



Rolling Prairie, Minnesota, Beneficial Use Area: A 100-Year Plan for Multiuse Land Management and Restoration Using Dredged Sediment

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PURPOSE: Inland waterway dredged sediment management is challenged by a lack of capacity in existing dredged material confined disposal facilities (CDFs) and a lack of available land to place sediment near frequently dredged navigation channels. Navigation operation and maintenance (O&M) dredging, material management, and coordination costs are increasing, and alternative long-term solutions are required. In response, the US Army Corps of Engineers (USACE), St. Paul District has addressed the challenge by investigating regional sediment management and beneficial use of dredged material when updating navigation pool-specific dredged material management plans (DMMP). The recently completed Pool 5 DMMP planning identified a 950 acre (384 ha)* placement site consisting of several land parcels available from willing sellers that will accommodate a “100-year plan” for dredged material management (USACE 2019). This technical note describes the multiple-use site plan that creates sand prairie and wetland habitat, provides public access to sand stockpiles, and implements agriculture studies with the University of Minnesota to evaluate the benefits of dredged material (i.e., sand) amendments in alluvial cropland soils, which has not been widely investigated. The Rolling Prairie site will demonstrate benefits of “distributed DMMPs” in which thin-layer placement on agricultural land near dredging locations can supplement traditional disposal methods. It also shows the advantage of having a large placement site to achieve multiple objectives.

INTRODUCTION: USACE St. Paul District is responsible for maintaining a 9 ft deep (2.7 m) commercial navigation channel from Minneapolis, Minnesota (river mile 857.6), to Guttenberg, Iowa (river mile 614.0), and on the lower reaches of three tributaries: the Minnesota, St. Croix, and Black rivers. There are 12 lock and dam structures creating riverine impoundments called navigation pools (Figure 1). They are low-head dams with no flood control function because dam gates are removed from the river at flood stage. There are 1,300 wing dams creating a scouring main channel within desired channel dimensions. Occasional dredging is also required in many locations and repetitively in frequently shoaled dredge cuts. The district routinely dredges more than 1 million cubic yards (cy) (765,000 cubic meters) of dredged sediment with less than 5% fines from the shifting sand bed main channel during each dredging season.

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

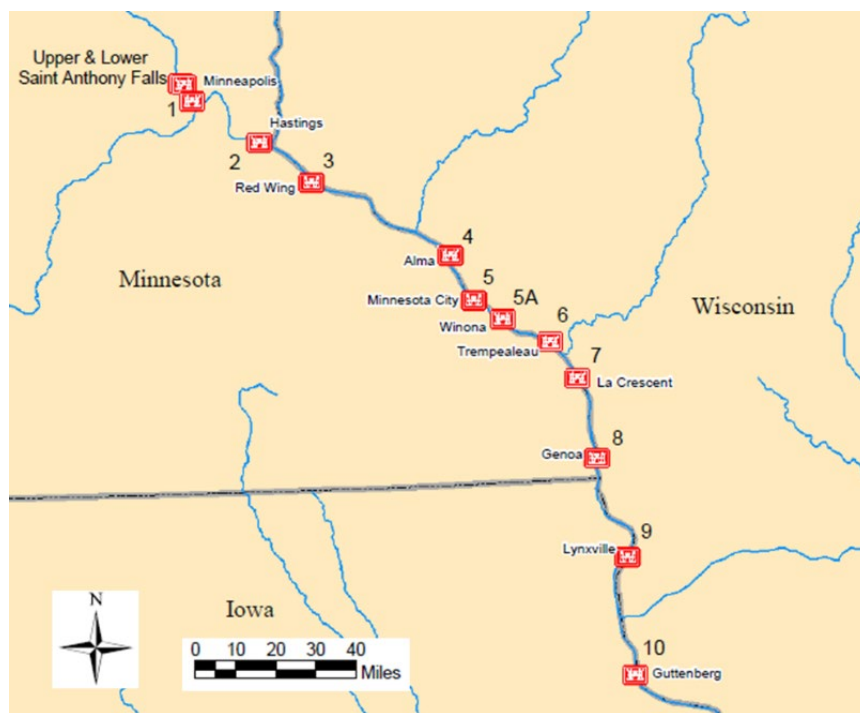


Figure 1. St. Paul District Upper Mississippi River Locks and dams.

Navigation maintenance dredging practices have changed over the history of the federal navigation channel. Prior to the 1980s, regulatory constraints were minimal and placement activities often included sidecasting and in-river placement methods. The passing of the Clean Water Act in 1972 Section 404 governing dredging and sediment placement substantially changed regulatory constraints, resulting in a transition of primary placement methods from in-water placement methods to upland confined placement. The passing of the Clean Water Act also prompted the creation of the Great River Environmental Action Team I (GREAT I) (USACE 1980a) consisting of the USACE; US Fish and Wildlife Service; US Environmental Protection Agency; US Soil Conservation Service; US Coast Guard; and the states of Iowa, Minnesota, and Wisconsin (GREAT II and III covered Rock Island and St. Louis Districts, respectively; USACE 1980b, 1982). The GREAT I group conducted a comprehensive study from 1975 to 1980 with the primary objective to develop a detailed site-specific channel maintenance plan and other recommendations for continued navigation system management. The resulting Channel Maintenance Management Plan was a comprehensive, long-term plan for guiding channel maintenance activities in the St. Paul District. It provided long-term planning, established coordination procedures, provided an evaluation process for dredged material placement site alternatives, and included historical data related to the channel maintenance program. While long-term in nature, the planning approach has been updated as ongoing pool-scale DMMPs that consider reach-scale sediment management solutions and more beneficial use alternatives.

The location of dredging areas and the volume of dredging have changed significantly since construction of the 9 ft (2.7 m) federal navigation channel. To maintain reliable and efficient navigation while reducing the need to dredge, USACE has also installed numerous training structures (e.g., wingdams) over the years to confine flows in the main navigation channel. In

addition to training structures, hydraulic modeling, adaptive structure design, and annual monitoring have increased predictability in annual dredging needs. As a result, contemporary dredging requirements are well understood, but each season is different and there is always a potential for flood events resulting in greater annual dredging needs. Therefore, in recent years dredging has primarily focused on managing chronic, repetitive dredge cuts and incidental sites.

Identifying additional long-term (40+ yr) suitable placement sites for chronic dredge cuts is a district priority to achieve more sustainable outcomes in the USACE navigation mission. Sediment in the valley constrained river reach must currently be removed from the floodway to minimize floodway filling. It is temporarily stored in stockpiles in the floodplain near the dredge cut but must ultimately be moved to upland sites (e.g., old quarries or leveed areas). Temporary sites are efficient for annual maintenance needs, but the double-handling required for offloading is expensive and requires additional time and resources to relocate.

Regional sediment management planning has identified many beneficial use habitat creation opportunities for such dredged sediment (mostly sand) in temporary placement sites. Upper Mississippi River Restoration is an active program with dozens of large projects spanning several past and future decades to accommodate dredged material placement where appropriate. Navigation dredged sand is typically removed from temporary stockpiles to create islands and berms topped with fine sediment dredged from degraded backwater lakes. Ecosystem restoration offers excellent beneficial use opportunities when project schedules, funding, and staff can be coordinated for mission integration cost savings. The Pool 5 DMMP is an example of how the St. Paul District is identifying more sustainable solutions to managing dredged sediments. Collaborative research including St. Paul District, Engineer Research and Development Center (ERDC) Dredge Operations Environmental Research Program (DOER), the University of Minnesota, county USDA staff, and local farmers can help document the benefits of dredge placement innovation at Rolling Prairie, Minnesota.

POOL 5 DREDGED MATERIAL MANAGEMENT PLAN: The purpose of the Pool 5 DMMP was to provide a coordinated, long-term plan for managing material dredged to maintain safe navigation (USACE 2019). There are nine active dredge cuts in Pool 5 where maintenance dredging has produced an annual average 117,000 cy (89,453 cubic meters) of sediment for around 4.7 million cy (3,593,400 cubic meters) of mostly sand sediment between 1981 and 2018. The plan was updated due to a change in the availability of dredged material placement sites in Pool 5 when landowners expressed a desire to sell bottomland properties near the Zumbro River mouth.

As part of the Pool 5 DMMP, USACE, St. Paul District, evaluated dredged material management costs for sediment from nine Pool 5 dredge cuts moved to several existing (historic) and potential dredged material placement sites in the vicinity of Pool 5 (USACE 2019). Placement sites were evaluated using factors such as cost effectiveness, environmental acceptability, and operational feasibility by a long-established, interagency natural resources work group that reviews USACE operations. The Corps and agency stakeholders assessed current local land uses and contacted landowners to develop a list of sites potentially suitable for permanent placement of dredged material. Several alternative sediment management plans to meet the study objectives were developed and evaluated by the criteria above. While a limited amount of beneficial use of dredged material in Pool 5 has been part of prior management plans, it was emphasized as a consideration in the Pool 5 DMMP. Beneficial use of dredged sediment employs environmentally and

economically sustainable methods to benefit local communities and restore degraded floodplain habitat (as described in subsequent sections).

The final Pool 5 DMMP (Figure 2) was selected because it is operationally and economically feasible and environmentally acceptable for long-term dredged sediment beneficial use. The DMMP includes the use of the existing West Newton Chute site as a transfer site prior to transporting the material to the Rolling Prairie Site by truck. The combined sites can accept material placed hydraulically and mechanically from Pool 5 for more than the 40-year planning horizon. Additionally, several other locations have been identified for future dredged material placement opportunities within Pool 5. Three island sites used in the past for temporary placement are retained in the plan. West Newton, Fisher Island, and Lost Island sites would remain available in the future if the permanent placement sites are at capacity, become unavailable for some unforeseen reason, or if it is operationally more feasible to use the island sites.

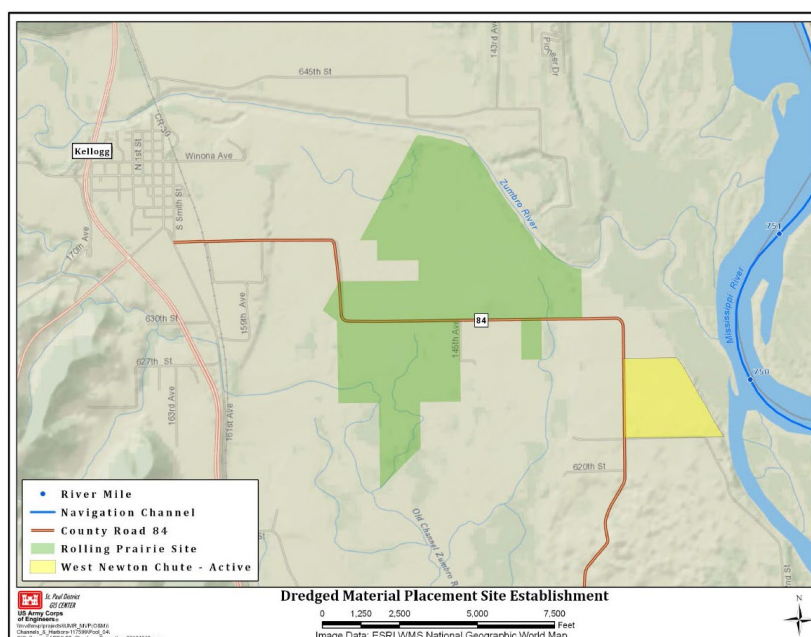


Figure 2. Rolling Prairie dredged material beneficial use site located near the active West Newton Chute placement site near Kellogg, Minnesota.

ROLLING PRAIRIE LAND USE MANAGEMENT PLAN: The Rolling Prairie, Pool 5 site is a recent land acquisition that provides a multiple-use land management plan to support the Pool 5 DMMP for 100 yr (Figure 3). Traditional DMMP land acquisitions had historically been relatively small (less than 100 acres [40 ha]) mission focused parcels to manage sand only. However, the Rolling Prairie land acquisition plan has created opportunities to implement multiple beneficial uses for dredged material. In total, approximately 605 acres (245 ha) of the 950 acre (384 ha) site will be dedicated to one of the beneficial use strategies accommodating approximately 15 million cy (115 million cubic meters) of dredged material over the next 100 yr (Table 1) and the remainder of the site will be restored or preserved as wetlands, riparia, and stream channels. The first stage of the plan is the construction of a beneficial use area, which is a conventional placement method in which sand is stockpiled for public use and replenished as necessary when material is available. A second use of dredged material is to create sand prairie/sand dune habitat, which is consistent

with Engineering With Nature® (EWN®) principles (Bridges et al. 2014; King et al. 2020). The third strategy, also consistent with EWN, is to use a portion of the property to assess the potential of using dredged material as a soil amendment to improve the structure, function, and overall health of agricultural soils to improve crop productivity. The latter two strategies are newer innovative and sustainable ideas that could provide a long-term solution to dredged material management nationwide. The remainder of the property includes other “conventional” ecosystem restoration efforts, such as emergent wetland restoration, riparian restoration, stream restoration, and wetland and riparian preservation areas. Nearly 100% of the property eligible for material placement will include one of the three beneficial use strategies (i.e., stockpile for public use, sand prairie restoration, agricultural soil amendment). The first stage of the construction plan is creating the 20 acre (8 ha) conventional beneficial use area, followed by a beneficial use study on a 70 acre (28 ha) parcel of agricultural land. The sand prairie/dune restoration areas are the long-term planned areas for dredged material placement. It is anticipated that the construction and restoration will be staged over time, with areas not receiving dredged sediment remaining in its current state (i.e., agricultural row crop) until it is needed for placement. The unused crop land will be available to lease until it is needed for dredged material placement.

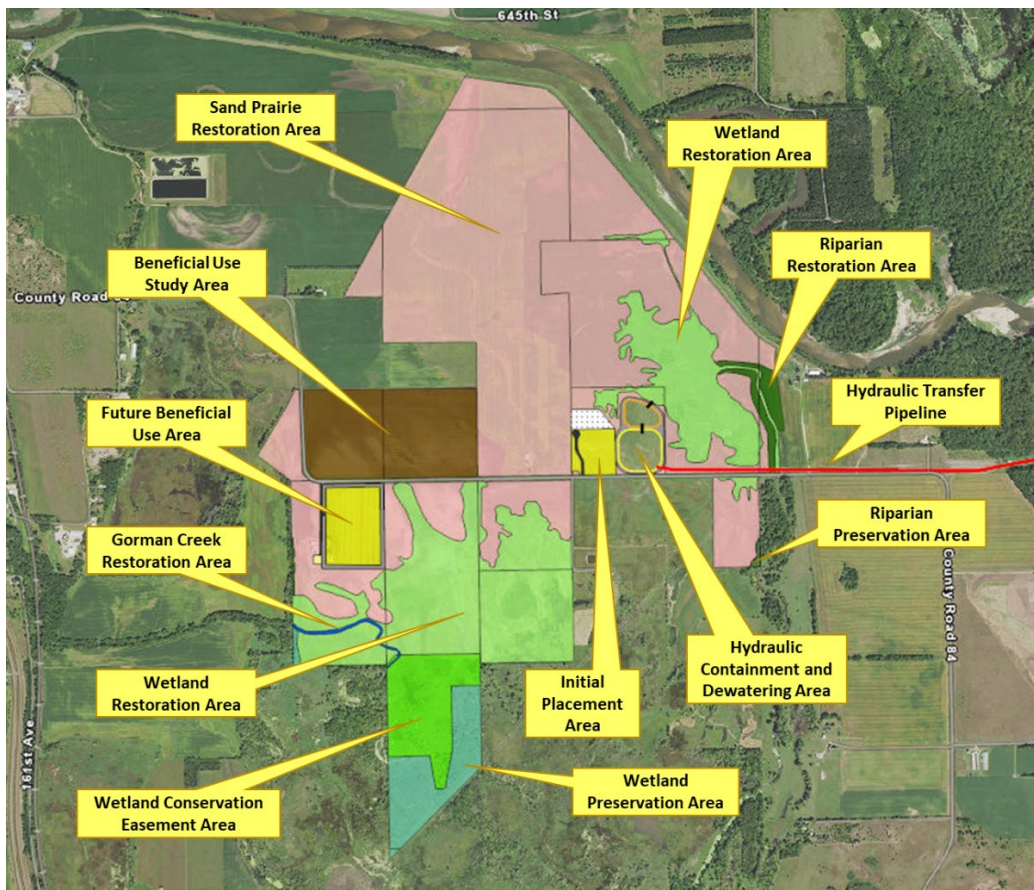


Figure 3. Rolling Prairie land use management plan. The plan will utilize three sediment beneficial use strategies to maximize the benefits of the project over a 100-year project life cycle. Sediment can be placed hydraulically (*red pipeline*) from the dredge, barge, or West Newton site into a central receiving basin and moved mechanically throughout the site.

Table 1. Sediment use measures and target benefits for the Rolling Prairie, Minnesota, beneficial use site.

Beneficial Use Measure	Acres (% of Total)	Target Benefits
Dune restoration	605 (64%)	<ul style="list-style-type: none"> • Native sand prairie habitat • Threatened, endangered, species of greatest conservation need (SGCN) species • Pollinators • Birds • Reptiles and amphibians
Wetland restoration	204 (21%)	<ul style="list-style-type: none"> • Native wetland habitat • Threatened, endangered, SGCN species • Pollinators • Birds • Reptiles and amphibians • Return water treatment
Public access to sediment	20 (2%)	<ul style="list-style-type: none"> • Municipalities • Citizens • Industry/agriculture
Cropland recovery	120 (13%)	<ul style="list-style-type: none"> • Crop productivity • New research • Potential for widespread application

Another component of the multiuse land management plan is to use hydraulic placement methods to accommodate large volumes of sediment moved to the site. To facilitate hydraulic placement, a portion of the site (25 acres; 10 ha) will include a containment and dewatering basin, a settling basin, and a small adjacent area for dewatered material handling, stockpiling or subsequent drying. Once the containment/dewatering and settling basins are constructed, sand can be pumped hydraulically from the West Newton Chute placement area or directly from barges on the river. The containment/dewatering and settling basins will manage sediment and return water filtered through restored wetlands before moving to the river. Dewatered and dried material will then be used to support one of the three beneficial use categories mentioned above depending on needs and capacity in the order of priority previously described. Each beneficial use category will be discussed in more detail below.

SAND PRAIRIE DUNE RESTORATION: Dredged sediment must be finished and landscaped when sites are filled. The Pool 5 DMMP (USACE 2019) stated the sandy sediment would be graded to a topography similar to the nearby Weaver Dunes Scientific and Natural Area (Minnesota Seasons 2024), capped with topsoil, and planted to a native sand prairie mix (Figure 4). Dune restoration will be the primary land use at the Rolling Prairie site encompassing approximately 605 acres (245 ha) of the 950 acre (384 ha) site. Initial placement will focus on lands south of the County Road 84, which includes approximately 65 acres (26 ha) of sand prairie/dune habitat that is expected to receive material for the first 10–20 yr. As each area is filled

and sand dunes are constructed, sand dunes will be finished with previously excavated topsoil and planted with a pollinator-friendly dry prairie seed mix to achieve restoration outcomes as sections of the project are completed. Perimeter work is expected to start first, followed by incremental filling toward the middle of the property (accessed by County Road 84; Figure 3). Sand dune dimensions will be variable, ranging in height from 0 to 25 ft (0–10 m) and gently sloped into rolling hills/dunes. Hill peaks will predominantly range from 10–25 ft (4–10 m) in height and be graded down into remnant low wet areas (seasonally flooded wetlands) where no material will be placed. Slopes will vary throughout the site but will generally be between 1:3 and 1:8. The resulting landscape will create a variety of microhabitats ranging from mostly dry sand dune prairie to riparian shrubs and emergent wetland habitats.

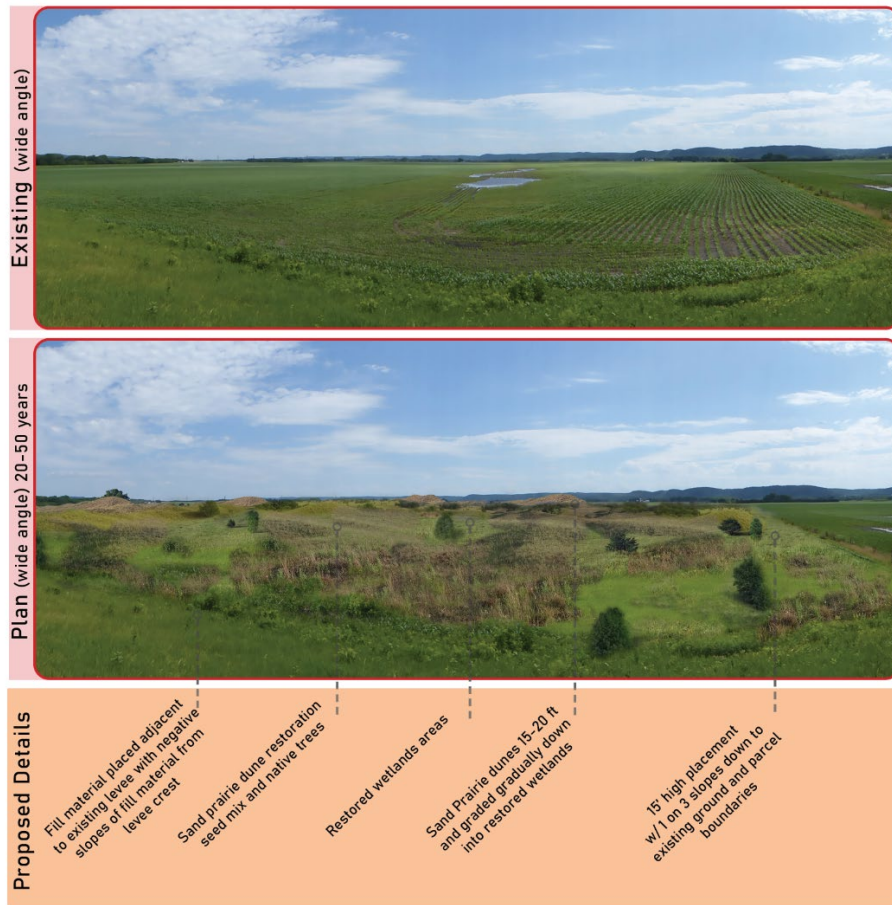


Figure 4. Rolling Prairie near the levee next to Zumbro River looking south of proposed restored sand prairie dunes. *Top* photo shows the existing land use; the *bottom* photo is a rendering of the desired end state.

WETLAND RESTORATION: Wetland restoration is planned for farmed wetland areas south of County Road 84 and remnant (also farmed) wetland areas north of County Road 84 (Figure 5) and at the outlet from the hydraulic containment and dewatering area to filter through. Wetland restoration will be achieved primarily by eliminating agricultural activities and reseeding with native wetland seed mixes. Wetland restoration in areas north of County Road 84 will be achieved by abandoning existing drain tile, decommissioning the existing pump station, and reseeding. A

fixed water-level control structure will also be considered to maintain hydrology to the restored wetland long term. As part of the overall land use management plan, approximately 204 acres (83 ha) of emergent and shallow marsh wetlands will be restored by restoring hydrology and reseeding. Restored wetlands will be used to generate wetland credits to offset unavoidable wetland impacts associated with future St. Paul District construction projects, while providing the added benefits of improving water quality in McCarthy Lake and additional habitat for resident wildlife which benefits biodiversity and native species.



Figure 5. Rolling Prairie wetland restoration in marginal drained cropland. *Top* photo shows the existing land use; the *bottom* photo is a rendering of the desired end state.

BENEFICIAL USE PUBLIC ACCESS: Access to river sand for public, municipal, or commercial beneficial use in construction and road maintenance will be provided in a designated public access area (Figure 6) that will be filled and restocked as necessary. The 20 acre (8 ha) area will be enclosed by 15 ft (4.6 m) high viewshed berms planted with the same prairie mix as the restoration areas. Some potential residential and commercial uses of the material include

- Manufactured topsoil,
- Beach nourishment,
- Winter road maintenance,
- Levee repair and improvement,
- General purpose fill, and
- Garden soil.



Figure 6. Rolling Prairie location where the public will be able to access dry dredged sediment placed here for public or commercial uses. *Top* photo shows the existing land use; the *bottom* photo is a rendering of the desired end state.

USACE is making sand at this site, and others like it, available on an as-is basis and makes no warranty, representation, or promise of any sort that there is beneficial use material currently at a given site, that the material that is present is suitable for use for any particular purpose, or that any given site is supervised or maintained in a particular condition. Access to the sites and the material there, if any, is generally on a first-come, first-served basis (<https://www.mvp.usace.army.mil/Missions/Navigation/Channel-Maintenance/Beneficial-Use-of-Dredge-Material/>).

CROPLAND RECOVERY: Improving low, wet farmland is another innovative beneficial use Rolling Prairie Land Use Management Plan (see Figure 3). There are 70 acres (28 ha) available for agricultural research implemented in collaboration with the University of Minnesota and a contract farmer who will be supporting land management on the site. The exact configuration of research plots is not determined, but in some plots, existing topsoil will be removed, the plot will be terraced at different elevations between 3 and 5 ft (1–1.5 m), and topsoil will be replaced (Figure 7). The purpose of implementing this method is to test the effectiveness of using dredged sand to reduce or eliminate groundwater intrusion and ponding and thus increase crop productivity. In other terraced plots, the topsoil layer will also be augmented with sand to improve topsoil structure to better facilitate surface drainage and prevent extended periods of topsoil saturation that result in crop stress. Thin-layer placement is another method that will be tested by placing the sand directly on top of the existing topsoil and then blending the sand existing topsoil using typical industry agricultural equipment such as a harrow, disc, or a plow. Thin-layer placement methods and various cultivation tools will be evaluated on the site. Plots of 0, 6, 12, and 18 in. (0, 15, 30, and 46 cm) of sand augmentation will be evaluated using crops and agronomic methods common to the area. Repetitive heavy traffic from large dump trucks and bulldozers moving sand and compacting soil is a concern, so innovative thin-layer placement methods like large agricultural sprinklers and diffuser pipes will also be investigated to hydraulically place sand over large areas. Thin layers of sand can be blended into soil using conventional farming equipment.



Figure 7. Rolling Prairie dredged sediment placement for the cropland recovery area shown in Figure 3. *Top* photo shows the existing land use; the *bottom* photo is a rendering of the desired end state.

BENEFICIAL USE INNOVATIONS: Rapid planning and acquisition. The USACE acquisition of the Rolling Prairie site represents a meaningful departure from typical planning efforts since the site includes a much larger size (950 acres [384 ha]) than would normally be considered. Acquisition of a larger than typical property size was made possible because USACE Operations staff responded rapidly to the desire of landowners willing to sell property. USACE also rapidly updated the Pool 5 DMMP to consider a much longer planning horizon (100 yr), than the typical 20–40 or 50-year planning horizon, which must be repeated. This departure from the norm was made possible by USACE staff who recognized the cost benefits of purchasing extra land today to address long-term dredged material placement needs for the Pool 5 area. Summarily,

purchasing extra land today was cheaper than buying smaller sized parcels (say 20–50 acres [8–20 ha]) every 5–15 years. The larger site size also has the added benefit of providing opportunities to integrate new beneficial use alternatives into the Pool 5 DMMP as well as comingle ecological restoration components into the mixed-use site. USACE completed the land acquisition in 2019 and work on the site began during the 2022 field season. Areas not actively under construction will be leased out for agricultural purposes until needed for other planned purposes as noted above. Continuing agriculture on acquired land is a practical land management practice, as it provides crops and income for farmers, and it maintains community relations.

Large multiple-use site. The large site supports a long-term multiple use plan not typically available on smaller placement sites. Typical dredged material placement sites are small areas, 20–50 acres (8–20 ha) in size that are entirely dedicated to a single sediment management activity. They are often enclosed in berms, filled level to capacity, and planted with regionally appropriate vegetation (e.g., sand prairie and savanna scrub habitat) when done. The practice usually creates a uniform mound of sand in the floodplain. The Rolling Prairie site will support three sediment beneficial uses: sand prairie restoration, public reuse of dredged sediment, and cropland enhancement. The relatively large acreage allows these benefits to be integrated with wetland restoration that also treats hydraulic placement dewatering, riparian restoration, stream restoration, and habitat preservation in addition to the primary objective to manage dredged material for the next 100 years. These activities can coexist and enhancing the cropland could maintain compatible agriculture and dredged material placement for many years with repetitive thin-layer placements. Fine sediment dredged from adjacent backwater lakes for aquatic habitat restoration could also be added intermittently to balance sand additions with fine clay and silt soils.

Agronomic research and innovative real estate agreements. The agronomic studies conducted with the University of Minnesota will provide substantial new information that will be applicable on floodplain farms throughout the Upper Mississippi River System and other major river systems where maintaining a safe navigation channel is a primary mission. While the cropland recovery study at the Rolling Prairie site will focus on using sand from the Mississippi River, the cropland recovery approach could easily be adapted to address the use of silt and clay sediment on agricultural soils where organic content is low. Fine sediment can also increase water retention in sandy soils requiring irrigation because they are too porous to hold moisture throughout the growing season.

If the practice of floodplain cropland improvement can be demonstrated at the Rolling Prairie site, it could be applied on a much wider scale to other private agricultural lands through nonstandard estate agreements where federal fee-title ownership is not required. Nonstandard estate agreements, such as the one recently approved for the Minnesota Port Authority’s Southport Placement Site in St. Paul “affords the district with an opportunity to seek more win-win solutions that are good for taxpayers and landowners, while being able to maintain a positive public-relations image for the agency” according to Project Management Branch Chief, Nate Wallerstedt (Moes 2020). Demonstrating agronomic benefits would likely create a demand for more of these nonstandard estate agreements.

Integrated education and research opportunities. The Rolling Prairie agronomic studies will provide the evidence to support developing USACE guidelines for riverine dredged material

placement. The integration of St. Paul District dredging operations and planning teams with DOER and EWN research opportunities will support the agronomic and beneficial use evaluations. For example, ERDC scientists are supporting site planning and environmental monitoring with remote sensing and ground truthing. Additionally, coauthor Eric Hanson will use this site to research cropland improvement using dredged sediments in support of his PhD candidacy at the University of Minnesota College of Food, Agricultural, and Natural Resource Science. Several anticipated projects are expected to support other student-focused research on the site.

CONCLUSION: The Rolling Prairie beneficial use site is a large, long-term dredged sediment beneficial use site that demonstrates many benefits beyond conventional sediment management. Conventional placement sites are usually small, single purpose, industrial sites compared to the larger site that offers multiple land management alternatives that save operating costs and provide multiple benefits. Engineering challenges are minimized at the site where sediment can be moved from two river sites with hydraulic transport from barges or by trucks from the adjacent West Newton Chute stockpile. Planning challenges and costs are minimized because the plan will support 100 years of Pool 5 dredging needs. Economic benefits are realized by the efficient operation of Pool 5 dredging, which maintains safe commercial navigation. Operations costs are reduced with less planning and fixed site infrastructure like roads and hydraulic pump lines that eliminates mobilization costs. The centrally located transfer station provides a compact material staging area. And if the agronomic productivity benefits are demonstrated, we can quantify the economic benefit to farmers, which may provide justification to use nonstandard estates to place sand on private land more often. Private and public economic benefits could be derived and the need for future fee title land purchases to store sediment will be reduced.

The environmental benefits of keeping the sediment in the floodplain ecosystem are significant and consistent with EWN principles. The sand is retained in the floodplain ecosystem where it will be placed and shaped like a natural reference sand prairie site at the Weaver Dunes located nearby. Topsoil will be placed, and a diverse native plant mix will be used throughout the site to ultimately create hundreds of acres of sand prairie and wetland. Significant ecosystem restoration will be achieved for the cost of navigation dredging operations activity.

In addition to the operational efficiencies described above, the Rolling Prairie land use planners used a science-based approach to integrate multiple environmental benefits and increase the abundance of a rare habitat type. The site will benefit the public and native species of vegetation, pollinators, and wildlife through sustainable sediment management. The sediment management approach at Rolling Prairie is transferrable; it supports Pool 5 sediment beneficial use directly but also provides a model to help USACE achieve the mandate to use 70% of dredged sediment in beneficial ways by 2030. More use of private land for sediment placement through nonstandard estate easements can also help achieve that objective.

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