DEWATERING AND WATER TREATMENT OPERATIONS OF THE OTTAWA RIVER SEDIMENT REMEDIATION PROJECT

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ABSTRACT

The Ottawa River Sediment Remediation Project, performed in Toledo, Ohio in 2010, involved hydraulic dredging to remove approximately 242,000 cubic yards of PCB contaminated sediment from the Ottawa River. The following describes landside operations on this project which involved dewatering the dredged sediment with geotextile tubes, as well as collecting and treating the water released from the sediment during the dewatering process. The methods and operating strategies utilized in landside operations proved to be very successful in accomplishing the major goals of the project.

Keywords: Geotextile tubes, sediment dewatering, water treatment, dredged material disposal, contaminated sediment

INTRODUCTION

Infrastructure Alternatives, Inc. (IAI) served as the Landside General Contractor for the Ottawa River Remediation Project. Landside operations were located at the Hoffman Road Landfill in Toledo, Ohio and took place over the course of 11 months, beginning with construction in February 2010. About 185,022 m^3 (242,000 yd^3) of polychlorinated bi-phenyl (PCB) contaminated dredged material was pumped to the Hoffman Road Landfill facility for processing over the course of the project. The majority of the sediment (approximately 172,789 m^3 or 226,000 yd^3) was dewatered with geotextile tubes placed in a newly constructed cell of the Hoffman Road Landfill and capped in place for final disposal.

Figure 1. Aerial view of the site during construction of the sediment dewatering pads; the larger non-TSCA pad is in the foreground.

The remaining sediments (about 12,233 m^3 or 16,000 yd^3) were believed to be in excess of 50 ppm total PCBs and were dewatered separately from the rest of the dredged material. These more highly contaminated sediments were regulated by the Toxic Substances Control Act (TSCA) and after dewatering, were hauled off-site for disposal in a TSCA permitted landfill.

TSCA regulated and non-TSCA sediments were delivered to the site by hydraulic dredges via separate High Density Polyethylene (HDPE) pipelines, were treated with a polymer emulsion and were dewatered in separate processes.

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Non-TSCA sediments were screened, thickened, treated with a second dose of polymer, and then dewatered in geotextile tubes. TSCA regulated sediments were not screened or thickened but went straight to geotextile tubes for dewatering.

Water released from the sediments in the dewatering process was collected and treated on site in a temporary water treatment plant (WTP), then discharged to the Ottawa River under an NPDES permit issued by Ohio Environmental Protection Agency (OEPA). The WTP utilized inclined plate clarifiers, sand filters, bag filters and Granular Activated Carbon (GAC) adsorption vessels.

Figure 2. Aerial view of landside operations during active dewatering. The non-TSCA dewatering pad can be seen at the top of the photo, with the TSCA pad below and to the right, and the WTP pad at the bottom of the photo.

CHEMICAL CONDITIONING OF THE DREDGED SEDIMENTS

Both dry and emulsion polymer options were competitively bid for this project. Emulsion polymer was ultimately selected by the General Contractor. An emulsion polymer make down system was cheaper to install for this particular project because it could be housed completely within two 12.2 m (40 ft) long shipping containers and required only the addition of one 79,494 L (21,000 gal) frac tank to the WTP pad. A dry polymer mixing system would have required construction of a building to store the dry polymer sacks and the mixing unit, since all of the WTP equipment was installed outdoors and there was no plan for a WTP building.

Figure 3. Emulsion polymer makedown system.

A cationic emulsion polymer was created in batches on site and was used to condition the sediment for dewatering. The neat solution (35 – 40% concentration) was diluted to 1% solution for application by two separate polymer make down systems, each enclosed in its own shipping container. Each make down system was capable of producing 757 L/min (200 gal/min) of diluted polymer solution, providing a total capacity of 1,514 L/min (400 gal/min) when operated simultaneously.

Diluted polymer was applied to the separate non-TSCA and TSCA regulated sediment header systems with 1,136 L/min (300 gal/min) progressive cavity pumps. The output of the polymer application pumps was automated, ramping up and down based upon real-time measurement of the dredge slurry flow rate and density, to produce the desired lbs/dry ton polymer dosage rate. The target polymer dosage rate was determined by operations staff, based upon jar tests and visual observation of floc formation in the header as well as the rate, appearance and volume of water released from the geotextile tubes.

SCREENING, THICKENING AND GEOTEXTILE TUBE DEWATERING OF NON-TSCA SEDIMENTS

Following the application of polymer, sediments not regulated by TSCA (non-TSCA) were screened with a static screen to remove large debris and then with shaker screens to remove additional debris and large coarse grain material. Each shaker screen was situated at the head of a sediment thickener, which removed free water by settling action. Separated water from the top of the thickeners flowed to the WTP for treatment. Underflow from the thickeners (thickened sediment) was treated with a secondary dose of polymer, and then pumped to the non-TSCA dewatering pad for dewatering in geotextile tubes.

Figure 4. Sediment thickeners

The non-TSCA dewatering pad was designed to accommodate up to 13,716 lineal m (45,000 lineal ft) of geotextile tubes, providing about 221,721 m^3 (290,000 yd^3) of capacity with geotextile tubes stacked in six layers over an area approximately 229 m by 180 m (750 ft by 590 ft). In fact, about 11,582 lineal m (38,000 lineal ft) of geotextile tubes, stacked in five layers, were filled in the non-TSCA pad, containing about 172,789 in-situ m^3 (226,000 in-situ yd^3) of material.

Figure 5. Non-TSCA dewatering pad with geotextile tubes stacked in 5 layers.

In order to match the existing elevations of the landfill, the non-TSCA pad was designed with a two tiered surface. The terraced dewatering pad limited the capacity of the second layer of the geotextile tubes filled on the lower tier, but this slight reduction in capacity was necessary to produce a level surface for stacking the three layers above. Overall, the design worked well, and reduced the total cost to the client.

Figure 6. Aerial view of the non-TSCA dewatering pad showing the tiered surface.

The non-TSCA pad was installed over a new landfill cell. The filled geotextile tubes will remain in place and be covered with fill as part of the closure of that cell.

GEOTEXTILE TUBE DEWATERING OF TSCA REGULATED SEDIMENTS

TSCA sediments were dredged intermittently with 33 total days of dredging taking place over a two month period. TSCA dredging was performed concurrently with non-TSCA, so separate crews performed dewatering operations on both non-TSCA and TSCA dewatering pads simultaneously.

TSCA sediments were not screened or thickened prior to dewatering in geotextile tubes because of the relatively low volume of TSCA material to be handled during the course of this project. TSCA material was pumped from the dredge directly to the geotextile tubes in the TSCA dewatering pad.

The TSCA dewatering pad was designed to hold 11,468 m^3 (15,000 yd^3) of dredged material in 655 lineal m (2,150 lineal ft) of 24 m (80 ft) circumference geotextile tubes, stacked in two layers. The actual volume of material received at the TSCA pad was nearly 12,233 m^3 (16,000 yd^3), which required some redesign of the tube layout scheme and the addition of 104 lineal m (340 lineal ft) of geotextile tubes.

Figure 7. TSCA dewatering pad during active dewatering operations.

WATER TREATMENT

Sumps were installed in each dewatering pad to receive water released from the geotextile tubes and stormwater. The non-TSCA sump flowed by gravity to the WTP for treatment; the TSCA sump was transferred by a 20 cm (8 in) diameter diesel pump.

The WTP incorporated three treatment processes: flocculation, coagulation and settling; two step filtration; and Granular Activated Carbon (GAC) adsorption. These processes removed suspended and colloidal solids and dissolved organic contaminants (such as PCBs) from the flow of water.

Figure 8. Aerial view of the WTP equipment during operations.

Flocculation, Coagulation and Settling

During normal dredging operations, the WTP received about 11,356 L/min (3,000 gal/min) of influent from the dewatering pads and the sediment thickener. Flocculation, coagulation, and settling of suspended solids were achieved using seven inclined plate separators (lamella clarifiers) arranged in parallel. The chemical coagulant used was ferric chloride ($FeCl_3$). The angle of the inclined plates in the lamella clarifiers enhance settling of coagulated floc. Effluent from the lamella clarifiers was monitored for turbidity, and then flowed to four 79,494 L (21,000 gal) frac tanks, which served to equalize the flow from the lamella clarifiers prior to further treatment.

Filtration

A 149 kW (200 HP) electric drive pump was used to draw water from the frac tanks and transfer it to five multi-media pressurized filters (operated in parallel). The filter beds included three sizes of filter gravel, filter sand and anthracite. Pressure drop across the filters was monitored to determine when backwashing was required. The multi-media filters were piped so that one filter could be backwashed while the others remained in service. The backwash was equipped with a hydrogen peroxide feed to help remove sticky buildup in the media.

Filtered water exited the multi-media filters and flowed through a common pipe to the bag filters, where the flow was split again, among the three units. Bag filters physically separate solids from the flow as the water passes through filtering fabric (bags). The bag filters acted as a buffer to protect the downstream GAC vessels from solids which would foul the GAC media and shorten its service life.

GAC Adsorption

GAC adsorption was the final process utilized in the WTP. The GAC was used to remove any remaining organic contaminants (such as PCBs) in the flow before it was discharged to the Ottawa River. A total of ten GAC vessels were arranged in five pairs of lead-lag units. Each vessel was loaded with 9,072 Kg (20,000 lbs) of GAC and was sized to treat up to 3,785 L/min (1000 gal/min). The turbidity and pH of the GAC effluent was closely monitored to verify water quality before discharge to the river. Differential pressure across the vessels was monitored to determine when backwashing was needed.

A side stream from the GAC vessels was used to fill three 21,000 gal frac tanks. This water was used for backwashing, polymer makedown and as mechanical seal water for the last dredge booster pump station.

Treatment Residuals

The WTP was situated on a gravel pad with a clay liner. The lamella clarifiers were installed on a concrete pad within the footprint of the larger gravel pad. The concrete lamella pad was constructed with berms and also had a sump for collection of lamella sludge. Water treatment residuals (lamella sludge, filter and GAC backwash water) were transferred to a waste tank, and then pumped to a geotextile tube in one of the two sediment dewatering pads (depending on whether or not TSCA dredging was on-going; during periods of TSCA dredging, water treatment residuals were directed to the TSCA pad for dewatering). After TSCA dredging was completed, water in the treatment plant waste tank was tested for PCBs to verify the contents were below TSCA levels before the contents of the tank could again be pumped to the non-TSCA pad for dewatering.

NPDES Permit Monitoring

The NPDES permit issued for the project set forth effluent limitations for Total Suspended Solids (TSS), pH, total PCBs and Total Filterable Residue (TFR), along with a rigorous sampling and analysis regimen. An Ohio Class 3 licensed operator served as Operator of Record for the facility.

CHALLENGES OF THE PROJECT

Fast Tracked Water Treatment Plant Design and Construction

The initial project schedule called for construction of the WTP and sediment dewatering pads, as well as dredging and dewatering of the TSCA sediment to be completed in the fall of 2009, with dredging and dewatering of the non-TSCA sediment to be completed in 2010. For a number of reasons, the project was delayed until the 2010 dredging season and needed to be completed within that calendar year.

As a result of this compressed schedule, WTP design was scaled back to achieve one season operation, with the installation and start-up of the systems to be completed in 60 days. A combination of used and rented equipment would be placed on a gravel pad with a small building to house controls. IAI engineering and dewatering operations staff worked together to update the design and draw plans for a more economical system that would meet the challenge of the new design parameters.

Non-TSCA and TSCA Dredging Operations Conducted Concurrently

In order for the non-TSCA and TSCA dredging operations to be conducted simultaneously, each dewatering system had to be fully separate and independently functioning. Special considerations had to be made for handling water treatment residuals during TSCA dredging. Crew strength had to be great enough to operate each system successfully without negatively impacting either dredging or water treatment operations.

TSCA Material Hauled Off-Site After Minimal Dewatering Time

The Hoffman Road Landfill where landside operations took place is a municipal landfill owned by the City of Toledo. It is not licensed to accept TSCA regulated waste. The geotextile tubes in the TSCA dewatering pad had to be transferred off site to a TSCA licensed landfill for final disposal. It was desired that the TSCA material be hauled off site beginning in November 2010. The last day of TSCA dredging was September 8, which left minimal time for the TSCA tubes to dewater.

The TSCA geotextile tube contents were too wet to be accepted at the TSCA landfill initially. In order to make the material easier to handle and acceptable at the landfill, IAI began mixing lime kiln dust with the TSCA material. Although concerns arose about the compressive strength of the material, it was eventually found to be >50% non-cohesive material and was only required to pass a slump test. IAI began performing slump tests at 30 minute intervals using a standard slump cone (ASTM C 143). None of the slump tests performed on site failed. As weather permitted, IAI continued mixing lime kiln dust into the TSCA material at a rate to keep prepped material ready for the hauling contractor until the task was complete on December 14. In all, IAI added about 907 metric tons (1,000 U.S. tons) of lime kiln dust to the TSCA sediment prior to its being hauled off site for final disposal.

Cold Weather Demobilization

Dredging and active sediment dewatering operations ceased on October 21, 2010. Operation of the WTP continued until December 21, with decontamination and demobilization wrapping up January 26, 2011. Freezing temperatures and icy conditions made demobilization difficult and increased the risk of personnel injury.

To prevent cold stress and related injuries, crews utilized electric and propane space heaters where possible, as well as personal hand and foot warmers and additional cold weather clothing. Personnel also began taking warm-up breaks in the heated office trailers.

To keep the WTP pipelines and equipment from freezing, water was continuously circulated through the plant. Heat tape was used to protect fragile sample ports and propane torches and torpedo heaters were used to thaw any valves that did freeze. All of these measures took time and patience to execute, but were absolutely necessary to accomplish the decontamination and removal of equipment from the site during the winter months.

SUMMARY AND CONCLUSIONS

Landside operations for the Ottawa River Sediment Remediation Project were completed successfully during the winter of 2010 – 2011. Highlights include:

- While logging 77,600 man hours during performance of the project, IAI personnel experienced no OSHA recordable injuries or illnesses.
- Ninety-six percent (96%) up time efficiency was achieved for sediment dewatering and WTP operations.
- Dredging and active dewatering operations finished ahead of schedule.
- No NPDES permit effluent quality limitations were violated while the WTP was in operation.

There were several critical factors that led to the ultimate overall success of both the sediment dewatering and water treatment operations. Those factors include:

- Leadership: The project sponsors, the Ottawa River Group (ORG) and the United States Environmental Protection Agency (USEPA) Region 5, along with the project coordinator, de maximis, inc., fostered a spirit of cooperation and accountability among all of the contractors involved. This created a true team atmosphere, which increased efficiency across the board and allowed contractors to work together to solve problems for the benefit of the project as a whole.
- Communication: Open, honest communication among the project team was critical to planning for, identifying and successfully handling challenges. Close communication among the sediment thickener, dewatering pad and WTP personnel was also crucial to maintaining tight control of the dewatering system as a whole.
- Experience: Involving as many experienced personnel as possible from previous large scale sediment dewatering projects allowed us to benefit from lessons learned during those previous projects and build many of those lessons into standard operating procedures and contingency plans for the Ottawa River project.
- Process control: Traditional water treatment process control techniques were used to meticulously monitor and manage chemical conditioning in order to achieve desired sediment dewatering in the geotextile tubes and at the same time, protect the WTP from residual polymer.
- Adaptive system design: The sediment dewatering system was designed to allow six different modes of operation. Under normal operating conditions, non-TSCA dredge flow was processed by the sediment thickeners and could be sent to either the east or the west side of the non-TSCA dewatering pad, or to both sides simultaneously. If a pump malfunctioned or required maintenance, the sediment thickeners could be bypassed and dredge flow could be run directly into the east, west, or to both sides of the non-TSCA dewatering pad. This arrangement enabled full scale dewatering operations to continue even while maintenance was being performed. Efficiency on the Ottawa River project was very high, which can partially be attributed to the adaptive design of the sediment dewatering system, reducing the effect of sediment dewatering on dredge up time.
- Coordination: Working closely together as a team, many subcontractors came together to design and install a water treatment system made up of many separate used and rented pieces of equipment.

- Personnel: Not enough can be said about the devoted and hardworking crews who put in long hours making this project a success on a day to day basis.

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