Group 1

Former Zephyr Oil Refinery Fire Suppression Ditch Area Sediment Remediation Remedy Effectiveness

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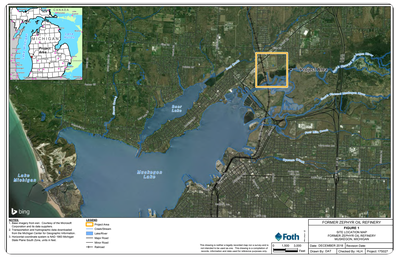
Introduction



The Former Zephyr Oil Refinery Fire Suppression Ditch Area (**Figure 1**), located in Muskegon, MI, within the Muskegon Lake Area of Concern (AOC) was remediated under the Great Lakes Restoration Initiative (GLRI) and the Great Lakes Legacy Act (GLLA) by the U.S. Environmental Protection Agency (USEPA) Great Lakes National Program Office (GLNPO) and Michigan Department of Environmental Quality (MDEQ). The USEPA contracted Sevenson Environmental Services (SES), in conjunction with Foth Infrastructure & Environment, LLC (Foth) and Environmental Consulting & Technology, Inc. (ECT), to assist with the contaminated sediment cleanup at the Former Zephyr Oil Refinery – Fire Suppression Ditch Area. The purpose of this remediation project was to address the following Remedial Action Objectives (RAOs):

- Remove sediment contributing to the following beneficial use impairments (BUIs) within the Muskegon Lake AOC:
  - Degradation of fish and wildlife populations
  - Degradation of benthos
  - Loss of fish and wildlife habitat
- Minimize potential risks to human health and the environment during remedial activities.
- Upon completion, restore habitat to the remediated areas.

The RAOs were addressed through the completion of a source removal of petroleum and heavy metal-contaminated sediment within the Fire Suppression Ditch Area and the adjacent wetland area. Removal of this sediment was intended to reduce the bioavailability of the heavy metals and petroleum compounds to benthic and aquatic organisms, as well as to wildlife and humans. A full description of the clean-up goals can be found in the *Final Basis of Design Report* (Basis of Design) (EA, 2017).

Summary of Remedial Design Work Activities

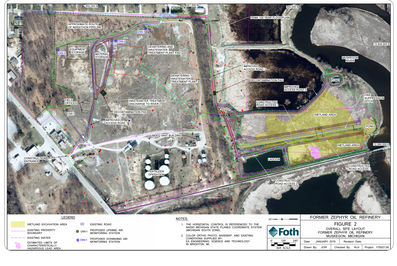
As laid out in the *Basis of Design*, the planned means, methods, and equipment for successfully completing the planned remedial design consisted of seven major project tasks:

1. In-situ dewatering of the proposed excavated wetland area.
2. Successful in-situ chemical stabilization of the characteristically hazardous area.
3. Excavation of an engineering estimate of 49,000 cubic yards (cy) of sediment to a depth of 5.05 feet over an area measuring 15.2 acres in size.
4. Dewatering, processing, and stabilization of the contaminated sediment as required for off-site disposal at a licensed non-hazardous waste landfill.
5. Loading and transportation of the processed sediments to the landfill.
6. In-situ cover placement of clean fill over exposed wetland sediment and sediment in the Fire Suppression Ditch.
7. Site restoration.

Summary of Project Work

Site Preparation and Temporary Facilities

SES received the Notice to Proceed (NTP) from the USEPA on August 20, 2017 and mobilization of project resources began on September 14, 2017. Full mobilization of equipment and materials continued throughout September. A general layout of the project site is shown on **Figure 2**.



Upland Dewatering Pad and Wastewater Treatment System

A dewatering system was constructed to dewater the wetland area during excavation of sediments. Excavated sediment was brought from the wetland project area via haul truck to the dewatering pad. The sediment was dumped onto the pad from a haul truck ramp and was spread into windrows along the southern side of the pad to be exposed to the sun and wind before being separated into one of six dewatering bins. The bins were constructed along the north side of the pad and were made of concrete blocks stacked approximately 4-feet tall. Runoff water, or water from the piled sediment, was directed towards a central sump to be pumped to the WWTS on the western side of the asphalt pad.

A temporary WWTS was constructed to remove contaminants from the surface water removed from the wetland areas, runoff water from contaminated sediment dewatering pad, and contact water generated by other construction activities. The adsorption train consisted of an organoclay filter to remove the heavier fraction of oils and a granulated activated carbon (GAC) filter to remove volatile organic carbons (VOCs). Prior to final polishing, the water was put through an ion exchange process (IEX) where the IEX resin removed dissolved lead. Treated water was conveyed from the WWTS effluent tanks to the Muskegon River discharge point. Wastewater influent and effluent were sampled on a weekly basis to ensure the discharged effluent met project goals and permit requirements.

Temporary Water Control Structures

Temporary cofferdams were constructed along the Muskegon River to keep river water out of the project site. The cofferdams were constructed of sheet pile, a lined earthen berm, and sand supersacks. Along the Muskegon River, the cofferdam sheet pilings were driving to a set elevation to keep flood waters from entering the project site below the typical high water elevation as described in the *Basis of Design*.

Excavation Activities

Following the construction of the upland staging area and temporary infrastructure, dewatering, stabilization, and removal of contaminated sediments in the shallow wetland and Fire Suppression Ditch began. The project operated on a 10-work day-per-14-calendar day schedule, with 10-hour shifts on Monday through Saturday during the first 7 days followed by 10-hour shifts on Monday through Thursday during the second 7 days. Work hours were from 0700 to 1800 hours each day.

Excavation of wetland soils and sediment begins in April 2018.

Excavation operations were performed in three main areas of the project site: the wetland area, the characteristically hazardous area, and the Fire Suppression Ditch. The first excavation activities began on April 18, 2018 on the southeast corner of the wetland area. Equipment worked across grids towards access roads from south to north.

Initial Dewatering

Since remedial activities were to be performed "in the dry" or using earth moving equipment on access roads, surface water overlaying the target sediment needed to be pumped to the WWTS. Prior to remedial activities, sumps and shallow ditches were dug into the sediment on each side of the project site to facilitate drainage towards the pond at the southern end of the Fire Suppression Ditch. Submersible pumps sent water to weir tanks located in the lowland and upland project areas to separate solids prior to treatment through the water treatment system.

Wetland Excavation

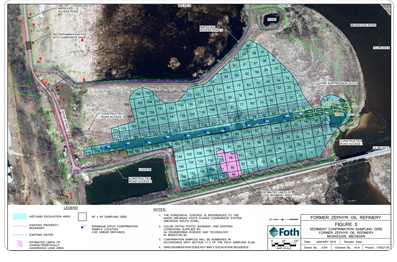
Wetland excavation began on April 18, 2018 and was completed in phases starting on the southern half of the wetland. Standard excavating equipment working from constructed access roads or off of timber mats conducted the excavation work in the dewatered wetland areas. The areas around the timber mats were excavated first with equipment working toward the nearest access road. Any vegetation removed with contaminated sediment was assumed to be contaminated and disposed of concurrently with stabilized sediment. Any large debris, most often consisting of buried logs or metal pipes, were removed during dewatering, stockpiled in the dewatering pad, and loaded with sediment for disposal.

Characteristically Hazardous Area

During pre-design investigation activities in 2014, high levels of lead were detected in approximately 10,800 square feet of the wetland along the western side of the project site. This area was defined through additional investigation in 2014 as the Characteristically Hazardous Area. To allow for disposal as a non-hazardous waste at a Subtitle D landfill facility, EnviroBlend®, a chemical stabilization/solidification agent, was added to the Characteristically Hazardous Area using specialized mixing methods and allowed to cure for two days. A total of 208.4 tons of EnviroBlend® was used to stabilize the lead in the sediment and render it nonhazardous. The treated sediments were then excavated, dewatered, and transported for offsite disposal independent of the wetland and ditch sediment.

Fire Suppression Ditch

Following the excavation of the characteristically hazardous area, the ditch excavation began on May 15, 2018. Contaminated sediment from the ditch was removed with a long reach excavator in three phases. Due to an excavation depth of 3 feet or more, excavation shoring was installed on both sides of the ditch to provide slope stability to the sediment during excavation, prevention of sloughing, and support for excavating machinery. As phases were completed, the area was backfilled with clean sand and sheet piling was pulled from the previous phase for structural support on the next phase. Excavation of the ditch also included removal of the existing water supply line that was used by the fertilizer company located adjacent to the project site.



Sediment Confirmation Sampling

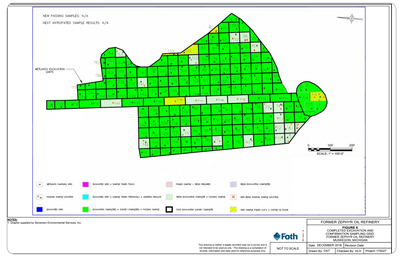
Changes in excavation depth were performed as necessary based on post-excavation survey results and confirmation sampling. The confirmation sampling grid locations are summarized on **Figure 5**. Confirmation sampling occurred concurrently with excavation to allow ease of equipment access. Sediment confirmation sampling consisted of a minimum of 2 feet of sediment core taken from a random location in a 50-foot grid across the wetland area. Ditch sediment confirmation samples were taken every 100 feet down the length of the ditch with four samples taken within the southern pond area. The core was processed with the first 6 inches of sediment analyzed for contaminants of concern (COCs), including arsenic, copper, lead, mercury, zinc, and total petroleum hydrocarbons (TPH). Post-construction samples were evaluated using the TPH and lead CUGs, as presented below, which were emphasized in the *Basis of Design*. Additional CUGs for other metals are included in the *Basis of Design*.

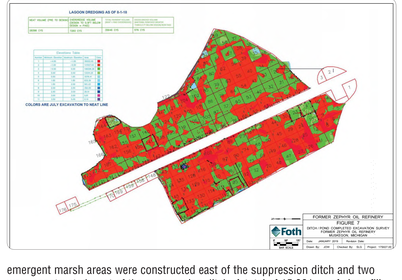
Contaminants of Concern	Cleanup Criteria		Cleanup Goals (mg/kg)
	Benthic Criteria (mg/kg)	Wildlife Criteria (mg/kg)	
Lead	128	134	128
TPH	2,000	5,020	2,000

When the first 6 inches of the sediment core failed to achieve the CUGs, the three subsequent 6-inch segments were analyzed for the COCs. If a grid required further excavation, based on confirmation sampling analytical results, the new target elevation was determined based on the 6-inch segment of the sediment core which met the CUGs, to a maximum of two additional feet of excavation depth. Confirmation samples of each re-dig were taken in new random locations within the grid and re-digs were completed until the surface segment of the sediment core met or exceeded cleanup goals. The excavation and sampling grid showing final conditions after completion of the project is shown on **Figure 6**.

Imported Clean Fill

Once results of confirmation sampling were received from the lab and validated, four emergent marsh areas were constructed in the dredged wetland area. Two





emergent marsh areas were constructed east of the suppression ditch and two were constructed west of the suppression ditch. A total of 15,381 cy of clean fill were imported over the course of the project.

Project Excavation Totals

Figure 7 shows completed project excavation relative to neat line. Excavation ended in August 2018, and the final quantities were reported to USEPA as follows:

- Total payable cubic yards removed equaled approximately 48,870 cy included all sediment removed from the ditch and wetland areas.
- Final quantities for excavation (48,870 cy) and tonnage sent to the landfill (84,178.45 tons) reflect final approvals and agreements reached between USEPA and SES concerning design excavation and additional quantities required due to analytical results.

Environmental Air Monitoring

Throughout remedial activities, air monitoring was conducted to evaluate air quality at key perimeter locations surrounding the project staging area. The perimeter air monitoring program combined real-time continuous monitoring along with a 24-hour time-weighted average monitoring at specified intervals to provide ongoing data regarding ambient air quality such that corrective actions can be taken. Air monitoring measured certain indicator organic compounds including particulate matter as PM10 and total lead at four stationary locations surrounding the site. The 24-hour measurements were carried out at a frequency of one 24-hour sample every three days at each of the four sample locations during the first 30 days of the project. After the first 30 days, the frequency was adjusted to one 24-hour sample every six days at rotating locations among the three downwind locations. No threshold exceedances was measured at any time during remediation activities.

Sediment Material Dewatering and Stabilization

The removed contaminated sediment materials from the wetland and ditch areas were transported directly from the excavation site to the upland dewatering pad. At the dewatering pad, sediment was off-loaded, distributed to bins for passive dewatering for a minimum of 24 hours, and stabilized with Portland cement. A CAT telehandler distributed Portland cement from storage silos to each bin where it would be mixed into the dewatered sediment mechanically with an excavator. The bins were mixed with approximately 10% cement by volume. Prior to being loaded for transportation to the landfill, each bin was subjected to a Paint Filter Test to determine passive moisture content. In the case of a failed paint filter test, additional Portland cement was added to the bin and the sediment was allowed to stabilize for an additional 24 hours before being re-tested. The quantity of Portland cement used over the course of the project was 3,910 tons.

Material Loading, Transportation and Offsite Disposal

Following stabilization, bins were scheduled for load-out and off-site transportation and disposal at the Waste Management Autumn Hills Landfill in Zeeland, MI from late April 2018 and continued on a daily basis through October 2018. A total of 62,000 tons of processed sediment and other related project materials were disposed of at the Autumn Hills Landfill.

Water Management

Collected water included surface water on contaminated sediment within the wetland, water drainage off the dewatering pad, decontamination water, and precipitation on the dewatering pad, decontamination pads, and within the lowland project area. All collected water was sent to the WWTS for treatment and discharge to the MDEQ permitted outfall. Approximately 91.9 million gallons of process and contact storm water were treated by the WWTS and discharged to the Muskegon River over the course of the project. Wastewater influent and effluent were sampled on a weekly basis to ensure the discharged effluent met project goals and permit requirements.

Decontamination and Demobilization

Following the completion of excavation in August 2018, all of the equipment used during the excavation and sediment processing operations and the water treatment operations were decontaminated and demobilized from the project site. Equipment including bin blocks were decontaminated with effluent water from the WWTS on the dewatering pad, allowing all decontamination water to be treated before demobilization of WWTS equipment.

Post-construction soil samples were collected from project roads and processing areas in the same locations where pre-construction samples were collected. The purpose of the sampling was to compare pre- and post-construction soil sample analytical results to ensure residual contamination was not left behind at the site at concentrations greater than project CUGs or greater than initial concentrations.

Operation and Maintenance Activities

The habitat restoration efforts in the emergent marsh areas and across the project site involves installation of native vegetation. Following successful establishment, verified by written approval of the Vegetation Establishment Period, the wetland restoration areas and upland staging area will be monitored and maintained for two years. As described in the approved *Maintenance and Habitat Restoration Monitoring Plan* (ECT, 2018), inspections will take place over two full growing seasons following the completion of the Vegetation Establishment Period. Inspections will be conducted monthly during the growing season for a minimum of six visits per season. The six visits will consist of three maintenance inspections and three monitoring inspections.

Sevenson Environmental Services, Inc.

Foth