dirt” approach to permitting. Ohio Environmental Protection Agency (EPA) created a two-path approach where the cleanest material is certified for use by the State, or it takes another route that requires additional testing. Scudder Mackey, Chief of Coastal Management, Ohio DNR, discussed the Ohio Healthy Lake fund investments in farm field, wetland, and engineered soil demonstration projects. They implemented the Dredging Center for Innovation demonstration projects, Port of Cleveland sediment processing, and Sandusky Bay wetlands. The Port of Cleveland facility uses a hydraulic self-sorting process where each type of material can be separately managed. Current harvest rates extend the CDF life by 20 years.

Dr. John Marlin, Research Affiliate, Illinois Sustainable Technology Center, is responsible for the Mud-to-Parks US Steel South Works site restoration on the Chicago, Illinois, lakefront, which moved over 200,000 tons of material from Lower Peoria Lake in 2004, 2007, and 2012 projects. The projects covered over 50 acres (20 ha) 1 to 3 ft (30–100 cm) deep, and material placed in the spring supported lush vegetation by fall. Chemical and agronomic studies conducted at the University of Illinois also demonstrate the sediment agronomic quality was comparable to native Illinois topsoil and met standards for use in metropolitan areas. Dr. Marlin offered his observation that Peoria Lakes restoration is a problem of "Ants and Elephants" where elephants build locks, dams, and initial dredging, but an ant-like dedicated system working slowly over long periods can be used to restore and maintain navigation and environmental objectives. That implicit understanding was the motivation for this workshop encouraging the beneficial use of sediment in construction and stormwater management where it has value and can be harvested for commercial use.

Beneficial Use Business Model: Don McNeil, Caterpillar Corporation, discussed the steps required to build a team and establish common goals for

- sustainability,
- habitats and ecosystem function,
- quality material, and
- cost.

Industry can support and benefit from river management operations in private-public partnerships based on specific problems where complimentary objectives can be achieved. They can help optimize material movement by minimizing “touches” on material because more touches create more cost. Identifying feedstock materials for beneficial use is supported by a new USACE/NII Natural Infrastructure Opportunities Tool that can match government and commercial resource availability and needs. Mr. McNeil also discussed progress on their Mapleton Foundry Engineered Soil Pilot Project. They demonstrated engineered soil technology could be identified, researched, transferred, and established in practice in only 18 months. The long-term vision for the project is to have a sustainable Mapleton Foundry that creates soil to support waterway operations and stimulate a new industry. They want to develop unique soils that can filter sediment and nutrients when placed in hydrologically optimized locations.

Dr. Yanfeng Ouyang, Department of Civil and Environmental Engineering at the University of Illinois, described a transportation optimization modeling proposal emerged from the Peoria Lakes



Comprehensive Conservation Plan (PLCCP). The waterway transport aspect of an engineered soil industry has never been evaluated but could be an important element to understand the feasibility of the rural-to-urban soil industry envisioned in the PLCCP. The model optimizes feedstock, production, and endpoint nodes and networks. It would provide a system-wide view of the IWW sediment market structure, as well as a holistic evaluation of its economic feasibility and sustainability.

Ray Lees, Tri-County Regional Planning Commission, presented the PLCCP for beneficial use of sediment in lake management, restoration, and economic development. One aspect of the Plan suggested that Peoria Lakes sediment could be blended with other waste products, creating an engineered soil used in highway construction and stormwater management. The business model to be studied included a nonprofit entity, like the Peoria Port Authority, to coordinate logistics, tipping fees, feedstock acquisition, soil production contractors, and sales. Specifically, the economic feasibility study would complete a Peoria Lakes sediment market analysis that includes (1) market sizing to understand the market for engineered topsoil, (2) customized business structure to identify the potential business structure for producing engineered topsoil, and (3) business model analysis to identify whether there is a route to long-term profitability

Dr. Chuck Theiling, USACE-ERDC, illustrated the potential demand for sand with a sequence of images of a Chillicothe, Illinois, quarry in the bluffs adjacent to Upper Peoria Lake. The sequence of Google Earth images shows 65 acres (26 ha) of dredging, probably 50 – 80 ft (15 – 25 m) deep in less than 20 years, which represents 5–8 million cy (380,000 – 610,000 m³) of material. He posed the following questions: Can a 100 yr Peoria Lakes material management plan be devised? Can commercial sediment harvest for construction be the “ants” who restore Peoria Lake?

STATE OF SCIENCE AND REGULATORY POLICY: Dr. Burton Suedel, USACE-ERDC Dredge Operations Technical Support program manager, prepared slides discussing USACE operating authorizations, regulations, and transition to more beneficial use of dredged material in private and public projects. Dr. Suedel emphasized an emerging “systems approach” that considers multiple objectives, safety and resiliency, and ecosystem supporting services. USACE follows regulatory procedures stemming from the Clean Water Act, multiple marine protections, and endangered and nuisance species listings. Many factors are driving USACE and others to increase beneficial use of sediment across the entire mission space. Navigation dredging is most common, but there is dredging to support flood risk management with floodway deepening and sand levee construction. Reservoir sustainability and recreation lake restorations are critical water supply issues in some locations. Environmental dredging for aquatic habitat restoration has increased since 1986 authorizations for ecosystem restoration. ERDC has studied many of these factors and has ongoing research supported by the Dredging Operations Technical Support program (<https://budm.el.erdcdren.mil/>). ERDC objectives for beneficial use of dredged material are to

1. focus energy to motivate and facilitate innovation in both technical and business processes,
2. accelerate progress through codevelopment of solutions, and
3. elevate communication about advancing practice to enhance project value.

Dr. Steve Vaughn, research plant physiologist, USDA Agricultural Research Service National Center for Agricultural Utilization Research, creates soil additives and investigates plant growth response. He obtained sediment samples from local marinas, terminals, and sand stockpiles and



subjected them to physical, chemical, and plant growth tests. He concluded that this is “real soil that meets high grades for many uses,” which is consistent with prior studies in Peoria Lake and elsewhere. The ARS lab is an excellent outlet to test and promote engineered soils for a range of agricultural, commercial, and horticultural uses.

Sara Strassman, Wisconsin Department of Natural Resources, explained that the USACE dredges near 1 million cy along the Wisconsin Mississippi River border every year. Material is placed at permanent placement sites, and temporary sites which must be offloaded to Wisconsin or Minnesota. Beneficial use regulations exist in Wisconsin, but there is no specific code to encourage beneficial use. Dredged material >3,000 cy (2,295 m³) is regulated as a solid waste subject to review and permitting, whereas other states exempt dredged material from solid waste or offer off-ramps from permitting based on grain sizes and/or contaminant testing. Beneficial use can be permitted under the original dredging permit to develop a cradle-to-grave management plan. Ms. Strassman recommended several avenues for regulatory reform to support increased beneficial use of dredged material in Wisconsin.

Stacia Bax, Missouri Department of Natural Resources, provided an overview of Missouri Clean Water Act implementation. Their waste management program has provisions for clean fill which allows uncontaminated soil, rock, sand, gravel, concrete, minimal amounts of wood and metal, or other inert solids. Land and mine reclamation programs may also support the use of clean sediment. A National Pollution Discharge Elimination System (NPDES) master general permit template may be issued to multiple facilities/sites with activities that are similar enough to be covered by a single set of requirements, such as upland placement of repetitive dredging material.

Joe Griffin, Stormwater program coordinator, Iowa Department of Natural Resources, described the abundance of lake remediation in Iowa that provides soil for beneficial reuse. A Lake Red Rock reservoir sustainability project could potentially support reclamation needed at many abandoned mine sites around the lake. Iowa is undergoing a solid waste regulatory review, so it may be good timing to consider new beneficial use alternatives that can be included in new rules.

OPPORTUNITIES TO USE ENGINEERED SOIL: Breakout groups were used to create interaction among participants and capture a broad range of perspectives. There were eight breakout tables discussing opportunities to use engineered soils. They addressed the following questions.

1. What are existing or potential approaches for BUDM (feedstocks, products, end uses)?
2. What regulatory support exists or can be created?
3. How to create new opportunities and markets through technology transfer?

The conversation on uses of sediment and engineered soil covered many familiar uses in construction, brownfield reclamation, agriculture, habitat projects, topsoil, fill, and mine reclamation. Some new or unfamiliar ideas included levee repair, industrial processes, liquid petroleum tank backfill, and downstream nourishment. Many new regulations can be recommended to encourage BUDM. Sediment recycling could be required to encourage more sediment reuse like how asphalt is now required on public projects. Complex Federal environmental risk determinations could be clarified to create more opportunity and reduce



unexpected outcomes. Most important, rules requiring risk sharing in-perpetuity places burdens on project cost-share partners which might prevent their sponsorship. Legislation requiring sediment use seems to be a strong motivator in Minnesota and Ohio, and legislation allowing use is helpful in Missouri and Iowa. Where regulations are prohibitive, such as Wisconsin, beneficial use of dredged material can be quite challenging. Pilot projects of different beneficial uses could support more implementation. Habitat management was another proposed opportunity not emphasized at the workshop.

CHALLENGES TO INTEGRATING ENGINEERED SOILS: The second breakout session on challenges to integrating engineered soils included the following questions.

1. What are technical challenges?
2. What policy or social challenges?
3. What are legal barriers to BUDM?

Material handling and transportation were the predominant technical challenges discussed. Stage placement, “touch it once” (i.e., moving material to a final destination without rehandling), was an important consideration. The lack of successful examples or available business plans makes it difficult to estimate the value and marketability of the material. Regulatory issues were viewed as common impediments to BU implementation. Access to material includes both physical factors discussed and legal access. The most frequent policy problem was the need to lower risk determinations and eliminate long-term, in-perpetuity liability/responsibility for sediment. Government business practice can also limit opportunities because there are many contracting and real estate considerations associated with accessing dredged material. Most beneficial use projects have been individual, case-by-case projects that have not established policy or precedent that a program for beneficial use or economic market would strive for. Awareness and coordination may be the biggest limiting factors in new regions.

The breakout groups were beneficial but not well facilitated because the number of workshop participants far exceeded expectations. They were a success in that future collaborators were introduced, and a common level of understanding was established. One group was populated with Chicago-area stakeholders and others from Peoria. Experts were available to support breakout discussions. The format allowed for informal discussions such as a group of Illinois DOT and EPA staff discussing procedure, policy, and regulatory requirements and potential adaptations.

PATH FORWARD: The significant outcomes of this beneficial use workshop were identifying local and regional champions and stakeholders, defining Illinois Waterway needs and objectives, learning about successful projects and mechanisms driving them in other regions, and outlining a business model for future success. The need and opportunity for sediment management is apparent on the IWW and Nationwide, and there is substantial annual spending at such sites that might be used to incentivize private-public partnerships for material management at chronic dredging locations. River soils have been used in many demonstration projects and ongoing practices. The abundance of public beneficial use access sites in Illinois and Minnesota inland navigation projects also demonstrates the material has value where people/contractors/municipalities can have access. There is a need to complete an economic feasibility analysis to document potential savings and economic development.



Minnesota and Ohio successes encouraged workshop participants that regulatory drivers can initiate industry change. Those states had environmental considerations beyond dredging that drove regulatory change, but so far, IWW beneficial use investigations have been mostly focused on sediment harvest and reuse (i.e., resource recovery) in commercial markets. There is great interest and some progress toward implementation, but government financial or regulatory incentives could encourage more activity. There is a need to review Illinois beneficial use and waste management regulations and make changes to encourage more beneficial use opportunities.

IWW beneficial use stakeholders share goals for environmental and economic sustainability, material management, habitat restoration, and cost effectiveness. Regional partnerships can be built based on shared problems, symbiotic relationships, and complimentary goals.

SUMMARY: Beneficial use of dredged material in engineered soils is an alternative to achieve environmental and economic sustainability for waterway operations. Engineered soils can combine navigation and environmental dredging with municipal and commercial waste streams to create a valuable commercial soil product while reducing public operating costs, creating economic opportunity, and creating better soil products for lower cost. The need, opportunities, and challenges to establishing an Illinois Waterway-based commercial soil industry were explored by river, highway, stormwater, environmental resource managers, and industry experts in this Peoria, IL, workshop.

Engineered soil and beneficial use experts from Minnesota, Ohio, and Illinois shared their experiences in changing traditional practices to increase environmental sustainability objectives. Dr. Marlin offered his observation that Peoria Lakes restoration is a problem of "Ants and Elephants" where elephants build locks, dams, and initial dredging, but an ant-like dedicated system working slowly over long periods can be used to restore and maintain navigation and environmental objectives. That implicit understanding was the motivation for this workshop encouraging the beneficial use of sediment in construction and stormwater management where it has value and will be harvested for commercial use.

The conversation on uses of sediment and engineered soil covered many familiar uses, but many new regulations were recommended to encourage BUDM. Most important, rules requiring risk sharing in-perpetuity places burdens on project cost-share partners, which might prevent their sponsorship. Legislation that creates opportunities to use dredged material seems to be a strong motivator in Minnesota and Ohio. Legislation allowing use is helpful in Missouri and Iowa; but where regulations are prohibitive, such as Wisconsin, beneficial use of dredged material can be quite challenging. The lack of successful examples or available business plans makes it difficult to estimate the value and marketability of the material.

Material handling and transportation were the predominant technical challenges discussed. Stage placement, "touch it once," was an important consideration. Access to material includes both physical factors and legal access. Government business practice can also limit opportunities because there are many contracting and real estate considerations associated with accessing dredged material. Awareness and coordination may be the biggest limiting factors in new regions.



The significant outcomes of this beneficial use workshop were identifying local and regional champions and stakeholders, defining Illinois Waterway needs and objectives, learning about successful projects and mechanisms driving them in other regions, and outlining a business model for future success. There is substantial annual spending at such sites that might be used to incentivize private-public partnerships for material management at chronic dredging locations. There is a need to complete an economic feasibility analysis to document potential savings and economic development. Minnesota and Ohio successes encouraged workshop participants that regulatory drivers can initiate industry change.

ADDITIONAL INFORMATION: This Technical Note (TN) was prepared by Dr. Chuck Theiling, ERDC-EL, Vicksburg, MS, and Ray Lees, Tri-County Regional Planning Commission, Peoria, IL. Questions about this TN can be addressed to Dr. Theiling (601-634-3684; Charles.h.theiling@usace.army.mil). Dr. Theiling's effort planning, attending, and summarizing the workshop was funded by the Dredging Operations Technical Support (DOTS) program. Mr. Lees was supported by the Tri-County Regional Planning Commission.

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