RIVER RAISIN AREA OF CONCERN – NAPL AREA REMEDIATION

M. Roberts[1], A. Corbin[2], P. Doody[3], T. Peters[4], and C. Robinson[5]

ABSTRACT

The primary objective of the project was to remove sediments and subgrade material containing polychlorinated biphenyls (PCBs) from the River Raisin Area of Concern (AOC) to supporting lifting the beneficial use impairment designations. The objectives of the project, as outlined in the Basis of Design Report (BODR; Anchor QEA 2016) include the following:

- Reduce relative risks to humans, wildlife, and aquatic life in the River Raisin AOC.
- Restore the aquatic habitat within the River Raisin.
- Reduce potential for migration and dispersion of contaminated sediment in the River Raisin and adjoining waterbodies.

The NAPL Area is defined as the portion of the River Raisin AOC containing an apparent nonaqueous phase liquid (NAPL) substance and concentrations of PCBs greater than 50 parts per million (ppm). The scope of remedial action activities consisted of dredging sediment and subgrade material containing PCBs to specified depths, followed by the placement of cover material in the Upper Shelf Area or an engineered cap in other dredge areas, as further described in the BODR and summarized herein.

The scope of activities performed at this site included the following:

- Installation of a sheetpile wall for shoreline erosion protection
- Dredging sediment and subgrade material containing PCBs to specified design depths
- Processing dredged materials, which included passive dewatering, water treatment, and solidifying the sediment by either Portland cement or Calciment
- Shipment and disposal of sediments to a US Ecology Toxic Substances Control Act (TSCA)-permitted landfill
- Installation and placement of a three-layer engineered cap in the Navigation Channel and Transition Areas
- Placement of residual cover material in the Upper Shelf Area
- Restoration of the sediment processing area (SPA), shoreline sediment offloading facility, access roads, construction laydown area, boat launch area and the Port of Monroe material staging area

This paper provides an overview of the remedy and a focus on the construction activities that were employed and measures used to monitor and verify compliance with the permit requirements and contract documents. The project required strong communication practices to coordinate the multiple contractors as well as to keep all the project

[1] Principal Construction Manager, Anchor QEA, LLC, Mike Roberts, P.E., CCM, 720 Olive Way, Suite 1900, Seattle, WA 98101, USA, T: (206) 971-2685, Email: mroberts@anchorqea.com.

[2] Principal Engineer, Anchor QEA, LLC, Andrew Corbin, P.E., 290 Elwood Davis Road, Suite 340, Liverpool, NY, 13088, USA, T: (315) 414-2046, Email: acorbin@anchorqea.com.

[3] Principal Engineer, Anchor QEA, LLC, Paul Doody, P.E., 290 Elwood Davis Road, Suite 340, Liverpool, NY, 13088, USA, T: (315) 414-2044, Email: pdoody@anchorqea.com.

[4] Senior Project Manager, Mannik & Smith Group, Inc., Thomas Peters, CPG, CHMM, 2365 Haggerty Road South, Canton, MI 48188, USA, T: (734) 397-3100, Email: tpeters@manniksmithgroup.com.

[5] Engineer, Anchor QEA, LLC, Chad Robinson, P.E., Grand Rapids, MI, USA, T: (231) 742-2735, Email: crobinson@anchorqea.com.

stakeholders informed and aware of project progress and issues. This permitted contemporaneous resolution of project impacts.

Keywords: Dredging, dredged material disposal, contaminated sediment, engineered capping, turbidity.

INTRODUCTION

Overview

This project was focused on the portion of the River Raisin Area of Concern (AOC) referred to as the NAPL Area (Figure 1) to address sediment and underlying subgrade material containing polychlorinated biphenyls (PCBs). Specifically, the NAPL Area is defined as the portion of the River Raisin AOC containing an apparent nonaqueous phase liquid (NAPL) substance and concentrations of PCBs greater than 50 parts per million (ppm). The scope of remediation activities performed within the NAPL Area consisted of dredging sediment containing PCBs to specified depths, followed by the placement of cover material in the nearshore area or an engineered cap in other dredged areas, as further described herein. The engineered cap included a chemical isolation layer to sequester remaining PCBs that will remain in place. The PCBs were observed in the softer overlying sediments, as well as within a very stiff underlying subgrade material characterized as glacial till, and weathered bedrock. PCBs above 50 ppm were found as deep as 8.5 meters (28 feet) below the mudline.

The scope of activities performed at this site included the following:

- Installation of a sheetpile wall for shoreline erosion protection
- Dredging sediment and subgrade material containing PCBs to specified design depths
- Processing dredged sediments, which included dewatering, water treatment, and solidifying the sediment by either Portland cement or Calciment
- Shipment and disposal of sediments to a US Ecology Toxic Substances Control Act (TSCA)-permitted landfill
- Installation and placement of a three-layer engineered cap in the Navigation Channel and Transition Area of the dredged NAPL Area
- Placement of residual cover material in the Upper Shelf Area
- Restoration of the sediment processing area (SPA), shoreline sediment offloading facility, access roads, construction laydown area, boat launch area, and the Port of Monroe material staging area

Background and Project Team

Remedial activities were conducted as part of the Great Lakes Legacy Act (GLLA) Project Agreement for the River Raisin AOC by the U.S. Environmental Protection Agency's (EPA's) Great Lakes National Program Office (GLNPO) and non-federal sponsors, including the Michigan Department of Environmental Quality (MDEQ) and Ford Motor Company (Ford). Collectively, EPA's GLNPO, MDEQ, and Ford are referred to as "Project Partners." Based on discussions among the Project Partners, the Mannik and Smith Group, Inc. (MSG) directly contracted with the selected remediation contractor, Sevenson Environmental Services, Inc. (Sevenson), on behalf of Ford, to perform the dredging, capping/cover installation, material processing, water treatment, loadout, and restoration work described herein. The Owner and Owner's Representative as defined in this document relates to Ford and MSG, respectively. Anchor QEA, LLC (Anchor QEA) was the Engineer of Record for the design and provided on-site observation and general construction management to support MSG's role of overall construction management of the project.

EPA's GLNPO contracted with Environmental Restoration LLC (ER) to install the sheetpiling, transport and dispose of processed sediments, and procure aggregate materials used for capping/covering activities. MSG was the Engineer of Record for the sheetpile design and provided quality assurance (QA)/quality control (QC) oversight of the sheetpile installation.

Close coordination between the contractors and Project Partners was extremely critical to the successful implementation of this project.

Project Identification and Site Location

The River Raisin AOC, as defined by the EPA, is located in the southeastern portion of Michigan's Lower Peninsula, in Monroe County, and is within the lower 4.2 kilometers (2.6 miles) of the River Raisin. The overall AOC extends approximately 0.8 kilometers (0.5 miles) out into Lake Erie. Previous remediation efforts have taken place in the AOC in 1997 and 2012. The NAPL area, and the focus of this project, is located within the AOC on the north side of the river, just downstream of the turning basin for the Port of Monroe, and encompasses an approximate 0.6-hectare (1.5-acre) area. The AOC, NAPL Area, and limits of work are shown in Figure 1.

Figure 1. Project location.

Dredging and capping was performed in the NAPL Area and included the following three subareas, as indicated in Figure 2:

- Upper Shelf Area: the relatively flat, elevated area closest to the shoreline
- Transition Area: the sloped area connecting the Upper Shelf Area to the Navigation Channel Area
- Navigation Channel Area: the portion of the NAPL Area located within the federally designated navigation channel of the River Raisin

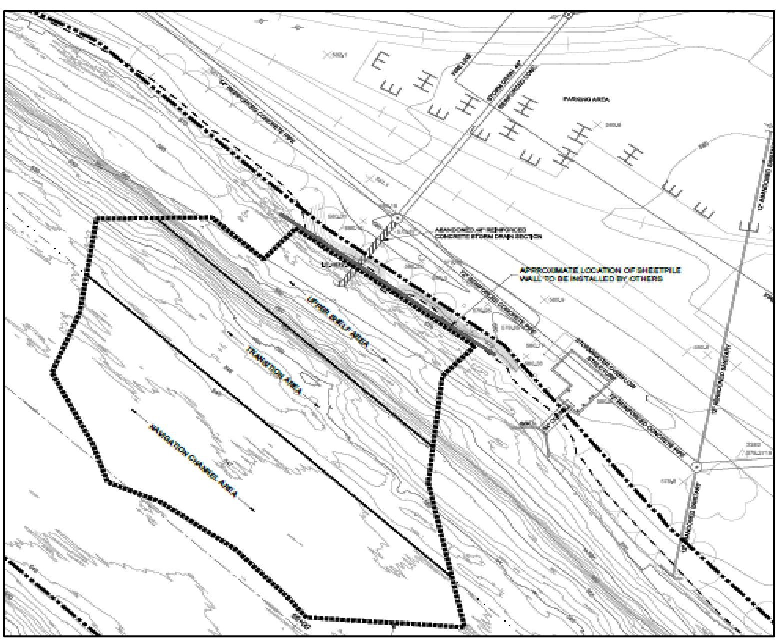

Figure 2. NAPL Area and subareas.

Historical Remedial Activities

In 1997, approximately 15,291 cubic meters (20,000 cubic yards (cy)) of sediment containing PCB concentrations up to 20,000 ppm were dredged from the AOC and disposed of at an approved upland facility. From 1998 through 2003, subsequent sediment and biological sampling identified areas within the AOC where sediment contained PCB concentrations up to 600 ppm. This sampling indicated these PCBs were potentially bioavailable to aquatic organisms and posing potentially unacceptable human health and ecological risks.

In 2004, MDEQ submitted a sediment remediation proposal to GLNPO for GLLA funding, which targeted dredging of approximately 76,455 cubic meters (100,000 cy) of PCB-contaminated sediment from the AOC and the disposal of this sediment at an approved upland facility. In 2011, as part of the GLLA River Raisin remedial design effort, EPA's contractor (CH2M Hill) submitted final engineering design documents for the sediment dredging project.

In 2012, the sediment dredging project was implemented by GLNPO contractors (including ER; J.F. Brennan Co., Inc.; and Natural Resource Technology, Inc.). During implementation, an apparent NAPL-like substance was observed in the NAPL Area, generally co-located with sediment containing PCBs at concentrations greater than 50 ppm. Specifically, the existence of NAPL was previously unknown and was discovered during post-dredging confirmation sampling at the completion of the dredging project in the fall of 2012. Following this discovery, GLNPO contractors implemented additional investigations to further understand the lateral and vertical extent of the NAPL.

Based on the 2012 observations of NAPL, post-dredging PCB confirmation sample concentrations greater than 50 ppm, and the results of the subsequent GLNPO contractor investigation, interim actions were implemented. These interim actions consisted of the installation of a sediment cover, consisting of approximately 5% organoclay and 95% sand mixture on a volumetric basis, installed at target thicknesses of 10 centimeters (4 inches) and 15 centimeters (6 inches) inside and outside the navigation channel, respectively.

From 2012 to 2015, Ford tasked MSG and Anchor QEA to further evaluate the NAPL Area and develop remedial alternatives. These alternatives were presented to the Project Partners and a final remedial design was agreed upon in November 2015 (BODR, Anchor QEA, 2015), which defined the current NAPL Area and the limits of the work described in this report and supporting documents.

Remedial Objectives

As described in the BODR (Anchor QEA 2015), the primary objective of the project is to remove sediments and subgrade materials from the NAPL Area to support lifting the beneficial use impairment designation in the River Raisin AOC. The project's objectives, as outlined in MDEQ's GLLA proposal includes the following:

- Reduce relative risks to humans, wildlife, and aquatic life in the River Raisin AOC.
- Restore the aquatic habitat within the River Raisin.
- Reduce the potential for migration and dispersion of contaminated sediment in the River Raisin and adjoining waterbodies.

Basis of Design

The BODR provides information defining the remediation of sediment containing PCBs within the NAPL Area. The BODR provides a comprehensive description of history, geotechnical site conditions, shoreline stability, river hydraulics, sediment stratigraphy, a site conceptual model, the design approach, the remediation objectives, descriptions of anticipated construction activities required to implement the design, and plans and specifications defining the work.

Remedy Description

The planned remedy to address the presence of PCBs and NAPL within the NAPL Area consisted of the following:

- Upper Shelf Area
    - Remediation activities in the 0.12 hectare (0.30-acre) Upper Shelf Area consisted of dredging to a target depth of 2.5 meters (8.2 feet). Prior to dredging operations, a steel sheetpile wall was installed by a GLNPO contractor, ER and J.F. Brennan Co., Inc., to facilitate the dredging depths directly adjacent to the shoreline (Figure 3). Over time, bathymetry in this area is expected to re-

establish itself to pre-existing conditions by natural and ongoing depositional riverine/riparian processes.

- Transition and Navigation Channel Areas
  - Remediation actions within the approximately 0.47-hectare (1.15-acre) Transition and Navigation Channel Areas consisted of dredging to a target depth of 3.0 meters (10 feet) below the mudline during sampling (actually defined by elevation). Upon completion of dredging, two types of armored engineered caps were installed, having minimum thicknesses varying from 114 centimeters (45 inches) to 152 centimeters (60 inches):
  - Cap A – minimum total thickness = 114 centimeters (45 inches)
    - A 30-centimeter (12-inch) thick chemical containment layer comprising sand and organoclay (a lower 15-centimeter (6-inch) layer to consist of 4% organoclay by weight, and an upper 15-centimeter (6-inch) layer to consist of 2% organoclay layer by weight)
    - A 15 centimeter (6-inch) thick filter layer comprising gravel material
    - A 69-centimeter (27-inch) thick armor layer comprising Ohio Department of Transportation (ODOT) Type C Material
  - Cap B – minimum total thickness = 152 centimeters (60 inches)
    - A 30-centimeter (12-inch) thick chemical containment layer comprising sand and organoclay (a lower 15-centimeter (6-inch) layer to consist of 4% organoclay by weight, and an upper 15-centimeter (6-inch) layer to consist of 2% organoclay layer by weight)
    - A 30-centimeter (12-inch) thick filter layer comprising gravel material
    - A 91-centimeter (36-inch) thick armor layer comprising ODOT Type B Material

The remedial approach planned for an estimated 20,184 cubic meters (26,400 cy) of dredged material.

Figure 3. Installed sheetpile wall adjacent to NAPL Area (prior to dredging in the NAPL Area).

PROJECT ELEMENTS

Sheetpile Installation

The sheetpile was installed along the bank of River Raisin, in support of the concurrent sediment remediation project in the River Raisin and is considered a permanent installation. The installation of the sheetpile wall was conducted in two phases. Phase I of the installation consisted of the installation of the middle portion of the total sheetpile wall, prior to the start of dredging operations, being completed on June 9, 2016. Due to presence of hard soils and refusal, the Contractor could not reach the design sheetpile wall embedment depth for all sheet sections. Just prior to the completion of the Phase I installation, heavy erosion of the riverbank occurred and the result was that the as-built location for the sheetpile wall led to unprotected riverbank on each end of the sheetpile wall. Therefore, the design was revised to add extensions, or wing walls, to the Phase I wall. Phase II of the installation started on December 12, 2016.

Dredging

In-water work began immediately following the completion of the sheetpile installation and final construction of the SPA. Initial navigational dredging was conducted near the offloading pad, to create sufficient water depth for the scows to tie off to the offloading pad. Remedial dredging then proceeded in the NAPL Area.

Construction Support Dredging

Construction support dredging was performed on June 25, 2016, from the sediment offloading pad with a CAT 349E excavator. The dredged area was contained with a double turbidity curtain to provide turbidity control, per the requirements of U.S. Army Corp of Engineers (USACE) nationwide permit. There were no turbidity permit exceedances during this operation. The purpose of this work was to provide transport scow barge draft clearance at the SPA for remedial dredging operations. This dredging allowed the transport scow barges to be tied off directly to the face of the offloading structure so they could be offloaded to the SPA for treatment, transportation, and disposal. The sediment removed had been sampled earlier during the mobilization period.

Remedial Dredging Operations

Remedial dredging activities began on June 28, 2016, within the Upper Shelf Area of the NAPL Area, which is nearshore, and adjacent to the sheetpile wall. To provide turbidity protection in nearshore shallow-water conditions, a double turbidity curtain was deployed to provide turbidity control. This was due to inadequate room to fit the moon pool against the sheetpile wall, as well as inadequate draft for the dredge barge. For deeper water operations, the moon pool turbidity control system was utilized and is described in the dredging equipment configuration discussion below. The typical sequence of dredging operations consisted of the following:

- The derrick barge was positioned on station with the Dredgepack GPS system.
- The derrick barge spuds were utilized to hold the barge in position.
- Inner and outer turbidity curtains were deployed and lowered to the river floor for turbidity control.
- Dredging was completed to design elevations, with control and tracking provided by a Dredgepack GPS system.
- Sediments were loaded into transport scow barges and offloaded to the SPA.
- When target elevations were achieved, the dredge barge and moon pool were moved and the process repeated.
- Verification of material removed and the achievement of design elevations was accomplished through periodic bathymetric surveys performed by Sevenson's subcontractor, Seaworks Group LLC.

At the beginning of dredging, softer sediments were encountered at the surface of the dredge cut, with nearly full bucket yields. Approximately midway through dredging, harder subgrade materials (characterized as glacial till, or weathered bedrock) slowed production and bucket yields were much smaller with removals often less than half of a bucket load per cycle time. Dredging production varied from a low of 34 cubic meters (45 cy) per day to a high of 447 cubic meters (585 cy) per day (Figures 4 and 5). The overall average production rate was approximately 252 cubic meters (330 cy) per day. In terms of barge loads, this equated to an average of about 8 barges per day. On September 12, 2016, Sevenson began a two-shift (day and night) dredge crew operation to meet schedule windows for cap placement, coordinate with ship movements at the Port of Monroe, and recover time due to less than anticipated daily dredge production. Dredging was completed on October 17, 2016, with 22,665 cubic meters (29,645 cy) of sediments and underlying subgrade material removed from the NAPL Area.

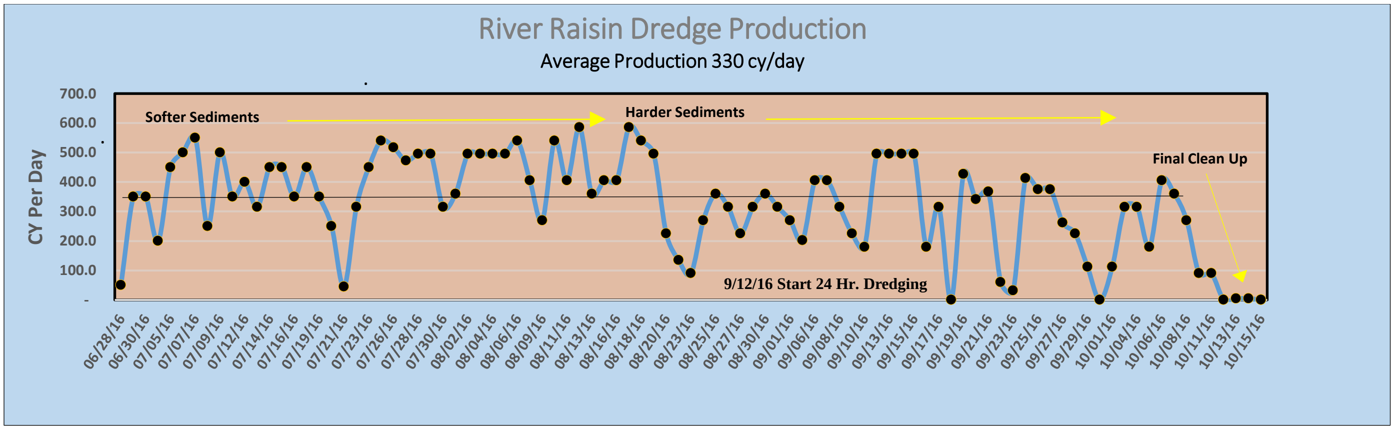

Figure 4. Daily production for dredging.

It is important to note that while dredging provided the physical removal of PCBs in the sediments and underlying subgrade, it also provided clearance so that the engineered cap (the functional remedy for the NAPL Area) could be installed leaving a minimum 0.9-meter (3-foot) buffer below the navigation channel.

Figure 5. Barge of hard friable rock typically found at greater dredge depths.

Dredging Control

Dredging control was accomplished through the use of Dredgepack and Hypack GPS software, which included GPS transmitters and receivers that were located on the Komatsu PC800 excavator, mounted to the dredge barge. The transmitters and receivers provided accurate differential position information that was linked to a laptop mounted in the excavator’s cab (Figure 6). The dredge prism design xyz files and surveyed bathymetric surface were loaded into the laptop. This provided the operator with a real-time display of the dredge bucket’s position in relation to the dredge prism and sediment surface. The system was calibrated to established reference benchmarks that were created by J.C. Andrus and Associates, a professional licensed surveyor. Periodic bathymetric surveys performed by Seaworks Group LLC were used to confirm and verify the sediments removed and design elevations attained. Adjustments were made to the Dredgepack software to correct for differences between the bathymetric surveys and the estimated dredged surface that was produced by Dredgepack.

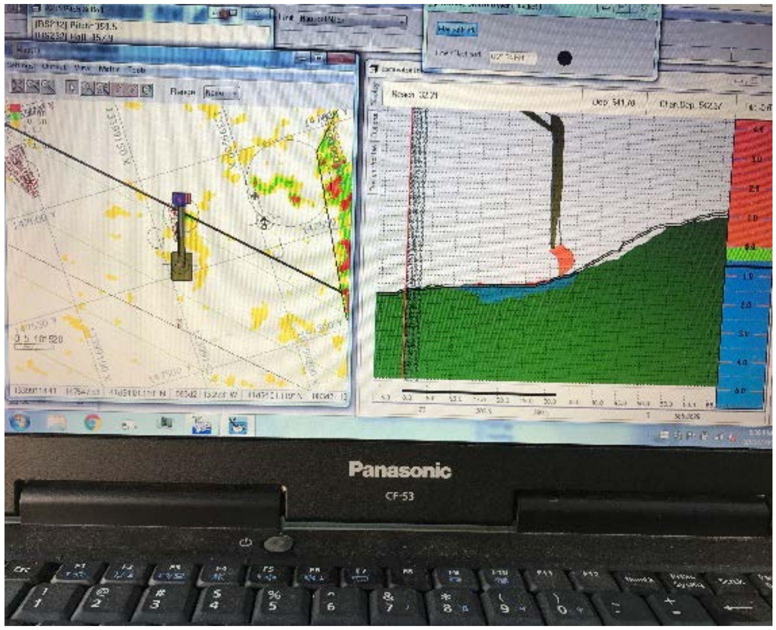

Figure 6. Operator's view of the Dredgepack software.

Dredging Equipment Configuration

The dredging equipment utilized was a 27-meter (90-foot) derrick barge fitted with three retractable spuds and a Komatsu PC800 long-reach excavator. The excavator was typically fitted with 2.1 cubic meter (2.8 cy) digging bucket and a modified thumb/plate that helped retain sediments in the bucket during sediment retrieval and barge loading, thereby reducing resuspension. Depending on bottom conditions, other bucket configurations were used, including a clamshell bucket, a smaller profile digging bucket, and a ripping tool when very hard bottom conditions were encountered. The derrick barge was primarily moved into position by either two small push boats, or a specialized tug that was used for moving sediment barges to and from the unloading facility. Small adjustments to the dredge barge position during dredging was accomplished by using the PC800 excavator's arm and bucket to move the barge to the required position.

Attached to the derrick barge, and within the swing radius of the PC 800 excavator, were drip pans that prevented drips or spills of contaminated sediments from falling into the river during barge loading operations (Figure 7). Any accumulated water was directed back into the limits of the moon pool.

Figure 7. Derrick barge with attached moon pool and drip pans in use.

Where water depth allowed, dredging excavation was performed within the confines of a mobile resuspension control system, commonly referred to as the moon pool. The moon pool was essentially a floating turbidity control system that was tethered to the front of the derrick barge. The moon pool system comprised floating sectional barges, which created the perimeter to which the turbidity curtains were affixed. The 10-foot-wide sectional barge configuration provided an inner working area of 12.2 meter (40 feet) by 12.2 meter (40 feet). On the inside of the moon pool, a non-permeable turbidity curtain was affixed to spuds that were spaced around the interior on an approximate 2.4-meter (8-foot) spacing. Along the exterior of the moon pool, a permeable turbidity curtain was attached. The permeable turbidity curtain was weighted on the bottom edge to minimize billowing. The spuds and exterior curtain were raised and lowered, depending on the working water depth. The depth adjustments were controlled with an electrical davit system that could be raised and lowered as the dredge barge moves from position to position and as water depth increased or decreased. The moon pool curtains were typically raised only enough to permit movement and to contain the turbid water within the water column of the moon pool during relocation. During dredging the turbidity curtains were lowered to the river bottom to minimize the release of resuspended sediments within the moon pool.

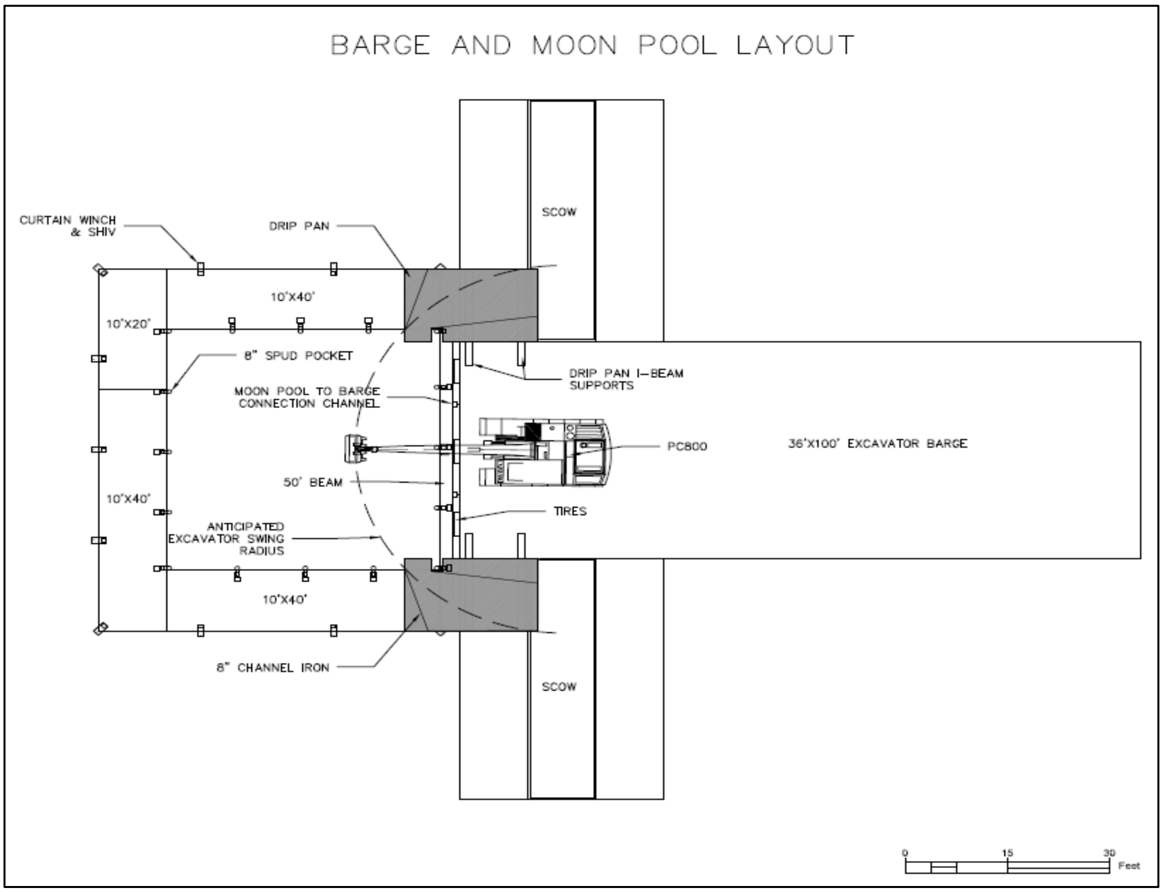

Figure 8. Plan view of moon pool configuration.

The moon pool proved to be very effective at controlling turbidity (Figure 8) and there were no turbidity permit exceedances attributable to dredging activities (see Water Quality Monitoring section).

Nearshore Dredging

For nearshore operations, where the water depth was shallow and did not allow the use of the moon pool system, a dual floating curtain system was deployed. The dual containment curtain system consisted of an impermeable inner curtain and a permeable outer curtain (Figure 9). Oil absorbent booms were deployed inside the interior curtain and in between the inner and outer curtains to capture any fuel, grease, or hydraulic oil that could be released or spilled or liberated during dredging. Sections of PVC piping were used to maintain separation between the two silt curtains.

Figure 9. Shallow-water dredging with double turbidity curtains deployed, without the moon pool.

Scows

In support of dredging, the contractor utilized three shallow draft scow barges that were used to transport sediments from the dredging operation to the SPA. Typically, two barges were used to ferry sediments with the third barge stationed at the derrick barge to allow uninterrupted dredging and loading during barge change operations. A small push tug was used to transport the scows. Figure 10 shows a scow being delivered to the SPA.

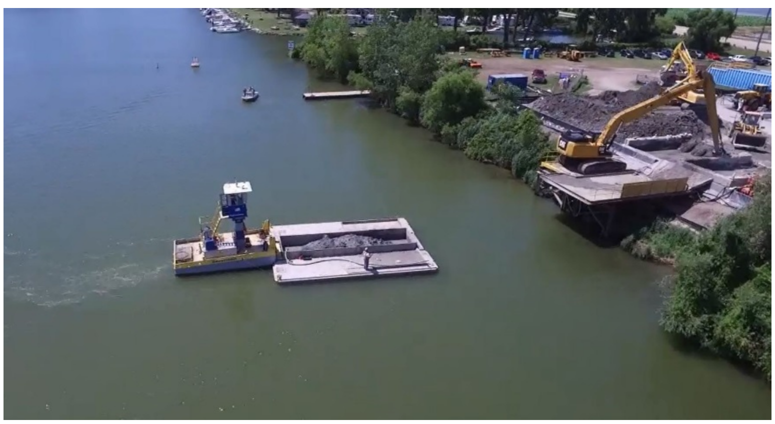

Figure 10. Transporting a full barge of sediment from the NAPL Area to the SPA and offloading area.

Sediment offloading and processing at the Sediment Processing Area (SPA)

Sediments were offloaded from scows at the SPA using a CAT 340 E excavator. The sediments were loaded into staging bins adjacent to the excavator. Note that spill plates were installed at the temporary offloading wharf within the swing radius of the excavator to contain sediment that may incidentally spill during offloading. Prior to offloading, free water was pumped from the scows (see Wastewater Treatment Process section).

The SPA (Figure 11) was an asphalt area that had been previously constructed to stockpile TSCA sediment during the 2012 dredging. The SPA was modified during the site mobilization with the addition of perimeter concrete jersey barriers and a new asphalt surface. The concrete jersey barriers were covered in a high-density polyethylene liner to contain any spillage of sediments from getting outside of the SPA facility. Contained within the SPA were a wastewater treatment system, a small sump, two silos for Calciment and Portland cement, and a truck wheel wash for cleaning sediment transport truck tires prior to the trucks exiting the SPA.

Sediment processing in the SPA was a two-step process first involving passive dewatering of sediments and then amending dredged sediments with either Portland cement or Calciment. After mixing of amendments in the staging bin area, processed sediments were allowed to cure prior to being loaded into trucks for off-site disposal.

Figure 11. Sediment processing area.

Wastewater Treatment Process

Wastewater treatment (Figure 12) was the first stage in the treatment of sediments and consisted of the following:

1. Sediment barges were first dewatered to remove standing water, which was either pumped directly into the lined sump or into geobags, adjacent to the sump. The geobags aided in reducing the sediment load on the water treatment system.
2. Water from the lined sump was treated by the on-site wastewater treatment system located within the SPA and included an oil/water separator, fine particulate filtration by geobags, sand filtration, and an activated carbon treatment train that removed PCBs and other chemicals of concern to meet permit discharge requirements per the Monroe Public Operated Treatment Works (POTW) discharge permit. The treated water was discharged to a wet well located in the adjacent Ford plant. This wet well was connected to the Monroe POTW sewer.
3. Confirmation of water treatment performance and conformance with permit requirements was determined by monthly sampling and initial performance sampling, inspection, and testing.

Figure 12. Water treatment plant within the SPA.

Sediment Amendment Process

Following completion of barge dewatering, sediments were then offloaded to the SPA. Depending on water content, sediments were segregated and allowed to passively drain and dry out in bins that were created out of concrete ecology blocks within the SPA. Portland cement or Calciment was then added to stabilize and dry the sediments to meet the waste profile requirements (no free liquids) established by the US Ecology landfill where the sediments were disposed. The amount of either Portland cement or Calciment varied from a ratio of 4 to 10% by volume. Mixing was conducted by a loader on the SPA asphalt working surface. The amended sediments were worked into stockpiles, where they could solidify (chemically react) and dry for approximately 24 hours. Daily dust monitoring and engineering controls were implemented for any fugitive dust emitted during mixing operations and other site operations.

Sediment Loading and Transportation

The bed of each transport truck was lined with poly liner prior to being loaded. After being loaded with processed sediment in the SPA, the trucks exited the SPA through an automatic wheel wash station. Each truck was weighed on a temporary certified scale upon leaving the project site for general tracking purposes. ER monitored truck scale weights and tracked overall manifests. Sediments were then transported to the US Ecology Landfill in Belleville, Michigan, for disposal, and weighed at the landfill site for determination of the actual scaled weight for manifest purposes.

Engineered Cap Components

The approved remedy to sequester PCBs remaining in deeper subgrade materials in the NAPL Area consisted of two types of multi-layered engineered caps (Cap A and Cap B) to be placed on the post-dredge surface within the Navigation Channel and Transition Areas (Figure 13). The difference between Cap A and Cap B was the size of armor stone needed to protect the chemical containment layer. As described previously, the cap profile consisted of a chemical containment layer (sand/organoclay mixture) to provide containment of potential PCB transport from underlying materials, overlain by a gravel filter layer flowed by the armor stone layer. The chemical containment layer was later modified to a single 30-centimeters (12-inch) chemical containment layer containing 3% minimum organoclay (see design revisions described previously). The engineered caps were designed in accordance with EPA's *Guidance for In-Situ Subaqueous Capping of Contaminated Sediments* (Palermo et al. 1998) with the objective of isolating PCBs, as well as resisting potential erosive forces identified within the river to protect and maintain the integrity of the caps. A residual cover area, located shoreward of the Cap Area B included a 15-centimeter (6-inch) thickness of gravel (8 centimeter (3-inch) minus gradation).

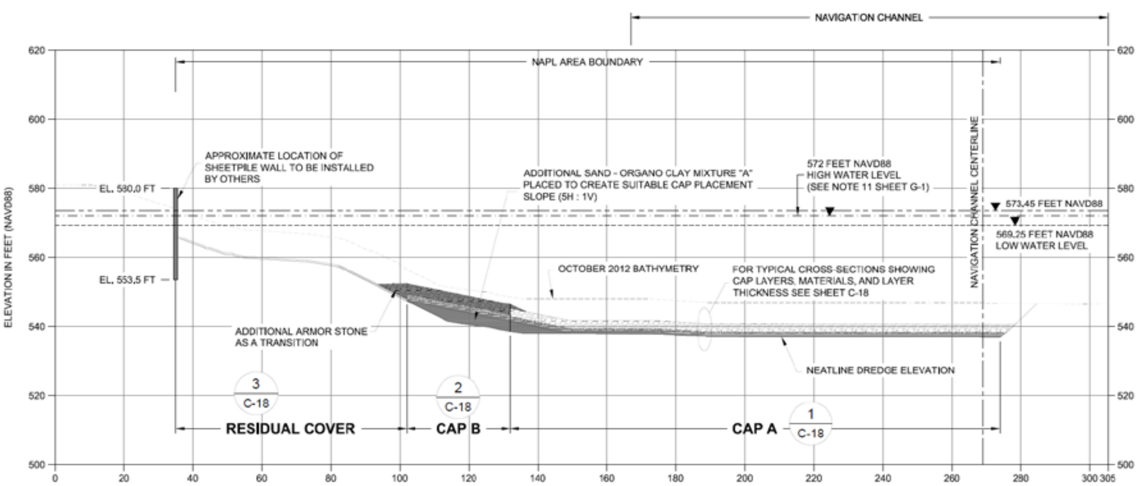

Figure 13. Engineered cap and residual cover areas.

Capping Schedule

Due to the extended dredging duration and concerns about protecting the chemical containment layer from the effects of commercial ship traffic, especially the propeller wash eroding and displacing the chemical containment layer in the navigational portion of the NAPL Area, capping was performed under a compressed 14-day schedule. Commercial ship traffic in the navigation channel was halted during a 2-week period to allow for the installation of the engineered cap. This allowed for the complete installation of the cap, which may have otherwise been compromised by propwash from passing cargo ships. This 2-week window required the contractor and the construction management team to work around the clock, 7 days per week. The chemical containment layer design was also modified during construction in an effort to decrease the overall installation duration. In lieu of two 15-centimeter (6-inch) thick layers of sand and organoclay mixture at 2% and 4% organoclay, a single 30-centimeter (12-inch) layer with a 3% organoclay mixture was installed. Placement of the engineered cap was conducted from October 29, 2016 to November 11, 2016, or 14 calendar days.

Organoclay Mixing Operations

Mixing of sand and organoclay was accomplished by loading two hopper conveyors—one for sand and one for organoclay from their respective staged stockpiles. These two hoppers then fed into another conveyor, which moved the material into a four-(quad-) screw mixing/homogenizing hopper that then conveyed the mixed sand and organoclay to a working stockpile. The feed rates of the hoppers and conveyors were adjusted to generate a stockpile with 6% organoclay (by weight) that was expected to achieve the in-place 3% organoclay requirement. Samples of the mixed material were collected at varying feed rates and analyzed by Anchor QEA so that the feed rates from the hoppers could be adjusted to achieve the 6% targeted stockpile material. Water jets were used in the mixing process to pre-wet the mixture of organoclay and sand to minimize the capillary bond of the organoclay allowing it to more effectively settle through the water column along with the sand.

Placement of the Engineered Cap

The sand and organoclay mixture was placed with the Komatsu PC800 long-reach excavator, using a 2.5 cy clamshell bucket. The sand and organoclay was placed through the interior of the moon pool, with the inner turbidity curtain removed. The use of the outer curtain contained turbidity and allowed the sand/organoclay mixture from the placement operation to fall within the approximate 18.3-meter (60-foot) by 18.3-meter (60-foot) footprint of the moon pool assembly. Lift thickness was verified by diver-assisted cores, and samples were taken via core tubes to verify the percent of organoclay in the chemical containment layer after placement to design thickness.

Placement of filter gravel and armor stone was performed by Sevenson and Geo Gradel, Sevenson’s subcontractor. The filter gravel layer was placed with clamshell buckets, without the use of the moon pool or turbidity curtains. Two separate lifts of filter gravel for cap area B were placed so as not to exceed the 15 centimeters (6-inch), per-lift maximum as called out in the specifications, to achieve a total)30 centimeters (12-inch) lift thickness for the filter layer in the Cap B area.

Geo Gradel placed armor stone with a derrick barge crane configured with a grapple for large stone/riprap and a 3.8 cubic meter (5-cy) clamshell bucket (Figure 14). The crane utilized a Clamvision/GPS system to locate and track capping placement areas. Verification of each layer of cap material placed and the achievement of design thicknesses was accomplished through daily multi-beam bathymetric surveys performed by Sevenson’s subcontractor Seaworks Group LLC.

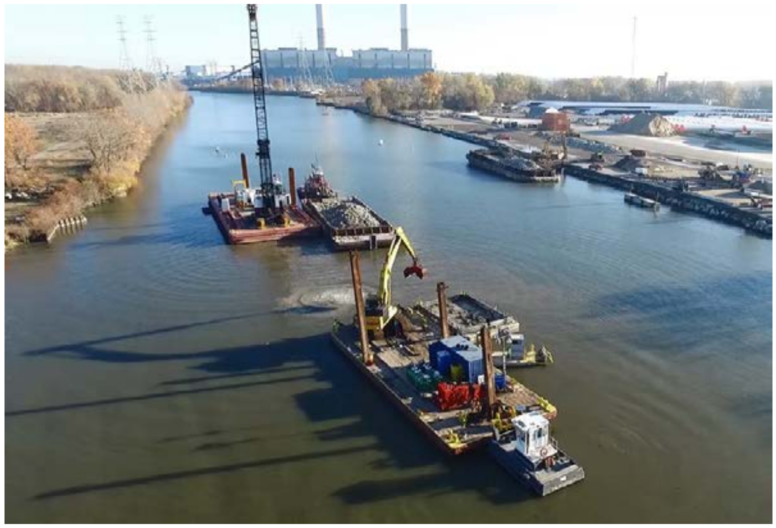

Figure 14. Placement of armor stone portion of the engineered cap.

Water Quality Monitoring

Two turbidity buoys were deployed, one approximately 76.2 meters (250 feet) upstream and one 76.2 meters (250 feet) downstream of the NAPL Area. Turbidity measurements were collected in the mid-water column at the upstream and downstream locations. Each probe automatically collected a turbidity reading every 10 minutes and data were stored on a web-based platform allowing real-time turbidity monitoring throughout construction. In addition, a cell phone notification was sent to designated project team members in the event of any turbidity quality exceedances.

A turbidity standard was defined as no more than 50 nephelometric turbidity units (NTUs) above the upstream reading, or 1.5 times the upstream reading, whichever was greater.

There were no turbidity exceedances for dredging, capping, or shoreline work that were attributable to construction during the project. There were turbidity spike anomalies, typically created by propeller wash from passing ships or boats and there were two instances where a sensor malfunctioned and was replaced, and one instance of a fouled sensor requiring maintenance on the buoys. Due to the proximity of the site to Lake Erie, the flow of the river was very slow and resulted in many of the downstream turbidity readings being lower than upstream readings (Figure 15).

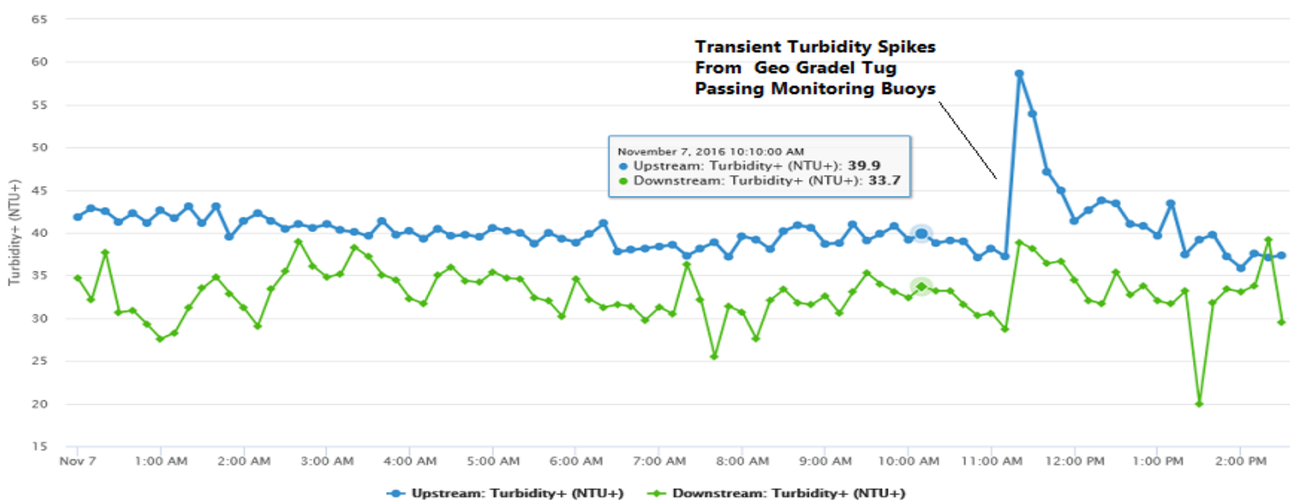

Figure 15. Typical turbidity reading from the automatic buoy system, showing the upstream readings in blue and downstream readings in green.

Decontamination and Demobilization

Upon the completion of dredging and capping, decontamination and demobilization of materials and equipment commenced. Equipment and materials that came into contact with the impacted sediment were decontaminated in general accordance with the contractor's decontamination plan. Decontamination of equipment and materials generally consisted of cleaning with brushes, scraping, and washing with high-pressure water spray. To the extent possible, equipment and materials were decontaminated within the confines of the SPA, where decontamination water could be collected and treated on site. After initial decontamination, Sevenson performed PCB wipe sampling under the observation of the Owner's on-site representative. Equipment and materials not passing the wipe testing criteria were further decontaminated using high-pressure water spray followed by the application of additional cleaning agent (Less Than Ten™). This decontamination process was repeated as needed until wipe testing results indicated PCB levels less than 10 micrograms per 100 square centimeters.

MONITORING AND MAINTENANCE

Periodic monitoring and maintenance of the installed cap is scheduled for years 1, 2, 3, 6, and 9, starting in 2017. Both chemical and physical monitoring is anticipated to assess the integrity and effectiveness of the engineered cap. Physical monitoring will consist of bathymetric surveys and probing surveys. These surveys will help define deposition of sediment in the cap area and confirm the integrity of the armor layer. Chemical monitoring will consist of surface water sampling, porewater sampling, and surface sediment sampling. Monitoring ports were integrated into the cap design and installation specifically to allow for porewater sampling of the chemical containment layer underlying the filer and armor stone. Surface water samples will be collected using semipermeable membrane devices (SPMDs) to assess PCB concentrations within the water column. The SPMD results will be compared to a baseline dataset to assess the overall changes in surface water concentrations over time. Surface sediment sampling will be performed using a ponar dredge or equivalent to take sediment samples at defined locations around the NAPL Area to assess PCB concentrations within the surface sediments. The combined results of the physical and chemical monitoring data will be used to determine the need for response actions or maintenance of the engineered cap.

REFERENCES

Anchor QEA (Anchor QEA, LLC) (2015). *Basis of Design Report*. River Raisin Area of Concern – NAPL Area.

Palermo, M., S. Maynord, J. Miller, and D. Reible (1998). *Guidance for In-Situ Subaqueous Capping of Contaminated Sediments*. USEPA, Great Lakes National Program Office, EPA 905-B96-004.

CITATION

Roberts, M., Corbin, A., Doody, P., Peters, T., and Robinson, C. "River Raisin Area of Concern – Napl Area Remediation," *Proceedings of the Twenty-First World Dredging Congress, WODCON XXI, Miami, Florida*, USA, June 13-17, 2016.