Appendix D

Facility Closure Plan
April 23, 2021

Ms. Bridget Henk  
Senior Project Manager  
Milwaukee Metropolitan Sewerage District  
260 W. Seeboh Street  
Milwaukee, WI  53204

Dear Ms. Henk:

RE: Facility Closure Plan  
Milwaukee Estuary AOC Dredged Material Management Facility

Attached to this letter is the project Facility Closure Plan (FCP), which is intended to meet contract requirements included in Appendix A (Scope of Services, Dredged Material Management Facility [DMMF] Permitting Task) Section B Permitting Assistance, Task 1 of the contract between the Milwaukee Metropolitan Sewerage District (District) and Foth Infrastructure & Environment, LLC (Foth), dated December 7, 2020 (Contract).

We appreciate this opportunity to provide the District with these services and will appreciate your feedback regarding this document when you have had a chance to review it.

Sincerely,

Foth Infrastructure & Environment, LLC

Michael S. Raimonde  
Project Manager

cc: Tom Chapman, MMSD  
Steve Laszewski, Foth

cc: Tom Chapman, MMSD  
Steve Laszewski, Foth
Facility Closure Plan

MMSD Project ID: M98001P01
Foth Project ID: 20M144

Prepared for
Milwaukee Metropolitan Sewerage District
260 W. Seeboth Street
Milwaukee, WI 53204

Prepared by
Foth Infrastructure & Environment, LLC

April 2021

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Facility Closure Plan

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List of Abbreviations, Acronyms, and Symbols

AOC       Area of Concern
BODR      *Milwaukee AOC-DMMF Basis of Design Report*
CDF       Confined Disposal Facility
cfs       cubic feet per second
cy        cubic yards
District  Milwaukee Metropolitan Sewerage District
DMDF      Dredged Material Disposal Facility
DMMF      Dredged Material Management Facility
FCP       *Facility Closure Plan*
Foth      Foth Infrastructure & Environment, LLC
GAC       granular activated carbon
GLLA      Great Lakes Legacy Act
gpm       gallons per minute
HDPE      high-density polyethylene
LHE       Low Hazard Exemption
LTWTF     Long-Term Water Treatment Facility
LWD       low water datum
MMSD      Milwaukee Metropolitan Sewerage District
PAH       polynuclear aromatic hydrocarbons
PCB       polychlorinated biphenyls
PFAS      per- and polyfluoroalkyl substances
Phase I Dewatering first phase of dewatering
Phase II Dewatering second phase of dewatering
Port      Port Milwaukee
USACE     U.S. Army Corps of Engineers
USEPA     U.S. Environmental Protection Agency
WDNR      Wisconsin Department of Natural Resources
1 Introduction

The Milwaukee Estuary Area of Concern (AOC) Dredged Material Management Facility (DMMF) will be a newly constructed facility to manage dredged material within the Milwaukee Estuary AOC. Management of the dredged material is key to achieving the goal established for the AOC by establishing a facility to manage contaminated sediments and other dredged materials that will help remove Beneficial Use Impairments and eventually lead to the delisting of the AOC from the 1987 designation by the U.S. Environmental Protection Agency (USEPA). The facility will provide storage for 1.9 million cubic yards (cy) of material (1.4 million cy of impacted sediments dredged within the Milwaukee Estuary AOC; 200,000 cy of material removed for Port Milwaukee (Port) commercial navigation purposes; and 300,000 cy of material from Milwaukee Metropolitan Sewerage District (MMSD) watercourse projects that include dredged materials and upland soils), and provide additional expansion capacity for the Port. The DMMF will be located north of and adjacent to the U.S. Army Corps of Engineers’ (USACE) Milwaukee Harbor Dredged Material Disposal Facility (DMDF), in the location shown on Figure 1-1. The elements of the DMMF as described here are presented in the Design Drawings and Technical Specifications in the Final Design Report (Foth, 2020).

1.1 Purpose

This Facility Closure Plan (FCP) provides guidance for closure of the DMMF upon completion of placement of dredged material and pumping out of the last of the ponded water. The FCP provides preliminary estimates of dredged material consolidation and conceptual options for dewatering the dredged material. The preliminary estimates of consolidation were used to evaluate additional dredged material capacity and final cover quantities. The conceptual dewatering options describe methods to manage water levels within the DMMF, and provide water treatment influent flow rates based on an assumed percent solids of dredged material, an assumed delivery rate of dredged materials to the DMMF, and an assumed annual precipitation. A general construction approach for the final cover elements is presented.

1.2 Scope of Work

This FCP is being written based on currently available information in advance of construction, dredging, and filling and will need to be revisited after these actions are completed and additional information becomes available, as further identified in the sections below.

This FCP is separated into two sections:

- Section 1 provides an introduction and overview of the project.
- Section 2 describes the closure plan design including conceptual rationale for consolidation, dewatering, water treatment, and final cover placement.

1.3 Regulatory Requirements

There are no Wisconsin statutes or administrative code requirements that directly address the design and operation of a DMMF. Prior Wisconsin approvals for similar facilities were grants of low hazard waste exemption. “The State of Wisconsin Approval Process for Dredging of
Commercial Ports, Guidance for Applicants and WDNR [Wisconsin Department of Natural Resources] Staff”, PUB -FH-061-2004 (WDNR, 2004), states that “The applicant for any new CDF [Confined Disposal Facility] would have to demonstrate that the facility is eligible for a low hazard exemption under s. 289.43 (8), Wis. Stats. In that case, there would be no licensing or other requirements by the Waste Program under landfill siting laws.”

The WDNR “Exempting Low Hazard Wastes from Solid Waste Regulations,” PUB-WA-1645 (WDNR, 2015), provides guidance on preparing a Low Hazard Exemption (LHE) in accordance with s. 289.43(8). To meet agency expectations for the information necessary to approving an LHE for the DMMF, three supporting documents are being developed to assure that the DMMF will be constructed and operated safely and in compliance with State solid waste regulations:

- **Construction Quality Assurance Plan** (Foth, 2021a)
- **Facility Closure Plan** (FCP)
- **Long Term Care and Maintenance Plan** (Foth, 2021b)
2 Closure Plan Design Elements

2.1 Design Overview

The purpose of the DMMF project is to manage a designed volume of 1.9 million cy: 1.4 million cy of impacted sediments from the Milwaukee Estuary AOC; 200,000 cy of material for Port commercial navigation purposes; and 300,000 cy of material from MMSD watercourse projects that include dredged materials and upland soils. The key factors driving closure plan development are consolidation and dewatering of the dredged material, water level management and treatment of expressed pore water and surface water runoff from the DMMF, and placement of a final cover layer.

In addition to providing a facility to manage dredged material, the DMMF will provide immediate expansion to the Port through placement of a final cover system designed to accommodate future development. These new Port facilities will be designed to accommodate the range of commercial shipping vessels found on the Great Lakes, including berthing for vessels greater than 1,000 feet in length. Further, though not immediately addressed by this design report, the new facility may provide additional public access use opportunities along this portion of the Lake Michigan shoreline.

2.2 Design Rationale

The prime design criteria for DMMF closure are to manage the dredged material and water within the DMMF to aid in drying and consolidation and to design a cover system that will be protective to human health and the environment, with an intended end use to accommodate multiple uses such expansion of Port Milwaukee facilities and other public access uses.

2.2.1 Hydraulic Offloading and Placement

The majority of dredging performed within the Milwaukee Estuary AOC under the Great Lakes Legacy Act (GLLA) Project Agreement will be accomplished using hydraulic dredging methods; therefore, this method has been used to inform design criteria for consolidation and dewatering.

To design the DMMF water collection systems to accommodate the delivery of hydraulically dredged material to the DMMF, an assumed average dredge rate was developed based on the anticipated yearly dredging rate of GLLA projects within the Milwaukee Estuary AOC. Through the discussions within the Design Technical Work Group, a multiple stakeholder group that worked cooperatively during the DMMF design process, at that time it was determined that an assumption of 500,000 cy of dredged material placed in the DMMF per year should be used for design of the DMMF. This target rate was based on the stated goal to complete sediment remediation within the Milwaukee Estuary AOC in the first three years after construction of the DMMF. Since those discussions with the DTWG, the construction completion date and expected duration of the GLLA projects has been modified, and the current rate is assumed to be 1,100,000 cy of dredged material placed in the DMMF on annual average basis. The GLLA projects are expected to dredge with the highest target rate during the operating life of the DMMF; projects thereafter from other sources are likely to be of a much smaller scale and dredging rate.
For the purposes of this evaluation, and consistent with the assumptions made in the *Final Design Report*, a dredge season was chosen to be 9 months or 274 working days. Based on an assumed 7 percent solids content of the dredge slurry, this equates to a discharge rate at the DMMF of 21 cubic feet per second (cfs) / 9,400 gallons per minute (gpm), to achieve this goal. Discharge of dredged material to the DMMF by hydraulic methods will be accommodated either through direct pipeline discharge from the dredge, and/or through a 12-inch pipe and manifold system to be incorporated into the perimeter of the DMMF. The DMMF is designed to accommodate inflows of up to 26 cfs / 11,700 gpm from either dredge source. This is to accommodate the potential for multiple dredging projects operating concurrently at a dredging rate in excess of the average rate.

To assist with hydraulic placement, a 12-inch high-density polyethylene (HDPE) pipeline is placed around the northern and eastern perimeter cellular walls of the DMMF with 8 manifolds spaced to provide varying discharge locations of the dredge slurry into the ponded area of the DMMF, as shown on Drawing S27 in Appendix J, of the *Final Design Report*. Portable HDPE piping could also be connected to these discharge locations on a project-specific basis to further increase the ability to discharge dredged material slurry throughout the DMMF. This approach could be used to accommodate methods such as sub aquatic placement using a tremie pipe and/or diffuser, to meet the needs of each individual dredge project. These methods would be project dependent and would rely on the individual dredge project proponent for design and implementation.

### 2.2.2 Consolidation in the DMMF

Long-term storage capacity is a major factor in design and management. Consolidation of the layers continues for long periods following placement, causing a decrease in the volume occupied by the layers and a corresponding increase in storage capacity for future placement. Once water is decanted from the area following active placement, natural drying forces begin to dewater the dredged material, adding additional storage capacity. The gains in storage capacity are therefore influenced by consolidation and drying processes as well as the techniques used to manage the site both during and following active placement operations. A nearshore site can be managed for dewatering by drying only for material placed above the mean high water elevation. Dewatering of material in the saturated zone is limited by consolidation processes. Consolidation is discussed further in Section 2.3.

### 2.2.3 Long-Term Water Management

Upon completion of placement of dredged material in the DMMF, and pumping out of the last of the ponded water, the DMMF will transition to long-term management of consolidation, dewatering, and water handling. The proposed design of the cellular cofferdam structure, including the DMMF-DMDF Connector between the last cell of the cofferdam structure and the existing DMDF, will keep the contaminated dredged material within the DMMF isolated from the waters of Lake Michigan adjacent to the DMMF. The underlying clay sediments, into which these structures will be keyed, will prevent seepage from the bottom of the DMMF into Lake Michigan. These design features will significantly minimize or eliminate seepage of contaminated pore water out of the DMMF. Surface water runoff is assumed to be negligible from the DMDF and is directed to a surface water collection system in the adjacent upland area.
Therefore, the long-term process will focus on managing expressed pore water during consolidation of the dredged material and any precipitation runoff on the site. To handle these water sources and maintain the interior water level to preserve structural integrity of cofferdam cells, design and implementation of collection structures will need to be completed based upon the final grades and material properties of the placed dredged material.

Similar to active dewatering, water collected during the long-term process is assumed to need treatment such that it can be returned to Lake Michigan. Performance requirements are likely to include removal of total suspended solids, heavy metals, polynuclear aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and per- and polyfluoroalkyl substances (PFAS) from the water, as described in the *Water Quality Modeling Report*, which is Appendix H of the DMMF Final Design Report.

Methods for dewatering and management of the expressed pore water from consolidation of the dredged material and precipitation runoff are described in Section 2.4.

### 2.2.4 Intended End Use

In addition to providing a facility to manage sediments, the DMMF will provide immediate expansion to Port Milwaukee facilities by approximately 42 acres. These new Port facilities will be designed to accommodate the range of commercial shipping vessels found on the Great Lakes, including berthing for vessels greater than 1,000 feet in length. Further, the new facility may provide additional public access use opportunities along this portion of the Lake Michigan shoreline.

To achieve the goals of the Port expansion, the exterior walls of the facility are designed to incorporate vessel berthing, loading, and unloading. Design criteria for the exterior walls includes the general main areas described below, as identified by Port Milwaukee:

- Able to accommodate both 1,000-foot-long laker and typical 740-foot Seaway Max vessels.

- Provide a location for offloading of large loads as described in the *Milwaukee AOC-DMMF Basis of Design Report (BODR)* (Foth, 2019).

- Flat face on exterior walls to allow for ease of vessel berthing.

- Provide for expansion of vessel berthing areas along the north and east walls as Port funding allows.

- Provide a platform for offloading of navigational dredged material by USACE and the Port for disposal at the Milwaukee Harbor DMDF. (The existing DMDF offloading platform is located on the north dike of that facility and will be enclosed within the new DMMF.)

The design criterion for the interior of the DMMF is to install a cover material and thickness that will provide a stable cover until the facility is developed in the future by the Port.
Considerations for potential end use of the DMMF include types of materials and load of the structures that will be placed on the final cover, structures that will penetrate the final cover, contaminants in the sediment placed in the DMMF, and how those contaminated sediments will affect foundational structures. Final cover design is discussed further in Section 2.5.

2.3 Preliminary Dredged Material Consolidation Analysis

The following preliminary dredged material consolidation analysis was based on data and methods of analysis described in Appendix L of the Final Design Report. For this preliminary analysis, the settlements associated with self-consolidation of the DMMF dredged material and consolidation of the DMMF foundation were estimated using the one dimensional primary consolidation equation. The time factor was used to estimate the expected duration to complete primary consolidation. In Section 2.4 Conceptual Dewatering Operations, consideration is given to methods to reduce the time factor through enhanced drainage installations.

It is noted that the self-consolidation of dredged sediments involves sedimentation and consolidation mechanisms not considered by the one dimensional consolidation equation. Furthermore, sedimentation processes are influenced by dredge methods, and consolidation mechanisms are influenced by dredged material properties. At the time of drafting this report, the dredge methods have not been identified and dredged material properties have not been developed. Therefore, the simplifying assumption was made to use the one dimensional consolidation equation until more detailed information is available for more detailed analysis. The expectation is that this preliminary analysis will be advanced in accordance with USACE publications (EM 1110-2-5025, USACE 2015) when dredge methods and dredged material properties are more formally identified and characterized.

The preliminary estimates for settlements associated with self-consolidation were based on conventional consolidation tests of in-place sediments within the AOC (Solvay Car Ferry Slip). The preliminary estimate for self-consolidation of the DMMF dredged material was 30 inches. The duration was estimated at 60 years without enhanced drainage, and 30 years with enhanced drainage. The calculations are provided in Appendix A.

The preliminary estimate for settlements associated with the foundation were based on consolidation tests of the DMMF lake bottom, reported in Appendix L of the Final Design Report. The preliminary estimate for consolidation of the DMMF foundation was 4 inches. The duration was estimated at 30 years without enhanced drainage. The calculations are provided in Appendix A.

The lake bottom within the DMMF varies from approximately -10 to -20 feet below the low water datum (LWD), with an assumed average value of -15 feet LWD. A range of potential settlements is provided below for reference purposes.
Table 2-1
Preliminary Estimates of Settlement

<table>
<thead>
<tr>
<th>Lake Bottom Elevation (-feet LWD)</th>
<th>Dredged Material Est. Settlement (inches)</th>
<th>Clay Foundation Est. Settlement (inches)</th>
<th>Total Settlement (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>21</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
<td>4</td>
<td>34</td>
</tr>
<tr>
<td>20</td>
<td>39</td>
<td>6</td>
<td>45</td>
</tr>
</tbody>
</table>

The complex mechanisms and cyclic relationship of sedimentation and consolidation for multiple lifts of compressible dredged material, and the changing nature of the resulting loads imposed on compressible foundation soils, may result in errors in projections of settlement and remaining storage capacity over long time periods. Accuracy can be greatly improved by updating the estimates every few years using data from newly collected samples and laboratory tests. Observed field behavior should also be routinely recorded and used to refine the projections.

2.4 Conceptual Dewatering Operations

Dewatering related activities will occur during two separate operating phases of the DMMF, each with separate objectives. The first phase of dewatering (Phase I Dewatering) will occur during and immediately following the completion of active filling operations of the DMMF. The objective of Phase I Dewatering is to accelerate consolidation of the dredged sediment, as well as manage surface inflows from upland areas and direct precipitation onto the DMMF. The second phase of dewatering (Phase II Dewatering) will occur during post-closure under the long-term operation of the Port. The objective of Phase II Dewatering is to manage entrained water levels within the DMMF materials, as well as manage surface infiltration from direct precipitation.

It is important to note that while the dewatering phases share dewatering infrastructure (drain tile) and hydraulic control (weir structure and sump pump lift station), the operating objectives and design basis of each are distinct. Consequently, where practicable, the design of dewatering infrastructure and hydraulic control may be scalable to accommodate both Phase I and Phase II Dewatering operating conditions. The dewatering infrastructure and hydraulic control of each phase are described conceptually in the following sections.

2.4.1 Phase I Dewatering

During Phase I Dewatering, the following infrastructure may be installed to accelerate consolidation and drying of the dredged sediment. The dewatering infrastructure may be installed during or after active filling operations which may include but is not limited to progressive trenching, drain tile, temporary sumps, geocomposite drainage nets, and prefabricated vertical drains. The installation of dewatering infrastructure across the DMMF requires adequate subgrade bearing to support construction equipment, which can either come from accelerated drying of dredged sediment, and ground improvement with granular fill, geosynthetics, and additives. The following discussion presents Phase I dewatering options that will require additional analysis as the final closure design progresses.
**Progressive Trenching**

The objective of progressive trenching is to develop temporary water conveyances, improve crust thickness, and improved access. Progressive trenching is progressive in the sense of vertical and lateral development. Progressive trenching develops vertically from the progressive deepening of trenches and sumps within the DMMF. Progressive trenching develops laterally from the progressive extension of trench networks from the perimeter to the interior of the DMMF. Progressive trenching is successful when observations suggest water levels are dropping, outflow is steady, desiccation cracks and crust are developing, and ground bearing is improving. The most common progressive trench pattern employs parallel trenching (100 to 200 feet), with radial trenching patterns for effective drainage of water to the weir structures. (USACE, 2015). A conceptual schematic of Progressive Trenching operations is provided on Figure 2-1. Note, the temporary water conveyances will be under hydraulic control from the weir and sump pump structure on the west side of the DMMF.

**Temporary Sumps**

The objective of temporary sumps is to mitigate difficult drainage situations, where progressive trenching or drain tile cannot readily dewater an area. Ideally progressive trenches or drain tile are installed to capture runoff or seepage from an area, but if drainages become disconnected or isolated, then temporary sumps are employed to address specific ponded areas. A temporary sump is simply a hole or area in the ground where water is collected and pumped for the purpose of removing water from the adjoining area. The temporary sump is constructed to a desired depth via excavation, perforated corrugated pipe, and granular backfill. The corrugated pipe is equipped with a sump pump to induce seepage and dewatering of adjoining areas. The discharge from the sump pumps is directed to established drainages via flexible hose or rigid piping. A conceptual schematic and plan for temporary sumps are provided on Figure 2-1. Note, the two temporary sumps on the western perimeter will be converted to permanent sumps, and equipped with weir and sump pump structures during operations of the permanent water treatment system.

**Grading Plan and Drainage Tile Collection System**

The objective of a drain tile collection system is to install permanent water conveyances to collect runoff and infiltration from graded areas. After the surface of the dredged material exhibits adequate bearing to support construction equipment, the dredged material will be graded and a drain tile collection system will be installed. The grading of the dredged material will provide gravity drainage to and from the drain tile collection system. The drain tile collection system will consist of perforated corrugated plastic pipe, wrapped in a fabric filter, and bedded with granular filtration media to prevent clogging and provide ballast from over-burden loads. A conceptual grading plan and drain tile collection system are shown on Figure 2-2. Note, the drain tile collection system will be under hydraulic control from the weir and sump pump structure on the west side of the DMMF.

**Geocomposites and Vertical Drains**

In addition to the conventional drainage solutions described above, there are also advanced drainage solutions that may be considered or evaluated on an as-needed basis. The primary
objective of these solutions is to create a path of least resistance to seepage and accelerate the dissipation of pore pressure. These include planar drainage solutions such as geocomposite drainage nets to capture infiltration across broad areas, and prefabricated vertical drains (wick drains) to leverage surcharge and confinement to produce capillarity induced seepage. A conceptual schematic and plan for advanced drainage solutions are provided on Figure 2-3. Note, these advanced drainage solutions will discharge to the drain tile collection system, which will be under hydraulic control from the weir structure and sump pump lift station on the west side of the DMMF.

2.4.2 Phase II Dewatering

During Phase II Dewatering DMMF filling operations will be complete, and construction and long-term operation of the facility by Port Milwaukee will begin. The construction of the facility includes installation and grading of the DMMF cover system. The long-term operation of the facility includes managing surface infiltration from direct precipitation through the cover system, and managing potential water level fluctuations within the DMMF materials. The following discussion presents Phase II Dewatering options that will require additional analysis as the final closure design progresses.

Cover System Installation and Grading Plan

An objective of the cover system is to promote surface runoff and drainage. A conceptual cover system detail and grading plan are shown on Figure 2-2. The cover system will discharge to the drain tile collection system, which will be under hydraulic control from the weir structure and sump pump lift station on the west side of the DMMF.

Weir and Sump Pump Structure Operations

During Phase I Dewatering and DMMF filling operations, the hydraulic control system is anticipated to operate at a relative maximum flowrate based on the previously stated assumptions of dredged material inflow during the execution of GLA projects. During Phase II Dewatering and port operations, the hydraulic control system is anticipated to operate at a relative minimum flow rate. The hydraulic control is comprised of the dewatering infrastructure, the weir and sump pump structure, and the water treatment system.

During DMMF filling operations the discharge of water into the sump pump structure will be regulated by weir sections. After active filling and to prepare for long-term operations, the sump pump structure will be backfilled with granular filtration media, and the sump pump will be shrouded to maximize drawdown within the sump and provide continuous flow across the motor for cooling. As the DMMF materials consolidate and become dewatered, the weir sections will be removed.

Post-closure, during Port operations, the discharge of water into the sump pump structure will not be regulated by weir sections. The maximum daily discharge of water into the sump pump structure is expected at 4,740 gpm (100-year/24 hour 5.98-inch rain on 42 acres). The water level in the DMMF is expected to be maintained at or below an elevation of approximately +4 LWD, in order to maintain the design basis of the difference in hydrostatic pressure between the
interior and exterior of the DMMF at or below 3 feet. The specific water level maintained inside the DMMF will, therefore, fluctuate to accommodate changes in Lake Michigan water level.

2.5 Final Cover System

The final cover system will complete the containment and confinement of dredged materials, and will provide separation from environmental release and/or exposure to contaminants of potential concern. The final closure grades were based on the Port’s end use plan and the WDNR required minimum slope of 1%, such that the elevation at the top of the cellular wall is equal to the elevation of the cover system.

The objective of the final cover system is to provide operational load bearing support of the Port and promote surface runoff and drainage. A conceptual cover system detail and grading plan are shown on Figure 2-2.

The proposed final cover system will consist of one foot of dense graded aggregate placed over the consolidated dredged materials. The final thickness of the cover system will depend on the consolidated height of the dredged material at the time of construction. If initial consolidation of the dredged material provides sufficient capacity, placement of additional dredged material may be considered prior to installation of the cover system. It is also possible that backfilling with additional dense aggregate on top of the dredged material may be necessary prior to installation of the cover system and achievement of final closure grades. For the purposes of this report the cover system has been designed minimally (e.g., applied loads less than 4,000 pounds per square foot), however additional ground improvement solutions can reduce ground pressure while minimizing cover thickness. Additional ground improvement solutions may be evaluated as the final closure design progresses. The final closure design will take into consideration potential end uses of the DMMF, types of materials and loads that will be placed on the final cover, and foundations that will penetrate the final cover will verify structural and chemical compatibility with dredged materials.

2.5.1 Port Facility Expansion Requirements

Potential development of land-based Port facilities such as buildings and roads on the DMMF will likely require the use of spread footings for light loads, and pile supported footings for heavy loads. Any expansion will need to account for the dredged material properties, as well as the design assumptions of the cellular cofferdam wall. All pile supported structures shall be designed to minimize the potential for contaminant release to the environment. Refer to Section 5 of the Long Term Care and Maintenance Plan (Foth, 2021b) for further detail.

2.6 Conceptual Water Treatment System Design

Due to the potential contaminants within the expressed pore water and surface water runoff, all water managed until site closure and covering will be required to be treated at the water treatment facility. The water treatment facility will likely be able to be operated at a reduced capacity from that when operating during placement of the dredged material. The final design of the DMMF Long-Term Water Treatment Facility (LTWTF) will be performed at a later date as additional information becomes available regarding dredging procedures, filling rates,
characteristics of dredged material, etc. and as permit limits are set; however, based on currently available information, a conceptual design for the post-closure, long-term water handling and treatment systems is described below.

Upon completion of placement of dredged material in the DMMF, and pumping out of the last of the ponded water, the DMMF will transition to long-term management of consolidation, dewatering, and water handling. The proposed design of the cellular cofferdam structure, including the DMMF-DMDF Connector between the last cell of the cofferdam structure and the existing DMMF, will keep the contaminated dredged material within the DMMF isolated from the waters of Lake Michigan adjacent to the DMMF. The underlying clay sediments, into which these structures will be keyed, will prevent seepage from the bottom of the DMMF into Lake Michigan. These design features will significantly minimize or eliminate seepage of contaminated pore water out of the DMMF. Surface water runoff is assumed to be negligible from the adjacent DMDF as it is directed to a surface water collection system within its upland area. Therefore, the long-term water handling needs will focus on managing expressed pore water during consolidation of the dredged material and any precipitation on the site that infiltrates the cover layer and is collected by the piping and sump system preliminarily described in the FCP. To handle these water sources, and maintain the interior water level to preserve structural integrity of cofferdam cells, design and implementation of collection structures will need to be completed based upon the final grades and material properties of the placed dredged material.

For purposes of FCP, a conservative estimate has been made that all of the precipitation that falls on the 42-acre surface area of the closed DMMF will infiltrate the cover layer and be collected by the piping and sump system. Based on National Oceanic and Atmospheric Administration estimates, the average annual precipitation at the DMMF location is 31.7 inches per year, or a total of 36,153,000 gallons. While this precipitation will vary in intensity and duration over the course of one year, the average inflow collected by the piping and sump system is calculated at 69 gpm. Consideration also is given for the case of an intense storm that may produce more precipitation over a short duration. The 100-year, 24-hour storm is estimated to produce 5.98 inches of precipitation, or 6,820,000 gallons. To handle that extreme storm event in a 24-hour period, the piping and sump system would deliver 4,740 gpm to an appropriately-sized treatment system.

Similar to active dewatering during dredged material disposal operations, it is assumed that water collected during the long-term process must be treated such that it can be returned to Lake Michigan. Performance requirements are assumed to include removal of total suspended solids, heavy metals, PAHs, PCBs, and per- and PFAS from the water, as described in the Water Quality Modeling Report, which is Appendix H of the DMMF Final Design Report.

Due to the potential contaminants within the expressed pore water and surface water runoff, all water managed until site closure and covering will be required to be treated at the DMMF LTWTF. The DMMF LTWTF will likely be able to be operated with similar, if not identical unit operations but at a reduced capacity from that when operating during active placement of dredged material. The final design of the DMMF LTWTF will be performed at a later date as...
additional information becomes available regarding dredging procedures, filling rates, characteristics of dredged material, etc. and as permit limits are set; however, based on currently available information, a conceptual design for the post-closure, long-term water handling and treatment systems is described below.

Water that is collected by the piping and collection system will be pumped from the two sumps converted from the weir boxes at a rate of up to 4,740 gpm.

The following general components for a 4,740 gpm design flow rate are preliminarily identified for the DMMF LTWTF:

- Sand Filters
- Frac Tanks
- Weir Tanks
- Open Top Tanks
- Electric Centrifugal Pumps
- Dual Carbon Vessels
- Multiple-bag Bag Filter Vessels
- Flow Meters, Sampling Ports, Associated Piping and Connections

In the DMMF LTWTF, influent water will be treated by the following treatment steps.

1. From the influent weir tanks, water is routed to settling tanks for sedimentation, if necessary. Different coagulant and polymer products will be tested and proposed for use with dosage to be confirmed upon start-up.

2. Water will be pumped at an average 4,740 gpm flow rate using electric in-line pumps through filters containing sand and gravel media.

3. Water subsequently flows through multiple multi-bag filters with 1-micron filters.

4. The water will be pumped electric in-line pumps through a minimum of two granular activated carbon (GAC) vessels in series. The GAC media in the vessels will be periodically backwashed to remove very fine particulate buildup.

5. From the dual GAC vessels, the process water flows through a polishing 1-micron multi-bag filter arrangement.

6. The water passes through a final turbidity meter and then is directly discharged through a permitted outfall or stored in batch tanks sized according to permit requirements for further testing prior to discharge.

7. At this stage of operation, the DMMF is scheduled to be near capacity and therefore can no longer accept solids from the LTWTF. Therefore, a plate and frame filter press is
proposed for use in dewatering recovered solids from weir tanks and settling tanks to be sent to a landfill for appropriate disposal.

The sizing and quantity of the individual unit operations will be determined as permit requirements are understood and final closure details influence the flow rate that forms the basis for the overall system sizing. For example, if the system size is large enough, more permanent structures may be designed in lieu of mobile or temporary components.

2.7 Future Plan Optimization

As described above this *FCP* is being written based on currently available information in advance of construction, dredging, and dredged material disposal operations. As the DMMF comes into operation, the details of the operation of the facility during active filling will better inform the design assumptions made herein, and this *FCP* can be revised to optimize the closure process. Any such modifications would be made consistent with all permits and permissions received and at the subsequent approval of the appropriate regulatory agencies.
3 References


Foth Infrastructure & Environment, LLC, 2021b. Long Term Care and Maintenance Plan. April 7, 2021.


Figures
Appendix A

Preliminary Consolidation Analysis
APPENDIX A1 UNIFORM SETTLEMENT
Self-Consolidation of DMMF Dredged Sediment at Design Mudline Elevation

<table>
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<tr>
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$\Delta \sigma := C_c \cdot \log \left( \frac{\sigma_0 + \Delta \sigma}{\sigma_0} \right)$

\[
S = \sum_{layer} \frac{C_{(c or r)} H}{1 + \varepsilon_0} \log_{10} \left( \frac{p_0 + \Delta p_{1 to n}}{p_0} \right)
\]

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Total Cons. Sediment: 68.74 inches

3D Effect

We know from lab results that the clay is not normally consolidated and there is a ratio of OCR about 2. Therefore, it is conservative to use a Skepmton A ratio of 0.5, resulting in $k=0.91$