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Dredge Material Center of Innovation

AAPA 2020 Environmental Improvement Awards Application

Project Background:

Toledo Harbor has a 25-mile federal shipping channel that must be maintained to adequate depth to support safe navigation. There is an 18-mile Lake Approach Channel in Maumee Bay and the western Lake Erie basin and a 7-mile River Channel in the Maumee River. To keep the Port operating, around 850,000 - 1 million cubic yards (CY) of sediment should be dredged annually from the Toledo Harbor's federal and non-federal channels. Contractors for the U.S. Army Corps of Engineers (USACE) dredged approximately 400,000 - 1.1 million CY annually. This amount varies by year based on target areas in the channel, lake levels and available funding. A significant backlog exists to reach the fully authorized channel depths.

USACE contractors primarily use mechanical dredging (with a clamshell bucket) for dredging the federal navigation channel. The sediment is loaded onto a scow that transports it to the open-lake placement location where it is released from the bottom of the scow. Most of the sediments dredged from the federal navigation channel are open lake placed, with a small amount placed into the confined disposal facility (CDF). Toledo Harbor's designated open lake placement location is a two-square mile area northwest of Lake Miles 11-13. Lake Mile 19 is the outer boundary of dredging and River Mile 7 is the upstream boundary. Lake Mile 0 is at the confluence of the Maumee River and Maumee Bay. Currently, the USACE places federally dredged material in the northeast half of the open lake placement area. Depths within this area are approximately 20-23 feet.

Unlike other Great Lakes ports where dredged material is largely comprised of sand and gravel, which can often be readily put into beneficial use, Toledo Harbor sediments are mostly finer grained materials – silts and clays – which can present significant challenges to direct use and dewatering.

The state of Ohio and other stakeholders have raised concerns about the practice of open lake placement and Ohio EPA requested local and state leaders to identify, fund and implement alternative management practices. As a result, the Ohio Lake Erie Commission pursued and received a $250,000 U.S. EPA Great Lakes Restoration Initiative grant in 2010 that was sub-granted to the Toledo-Lucas County Port Authority to assist the Toledo Harbor Task Force with developing a Toledo Harbor Sediment Management & Use Plan. This plan, finalized in 2012, identifies interim and long-term dredge material management and beneficial use options to reduce the reliance on open lake placement of dredged materials. The plan includes an evaluation of opportunities and costs for the management of one million cubic yards of material each year over the next 30 years. The plan recommends the implementation of a combination of beneficial use options, including in-water and upland wetland restoration and shoreline protection areas (7 million CY), placement of dredged material onto improved agricultural fields (7 million CY), development of products for landscaping or non-structural fill (3 million CY), and open lake placement with controls (13 million CY). The Ohio Lake Erie Commission provided matching funds from the Ohio Lake Erie Protection Fund to further evaluate the agricultural field improvement option and to help develop this concept as a near-term pilot demonstration project. Details of this concept are in the next section and the demonstration of this concept is being implemented at the Dredged Material Center of Innovation.

The concept of the Agricultural Field Improvement Option is to pump dredge slurry or truck dry dredged material to existing agricultural land. Land would be purchased or rented for the timeframe required to complete the improvements. The property would have drainage tile installed to promote dewatering, berms would be built, and an edge of field system would be established. The elevation of agricultural fields would be permanently raised which would have long term benefits allowing farmers to get into the fields sooner after precipitation events. In addition to improved drainage, this option would potentially supply the soil with nutrients, and permit the incorporation of passive edge of field nutrient management systems for future farming activities.

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Objectives and Methodology

To advance the concept of the feasibility for the placement of material onto agricultural fields, the Toledo-Lucas County Port Authority (TLCPA) received a $2.5 million grant through the Ohio Healthy Lake Erie Fund in 2014 to design and construct the Great Lakes Dredged Material Center of Innovation at the Riverside Confined Disposal Facility (CDF) in north Toledo. Ohio Department of Natural Resources and Ohio EPA co-administered the grant. The City of Toledo was an integral project partner and owns the project property leased to the Port Authority. Hull & Associates, Inc. led a team of experts (including private industry and the University of Toledo), was selected through a competitive procurement process orchestrated by the TLCPA, to design and support construction activities.

When looking for an ideal location for a pilot agricultural facility, the TLCPA quickly settled upon the Riverside Park location. This is a former confined disposal facility located along the Maumee River at River Mile 3. It was vacant and underutilized and was already owned by the City. The adjacent City of Toledo leaf composting facility would complement the new operations. Also, with moderate infrastructure upgrades, this property would be readily accessible and ideal for site tours by farmers, public officials, researchers, and other interested stakeholders.

The site was designed to accommodate dredged material from the federal Toledo Harbor maintenance program for hydraulic offloading into earthen cells. The project involved the construction of four containment cells to manage the offloaded material to evaluate dewatering and consolidation under varying sub-drainage and seasonal fill rate conditions. These cells had containment areas between approximately 1.8 and 2.3 acres and individual airspace capacity between 13,500 cubic yards and 16,500 cubic yards of dredged material.

The site was constructed between November 2015 and June 2016 by a local earthwork/dredging contractor, Geo. Gradel Company. The cells, which included underdrain, inter-cell weirs, and edge of field treatment systems (EOFTS), were constructed with on-site soil materials only, due to an overall soil balance provided by the design which minimized project costs. A gravity dewatering system incorporating sloped drainage tiles, weirs, etc. was constructed to discharge the water and contain the solids from the hydraulically offloaded slurry, and to control the water flow from the containment cells to the EOFTS. The EOFTS passively treated effluent water from the filled cells using vegetated buffer strips and could later incorporate sorbent medium for future research activities. During offloading, the EOFTS served as a secondary settling basin prior to discharge of return water to the river.

The subsurface drainage system is composed of 6-inch diameter perforated single wall corrugated polyethylene pipes that are sloped towards the EOFTS, except for Cell 4. The two eastern-most drainage pipes of Cell 4 drain away from the EOFTS and connect to the western-most pipes, which drain towards the EOFTS, at the northern end of the cell. The redesign of a modified drainage system for Cell 4 was required due to encountering different field conditions than what was anticipated based on a topographic survey originally provided by the City of Toledo. The drainage tiles connect to a solid outlet pipe, consisting of 12-inch diameter solid dual-wall CPE pipe, prior to discharging to the EOFTS. The drainage tiles were installed in a one-foot wide trench, backfilled with Ohio Department of Transportation (ODOT) #57 stone, and covered with geotextile. The cells have drainage tiles placed with lateral spacing of 50 feet in Cells 1 and 4, and100 feet in Cells 2 and 3.

Although the original intent of the conceptual design (which was completed prior to the City of Toledo's December 2014 topographic survey of the site that was used in the final design), was to construct the cell floors to also slope towards the Maumee River, the existing grades at the site prior to construction sloped away from the Maumee River towards Summit Street (from south to north). To minimize unanticipated regrading activities and related costs, the cells were designed to slope away from the river, and the drainage system conveyed the water towards the river (in trenches) into the EOFTS, which was constructed between the cells and the river (final discharge), to simulate a large-scale scenario.
Another construction challenge of this scaled down project was the requirement from USACE for the final discharge to the river to be located above the river's Ordinary High-Water Mark, which significantly limited the sloping and depth options for the cells, unless a permit was pursued, which would have delayed the project.

In addition, the surface water drainage system incorporated weirs and riser pipes to help decant and dewater the cells during offloading. The weirs are fitted with adjustable "tongue and groove" wooden stop logs and held in place by a metal structure to regulate the decanted water discharge. The weirs are located on the north end of the center berms, between Cells 1 and 2 and Cells 3 and 4 (opposite locations from the inlet). The weirs were used to allow settlement of dredged sediments, and water to flow from the cells of higher elevations, to the cells at a lower elevation. Riser pipes with orifices are also located in Cells 1 and 3 and are surrounded by ODOT #57 stone to further reduce the transport of sediments in the slurry while allowing decanted water to flow from all sides. The 6-inch drainage tiles within each cell also tie into the riser pipe before discharging to the EOFTS via the 12-inch diameter CPE. After the lessons-learned from the 2016 dredging activities, individual weirs were designed for each separate cell to enhance the dewatering system during and after dredging activities. The weirs consisted of a box riser with 6" tall stop logs, connected to a 12" discharge pipe (Inlet Water Level Control Structure™ by Agri Drain Corporation), which allowed decanted water to be discharged from the top of the water column in the cell during and after dredged material offloading, thereby creating more capacity faster while meeting discharge water quality criteria.

Since the USACE ceased using the property in the 1970s, some non-federal dredged material had been placed at the site, including material recently dredged to accommodate the new berth of the USS Schoonmaker museum ship. This material was placed and stockpiled in the southwestern area of the site. Approximately 40,000 cubic yards of material was estimated to be in the stockpile based on survey data provided by the City of Toledo. As this material was used to complete on-site grading, characterization of the material was necessary.

A Baseline Characterization Field Sampling and Analysis Plan (FSAP) was completed in June 2015 and samples of the Schoonmaker stockpile were collected in July 2015 and analyzed for semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, herbicides, polycyclic aromatic hydrocarbon (PAHs), and inorganics. Access restrictions (e.g., heavy vegetation, trees) precluded the collection of soil samples in the proposed cell areas. Metals were present in all samples. Arsenic concentrations exceeded USEPA Region 5 residential and industrial/commercial Regional Screening

Levels (RSLs). The residential and industrial/commercial RSLs are considered by USEPA to be protective for humans (including sensitive groups) over a lifetime for the specified end use. Arsenic values were similar to typical background concentrations for Lucas County soils. Herbicides and pesticides were detected in select samples and were below both the Ohio EPA Voluntary Action Program (VAP) and Region 5 RSLs. Some PAHs were detected in some of the samples; however, these were below the USEPA Region 5 RSLs and Ohio EPA VAP generic direct contact standards for construction/excavation. Based on the chemical and geotechnical characterization, the stockpile was suitable for use in the construction of berms and did not pose an unacceptable risk to construction workers.

Following construction in spring 2016, Hull personnel oversaw the installation of five soil borings (SB-1 through SB-5) that were spatially distributed across the four cells. Chemical data was compared to USEPA RSLs for commercial/industrial use, Ohio VAP standards for construction workers, Ohio EPA Huron Erie Lake Plains Sediment Reference Values, and background concentrations for Lucas County and the region.

The TLCPA and Hull coordinated with USACE during preparation of bid documents for the USACE's 2016 dredging contract, which included a drawing and specifications for the hydraulic offloading into the Center for Innovation cells that were based on the anticipated procedures discussed above. The offloading was included with the USACE's river dredging contract, which was awarded to Ryba Marine Construction (Ryba) in both 2016 and 2017.

The 2016 offloading into the site occurred during the USACE's River Maintenance Project, where dredged material was removed from between stations 365+00 and 566+00 (approximately River Mile 0.8 and Lake Mile 3). On the first day of offloading, the USACE requested that the site receive more than one scow per day (more than originally agreed upon) in an attempt to fit within the actual schedule of the 2016 river dredging activities. To accommodate this request, offloading began in Cell 2, which overflowed at the time to Cell 1 via a decant weir with stop-logs. Cell 2 was able to receive two scows per day for the first three days, at which time the water level reached the top of the stop-logs. From that point forward, only one scow per day was offloaded into Cell 2, which occurred until the water level in Cell 1 was near the top of the riser pipe. Offloading was then moved to Cell 4 and occurred in the same process as described above, with decanted water overflowing into Cell 3 via the weir. When the sediment level in Cell 4 reached the top of the weir and the water level in Cell 3 was near the top of the riser pipe, direct offload into Cell 4 stopped. For the final week of offloading, the discharge location changed on a regular basis based on the water levels within each cell.

A total of 27 scows were offloaded into the site over a period of 21 days in 2016, with a total volume of 40,286 cubic yards of dredged material, as determined by USACE based on measurements of the delivered and offloaded scows. The average volume per scow was 1,492 cubic yards with a pumping rate of approximately 9,000 gallons per minute. In 2017, 21 scows were offloaded over 20 days with a total material volume of 35,215 cubic yards. The average volume per scow was 1,677 cubic yards with the pumping rate of approximately 9000 gallons per minute.

Based on the results of the Phase II Post-Placement sampling, the dredged material met a variety of beneficial use standards, including agricultural improvements. Nutrient and micronutrient testing further supports the use of dredged material for agricultural use as the soil has optimum or above optimum levels needed for crop growth. It appears that approximately 10%-12% of the total phosphorus is bioavailable. While some micronutrients were present in high levels (e.g., sulfur, chloride) these should not significantly impact crops. Testing results suggested considering the addition of manganese and zinc should soybeans be grown. Prior to any beneficial use project, coordination with Ohio EPA should be completed to ensure proper programmatic compliance as new standards and requirements are developed. Vegetative growth in the spring was observed to greatly accelerate the dewatering process and potentially help introduce organics to the sediment composition.

The 2016 and 2017 dredging seasons provided a good understanding of real costs associated with hydraulically offloading dredged material from the Toledo Harbor based on competitive bidding via the USACE's annual contracts. In 2016, the additional cost relative to hydraulically offloading material was $1.67 per cubic yard; in 2017, the cost was lower, at $1.40 per cubic yard. Both contracts were awarded to the same dredging contractor, which suggests that the $1.40 per cubic yard additional cost is more accurate, since it was provided in the 2017 competitive bid after the initial experience in 2016.

In 2018, the Ohio Lake Erie Commission established a public advisory council called the Dredge Research and Innovation in Farming Team ("DRIFT" team) to advance and develop agricultural application of dredged material as an alternative to open Lake disposal by providing expertise and guidance. The DRIFT team is comprised of agricultural experts, local farmers, and other local stakeholders. The executive committee is comprised of the Lucas County Soil and Water Conservation District, the Toledo Lucas County Porth Authority, and the Ohio Lake Erie Commission. One of the primary missions of the DRIFT team is advising on use of the Center of Dredge Innovation and coordinating research performed at the Center of Dredge Innovation.

In late 2018, the DRIFT Team released a request for proposals for agricultural research at the Center of Dredge Innovation to be funded through the Lake Erie Protection Fund. The DRIFT team received six proposals and selected two to recommend to the Ohio Lake Erie Commission for funding. The Ohio Lake Erie Commission approved the DRIFT team recommendation, funding the following two projects: (1) Improving soil health to increase plant production and quality on dredged material, by Dr. Megan Rua, Wright State University; and (2) Dredged Material Benefits for Crop Production and Environmental Implications, by Angelica Vazquez-Ortega, Bowling Green State University. After being selected, the researchers met with the DRIFT team to solicit feedback from the local agricultural stakeholders to incorporate into the research projects.

Dr. Rua's project examined developing more efficient agricultural practices, which is critical to support a growing global human population. The researchers stated that current large-scale agricultural practices lead to severe soil degradation. To alleviate soil degradation, cover crops, or crops planted in off seasons, are increasingly common components in Midwestern agricultural practices. Despite their benefits, soil amendments are often used in conjunction with cover crops to further improve soil properties. The use of dredged sediments as a soil amendment is increasing worldwide but little is known about mechanisms driving these soil improvements. To fill this knowledge gap, the researchers experimentally manipulated two agricultural fields made of 100% dredged sediments at the Center for Innovation in Toledo, Ohio. The researchers planted one field with a common cover crop, winter rye (*Lolium perenne*) and left one field fallow through winter. Throughout the following growing season, they measured ten corn plants from each plot for relative growth rate. After the growing season, they determined above and below ground biomass and final yields. To asses soil property shifts, they performed physiochemical and biological assays on sediment samples collected from three time periods: before cover crop planting, after cover crop life cycle, and after final corn harvest. They analyzed these data using univariate and multivariate statistics to establish mechanistic changes.

In 2019 and 2020, the researchers reported that their results showed that applying winter rye to dredged sediment fields increased corn crop yield and alleviated soil degradation. There were no significant differences in above ($P = 0.4587$) and below ground corn biomass ($P = 0.9578$) between cover crop and non-cover crop fields. However, application of winter rye resulted in corn yields 20% greater than the non-cover crop field ($F_{1,22} = 0.6729$, $P = 0.0012$). Cover crop application also eliminated differences in pH between the fields, making the sediments more basic ($P < 0.0001$) but had no impact on sand, silt or clay content between the plots ($P = 0.136$, $P = 0.089$, $P = 0.360$,). These data suggest that dredged sediments are suitable for agricultural soil amendment when used in combination with a cover crop. This work represents an important component for understanding the potential agricultural benefits of cover crop use in conjunction with dredged material. This research will provide much needed improvements to agricultural practices worldwide, as demands on agricultural systems continue to increase.

Dr. Vazquez-Ortega's project aimed to quantify the effect on soil health amended with various dredged sediment ratios, determine nutrient export under induced storm-events, and quantify the effect on soybean below biomass and yield. They used de-watered dredged sediment from the Center of Dredge Innovation and farm soil from a legacy phosphorous farm. At the time of collection, the soil and dredged sediments were characterized for baseline data. Four soil blends were generated, including 100% farm soil, 90% farm soil to 10% dredged sediment, 80% farm soil to 20% dredged sediment and 100% dredged sediment and planted with soybeans. Daily watering and storm events consisted of synthetic rainwater.

After 123 days, the soybean plants were harvested, and soil cores were collected for analysis. Physico-chemical analyses were conducted on the soil, biomass, and percolated water. The researchers reported that their results showed that dredged sediment amendment improved the quality of the farm soil by providing additional soil organic matter, increasing the cation exchange capacity, and decreasing bulk density. Nutrient loss in the percolated solutions from the blended soils showed no significant changes when compared to the percolated solutions in the 100% farm soil treatment, indicating no significant contribution to the export of nutrients that exacerbate the harmful algal blooms. The study showed that adding dredged sediment to farm soil improved the farm soil health and showed potentially no negative environmental impacts with respect to additional nutrient loss.

The Center for Innovation project was successful in its primary purpose of establishing a demonstration facility and acquiring valuable engineering and economic information for future beneficial use projects. The Center for Innovation is an ideal venue for future research and educational activities and will advance plans that could lead to the widespread use of dredged material, particularly for agricultural purposes. Future beneficial use permitting efforts will be streamlined due to the information gained with this project. Strengthened relationships and trust built throughout this process will also prove beneficial as our community moves forward with addressing the ongoing challenge of dredged material management.

Many important goals and actions were achieved in the course of this project, including:

- Preparation of a community relations plan that provided guidance to the project team as it implemented outreach and education activities for project neighbors as well as interested stakeholders.

- Construction of the four containment cells that included the gravity dewatering system, and edge-of-field treatment systems and placement of dredged material into the site.

- Infrastructure improvements through the installation of utilities that included approximately 710 feet of water main and approximately 510 feet of sanitary sewer line. Additionally, two fire hydrants were installed to assist in fire suppression for the City's composting facility and another building. Approximately 1,870 feet of paved road and approximately 1,780 feet of gravel road were installed to improve access to the Great Lakes Dredged Material Center for Innovation and the City's composting facility. Approximately 5,300 feet of perimeter fencing with six access gates were installed surrounding the two facilities.

- Completion of nutrient testing of placed materials and decant and underdrain water, the analysis of vegetative growth, and the preparation of a Material Certification Plan.

- Development of the project cost analysis and recommendations for large-scale project implementation based on the lessons learned provide the basis for realizing the future benefits from the use of dredged material management as a result of this highly collaborative and successful project.

Five years after initial engineering and design activities were initiated at this agricultural beneficial use demonstration site, local and state officials have seen first-hand that sediments dredged from the Maumee River can be readily used for crop production. This is very good news as earnest efforts are underway to find alternatives to dredged material placement in Lake Erie to meet Ohio's open lake placement ban effective July 1, 2020.

Open lake placement was standard practice over the last few decades to manage most of the approximately one million cubic yards of dredged materials generated annually from Toledo Harbor's 25-mile federal navigation channel in Maumee Bay and the Maumee River. While Ohio is banning open lake placement of dredged material from federal channels, state law provides a few exceptions, including some relief for dredged material generated from Toledo Harbor due to the tremendous volume of material. Nevertheless, local officials must demonstrate a serious commitment to comply with the law and having a viable option to beneficially use dredged material for agricultural purposes is an important component of the Toledo-Lucas County Port Authority's material management plan.

AWARD CRITERIA

1. **The level and nature of benefits to environmental quality, beautification or community involvement:** The reduction and elimination of the open lake placement of dredged material provides a direct benefit to the water quality of Lake Erie. By removing the dredged material, the total phosphorous load is reduced and the phosphorous and nutrients in the material are beneficially reused on agricultural fields. As noted above, through the DRIFT team, university researchers, public agencies and the collaborative involvement of many other stakeholders, the Center of Innovation was constructed and agricultural field placement was confirmed to be a viable alternative to open lake disposal for dredge material placement.

2. **The level of independent involvement and effort by the port:** As the local public agency, it was up to the Toledo-Lucas County Port Authority to coordinate the work described above. From bidding out the design and construction, to working with the agricultural community to consider the use of dredged material on farm fields, the Port Authority took the lead in implementing the project with the support of the State of Ohio, City of Toledo and other stakeholders noted above.

3. **The creativity of the solution or programs:** The creativity for this project revolved around the concept of changing perceptions of the dredged material from a waste product to something that could add value to agricultural practices. To change perceptions of the material, the concept had to be verified by data. The project demonstrated the success of agricultural field placement on a pilot scale so it could be replicated on a larger scale in the future.

4. **Whether the project or program results are apparent (the project must be complete through some beneficial increment):** The program results are demonstrated in achieving the goal of designing and constructing the Center of Innovation, successfully planting and harvesting crops within the Center of Innovation, and through the research and reports generated by Wright State University and Bowling Green State University. The research is currently being shared with the DRIFT Committee to be vetted before being distributed to the regional agricultural community on a wider scale.

5. **The cost effectiveness of the activity or the program:** As noted above, the project construction and all associated research was funded entirely through a combination of grant sources including the Ohio Healthy Lake Erie Grant, US E.P.A. Great Lakes Restoration Initiative, and the Ohio Lake Erie Protection Fund. All grants were awarded to and administered by the Toledo-Lucas County Port Authority.

6. **The transferability of the technology or idea to the port industry:** The transferability of this project is twofold. First, the placement of dredged material on the agricultural plots at the Center of Innovation could be replicated in farm fields throughout the region with the transportation cost of the material being the only constraint. Secondly, while dredge material may have different characteristics than Toledo's other ports can utilize the research from the Center of Innovation to pursue agricultural field placement within their own communities.