**REMEDIAL ACTION CONTRACT 2 FOR
REMEDIAL, ENFORCEMENT OVERSIGHT, AND
NON-TIME CRITICAL REMOVAL ACTIVITIES
IN REGION 5**

DRAFT

REMEDIAL ACTION REPORT

**OTTAWA RIVER
LUCAS COUNTY, OHIO**

**Prepared for
United States Environmental Protection Agency
Region 5
77 West Jackson Boulevard
Chicago, IL 60604**

Work Assignment No:	146-RARA-1520
Contract No:	EP-S5-06-02
Date Submitted:	September 2011
Prepared by:	SulTRAC
SulTRAC Project Manager:	Jack Brunner
Telephone No:	(312) 201-7788
EPA Work Assignment Manager:	Scott Cieniawski
Telephone No:	(312) 353-9184

CONTENTS

CONTENTS

Section **Page**

FIGURES

TABLES

APPENDICES

1.0 INTRODUCTION

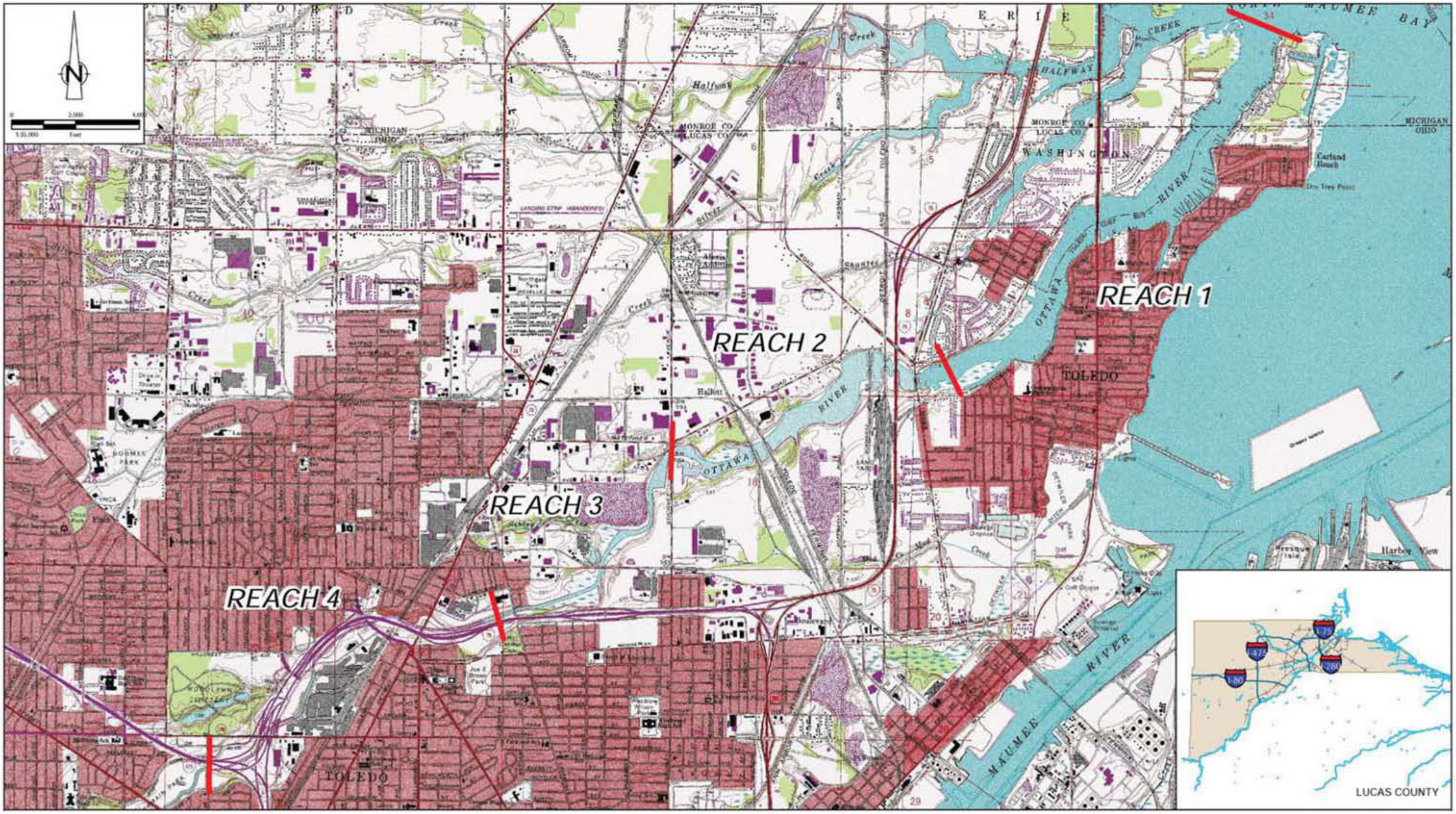
SulTRAC has prepared this remedial action report (RAR) as a supporting document for the U.S. Environmental Protection Agency (EPA) Region 5 under Work Assignment No. 146-RARA-1520, Remedial Action Contract (RAC) 2 No. EP-S5-06-02 for the remedial action (RA) completed at the Ottawa River in Lucas County, Ohio. The Ottawa River is approximately 15 miles long located in northwest Ohio, and its drainage basin covers an area of 221 square miles in Ohio and Michigan. The Ottawa River basin is a constituent portion of the Maumee Area of Concern (MAOC) identified by the International Joint Commission, which includes the Maumee River, the Ottawa River, and a number of other rivers and creeks draining into western Lake Erie. The purpose of the Ottawa River RA was to remove a significant volume of contaminant sediment from the Ottawa River and thus contribute to the delisting of one or more of the following beneficial use impairments that have been identified for the Ottawa River and the MAOC:

- Restrictions on fish or wildlife consumption
- Degradation of fish and wildlife populations
- Fish tumors or other deformities
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Beach closings
- Degradation of aesthetics
- Loss of fish and wildlife habitat.

The Ottawa River is divided into four reaches (Reaches 1 through 4) defined as follows:

- Reach 1 starts at River Mile (RM) 0 at Maumee Bay to RM 3.2 just downstream of Suder Road.
- Reach 2 extends from RM 3.2 to RM 4.9 at Stickney Avenue (1.7 miles long).
- Reach 3 extends from RM 4.9 to RM 6.5 just upstream of Lagrange Road (1.6 miles long).
- Reach 4 extends from RM 6.5 to RM 8.8 at Auburn Road (2.3 miles long).

Reaches 2, 3, and 4 of the Ottawa River constituted the project area for this RA, which was undertaken through the Great Lakes Legacy Act (GLLA) by the EPA Great Lakes National Program Office (GLNPO) and its non-federal partner, the Ottawa River Group (ORG). Figure 1-1 shows the Ottawa River project location. This stretch is highly industrialized, with numerous historical and current industrial facilities, combined sewer overflows, and landfills surrounding and/or discharging into the Ottawa River. The primary contaminants of concern (COC) are polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbons (PAH), heavy metals (primarily lead), and oil and grease.



LEGEND

River Mile Marker

Modified from MSG 2010a.

OTTAWA RIVER REMEDIAL ACTION
TOLEDO, OHIO

FIGURE 1-1
PROJECT LOCATION

SulTRAC

The selected remedy, as detailed in the GLLA – Request for Projects, called for environmental dredging, dewatering, and disposal of approximately 250,000 cubic yards of contaminated sediment from Reaches 2, 3, and 4 of the Ottawa River. The major components of the RA designed by ORG included:

- Constructing a water treatment plant (WTP) and two dewatering pads at the Hoffman Road Landfill (HRLF)
- Dredging contaminated sediments from the Ottawa River
- Hydraulically transporting sediments from the dredging locations to the dewatering pads at HRLF
- Dewatering sediments utilizing geotextile tubes (geotubes)
- Treating water from sediment dewatering activities to meet permit requirements, and discharging that water (post-treatment) to the Ottawa River
- Disposing of dewatered sediments at the HRLF
- Disposing of dewatered sediments containing greater than 50 parts per million (ppm) PCBs at a Toxic Substances Control Act (TSCA) licensed landfill.

ORG is an association of private entities (Honeywell, Chrysler, GenCorp, Allied Waste, DuPont, United Technologies, and Illinois Tool Works) and the City of Toledo. ORG is the non-federal partner established to implement the RA that was to clean up the Lower Ottawa River. ORG designed the RA, which EPA, ORG, and their contractors partnered to implement. SulTRAC (a joint venture between Tetra Tech and Sullivan International Group) and de maximis, inc. (de maximis), were the prime RA contractors for EPA and ORG, respectively. SulTRAC's main RA responsibilities on behalf of EPA included the following activities:

- Environmental dredging of about 227,000 cubic yards (CY) of contaminated sediment from the Ottawa River at 33 separate dredge management units (DMU). Fourteen sub-areas within these DMUs contained about 14,500 CY of sediment with TSCA-level concentrations of PCBs (greater than or equal to 50 ppm or milligrams per kilogram [mg/kg]), and are referred to herein as "TSCA Areas."
- Hydraulic transport of sediment from the dredging/excavation site to the dewatering facility located at the HRLF property.
- Construction of separate 10- and 2-acre dewatering pads for TSCA and non-TSCA sediments, respectively, as well as connection of pipeline(s) to and from the dewatering pads, WTP, and/or discharge areas.
- Procurement and supply of dewatering polymers and geotubes for use by ORG.
- Off-site transport and disposal of approximately 14,500 CY of dewatered sediment containing PCBs greater than 50 ppm at a TSCA-licensed landfill; the dewatered non-TSCA sediment was left in place on the dewatering pad at HRLF, and the geotubes of sediment were covered with soil.

- Monitoring of dredging operations to assure conformance with design plans and permit requirements according to the "Ottawa River Cleanup Project Dredge Monitoring Plan" provided by ORG (CRA 2010).
- Confirmation sampling to determine if the RA had met the remedial goals outlined in the engineering design plans.

The main RA responsibilities of de maximis on behalf of ORG included the following activities:

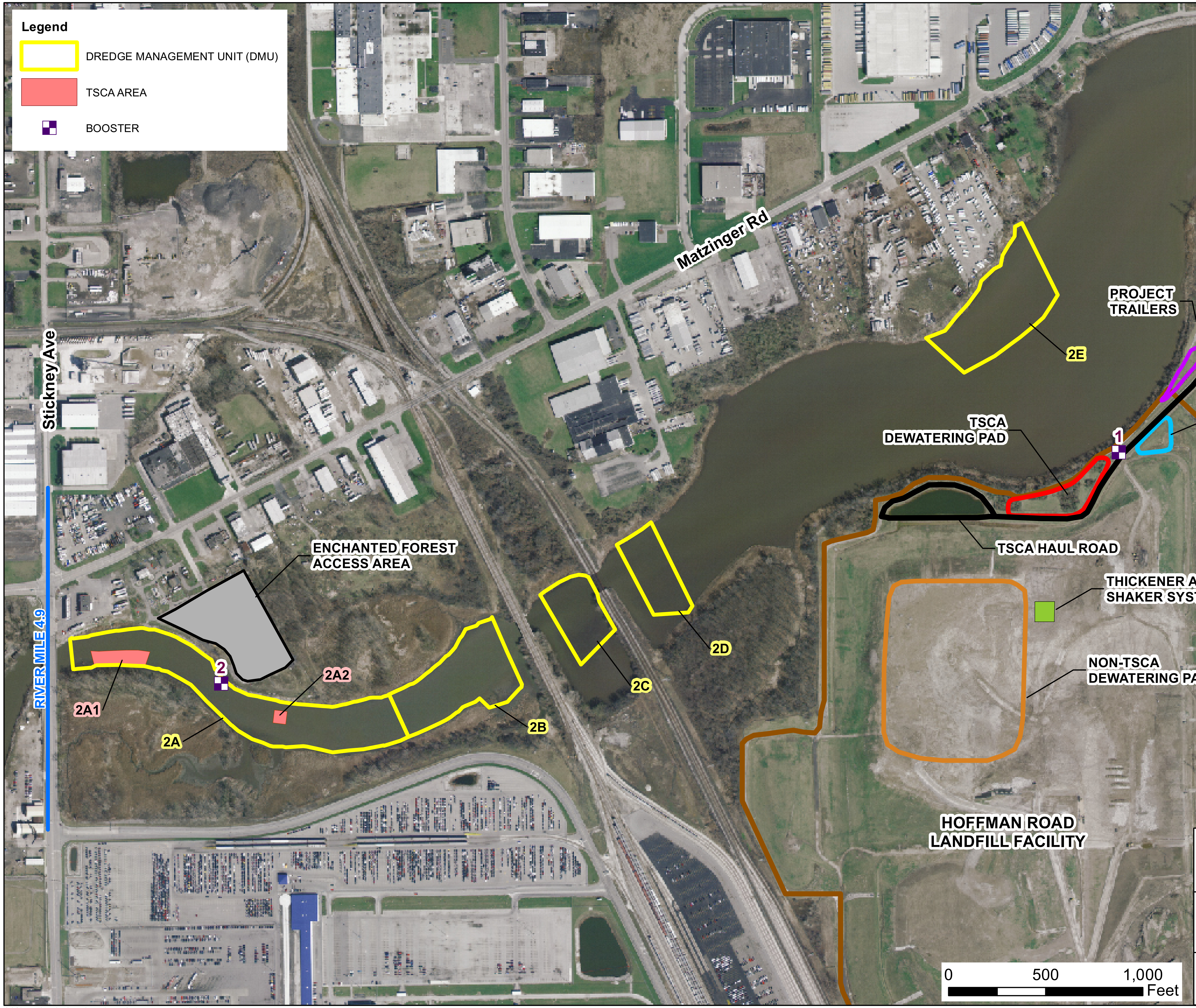
- Obtaining and maintaining necessary project permits
- Constructing and operating the WTP on HRLF property
- Dewatering contaminated sediment in dewatering pads
- Capping non-TSCA pad at completion of environmental dredging
- Mechanically excavating contaminated material from Sibley Creek and disposing of it at HRLF.

The major RA subcontractors, their roles, and their associated prime contractors are listed in Table 1-1. The DMUs, TSCA Areas, and other significant RA components within Reaches 2, 3, and 4 of the Ottawa River area shown in Figures 1-2, 1-3, and 1-4, respectively.

This RA report was prepared in accordance with the fact sheet entitled *Remedial Action Report, Documentation for Operable Unit Completion*, Publication 9355.0-39FS, June 1992 (EPA 1992). The following sections provide additional details regarding SulTRAC's RA activities performed for EPA. Section 2.0 presents a chronology of RA events. Section 3.0 discusses performance standards and construction quality control (QC) during RA activities, including dewatering, pad construction, geotube manufacturing, and dredging. Section 4.0 summarizes RA construction activities. Sections 5.0 and 6.0 present final inspection results and certification that the remedy is operational and functional. As discussed in Section 7.0, no operation and maintenance (O&M) requirements apply to this RA. Section 8.0 summarizes costs of project activities for which EPA and SulTRAC were responsible. A list of sources referenced to develop this report appears following Section 8.0. Additional details on the work conducted by ORG and de maximis are in the "Ottawa River Land Side Report" (de maximis 2011).

Table 1-1 Subcontractor List

Subcontractor	Task	Prime
Miller Bros Construction Inc. (MBC)	Construct dewatering pads	SulTRAC
J.F. Brennan (JFB)	Conduct environmental dredging; dispose of TSCA sediment	SulTRAC
Geo Synthetics LLC (GSI)	Supply geotextile tubes (geotubes)	SulTRAC
Belmont Labs and Pace Analytical	Analyze confirmatory sediment samples	SulTRAC
Axchem USA Inc.	Supply polymer	SulTRAC
Infrastructure Alternatives, Inc. (IAI)	Construct and operate WTP; dewater contaminated sediment	de maximis
SUNPRO	Cap non-TSCA dewatering pad; excavate contaminated sediment from Sibley Creek	de maximis



OTTAWA RIVER REMEDIAL ACTION
TOLEDO, OHIO

FIGURE 1-2
PROJECT AREA - REACH 2

SulTRAC

G:\G\9021\046\07\mxd\2011\REACH-2.mxd 9/8/2011 m.banh

OTTAWA RIVER REMEDIAL ACTION
TOLEDO, OHIO

FIGURE 1-3
PROJECT AREA - REACH 3

SulTRAC

G:\G\9021\046\07\mxd\2011\REACH-3.mxd 9/8/2011 m.banh

OTTAWA RIVER REMEDIAL ACTION
TOLEDO, OHIO

FIGURE 1-4
PROJECT AREA - REACH 4

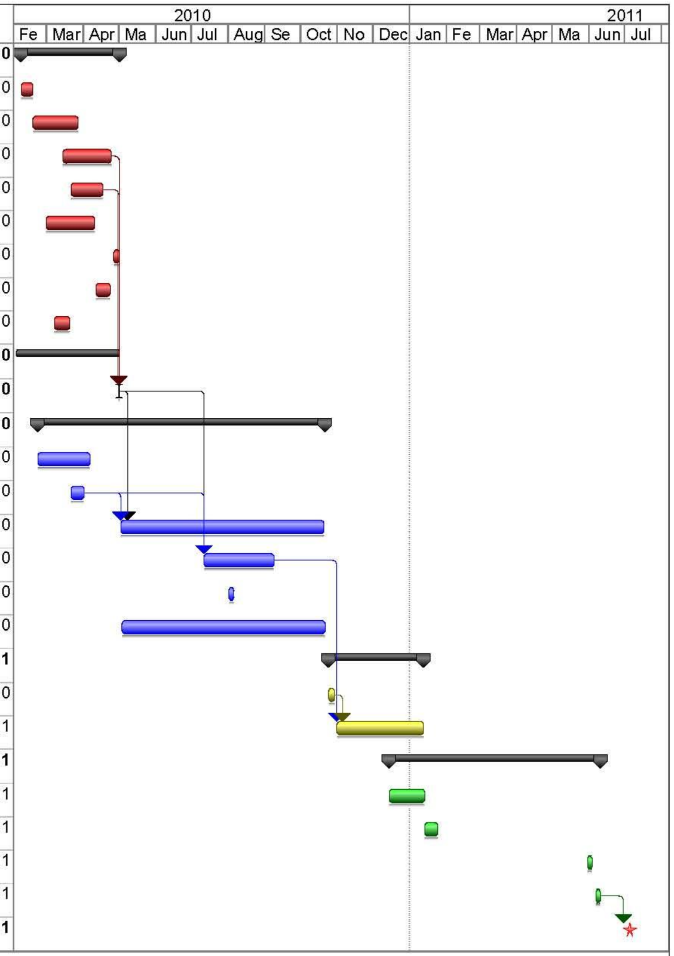
2.0 CHRONOLOGY OF EVENTS

Mobilization to the project site began on February 1, 2010, and the final RA inspection for the project was conducted on July 6, 2011. Construction of the dewatering pads and the WTP began in February 2010, with substantial completion of the dewatering pads on May 1, 2010. Dredging activities began on May 3, 2010, and concluded on October 21, 2010. TSCA load out began on October 25, 2010, and was completed on January 12, 2011. TSCA dewatering pad and other site restoration concluded on June 10, 2011.

Figure 2-1 shows additional detail regarding the project schedule.

Figure 2-1 Ottawa River Remedial Action Project Schedule

ID	Task Name	Duration	Start	Finish
1	**Dewatering Pad Construction (Miller Brothers)**	**67 days**	**Mon 2/8/10**	**Sat 5/1/10**
2	Site mobilization	8 days	Mon 2/8/10	Wed 2/17/10
3	Non-TSCA Earthwork and Waste Relocation	30 days	Thu 2/18/10	Sat 3/27/10
4	Non-TSCA Pipeline Installation	35 days	Mon 3/15/10	Sat 4/24/10
5	Non-TSCA Liner and Geocomposite Installation	23 days	Mon 3/22/10	Sat 4/17/10
6	TSCA Earthwork and Waste Relocation	34 days	Mon 3/1/10	Sat 4/10/10
7	TSCA Pipeline Installation	5 days	Tue 4/27/10	Sat 5/1/10
8	TSCA Liner and Geocomposite Installation	11 days	Mon 4/12/10	Fri 4/23/10
9	Landfill Gas System Installation	11 days	Mon 3/8/10	Sat 3/20/10
10	**Water Treatment Plant (WTP) Construction (Ottawa River Group)**	**69 days**	**Thu 2/4/10**	**Sat 5/1/10**
11	**Sediment Delivery System and WTP Testing**	**1 day**	**Sat 5/1/10**	**Sat 5/1/10**
12	**Dredging (J.F. Brennan)**	**183 days**	**Mon 2/22/10**	**Thu 10/21/10**
13	Site Mobilization	35 days	Mon 2/22/10	Tue 4/6/10
14	Pre-Dredge Surveys	10 days	Mon 3/22/10	Thu 4/1/10
15	Non-TSCA Sediment Dredging	125 days	Mon 5/3/10	Wed 10/20/10
16	TSCA Sediment Dredging	43 days	Mon 7/12/10	Wed 9/8/10
17	Temporary Dam Installed	4 days	Mon 8/2/10	Thu 8/5/10
18	Post-Dredge Surveys	125 days	Tue 5/4/10	Thu 10/21/10
19	**TSCA Load Out (J.F. Brennan)**	**58 days**	**lon 10/25/10**	**Wed 1/12/11**
20	TSCA Load Out Road Improvements	5 days	lon 10/25/10	Fri 10/29/10
21	TSCA Sediment Load Out	53 days	Mon 11/1/10	Wed 1/12/11
22	**TSCA Dewatering Pad Restoration**	**128 days**	**Ved 12/15/10**	**Fri 6/10/11**
23	Grading (J.F. Brennan)	22 days	Ved 12/15/10	Thu 1/13/11
24	HRLF Fence Reinstallation (American Fence & Supply)	7 days	Fri 1/14/11	Mon 1/24/11
25	Interpretive Trail Replacement (Buckeye Asphalt Paving Co.)	4 days	Tue 5/31/11	Fri 6/3/11
26	Turf Restoration (Stante)	4 days	Tue 6/7/11	Fri 6/10/11
27	**Final Remedial Action Inspection**	**1 day**	**Wed 7/6/11**	**Wed 7/6/11**



3.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

The RA for Ottawa River included collection of confirmatory surface sediment samples to verify that project cleanup goals had been met via the dredging activities. These cleanup goals constituted the primary performance standard for the RA, and evaluation as to whether these had been attained is discussed below. Also discussed below are performance standards and construction QC for dewatering pad construction and geotube manufacturing.

3.1 PROJECT CLEANUP GOALS AND CONFIRMATORY SAMPLING

The primary cleanup goals—performance standards to determine sufficiency of RA activities—were established on the basis of the following Surface Weighted Average Concentrations (SWAC):

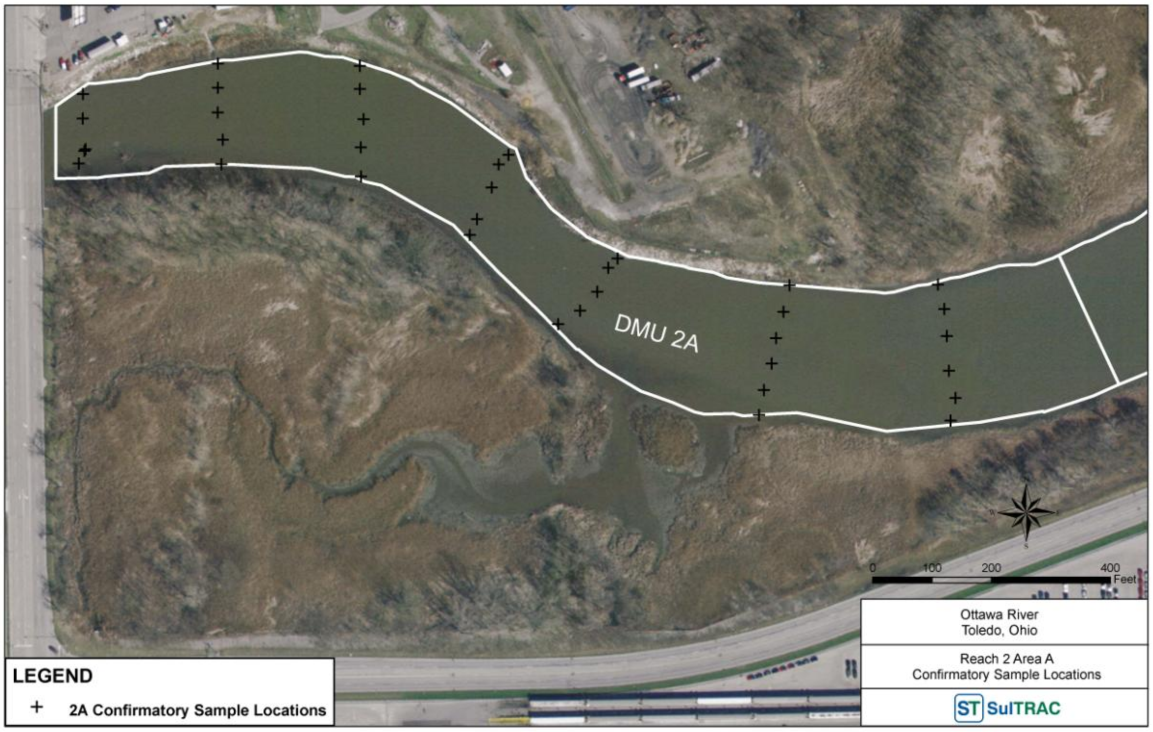
- 1.5 mg/kg for total PCBs
- 30 mg/kg for total PAHs
- 180 mg/kg for lead.

The project area included Reaches 2, 3, and 4 of the Ottawa River, within which 33 DMUs of varying sizes up to 8.22 acres and depths up to 9 feet were established (see Figures 1-2 through 1-4). The naming convention for each DMU was "DMU" followed by the reach number and then a letter representing the area in the reach. For example, DMU 4A is in reach 4 and is area A. For post-cleanup verification, the SWAC was calculated across each entire reach, including dredge and non-dredge areas.

3.1.1 Confirmatory Sampling Approach

Once sediment within a DMU had been dredged to design depths, confirmatory surface sediment samples (0 to 4 inches from top of sediment) were collected at predetermined locations that were generally at 50-foot intervals on transects spaced 250 feet apart (see Figure 3-1). The confirmatory sediment samples were collected and processed in accordance with the EPA GLNPO-approved Quality Assurance Project Plan (QAPP) (SulTRAC 2010a); this sampling is discussed in more detail in Section 4.4.4. The samples were analyzed for total PCBs, total PAHs, and lead. The confirmatory sampling results and the resulting SWAC calculations were compared to the cleanup goals in order to determine whether the individual DMUs could be "cleared" (released from further dredging or other remedial activities).

Figure 3-1. Example Confirmatory Sediment Sample Location Grid



Based on pre-design sampling results, 12 TSCA Areas (containing approximately 14,000 CY of sediment within seven of the DMUs) were identified for sediment removal, dewatering, and off-site disposal at a facility approved to accept TSCA-regulated concentrations of PCBs. Within all 12 TSCA Areas, the TSCA sediment overlaid non-TSCA sediment. Therefore, dredging in these DMUs occurred in two phases—first TSCA removal and then non-TSCA removal. Once sediment within one of these 12 TSCA Areas had been dredged to design depth, confirmatory samples were collected within the DMUs as discussed above. If the average concentration of total PCBs in the samples collected within the TSCA Area was less than 25 mg/kg and no individual sample result exceeded 40 mg/kg PCBs, the TSCA Area was cleared, and additional dredging in the DMU proceeded to the pre-set depth for assessing non-TSCA sediment. Non-TSCA confirmatory samples were then collected at the same locations as the TSCA samples, and used for SWAC calculations and cleanup verification for DMUs as discussed below.

Based on additional sediment sampling results in areas that had not been sampled during the design, two other TSCA Areas were added to the project scope: TSCA Areas 4Y and 4X1. These TSCA Areas did not require interim sampling because the TSCA depth of contamination was also the depth of design for the additional DMUs.

Total PCB and PAH analyte concentrations were calculated for each sample by summing those of their individual aroclors (PCBs) and compounds (PAHs). Calculations of total PCB concentration from nondetect (estimated) results involved summing half the detection limits for Aroclor 1242, Aroclor 1254, and Aroclor 1260 only. Based on historical sampling results, the project team determined that the remaining aroclors likely were not present in Ottawa River sediment, and that including half the respective detection limits of those remaining aroclors in the summation would result in estimates of total PCBs biased high. To calculate total PAH concentration from nondetect results, half the detection limits were summed, respectively, for all PAH compounds.

3.1.2 Data Quality

Confirmatory sampling and analysis proceeded in accordance with the EPA GLNPO-approved QAPP (SulTRAC 2010a). As part of its project responsibilities and in accordance with the QAPP, SulTRAC validated all sediment sampling data in general accordance with the EPA Contract Laboratory Program (CLP) National Functional Guidelines (NFG) for Inorganic Review, dated January 2010, and the EPA CLP NFG for Organic Data Review, dated June 2008 (EPA 2008, 2010). The NFG guidelines were modified, as appropriate, to correspond to the specific requirements of the non-CLP methods used in these analyses. Based on the validation results, SulTRAC assigned both the applicable standard and GLNPO data qualifiers to the analytical data. No analytical results were rejected, but many were qualified as estimated. Almost all qualifications were due to the nature of the sediment samples, rather than to laboratory irregularities. More details on the data validation appear in the "Data Validation Summary Report, Ottawa River, Lucas County, Ohio" (SulTRAC 2011b). All results can be used, as qualified, for any purpose. The only caveat is that because of pervasive heterogeneity in contaminant distributions, individual sample results should not be considered fully representative of the respective locations at which they were collected. Therefore, consistent with the SWAC methodology used to evaluate post-cleanup goals, multiple samples averaged across an area would more accurately represent contaminant concentration in the sediment.

3.1.3 SWAC Calculation for Cleanup Verification

A 95% Upper Confidence Limit (95%UCL) was calculated using ProUCL software for total PCBs, total PAHs, and lead within each DMU. These results then were entered in the project SWAC calculator—a MS Excel spreadsheet that included SWACs for non-dredge areas and fields for entering 95%UCL results for each DMU. Field duplicates were treated as unique samples and were included in the calculation of the 95%UCL. For some DMUs, not enough samples were available to use parametric methods in ProUCL. In these cases, Chebyshev Inequality, a non-parametric method, was used to calculate the 95%UCL. This was the most appropriate method to use with the limited sample sizes. In cases where the 95%UCL calculated by Chebyshev resulted in a higher value than the maximum value of the sample results, the maximum sample result was the default value used for the SWAC calculation.

The SWAC calculator was updated as post-dredge 95%UCL values were calculated for each DMU.

The "Ottawa River Cleanup Plan Design Report" prepared by Conestoga Rovers and Associates (CRA 2009) indicated that cutlines projected to contain concentrations greater than or equal to 5 mg/kg total PCBs, 30 mg/kg total PAHs, and 200 mg/kg lead would suffice to achieve SWAC concentrations meeting the cleanup goals. Therefore, these cutline projection values were temporarily used in the SWAC calculator to represent DMUs that had not yet been dredged and for which post-dredge verification sampling results were not yet available.

Representatives from EPA GLNPO and ORG considered the overall SWAC calculator, 95%UCL, and mean values for each DMU when determining whether a DMU could be cleared; TSCA Areas were also evaluated by these representatives, as discussed in the previous section. Appendix A contains contaminant concentration maps created for each DMU to assist in the decision-making process. DMUs or TSCA Areas that had not been cleared based on post-dredge verification sampling results were re-dredged and re-sampled at the original sample locations. Concentrations detected by re-sampling the DMU replaced those detected in the original confirmatory samples in the SWAC calculations. This process was repeated until cleanup goals were met and the DMU was cleared by EPA and ORG representatives. Table 3-1 lists the final SWAC calculations based on the confirmatory samples for each reach, and shows that the concentrations remaining in all three reaches are less than the cleanup goals. The "Ottawa River Statistical Analysis Memo" in Appendix B contains the final post-dredge SWAC calculator for each reach, and a summary of the mean, maximum, and 95% UCL for each DMU.

Table 3-1 Final SWAC Calculations and Cleanup Goals

SWAC	Total PCBs	Total PAHs	Lead
Goal	***1.5***	***30***	***180***
Reach 2	0.8	3.8	93.9
Reach 3	1.1	4.4	99.8
Reach 4	0.5	6.0	65.9

Note:

All values are concentrations in milligrams per kilogram (mg/kg).

Based on additional sediment sampling results in areas not sampled during design, three more DMUs in Reach 4 (DMUs 4X, 4Y, and 4G) were added to the dredging scope. The 95%UCL, mean, and maximum concentrations for COCs within these DMUs were compared to the cleanup goals by EPA, ORG, and other project partners for cleanup verification. However, these additional DMUs were not included in the SWAC calculator.

3.1.4 Additional Statistical Analysis

After completion of sediment remediation activities, additional exploratory statistical analysis of the post-cleanup verification data was conducted. The primary goals of this additional analysis were to calculate a more robust 95%UCL, mean, and standard deviation (SD) in dredged areas for COCs within the three individual reaches, as well as the combination of the three reaches to encompass the project area. The mean and 95%UCL values within the dredge areas were also then entered into the SWAC calculator to determine an overall SWAC that included non-dredge areas. More details on the statistical approach and methodology appear in the Ottawa River Statistical Analysis Memo in Appendix B.

The 95%UCL, mean, and maximum values analysis for total PCBs, total PAHs, and lead within DMUs only for each reach based on the additional statistical analysis are presented in Table 3-2. The SWAC was also updated with these statistical analysis results. Specifically, the mean for lead, total PAHs, and total PCBs within each reach were incorporated into the SWAC calculator. Table 3-3 shows the SWAC calculator results using the mean calculated for each reach, and Table 3-4 shows the resulting SWAC for the overall project area (Reaches 2, 3, and 4). The SWAC values based on the results of this additional analysis meet the post-cleanup goals for all reaches. Also, the overall project SWAC values for lead, total PAHs, and total PCBs are well below the post-cleanup goals, as shown in Table 3-4.

Tables 3-2, 3-3, and 3-4 show that the goal of the RA has been met. Sections 3.2 through 3.5 discuss other performance standards and construction QCs that were met during the RA.

Table 3-2 Additional Statistical Analysis Results

		Reach 2	Reach 3	Reach 4[1]
Lead	95%UCL	140	101	132
	Mean	111	84.7	104
	Maximum	649	350	376
Total PAHs	95%UCL	8.39	4.5	9.32
	Mean	4.64	2.75	6.47
	Maximum	100	35	50
Total PCBs	95% UCL	2.14	1.92	2.16
	Mean	1.52	1.02	1.29
	Maximum	9.6	17	5.25

Notes:

All values are concentrations in milligrams per kilogram (mg/kg).
[1] Summary statistics for sediment in Reach 4 excluding DMUs 4G, 4X, and 4Y
UCL Upper confidence limit
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl

Table 3-3 Updated SWAC for Reaches 2, 3, and 4 Based on Additional Statistical Analysis

Reach 2				
	Lead (mg/kg)	**Total PCBs (mg/kg)**	**Total PAHs (mg/kg)**	**Surface Area (acres)**
Total for DMUs - Mean [(a)]	111.00	1.52	4.64	23.89
Total for non-DMUs - Area Weighted Average[(b)]	80.10	0.39	2.00	78.24
$SWAC_{estimate}$ (mg/kg)	87.33	0.66	2.62	

Reach 3				
	Lead (mg/kg)	**Total PCBs (mg/kg)**	**Total PAHs (mg/kg)**	**Surface Area (acres)**
Total for DMU - Mean [(a)]	84.70	1.02	2.75	13.43
Total for non-DMU - Area Weighted Average[(b)]	29.86	0.56	2.38	12.14
$SWAC_{estimate}$ (mg/kg)	58.66	0.80	2.57	

Reach 4				
	Lead (mg/kg)	**Total PCBs (mg/kg)**	**Total PAHs (mg/kg)**	**Surface Area (acres)**
Total for DMU - Mean [(a)]	104.00	1.29	6.47	3.39
Total for non-DMU - Area Weighted Average[(b)]	45.95	0.25	4.03	21.36
$SWAC_{estimate}$ (mg/kg)	53.90	0.40	4.37	

Notes:

(a) Mean obtained from additional statistical analysis shown in Appendix B
(b) Area weighted average for areas not dredged. Values provided by Conestoga Rovers and Associates (CRA)

mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl
PAH Polynuclear aromatic hydrocarbon
DMU Dredge management unit
SWAC Surface weighted average concentration

Table 3-4 Overall Project SWAC Based on Additional Statistical Analysis

Overall Project SWAC				
	Lead (mg/kg)	Total PCBs (mg/kg)	Total PAHs (mg/kg)	Surface Area (acres)
Total for DMU - Weighted Mean [(a)]	102.00	1.34	4.17	40.71
Total for non-DMU - Area Weighted Average [(b)]	68.11	0.38	2.43	111.74
$SWAC_{estimate}$	**77.16**	**0.64**	**2.89**	
Cleanup Goal (mg/kg)	180	1.5	30	
Cleanup Goal Met	Yes	Yes	Yes	

Notes:

(a) Weighted mean from additional statistical analysis
(b) Weighted average calculated from area weighted per reach provided by Conestoga Rovers and Associates (CRA)

mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl
PAH Polynuclear aromatic hydrocarbon
DMU Dredge management unit
SWAC Surface weighted average concentration

3.2 DEWATERING PAD CONSTRUCTION

Miller Brothers Construction Inc. (MBC) constructed 10- and 2-acre dewatering pads for TSCA and non-TSCA sediments, respectively. The dewatering pad construction activities included stripping soil interim cover material; regrading and relocating municipal solid waste; modifying the existing landfill gas collection and conveyance system; installing a 1-foot-thick, recompacted, soil subbase layer over the footprint of the containment area; constructing structural fill berms around the perimeter of the membrane subbase; and installing a Linear Low Density Polyethylene (LLDPE) liner and an overlaying, double-sided, geocomposite drainage material. These activities are discussed further in Section 4.1.

Soil used for the subbase and structural fill, LLDPE liner, geocomposite drainage layer, conveyance piping, and high mast light pole concrete foundations were required to meet certain construction QC standards prior to use and after the materials had been place. MBC contracted The Mannik & Smith Group, Inc., (MSG) to conduct construction QC and quality assurance (QA). Appendix C contains the testing requirements and standards for the materials discussed in the following sections.

3.2.1 Soil Construction Quality Control

Soil used for the membrane subbase and structural fill met both pre-qualified standards and placement standards. Soils were pre-qualified for use in the recompacted soil layer and structural berms by application of the required tests at a frequency of one sample per 4,000 CY of material.

Prequalification testing results are in Appendix E of the Construction Quality Assurance Report by MSG (MSG 2010a). The pre-qualified material was placed and compacted in lifts in order to meet certain criteria; if the criteria were not met, the material was reworked and re-tested. Results of compaction testing are in Appendix G of the Construction Quality Assurance Report by MSG (MSG 2010a).

Photo 3-1. Earthwork and Compaction Testing at Non-TSCA Dewatering Pad

MSG performed construction quality assurance (CQA) testing to ensure the membrane subbase was constructed according to project specifications. MBC surveyed the construction area, and MSG reviewed the survey data to ensure establishment and maintenance of proper lines and grades for the dewatering pad construction. MBC placed the soil material in 8-inch-maximum loose lifts, graded the lifts, and compacted each lift. Project specifications required testing at a minimum frequency of 5 tests/lift/acre. Actual testing frequency was 5.2 tests per lift per acre. Testing results presented in Appendix G of the Construction Quality Assurance Report by MSG (MSG 2010a) indicate achievement throughout the subbase area of project specifications of compaction to at least 85% of the maximum dry density, as determined by the Modified Proctor, test method ASTM D 1557. If a field test indicated the compaction criterion had not been met, MBC re-worked the area and MSG retested it. All areas initially failing to meet the minimum compaction criterion subsequently met the compaction criterion after having been reworked.

By following project specifications for structural fill, MBC constructed berms of recompacted soil surrounding TSCA and non-TSCA dewatering pads. MSG documented that MBC obtained soil from stockpiles of pre-qualified material, spread the material using dozers equipped with Global Positioning

System (GPS) attachments for grade control, and then compacted the soil. MBC maintained lift thickness control so that the final compacted lift was approximately 12 inches thick. After MBC had compacted the structural fill soil, MSG tested the material and recorded moisture and density data. Results of this testing are in Appendix G of the Construction Quality Assurance Report by MSG (MSG 2010a). Any areas failing to meet the minimum density requirement of 90% of the maximum dry density, as determined by the Modified Proctor test, ASTM D 1557, were reworked by MBC and then retested by MSG. All reworked areas met minimum project specifications when retested.

3.2.2 LLDPE Liner Construction Quality Control

The LLDPE liner met both manufacturer's material testing and field test requirements. CQA personnel reviewed the manufacturer's QC certification of the liner/geomembrane. Copies of the documents are in Appendix H of the Construction Quality Assurance Report by MSG (MSG 2010a).

Construction QC implemented during LLDPE geomembrane installation involved both destructive and non-destructive testing of the geomembrane and its seams. Pressure and vacuum testing methods were both utilized for the non-destructive testing requirements of seams and repairs. Installation of the LLDPE geomembrane layer of the TSCA and non-TSCA dewatering pads involved two types of welding: hot wedge and extrusion welding. Non-destructive testing was performed on 100 percent of the field seams in the geomembrane barrier layer and on all portions of the geomembrane seams to ensure seam continuity, as well as to measure seam quality.

Destructive testing occurred at representative fusion seam locations at a frequency of approximately one test per 690 feet of seam for the non-TSCA dewatering pad, and approximately one test per 813 feet of seam for the TSCA dewatering pad—exceeding the project specifications of one test per 1000 feet of seam. Destructive seam testing is utilized to ensure seam quality during the LLDPE geomembrane layer installation for the dewatering pads. No deficiencies were detected during destructive seam testing.

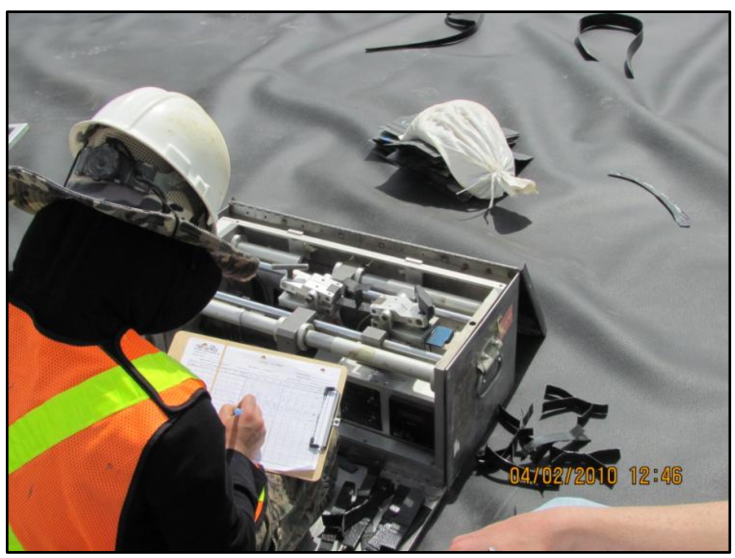


Photo 3-2. Destructive QC Testing of Geomembrane at Non-TSCA Dewatering Pad

CQA personnel were on site monitoring and documenting the performance of non-destructive and destructive testing. For more details on the construction QC measures implemented by MSG, refer to the Construction Quality Assurance Report by MSG (MSG 2010a).

3.2.3 Geocomposite Drainage Layer

The geocomposite drainage layer met all necessary requirements prior to use on the site. Manufacturer-provided certificates of the test data for each roll of material supplied for the project appear in Appendix J of the Construction Quality Assurance Report by MSG (MSG 2010a).

3.2.4 Conveyance Piping

Manufacturer-provided certificates of the piping materials, fittings, and components supplied for this project appear in Appendix K of the Construction Quality Assurance Report by MSG (MSG 2010a). As the pipeline was constructed, CQA personnel made periodic field observations. Visual inspections of fusion welding proceeded in accordance with manufacturers' recommendations. Hydrostatic leak testing was conducted for the sediment transfer pipeline and treated water pipeline. After all free air had been removed from the test section, the pressure was raised at a steady rate to the required pressure. Initially, the pipe was raised to test pressure and allowed to stand without makeup pressure for a sufficient time to allow for expansion of the pipe. After equilibrium had been established, the test section was pressurized, the pump was turned off, and the final test pressure was held. For more details on the hydrostatic leak test procedure, see the Construction Quality Assurance Plan by MSG (MSG 2010b).

3.2.5 High Mast Light Pole Concrete Foundation

The concrete foundations of the high mast light poles met the specification of 28-day strength of 4,000 pounds per square inch (psi). The results of the concrete testing are in Appendix L of the Construction Quality Assurance Report by MSG (MSG 2010a).

3.3 GEOTEXTILE TUBES

SulTRAC procured Geo-Synthetics Inc. (GSI) to supply the geotextile bags (geotubes) used by ORG in the dewatering pads at HRLF to dewater the sediment. GSI had to implement QC to ensure the geotubes it provided met performance standards. GSI furnished geotubes with 75-, 80-, and 85-foot diameters and various lengths from 85 to 343 feet. Appendix D contains the standards and control measures that the geotubes were required to meet. GSI used a A2LA accredited lab to perform the QC tests at the

Photo 3-3. Construction of Geotextile Tube

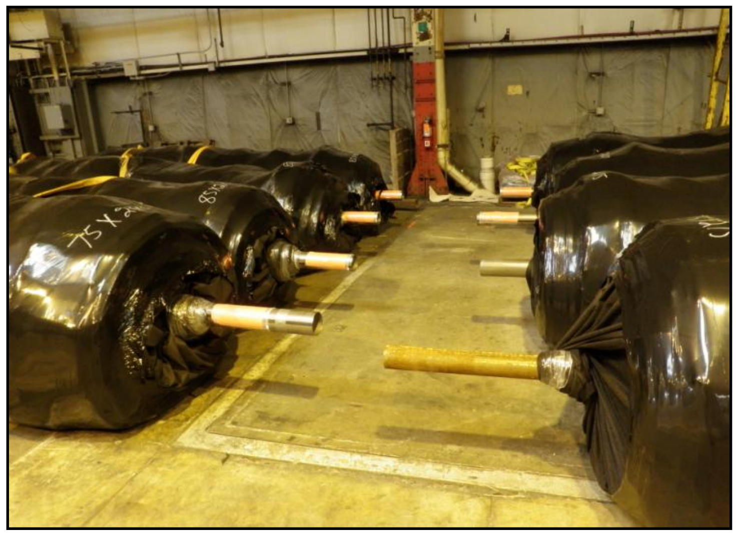


Photo 3-4. Geotextile Tubes Ready to be Shipped to Site

frequencies specified in Appendix D, and provided manufacturer's certificates for the geotubes delivered to the project. The QC certificates were to include results of at least the following tests: unit weight, tensile strength, elongation at break, Mullen Burst strength, puncture strength, permittivity, apparent opening size, ultraviolet stability, and manufacturer's records for storage, handling, and shipping of geotextile. Materials and tubes failing to comply with the minimum required properties were to be rejected. No tubes were rejected based on these requirements. GSI issued a credit for one geotube that apparently failed after deployment because of a possible manufacturing defect; however, this failure represented less than 1 percent of the geotubes delivered to the site.

In addition, SulTRAC conducted monthly site visits to the GSI facility to observe the manufacturing process and to verify measurements of the tubes being built as part of the QC process. Site visits occurred on May 12, June 25, July 22, and August 26, 2010.

3.4 DREDGING OPERATIONS

In addition to collecting post-dredging confirmatory samples to verify attainment of project cleanup goals, J. F. Brennan (JFB) was required to meet other performance standards and construction QCs during the dredging operations. Pre- and post-dredging bathymetric surveys were conducted, and high subgrade polings were collected to ensure achievements of predredge design elevations and quantities. Turbidity as a surrogate for total suspended solids (TSS) was monitored on an hourly basis during dredging activities to verify continued compliance with surface water quality standards set for the project.

3.4.1 Bathymetric Surveys

Pre- and post-dredge bathymetric surveys were performed by JFB with oversight from SulTRAC to ensure that depths complied with those specified in the target design. JFB also conducted daily QC surveys to determine dredging progress since the previous survey. Just prior to and during dredging activities, one dedicated bathymetric survey vessel was maintained on site. The vessel was equipped with a single-frequency 200 kiloHertz (KHz) fathometer for depth measurement, one RTK-GPS unit for position, one Differentially-Corrected GPS receiver for heading, and one Windows-based computer unit.

For all bathymetric surveys, QC procedures were observed and documented by JFB. The calibration techniques used for the bathymetric surveys accorded with the U.S. Army Corps of Engineers (USACE) *Engineering and Design Hydrographic Surveying Manual* No. 1110-2-1003 (USACE 2002), and followed the approved survey plan in Appendix E of JFB's "Ottawa River Sediment Remediation Project Completion Report" (JFB 2011). GPS survey equipment used for the hydrographic survey was checked twice daily (before and after surveying activities) against established land-based control monuments published by the National Geodetic Survey or project benchmarks. The coordinates and elevations of the benchmark being reported by the GPS were checked against the published values. Discrepancies outside of normal survey tolerances were addressed until the accuracy was within the required tolerances of a horizontal offset of +/- 0.13 feet and a vertical offset of +/- 0.13 feet.

Bar-checks were conducted at the start and end of each bathymetric survey, and after activity at each DMU. Bar-checks conducted prior to survey activities adjusted for draft and speed of sound in order to ensure accurate sounding and data. Bar-checks conducted at the end of the day and after activity at each DMU ensured acquisition of accurate elevation data. To perform a bar-check, an aluminum plate (bar) was lowered below the sonar transducer to a known depth below the water surface. The fathometer was then read to check for agreement with the bar depth. This procedure was performed at a minimum of two depths: one at the anticipated typical depth to sediment and one a few feet deeper. The acceptance criterion for the bar-checks was +/-0.2 feet.

Areas with water too shallow for a bathymetric survey or hindered by obstructions were surveyed by a topographical method. This was achieved using a RTK-GPS rover pole capable of performing land surveys and gathering data points in shallow water. Data points were integrated into the same data software used to process the bathymetric surveys. The rover pole complies with USACE specifications to collect submarine data points in shallow areas. This was accomplished using a 6-inch-diameter aluminum plate attached to the bottom of the pole.

Pre-Dredge Quality Assurance Bathymetric Surveys

Prior to the start of dredging operations, JFB (with oversight by SulTRAC) conducted a pre-dredge QA bathymetric survey in each DMU to establish baseline conditions. All QA surveys were completed using the approved survey plan outlined in Appendix E of JFB's "Ottawa River Sediment Remediation Project Completion Report" (JFB 2011).

Once QA pre-dredge surveys had been completed, a survey package was delivered to SulTRAC that included a difference chart of the initial surface versus the design surface, a bathymetric chart of the initial surface, and a table showing the volume remaining above design. These data became the baseline conditions for comparison with the post-dredge surveys.

Post-Dredge Bathymetric Surveys

Two types of post-dredge bathymetric surveys were conducted during the dredging activities: QC and QA. Both the QC and the QA surveys used the same equipment. QC bathymetric surveys were conducted daily at a minimum, and additionally as deemed necessary by the project management team. The results of the QC surveys were used to track and increase efficiency of the dredge, and as a QC tool to minimize over-dredging. QC surveys did not require oversight by SulTRAC because their purpose was to aid JFB in daily operations. At the conclusion of each week, JFB compiled results of the QC surveys, and the total yards removed was reported in JFB's Ottawa River Weekly Report of Operations.

Post-dredge QA bathymetric surveys occurred in areas where dredging operations had reached target elevations or had removed the organic material above any high subgrade areas. High subgrade areas are defined as areas where native clay or rock (i.e., hard bottom) occurs above the design dredge elevation. Native clay and/or rock encountered in high subgrade areas were not removed because these materials provide a barrier against contamination. High subgrade was determined using the high subgrade sampling procedure described in Appendix D of JFB's "Ottawa River Sediment Remediation Project Completion Report" (JFB 2011). The locations of the high subgrade areas were documented by JFB with GPS coordinates for approval by SulTRAC representatives after SulTRAC had overseen high subgrade sampling.

The post-dredge QA surveys were performed after JFB had deemed a DMU area complete based on the QC surveys, or at the end of a pay period. JFB conducted the post-dredge QA surveys (with SulTRAC oversight) as quickly as possible to minimize potential influence of re-deposition of non-native sediments into the dredged areas from upstream transport, downstream flow reversal due to seiche events, or side-slope sloughing.

At completion of each QA post-dredge survey, a survey package was delivered to SulTRAC that included a difference chart of final surface versus the design surface, a difference chart showing QA post-dredge sample points, a difference chart showing any high subgrade points taken, a bathymetric chart of the final surface, and a table showing the volume remaining above design. Post-dredge survey packages are in Appendix G of JFB's "Ottawa River Sediment Remediation Project Completion Report" (JFB 2011). JFB used the following procedure to determine if required dredge elevations had been attained:

1. Prepare a modeled surface of post-dredge elevations using post-dredge QA survey data for the DMU being evaluated.
2. Prepare an isopach drawing by comparing the post-dredge QA survey modeled surface elevations with the design elevations provided by CRA.
3. If actual dredge cuts within a DMU are found to be above the design elevations, implement a second dredge pass to achieve design elevation. Consider the dredge performance specification of ±6 inches, as well as whether hard bottom had been encountered (i.e., high sub-grade) above the design elevation.

Once the QA survey had been completed, JFB processed the raw hydrographic survey data to generate pre- and post-dredge contour maps for comparison to design elevations supplied by CRA. Using this output, SulTRAC and JFB determined if target elevations had been achieved and then calculated the volume of sediment removed. A comparison of actual dredge over-cuts to planned over-cuts was also prepared by JFB.

JFB also provided AutoCAD DXF files to SulTRAC in order to allow SulTRAC to perform independent QC checks on JFB's data. SulTRAC conducted an independent check of JFB's survey volumes for 65% of the non-TSCA DMU volume surveyed and 45% of the TSCA DMU volume surveyed. SulTRAC incorporated the xyz point files collected by JFB into Trimble Terramodel™ software to compare the survey volumes JFB calculated using HYPACK® software. The overall average difference between the two programs for the selected DMUs was 0.49%. Table 3-5 shows percent differences for the selected DMUs.

Table 3-5 QA Survey Volumes and QC Check Results

TSCA				
DMU	**Percent of Total Survey Volume**	**JFB Survey CY Removed**	**SulTRAC QC Check CY Removed**	**Variance**
2A	33%	72,818	73,190	-0.51%
2B	19%	45,468	45,561	-0.20%
2E	6%	16,144	16,243	-0.61%
3P	5%	10,863	10,751	1.05%
4G	2%	3,863	3,798	1.72%
TOTAL	**65%**			
Non-TSCA				
2A1	35%	4,616	4,632	-0.35%
3N2	10%	1,338	1,308	2.30%
TOTAL	**45%**			
			Project Average:	**0.49%**

Notes:

CY Cubic yards
DMU Dredge Management Unit
JFB J.F. Brennan
QA Quality assurance
QC Quality control
TSCA Toxic Substances Control Act

3.4.2 Surface Water Quality Monitoring

JFB and Natural Resource Technology, Inc. (NRT), a sub-consultant of JFB, performed environmental monitoring to verify compliance with project performance goals. Environmental monitoring included surface water quality monitoring and post-dredge verification sampling, which was discussed in Section 3.1.

Surface water quality was monitored by determining concentrations of TSS using turbidity as a surrogate measurement in order to evaluate levels of particle re-suspension during dredging operations. NRT installed calibrated, real-time turbidity monitoring stations in the Ottawa River prior to initiation of dredging. A background station was located upstream of the dredging operations, and additional stations were located within 700 feet downstream of each active dredge. The GPS coordinates of each monitoring station were recorded in JFB daily reports and updated as stations were moved.

An acoustic doppler current profiler (ADCP) was installed in the Ottawa River to monitor river velocity for detection of seiche events (flow reversal). Identification of seiche events was important in evaluating turbidity data because upstream and downstream monitoring stations became inverted when flow was reversed. The ADCP was installed on the train bridge located between DMUs 3L and 3M (see Figure 1-3). This location was selected for its central location in the dredge areas and its ability to accommodate the ADCP and associated power equipment.

Turbidity as a Surrogate to TSS

Real-time monitoring stations recorded turbidity in nephelometric turbidity units (NTU) to evaluate compliance with TSS specifications. To use turbidity as a surrogate for TSS, a site-specific correlation was developed. Water samples were collected every 4 hours for the first 48 hours of dredging operations at locations both upstream and downstream of active dredges, for a total of 24 samples. The samples were analyzed for both turbidity and TSS.

A linear regression was fit to the laboratory data and served as the site-specific correlation between turbidity and TSS. The slope of the linear regression was less than 1.0; therefore, a simplified and conservative 1:1 correlation was selected for the project. The site-specific correlation was evaluated throughout the project via monthly surface water sampling events.

Photo 3-5. Turbidity Monitoring Station

Monthly sampling events confirmed that the continued use of the 1:1 correlation was appropriate and conservative.

Turbidity data were obtained hourly during dredging operations and transmitted through telemetry to an on-site computer located in the JFB job trailer. Acquired data were uploaded each hour to a website for viewing. NRT personnel frequently checked acquired turbidity data throughout the day to monitor turbidity trends and evaluate situations as necessary. Monitoring stations were cleaned and calibrated approximately every 10 days; however, more frequent cleaning was required in the summer months when warm water temperatures and stagnant conditions caused significant biological growth on the buoys and sensors.

TSS Advisory and Action Levels

Requirements for turbidity and TSS monitoring are specified in the "Ottawa River Cleanup Project Dredge Monitoring Plan" (CRA 2010) and Contractor Quality Assurance Plan (NRT 2010). TSS concentrations were reported over a 4-hour rolling average for comparisons among monitoring stations. TSS advisory and action levels were specified at 25 and 50 milligrams per liter (mg/L) above background levels—corresponding, respectively, to 25 and 50 NTU using the assumed 1:1 correlation.

If a downstream monitoring station recorded turbidity exceeding the advisory level of 25 NTU above the background concentration for the same time interval, field staff evaluated conditions to verify compliance with specifications. If the recorded exceedance occurred during a seiche event, this was noted on the daily report and no further action was taken. During normal downstream flow conditions, field staff used a handheld turbidity meter to measure turbidity both upstream and downstream of the dredge in question to verify compliance.

Field staff continued to monitor turbidity readings to evaluate increases approaching or exceeding the action level of 50 NTU above background levels. Again, if a recorded exceedance occurred during a seiche event, this was noted on the daily report and no further action was taken. If normal flow existed during the recorded exceedance, NRT field staff notified JFB and SulTRAC, and then evaluated conditions on the river with the handheld turbidity meter to verify compliance at the location of the dredge.

Recorded turbidity greater than 50 NTU above background levels was never linked to dredging operations during the project. Elevated turbidity was attributed to the following sources: seiche flow, rain events, and differing river conditions between buoy locations. River conditions at the background monitoring station were frequently not representative of downstream conditions where dredging was occurring. At times, the background station was located approximately 5 miles upstream of buoys monitoring the most downstream dredging. Along the river were numerous outfalls that could have affected turbidity between the background buoy and downstream monitoring locations (JFB 2011).

3.5 TSCA LOAD OUT AND CONFIRMATORY SAMPLING

Prior to completion of the project, off-site disposal of the TSCA sediment and other materials occurred at a TSCA-permitted landfill. Before trucks containing TSCA material could leave the project site, SulTRAC completed a truck inspection checklist and manifest . The truck inspection checklist ensured that the truck met all criteria necessary for traveling on public roads; copies of the checklists were also provided to HRLF. Manifests for each truck were signed by SulTRAC personnel, and a copy of each manifest remained with SulTRAC. SulTRAC maintained a database by manifest number and truck ID for every truck loaded with TSCA material. SulTRAC received an additional copy of each manifest from the TSCA-permitted landfill, as well as daily load weight tickets to compare to and update the load out database. TSCA load out activities are discussed further in Section 4.5.

To verify that the TSCA dewatering and load out operations had not contaminated the area, ORG collected confirmatory surface soil samples following removal of the TSCA materials from the site. Results of this sampling would be compared to results of surface soil sampling by ORG prior to construction of the TSCA dewatering pad. ORG representatives collected the verification samples once the TSCA sediment and material had been removed from an area of the TSCA pad. After results of the verification sampling confirmed that the area was not contaminated, the area was re-graded to a minimum of a 1% slope and then further restored as discussed in Section 4.6.3. Additional details on the verification sampling and results are presented in the "Ottawa River Land Side Report" (de maximis 2011).

4.0 CONSTRUCTION ACTIVITIES

The RA project area included three reaches of the Ottawa River, within which were 33 separate DMUs. Fourteen sub-areas within these DMUs contained sediment with TSCA-level concentrations of PCBs (≥ 50 ppm or mg/kg), and are referred to herein as "TSCA Areas." The sediment from the river was hydraulically dredged and transported through a pipeline to HRLF, which is the City of Toledo's active municipal solid waste landfill, and pumped onto separate 10- and 2-acre dewatering pads for TSCA and non-TSCA sediments, respectively. Geotubes were used to dewater sediment on the pads, water collected from the dewatering pads was treated in an on-site WTP, and the treated water was discharged back to the Ottawa River. The dewatered, non-TSCA sediment was left in place on the dewatering pads at HRLF, and the geotubes of sediment were covered with soil. The dewatered TSCA sediment was removed from the geotubes and disposed of at an off-site TSCA-permitted landfill near Detroit, Michigan. The TSCA dewatering pad area was then restored. This section describes SulTRAC's activities and lessons learned during the RA.

4.1 CONSTRUCTION OF DEWATERING PADS

Before dredging could begin, the TSCA and non-TSCA dewatering pads and the WTP had to be constructed at the HRLF. ORG was responsible for construction of the WTP, and SulTRAC was responsible for construction of the dewatering pads and piping connecting the dewatering pads to the WTP. SulTRAC procured MBC to construct the dewatering pads, which involved the following primary activities:

- Stripping soil interim cover material (approximately 1 foot) from the northwest portion of the HRLF
- Regrading and relocating more than 50,000 CY of municipal solid waste
- Modifying the existing landfill gas collection and conveyance system, involving relocation of gas wellheads and installation of horizontal gas collection and conveyance piping
- Installing a 1-foot-thick, recompacted, soil subbase layer over the footprint of the containment area consisting of material from excavated interim soil cover and soil from the on-site soil stockpile as necessary
- Constructing structural fill berms around the perimeter of the membrane subbase consisting of material from the on-site soil stockpile
- Installing the 40 mil LLDPE geomembrane barrier
- Installing overlaying, double-sided, geocomposite drainage material

- Installing 24-inch-diameter, high-density polyethylene (HDPE) elutriate drainage pipe to convey liquids to the WTP from the sediment containment area, and installing 18-inch-diameter HDPE backwash pipe from the plant back to the sediment containment area
- Constructing light towers
- Constructing access roads
- Constructing surface water culverts/ditches.

4-1. Completed Non-TSCA and TSCA Dewatering Pads

MBC began construction of the dewatering pads in February 2010, and substantially completed construction on May 1, 2010.

4.1.1 Earthwork for Dewatering Pads

Construction of the 10-acre (TSCA) and 2-acre (non-TSCA) dewatering pads began in February 2010 and proceeded in the following manner. The first step was for MBC to strip the existing 12 inches of intermediate cover soils from the municipal waste in the non-TSCA cell and relocate it on site at the HRLF. MBC removed and relocated municipal waste in order to bring the non-TSCA pad to grade. The intermediate cover soil was then re-used to cover the relocated municipal waste. To address the cases of less than 12-inch cover on the municipal waste, MBC used approximately 6,500 CY of on-site soil to cover the re-located waste. MBC placed the subbase for the non-TSCA pad in 8-inch loose lifts with soil obtained from on-site stockpiles. A bulldozer was used for grading and a compactor compacted each lift until the subbase was 1 foot thick. For more details and as-builts of dewatering pad construction, see MSG's Construction Quality Assurance Report (MSG 2010a)

Photo 4-2. Municipal Waste Relocation at Non-TSCA Dewatering Pad

Municipal waste relocation was not necessary for construction of the TSCA pad. It was necessary only to remove topsoil from the TSCA pad to attain design grade prior to placement of the geomembrane. The TSCA pad was otherwise constructed applying the same methods and procedures as those used for the non-TSCA pad.

As a result of a change order to improve constructability, the base grades of the non-TSCA dewatering pad were lowered by approximately 16 inches from the original design grades. The overall horizontal alignment of the dewatering pad remained the same, with the net effect of the changes leading to increased waste cut and reduced fill on the outside slopes. This change was implemented to accelerate the project schedule because construction of the non-TSCA dewatering pad was originally anticipated to begin approximately 9 months earlier, when the weather was warmer and more conducive to completing the associated earthwork

MBC constructed berms surrounding both the TSCA and non-TSCA dewatering pads. These berms were composed of re-compacted soil obtained from stockpiles on site. Once the structural fill for the dewatering pads was brought to design grades, the surface of the pads was graded, sealed, and smoothed with a drum roller, and prepared for deployment of the geomembrane.

4.1.2 Geomembrane Liner Installation

MBC installed a 40 mil LLDPE geomembrane barrier over both dewatering pads to prevent any contamination of the subbase soils. The panels of the LLDPE were deployed using a link-belt excavator with a spreader bar attachment which remained stationary on the top of the slopes, and a 4-wheeler which pulled the geomembrane into place. Final positioning of the panels was done by hand and included overlapping the panels a minimum of 4 inches to allow for seaming. Photo 4-3 shows the LLDPE line being pulled into place in the non-TSCA dewatering pad.

Photo 4-3. LLDPE Liner Installation in Non-TSCA Dewatering Pad

Installation of the LLDPE barrier layer during construction of the dewatering pad involved field welding using specialized welding equipment including a hot wedge welder and an extrusion welder. The hot dual wedge welder was primarily used for long geomembrane panel-to-panel welding and large repair areas, as it is best suited for relatively straight-line seaming (see Photo 4-4). For that reason, the majority of field seams were produced by the hot wedge welder. Typically, the extrusion welder was used for small repairs (patches), mild surface damage repairs, repairs to deficient hot wedge seams, and in restrictive locations. As mentioned in Section 3.2, during LLDPE geomembrane installation, CQC conducted destructive and non-destructive testing of the geomembrane and its seams.

Photo 4-4. Hot Dual Wedge Welding of LLDPE Liner Panels

A geocomposite drainage layer was installed over the 40 mil LLDPE liner to assist with drainage in the dewatering pads (see Photo 4-5). The geocomposite layer was deployed in the same manner as the geomembrane. The geocomposite was positioned with a minimum of 4-inch overlap. The overlaps were joined by tying the geonet structure with cable ties. Plastic ties were used at 5-foot intervals in the direction of the roll length and at 2-foot intervals across the end of the panel to tie the drainage net panels. The geotextile flaps of the adjacent panels were sewn together. Adjoining geocomposite rolls (end to end) across the roll width were shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width.

4.1.3 Piping

Water from the geotubes drained to the sump, where it was then transferred through 24-inch-diameter HDPE pipelines to the WTP for treatment. After the water was treated, it was discharged to the Ottawa River. The major pipe installations performed by MBC included (1) two 24-inch-diameter HDPE elutriate water transfer pipelines, which provided flow from the TSCA and the non-TSCA dewatering pads to the WTP; (2) a 24-inch-diameter water discharge pipeline that provided flow from the WTP to the NPDES outfall at the Ottawa River; (3) a 6-inch-diameter leachate removal pipe from the non-TSCA dewatering pad to the existing HRLF leachate system; and (4) an 18-inch-diameter HDPE backwash pipe from the WTP to the non-TSCA dewatering pad. Sump and suction pipes were also installed in both the TSCA and non-TSCA dewatering pads. Surface water and drainage culverts were also placed to maintain positive drainage throughout the disturbed portions of the HRLF.

Photo 4-5. Sewing Geocomposite Layer

4.1.4 Gas Collection System Modifications

Modifications to the landfill Gas Collection and Control System (GCCS) included: (1) decommissioning one existing landfill gas collection well, (2) installing six landfill gas horizontal collection trenches under the subbase of the non-TSCA dewatering pad, (3) installing seven remote well heads to either the horizontal gas collection trenches or to one of the existing landfill gas collection wells, and (4) extending the riser on two other existing landfill gas collection wells. For more details on the modifications to the landfill GCCS and as-builts of the final design, see MSG's Construction Quality Assurance Report (MSG 2010a). Per request of the City of Toledo, owner of the HRLF, the design was modified by altering the layout of the landfill gas collection (LFG) trenches that underlie the non-TSCA dewatering pad—to improve performance of the LFG system and to address operation and maintenance concerns.

4.1.5 Lighting Structures

MBC constructed eight light towers around the non-TSCA pad and ran the electrical conduit to the light poles. Light towers were essential because RA project activities were to run 24 hours per day. One initial problem with the associated electrical transformers was detection of methane gas entering transformer cabinets through conduits at the bases of the transformers. The conduits were sealed at the transformers before the utility company energized the transformers.

4.1.6 Access Roads

MBC constructed an access road to the non-TSCA dewatering pad with Ohio Department of Transportation (ODOT) #1 and #2 road stone, and constructed a perimeter road around both dewatering pads. After installation, ODOT #1 and #2 aggregate started separating due to a lack of fines, particularly at bends and curves. MBC added fines to lock up the sloped portions of the road.

4.2 SHAKER AND THICKENER SYSTEM

A shaker and thickener system designed and provided by JFB was staged adjacent to the northeast corner of the non-TSCA dewatering pad. The non-TSCA dredge slurry went through the shaker and thickeners prior to entering the dewatering pad. The scalping screen and thickeners were used in combination to remove large debris and to thicken the low-density slurry. The original design by ORG required only use of a shaker to strip off any large debris before entry into geotubes; however, JFB and IAI, the contractor retained by ORG to perform upland dewatering and water treatment operations, felt that including the thickeners would be beneficial. The thickener tanks allowed for better control of polymer application and provided additional time for the sediment to consolidate and settle. They also allowed for removal of clear water via a weir system, which decreased the overall amount of water sent to the geotubes and accelerated the dewatering process.

The non-TSCA dredge slurry was pumped to the velocity box above the shaker screen, where material 2 inches in size or greater was stripped off, allowing the slurry to be routed into one of the two thickener units. The material stripped prior to the thickener units fell into roll-off dumpsters, which were emptied at HRLF. The clear water removed from the thickeners using a weir system was routed directly to the WTP, while the thickened sediment slurry settled toward the bottom, where it was routed to the non-TSCA dewatering pad. Photo 4-6 shows the setup of the shaker and thickeners at HRLF.

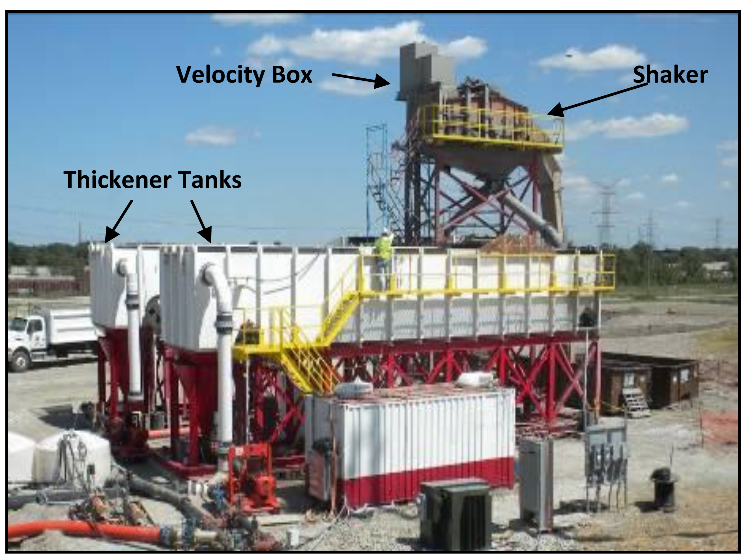


Photo 4-6. Thickeners and Shaker

4.3 GEOTUBES AND POLYMER

Geotubes and polymer were utilized to dewater the sediment. The polymer encouraged flocculation and enhanced geotube performance; it was added to the HDPE line as the dredged slurry was pumped into the thickener plant. SulTRAC was responsible for supplying both the geotubes and polymer. As mentioned earlier, SulTRAC procured GSI to supply the geotubes and Axchem USA Inc., to supply the polymer. ORG continuously monitored the clear water effluent from the thickener tanks and the condition of the material entering the geotubes in order to regulate the amount of polymer needed. ORG was also responsible for deploying more than 160 geotubes in the dewatering pads. The final geotube configurations were stacked five layers high in the non-TSCA pad (Photo 4-7 shows these geotubes stacked five layers high). For more details on the operations of the dewatering or WTP, see the "Final Ottawa River Land Side Report" (de maximis 2011). It was important for SulTRAC to coordinate with ORG and its contractors to schedule deliveries of the polymer and the geotubes according to the project needs. A total of 802,600 pounds (lbs) of polymer was used during the remedial dredging operations. Table 4-1 shows the amount of polymer delivered to the site on a monthly basis. Geotubes with a variety of diameters and lengths were used during the RA, depending on the layout of the dewatering pad. Table 4-2 lists the diameters and lengths of the geotubes delivered to the site.

Photo 4-7. Geotubes Stacked Five High in Non-TSCA Pad

Table 4-1 Polymer Delivered on Monthly Basis

Month	Polymer Delivered (pounds [lbs])
April	91,200
May	180,420
June	228,360
July	91,120
August	135,220
September	45,780
October	31,840
November	-1,340*
*Unused polymer at the end of the project was returned to the supplier.	

Table 4-2 Geotubes Delivered to the Site

Circumference (feet)	Length Range (feet)	Number of Tubes	Number of Feet	Total # of Tubes	Total Feet
30	100	2	200	3	400
30	200	1	200		
75	140-190	19	3,479	57	14,966
75	200-240	10	2,275		
75	300-340	28	9,212		
80	50-150	7	735	71	17,828
80	151-250	40	94,56		
80	251-350	24	7,637		
85	150-200	7	887	34	8,482
85	201-250	17	4,305		
85	300-350	10	3,290		
Project Totals				**165**	**41,676**

4.4 DREDGING

The RA design originally included 30 DMUs within which 12 sub-areas had sediment containing TSCA-level concentrations of PCBs. During the dredging operations, three additional DMUs and two TSCA areas were added to the dredging scope. More detail about these additional areas is discussed later in this section. The DMUs were distributed over 5.5 river miles. This required five boosters and approximately 62,000 feet of pipeline to pump the dredge slurry to HRLF. Four different dredges—the Michael, the Fox River, the Block Island, and the Grand Calumet—were utilized during the dredging operations to minimize downtime between activities at DMUs. After each DMU had been dredged to design depth, confirmatory samples were collected to confirm attainment of project cleanup goals. EPA and ORG representatives used the sample results to determine if a DMU was considered "cleared," meaning no further remedial activities would be needed in this DMU. With multiple dredges on site, JFB was able to switch to another DMU while waiting for DMUs to be cleared. At completion of dredging activities, the dewatered TSCA sediment was loaded out and transported off site to an approved landfill.

Testing of the dredge transportation system was completed on May 1, 2010, using water first and then a short period of slurry. During the dredge transportation system test, water was pumped to pressure test the pipeline. While water was being pumped, JFB personnel visually inspected the entire length of pipeline for leaks and found no breaches. Once the pressure test was confirmed, pumping of slurry was allowed through the line. Dredging operations began on May 3, 2010, proceeding the first 2 days for 16 hours before 24-hour production initiated on May 5, 2010.

During dredging operations, JFB had three access areas in addition to the HRLF site (see Figures 1-2 through 1-4). The "Enchanted Forest" was located along Reach 2 near DMU 2A. The second access area was located along Reach 3 between DMUs 3H and 3I at the sheet pile wall (SPW) area owned by the City of Toledo. The third area, used to access DMUs 4X and 4Y, was located in Beatty Park near the Auburn Street Bridge. This section discusses the equipment used during the dredging process, debris and Aqua-Blok removal, areas and volumes dredged, areas added to the dredging scope, confirmatory sampling results, dredging production rates, and TSCA loadout. For more detail on dredging activities, see "Ottawa River Sediment Remediation Project Completion Report" by JFB (JFB 2011).

4.4.1 Adjustments to Dredging Areas and Volumes

The dredging design for the RA originally targeted 30 DMUs, with anticipation of (1) approximately 249,500 CY of non-TSCA material and (2) approximately 14,000 CY of TSCA material from 12 TSCA sub-areas. This volume calculation was based on a "stair step" approach for the design surface that was included in the RA design. JFB suggested implementation of a "neat line" approach in the non-TSCA DMUs to reduce the amount of non-contaminated material that would be removed. The volume was further reduced because actual volumes determined in the pre-dredge survey differed from volumes expected according to the design. Offsets for submerged utility lines that transected the dredge areas also reduced the overall dredge volume.

Higher than anticipated contaminant concentrations were found within the typical 50-foot utility offset areas of two different DMUs, one in DMU 4C and one in DMU 2C. In both cases, JFB was able to delineate the utilities that were crossing the river accurately enough so that JFB felt comfortable dredging closer to the pipelines. In DMU 2C, JFB was able to physically locate the utility in the river by poling, allowing the line to be marked with stakes. This accurate delineation of the pipeline allowed dredging operations to utilize a 5-foot offset on each side of the pipeline. In DMU 4C, the pipeline could not be physically located; however, knowledge of the exact locations of the pipeline on each bank and the narrowness of the river in this area gave JFB the confidence to dredge with only a 10-foot offset from the utility.

Because some sample results from the utility offsets indicated PCB concentrations higher than anticipated, additional samples were collected in Reach 4 between previous sample transects specified in the project design. After EPA and ORG reviewed these sample results, it was determined that some PCB concentrations were higher than acceptable in this newly sampled area. To remediate the contamination, an additional dredging area identified as DMU 4G was added between DMUs 4B and 4C.

Prior to the start of dredging operations, high PCB concentrations were discovered by EPA in Reach 4 upstream of DMU 4A. Dredging in this area was not originally included in the RA design but was added after supplemental sampling had indicated both that PCB concentrations were higher and that the area affected was larger than expected. The new dredge areas were identified as DMU 4X and DMU 4Y, and included both TSCA and non-TSCA materials. Due to the difficulties involved with dredging in this portion of the river, a temporary dam structure and additional equipment were required. The temporary dam and additional equipment are described in more detail in Section 4.4.2.

Changes to the original dredging design resulted in a total non-TSCA estimated revised design volume of 205,527 CY. The resulting TSCA estimated revised design volume was 12,600 CY.

4.4.2 Equipment

JFB used hydraulic cutterhead dredges to remove the sediment from the river bed. This type of dredge was used because of its ability to accurately remove the targeted material and transport it from areas inaccessible to other means of dredging. Hydraulic dredging also minimizes the amount of suspended solids released to the water, which prevents spread of contamination to downstream areas.

For the Ottawa River sediment remediation project, the hydraulic transportation system required use of five booster pumps to convey the material over 5 miles to the HRLF (see Figures 1-2 through 1-4). The boosters were used to maintain the required head and prevent the material from settling out in the pipeline and plugging it. A temporary dam was required to raise water levels in Reach 4 to dredge the additional DMUs 4X and 4Y. Details regarding the dredges, booster pumps, and temporary dams are discussed below.

Dredges

Initially, three hydraulic dredges were used to remove sediment from the river. This allowed JFB the flexibility to operate one or two dredges while the other dredge awaited a change in water elevation to move to a new area or awaited results of confirmation sampling. A fourth dredge was added after DMUs 4X and 4Y were added to the dredging scope in order to maintain the aggressive schedule.

Table 4-3 describes the dredges used during the project.

Table 4-3 Dredge Descriptions

Dredge	Type	Pipeline Size	Draft (feet)	Typical Working Pressure in Pipeline
Michael	10-inch swinging ladder	10-inch iron pipe size high density polyethylene (HDPE) pipeline	4	100 pounds per square inch (psi)
Block Island, Fox River, and Grand Calumet	8-inch swinging ladder	8-inch ductile iron pipe size HDPE pipelines	2	100 psi

All four dredges were outfitted with a real-time kinematic global positioning system (RTK-GPS) for maximum dredging accuracy within the dredge tolerance specifications of ± 3.0 feet horizontally, and ±0.2 feet vertically. The RTK-GPS signals were combined with various sensors located onboard the dredge to measure rotation, ladder inclination, and the pitch and roll of the vessel itself. X-Y-Z files (point files) representing the neat line design were entered into the dredge's onboard computer and viewed through the dredging software Dredgepack®. All information generated from the GPS system and the sensors was processed in real time and combined through Hypack Inc., and Dredgepack® software to facilitate accurate operation of the dredge. Daily QC surveys discussed in Section 3.4.1 were performed by JFB to compare logged dredge volumes to actual volumes removed. These volumes were communicated intermittently during daily meetings, and results of week ending surveys appeared on the weekly reports.

The Michael began dredging operations on May 3, 2010, in Reach 2 DMU 2A, and completed the non-TSCA areas in DMUs 2A and 2B. The Michael removed more than 121,000 CY of material from these two areas—roughly 50 percent of the project's total volume removed. Due to Michael's large dimensions, it was unable to operate in any other areas on the Ottawa River. The Michael completed all dredging operations on September 18, 2010, and was removed from the project on September 22, 2010. Photo 4-8 shows the dredge Michael.

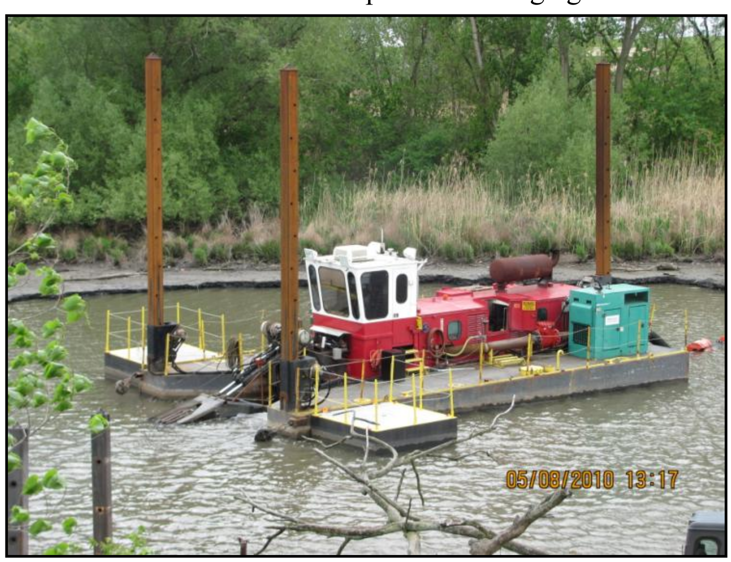


Photo 4-8. 10-inch Swinging-Ladder Hydraulic Dredge Michael

The Fox River also began dredging on May 3, 2010, in DMU 4A, and worked its way downstream through Reach 4. The Fox River moved into Reach 3, where it dredged both TSCA and non-TSCA areas. Whenever a pipeline was switched from transporting TSCA slurry to non-TSCA slurry, it was flushed out for at least 2 hours. Photo 4-9 shows the dredge Fox River, a typical 8-inch dredge, on the Ottawa River. The Block Island was used to complete non-TSCA operations in Reach 2 DMUs 2C through 2G and TSCA area 2A. Only two dredges could operate at one time due to flow restrictions from the WTP. The Block Island was utilized when the Michael or Fox River was down because of mechanical issues or while awaiting confirmatory sampling results. Once operations were completed in Reach 2, the Block Island was used as a booster for the other two 8-inch dredges completing Reach 3.

Photo 4-9. 8-inch Swinging-Ladder Hydraulic Dredge Fox River

The Grand Calumet was brought to the project to complete DMUs 4X and 4Y so that dredging would stay on schedule. Once operations were completed in Reach 4, the Grand Calumet was moved to Reach 3, where it completed DMUs 3A to 3J. Table 4-4 lists the start and completion dates for each DMU and T

<u>Boosters</u>

Because of the distance along which the sediment was pumped, five booster pumps were needed to transport the sediment to the HRLF bag field. Boosters #1, #3, and #4 were staged on land, and the Boosters #2 and #5 were barge-mounted, 8-inch booster pumps. Booster #2 was staged adjacent to the Enchanted Forest property in DMU 2A, while Booster #5 was staged in Reach 4 near DMU 4X. All booster barges were held in place by two spuds. Photo 4-10 shows Booster #2 staged in DMU 2A.

Photo 4-10. JFB Booster Barge – Mounted Booster #2

Table 4-4 Start and Completion Dates for DMUs and TSCA Areas

Start & Completion Dates for DMUs			
Area	**Start**	**Completion**	**Dredge**
2A	5/3/10	9/17/10	Michael
2B	6/10/10	8/6/10	Michael
2B*	8/18/10	9/4/10	Michael
2C	5/10/10	6/5/10	Block Island
2C*	8/6/10	8/10/10	Block Island
2D	5/27/10	7/16/10	Block Island
2E	6/14/10	7/6/10	Block Island
2G	7/17/10	7/23/10	Block Island
3A	7/11/10	9/14/10	Grand Calumet
3B	9/13/10	9/17/10	Grand Calumet
3C	9/17/10	9/20/10	Grand Calumet
3D	9/20/10	9/26/10	Grand Calumet
3E	9/25/10	10/5/10	Grand Calumet
3F	10/3/10	10/6/10	Grand Calumet
3G	9/9/10	10/7/10	Grand Calumet
3H	10/7/10	10/9/10	Grand Calumet
3I	10/10/10	10/14/10	Grand Calumet
3J	10/15/10	10/21/10	Grand Calumet/Fox River
3K	10/15/10	10/20/10	Fox River
3L	10/12/10	10/15/10	Fox River
3M	10/7/10	10/12/10	Fox River
3N	9/1/10	9/18/10	Fox River
3O	9/16/10	9/29/10	Fox River
3P	7/29/10	8/19/10	Fox River
3Q	8/19/10	9/1/10	Fox River
3R	9/26/10	10/7/10	Fox River
4A	5/3/10	5/9/10	Fox River
4B	5/14/10	5/25/10	Fox River
4C	5/25/10	5/25/10	Fox River
4D	5/26/10	5/30/10	Fox River
4E	6/28/10	7/7/10	Fox River
4F	7/6/10	9/10/10	Fox River
4G	6/5/10	6/19/10	Fox River/Grand Calumet
4X1	8/24/10	8/27/10	Grand Calumet
4X1*	8/28/10	8/28/10	Grand Calumet
4X2	8/21/10	8/24/10	Grand Calumet
4Y*	8/28/10	8/29/10	Grand Calumet
4Y**	9/2/10	9/3/10	Grand Calumet

Start & Completion Dates for TSCA Areas			
Area	**Start**	**Completion**	**Dredge**
3H1	7/12/10	7/13/10	Fox River
3K1	7/12/10	7/15/10	Fox River
3K1*	9/8/10	9/8/10	Grand Calumet
3M1	7/16/10	7/21/10	Fox River
3M1*	8/11/10	8/12/10	Fox River
3M2	7/18/10	7/21/10	Fox River
3M2*	8/12/10	8/12/10	Fox River
3N1	7/20/10	7/22/10	Fox River
3N1*	8/12/10	8/12/10	Fox River
3N2	7/21/10	7/26/10	Fox River
3N3	7/26/10	7/26/10	Fox River
3N4	7/26/10	7/27/10	Fox River
3O1	7/27/10	7/28/10	Fox River
3P1	7/28/10	7/29/10	Fox River
2A1	8/31/10	9/5/10	Block Island
2A2	8/30/10	8/31/10	Block Island
4X1	8/19/10	8/21/10	Grand Calumet
4Y	8/12/10	8/19/10	Grand Calumet
* first re-dredge, ** second re-dredge			

JFB staged Boosters #1, #3, and #4 on land along the Ottawa River. Booster #1 was a 10-inch pump staged near the WTP at the HRLF site, and was common to both the 8-inch and 10-inch lines via a Y-connection located just before the pump intake. This pump transported slurry from the edge of the river bank at HRLF through 1,000 feet of 10-inch, double-wall HDPE pipeline to a velocity box above the shaker screen, resulting in a discharge elevation of over 60 feet above the booster intake. Photo 4-3 shows Booster #1 located at the HRLF.

Photo 4-3. Y Connection at 10-inch Booster – Booster #1

Booster #3 was an 8-inch pump staged at the SPW property owned by the City of Toledo and located along the Ottawa River. Booster #4, an 8-inch pump, was staged under the I-75 Bridge on an ODOT property immediately adjacent to the Ottawa River. Table 4-5 lists all of the pipeline lengths between the boosters and dredges.

Table 4-5 Pipeline Lengths

Grand Calumet (Reach 4)	Length (feet)	Fox River (Reach 4)	Length (feet)
Thickener to Booster #1	1,000	Thickener to Booster #1	1,000
Booster #1 to Booster #2	5,500	Booster #1 to Booster #2	5,500
Booster #2 to Booster #3	6,200	Booster #2 to Booster #3	6,200
Booster #3 to Booster #4	7,000	Booster #3 to Booster #4	7,000
Booster #4 to Booster #5	6,350	Booster #4 to Fox River	5,500
Booster #5 to Grand Calumet	1,450		
Total	**26,500**		**24,200**

Block Island (Reach 2)	Length (feet)	Michael B. (Reach 2)	Length (feet)
Thickener Booster #1	1,000	Thickener to Booster #1	1,000
Booster #1 to Block Island	3,500	Booster #1 to Michael	6,100
Total	**4,500**		**7,100**

All pipeline lengths between boosters and dredges represent the longest line required on this project. The lines were shortened and boosters were taken out of line as dredging operations moved downstream toward the HRLF.

All booster stations were manned during dredging operations. The operational hours for the project during dredging activities were 24 hours per day from 7:00 a.m. Monday until 7:00 a.m. Sunday. A roaming foreman was also on site during operational hours to monitor all pipeline operations and assist with any mechanical problems. All boosters received their operating directions from the dredge leverman via an ultra-high frequency (UHF) radio. Also, JFB had a mechanic on site during the day shift to address any problems that arose.

Support and Miscellaneous

Jon boats and a jet boat were used to support all water-based activities. The jet boat was mainly used to move Booster #2, the marine plant, and grounded pipeline, and was utilized only in DMUs 2A and 2B because of bridge clearance limitations. JFB had up to seven Jon boats on site for changing crew, moving pipeline, moving dredges and barges, and fueling the dredges and water-based boosters. Two of the Jon boats were equipped with 100-gallon fuel tanks at all times.

Photo 4-12. Jet Boat Docked at Reach 2 Marine Plant near Enchanted Forest

JFB used two marine plants as support vessels throughout the project. The marine plant staged at the SPW in Reach 3 consisted of an 18,500-lb excavator placed on a sectional barge. This plant was mainly used to remove debris from the dredge areas and assist with moving the dredges under low-clearance bridges. In addition to an excavator, the marine plant located in Reach 2 was equipped with a fuel tank and generator. When docked at the Enchanted Forest, this plant was used as a docking point for the Jon boats and a refueling station. This plant was also used to repair pipeline kinks in DMU 2B. Photo 4-12 shows both the jet boat and the marine plant docked at Enchanted Forest staging area.

Temporary Dam

DMUs 4X and 4Y were added to the dredging scope of work after elevated concentrations of PCBs were found. Due to the very shallow water conditions in DMU 4X and 4Y, JFB required installation of a temporary dam structure to raise the water elevation. The typical water depth in this stretch of the river was approximately 1 foot, and the 8-inch dredge required about 2.5 feet of draft to operate.

Photo 4-13. Temporary Dam Structure in Reach 4

After discussing with EPA and ORG project team several options to raise the water level and the associated permitting requirements, JFB subcontracted Portadam Inc. (Portadam) to install a temporary dam that would raise the water level approximately 2 feet from the normal water elevation, which was approximately 572.5 feet. The A-frames that Portadam used required typical water depth across the river bed no deeper than 7 feet prior to dam placement. Also required was a relatively flat and dense base for the dam to rest upon so that scouring would not occur. The first location selected by the Portadam representative met the depth requirement but had suspect base material. This temporary dam site, located between DMUs 4C and 4G, incurred a breach during the initial construction when the crew installing the tarp onto the A-frames allowed the tarp to become pinned against the A-frames without the base of the tarp secured to the river bed. The small gap between the tarp and the river bed caused an increase in the water’s velocity at the toe of the dam, resulting in severe scouring. That scouring caused the dam to fail in less than 20 minutes. Portadam then spent the next 3 days removing that dam from the river.

Portadam mobilized heavier components and placed the dam at a new location upstream of the West Central Avenue Bridge. The heavier components were placed on a more granular stretch of the river that was slightly deeper. The temporary dam was successful in raising the water to operable levels for the time period needed to dredge DMUs 4X and 4Y. Photo 4-13 shows the temporary dam in place.

Additional Equipment and Access Area for DMUs 4X and 4Y

Reach 4 DMUs 4X and 4Y were upstream of Reach 4 DMU 4A, which previously had been the farthest location from which JFB was required to pump sediment for the project. This increased the total pipeline length from 24,200 to 26,500 feet—exceeding the pumping capability of the current system. To accommodate the additional line length, a fifth booster was installed to maintain the necessary line velocity. The 8-inch dredge Grand Calumet was also brought to the site to complete dredging at these additional areas; this minimized the effect of DMUs 4X and 4Y on the overall project schedule. The additional dredge was mobilized from another project, and a crane was brought on site to launch it into the river.

JFB also needed an area near the new dredge area from which to launch the dredge, booster, and support equipment. The City of Toledo allowed JFB to access the river via Beatty Park near the Auburn Street Bridge. Once all operations within this area had been completed, this site was restored by planting grass and reinstalling a fence along the river (see Section 4.6.2).

4.4.3 Debris and Aqua-Blok removal

Debris Removal

Before dredging operations began, a debris survey was conducted to determine amounts and locations of debris. Debris found included, but was not limited to, wood and metal posts, stumps, logs, and rocks.

During dredge operations, smaller debris such as lumber, tires, strapping, cable, and chain accumulated in the pump impeller vanes. This accumulation decreased pumping efficiency dramatically, and posed possible mechanical damage to the pump and the pump drive system. To address this issue, a cleanout or "rock box" was located on the intake of the dredge and booster pumps to allow access into the impeller vanes in order to remove the debris. All debris was placed directly into a heavy-duty plastic garbage bag for removal and disposal at HRLF. Photo 4-14 depicts the dredge pump rock box.

Photo 4-14. Dredge Pump Rock Box

Due to river conditions, smaller debris such as plastic bags, rope, and wire also became entangled in the cutterhead during operations. Debris caught in the cutterhead was removed by the leverman and dredge engineer from a work boat. A small amount of large debris was encountered in the water during the project, which primarily included as trees and boulders. JFB relocated these objects within the river but outside of the DMUs using one of the two marine plants on the river. Both marine plants were equipped with an 18,500-lb excavator to efficiently move the debris. No large debris requiring disposal was encountered.

Aqua-Blok Removal

Prior to this project, an Aqua-Blok cap had been placed over a contaminated area in Reach 3 adjacent to the sheet pile wall/boat landing at the City of Toledo's property (see Figure 1-3). During the 1990s, cap had been placed bank-to-bank along approximately 1,000 linear feet of the river bed as part of a remedial demonstration project. Three different variations of the cap had been placed over this region. Type A was Aqua-Blok placed directly on top of contaminated sediments. Type B was a layer of geo-grid placed on top of the sediment with a layer of Aqua-Blok on top of the geo-grid. Type C was a layer of geo-grid placed on top of the sediment, a layer of Aqua-Blok on top of the geo-grid, and a thin layer of gravel on top of the Aqua-Blok.

Photo 4-15. Geo-grid Removal from Ottawa River in Reach 3

JFB was able to hydraulically dredge the Aqua-Blok and gravel cover material, but the geo-grid needed to be mechanically removed prior to hydraulic activities. To perform the mechanical removal, JFB utilized the same marine plant that was used for debris removal. The Aqua-Blok capping removed from the non-TSCA and TSCA areas was handled according to the classification of the area from which the material was removed. Geo-grid was first removed from the non-TSCA areas and placed in a sealed 20 CY roll-off dumpster staged on a barge near the marine plant removing the material. Once the roll-off was full, it was off-loaded and hauled to HRLF for disposal. The geo-grid in TSCA areas was removed and placed in a 20 CY roll-off dumpster provided by The Environmental Quality Company (EQ), and was transported by EQ to its TSCA-permitted Wayne Disposal, Inc. (WDI), facility located at 49350 North I-94 Service Drive, Belleville, MI. in Wayne, MI. Photo 4-15 shows the excavator removing geo-grid from the Ottawa River.

4.4.4 Confirmatory Samples

As described in Section 3.1, post-dredge sediment sampling was performed following both TSCA and non-TSCA sediment removals to verify achievement of SWAC goals. Sampling was conducted according to the Dredge Monitoring Plan (CRA 2010) and the Contractor Quality Assurance Plan (NRT 2010). Sediment sampling was conducted by NRT and JFB field staff (and overseen by SulTRAC) using a "push-core" sampler from a sample boat. A Trimble GeoXH DGPS capable of sub-foot accuracy was used by field staff to navigate the sample boat to pre-determined sample locations. Photo 4-16 shows the confirmatory sample collection.

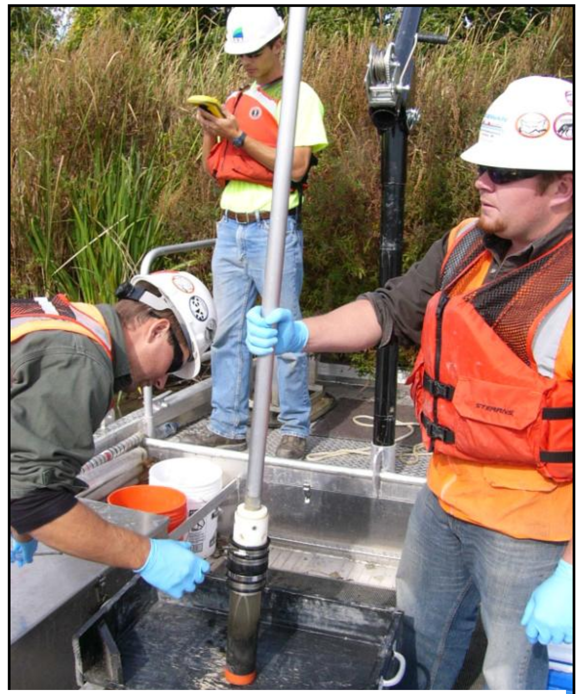


Photo 4-16. Collecting Confirmatory Sample

Post-Dredge TSCA Sampling

Post-dredge TSCA samples were collected from the top 4 inches of sediment within TSCA DMUs. This sampling occurred at pre-determined sample locations specified by CRA and listed in Appendix E of the Dredge Monitoring Plan (CRA 2010). Samples were capped and labeled, and given to a SulTRAC representative on the boat for storage in a cooler prior to processing the sample on land. NRT and SulTRAC field staff processed all sediment samples on land, and SulTRAC submitted samples for PCB analysis to confirm that average residual PCB sediment concentrations were less than 25 ppm, with no individual sample containing over 40 ppm PCBs. See Section 3.1.1 for additional information regarding the evaluation of confirmatory sampling results. Post-dredge samples collected in TSCA areas were analyzed for PCBs only, and the results appear in Table 4-6.

Table 4-6 Interim TSCA Post-Dredge Sample Results

TSCA AREAS		
Area	Total PCB Maximum (mg/kg)	Total PCB Average (mg/kg)
3H	1.55	0.50
3K	6.22	3.27
3M-1	5.96	2.36
3M-2	4.05	2.07
3N-1	2.06	0.68
3N-2	0.89	0.17
3N-3	0.67	0.20
3N-4	12.23	2.00
3O	5.28	2.65
3P	10.04	5.25
2A-1	8.5	3.95
2A-2	3.45	3.06

Notes:

mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl
TSCA Toxic Substances Control Act

<u>Final Post-dredge Sampling</u>

All TSCA areas had non-TSCA material below the TSCA sediment. After TSCA sediment had been dredged and TSCA verification sampling had been completed, remaining non-TSCA sediments were dredged within each DMU. DMUs 4X and 4Y also had TSCA material dredged, but did not require post-dredge TSCA sampling for PCBs only. In these areas, there was no non-TSCA material to dredge below the TSCA material so at the completion of TSCA dredging in DMU 4X and 4Y, samples were collected for total PCBs, total PAHs, and lead.

Once non-TSCA dredging in a DMU had been completed, confirmation sampling of the surface sediments occurred: push-core samples were collected, capped, and processed following the same procedures previously used for the TSCA sampling. A reasonable attempt was made to collect samples according to the locations specified by CRA in the Dredge Monitoring Plan (CRA 2010); however, several points along the river bank were actually located on shore. These points were offset along the original transect until a sample could be collected from the river, following approval by a SulTRAC representative.

NRT and SulTRAC field staff processed all post-dredge cores on land. SulTRAC submitted the post-dredge samples for laboratory analyses for PCBs, PAHs, and lead.

See Section 3.1 for additional information regarding the evaluation of confirmatory sampling results and SWAC calculations. Table 4-7 lists the resulting mean, maximum, and 95% UCLs for PCB, PAH, and lead concentrations in the post-dredge, non-TSCA confirmation samples collected within each DMU.

4.4.5 Final Dredge Volumes and Production Rates

Dredging operations were completed on October 21, 2010. Table 4-8 lists the non-TSCA volumes for the individual DMUs, and Table 4-9 lists the TSCA volumes for each TSCA Area. These volumes were derived from comparison of the QA pre- and post-dredge bathymetric survey surfaces with the design surface. The volume of sediment above the design surface to the pre-dredge surface represents the CY of material available for removal above the design surface. A second design surface, the overcut surface—6 inches below the design surface—represents the surface to which JFB was paid to remove material. The volume between the pre-dredge surface and the overcut surface represents the total volume that JFB was paid to remove. Figure 4-1 shows an example cross-section with the surfaces cited above. Detailed figures explaining how the dredge volumes were calculated for Tables 4-8 and 4-9 are in Appendix C of JFB's "Ottawa River Sediment Remediation Project Completion Report" (JFB 2011); the hatched area in these figures represents the volume that would be included in the dredge volume calculations.

Table 4-7 Summary of Non-TSCA Sample Results

	PCB			PAH			LEAD		
DMU	Mean	Maximum	95% UCL	Mean	Maximum	95% UCL	Mean	Maximum	95% UCL
2A	1.32	4.90	1.82	2.76	13.83	4.05	131.9	304.0	151.0
2B	1.89	9.19	3.55	9.43	51.60	18.18	90.0	204.0	109.2
2C	0.59	3.74	1.30	10.46	98.94	24.76	106.1	649.0	145.4
2D	0.87	2.96	1.84	4.72	13.49	7.36	105.2	290.0	135.8
2E	1.02	4.31	1.63	8.37	13.21	9.08	101.2	336.0	132.3
2G	0.23	0.61	0.33	1.68	3.24	2.25	132.5	273.0	177.6
3A	0.20	0.42	0.34	2.59	6.08	4.97	67.1	173.0	133.2
3B	0.56	0.94	0.94	1.68	2.39	2.39	171.3	256.0	256.0
3C	0.22	0.54	0.54	0.46	0.81	0.81	43.0	75.1	75.1
3D	0.68	2.56	2.16	2.13	6.12	4.56	139.3	350.0	221.7
3E	0.35	0.77	0.77	1.69	4.40	4.40	86.7	171.0	171.0
3F	0.17	0.38	0.31	5.32	10.04	9.50	69.6	199.0	140.6
3G	0.17	0.34	0.34	1.96	4.58	4.58	101.7	334.0	334.0
3H	0.34	1.13	1.13	2.90	8.54	8.54	115.6	276.0	276.0
3I	0.63	0.93	0.93	3.50	7.48	6.21	127.4	234.0	218.1
3J	0.98	3.70	3.70	1.14	3.52	3.52	60.7	217.0	217.0
3K	0.70	2.29	1.62	1.67	4.97	3.68	43.9	135.0	97.5
3L	0.61	1.00	1.00	7.07	12.70	12.70	69.5	109.0	109.0
3M	2.96	11.50	11.50	4.61	11.55	11.55	50.1	97.9	97.9
3N	0.27	1.01	0.77	3.25	7.60	4.86	51.6	108.0	73.3
3O	1.32	7.20	3.06	4.66	35.24	17.03	79.2	262.0	131.8
3P	0.28	0.66	0.55	2.53	14.18	9.83	59.6	162.0	95.8
3Q	0.85	2.77	2.48	1.49	4.05	2.39	199.8	975.0	402.3
3R	0.43	1.61	1.20	1.78	4.82	2.57	41.5	131.0	105.6
4A	1.61	2.67	2.67	5.32	5.51	5.51	73.3	178.0	178.0
4B	2.40	4.80	3.30	11.09	43.93	27.67	136.4	376.0	200.6
4C	0.73	1.61	1.06	7.48	13.50	9.30	53.5	127.0	81.0
4D	0.88	2.55	2.53	13.36	46.64	37.91	141.8	338.0	236.7
4E	0.65	2.53	1.65	7.38	15.59	9.01	97.7	300.0	168.7
4F	0.16	0.34	0.26	1.27	3.12	2.38	113.2	324.0	230.2
4G	1.53	3.81	2.87	6.01	7.10	6.68	121.5	326.0	220.3
4X1	1.11	4.70	2.19	2.31	16.52	4.57	54.0	138.0	73.5
4X2	1.02	1.84	1.84	3.44	6.27	6.27	74.5	156.0	156.0
4Y	2.93	24.10	6.69	1.91	3.66	3.30	36.3	106.0	47.0

Notes:

All values are concentrations in milligrams per kilogram (mg/kg).
DMU Dredge management unit
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
TSCA Toxic Substances Control Act
UCL Upper confidence limit

Table 4-8 Non-TSCA DMU Volume Calculations

DMU	Volume Removed to Design	Yards Removed to Overcut	Total Removed
2A	63,977	67,963	72,818
2B	39,149	42,149	45,468
2C	3,929	4,561	4,840
2D	7,287	8,189	8,449
2E	12,465	15,250	16,144
2G	2,786	3,329	3,718
3A	1,428	1,513	1,531
3B	1,982	2,095	2,125
3C	1,013	1,175	1,201
3D	2,163	2,354	2,381
3E	4,434	4,695	4,720
3F	1,143	1,301	1,323
3G	651	694	695
3H	1,161	1,256	1,269
3I	2,392	2,677	2,844
3J	4,431	4,733	4,984
3K	949	999	1,049
3L	1,504	1,560	1,598
3M	2,527	2,649	2,700
3N	5,532	5,966	6,034
3O	5,497	6,629	7,064
3P	9,560	9,971	10,125
3Q	2,585	2,788	2,820
3R	1,528	1,636	1,800
4A	944	1,013	1,015
4B	2,373	2,585	2,616
4C	66	105	130
4D	688	925	948
4E	1,405	1,510	1,528
4F	1,574	1,590	1,590
4G	3,863	3,863	3,863
4X1	1,488	1,671	1,771
4X2	469	511	519
Total	**192,944**	**209,905**	**221,680**

Notes:

DMU Dredge management unit
TSCA Toxic Substances Control Act

Table 4-9 TSCA Area Volume Calculations

TSCA Area	Volume Removed to Design	Yards Removed to Overcut	Total Removed
2A1	4,368	4,567	4,616
2A2	371	428	441
3H1	50	77	92
3K1	1,041	1,130	1,177
3M1	836	871	878
3M2	634	648	652
3N1	389	448	482
3N2	1,200	1,299	1,338
3N3	50	82	117
3N4	399	502	551
3O1	407	492	539
3P1	519	625	738
4X1	771	823	842
4Y	1,175	1,506	1,634
Total	**12,210**	**13,498**	**14,097**

Notes:

TSCA Toxic Substances Control Act

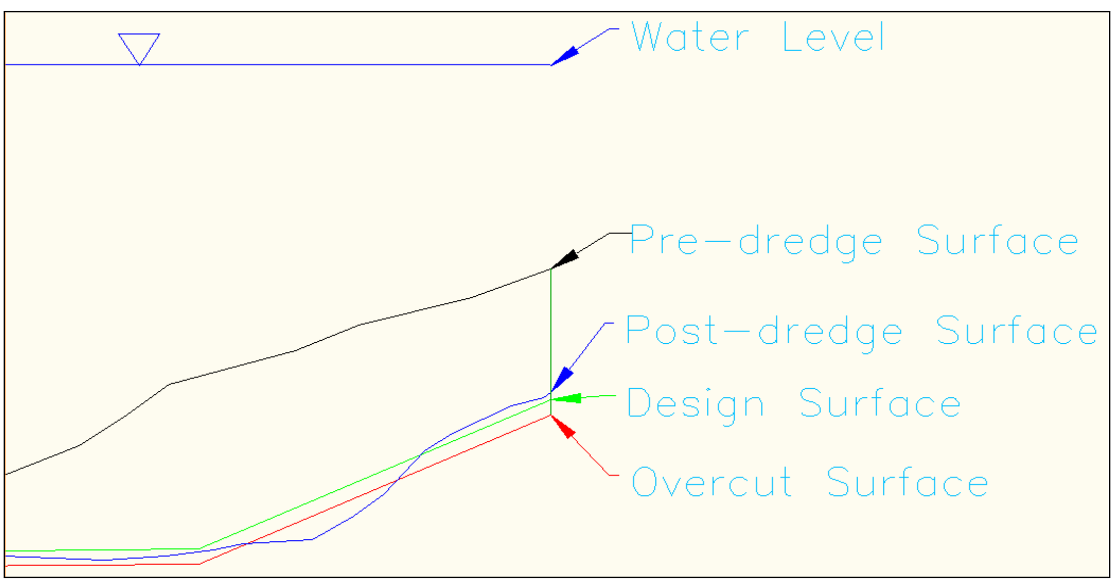


Figure 4-1. Example Cross Section

Additional dredging was required in several areas that had been dredged to grade but for which confirmatory sampling results showed remaining contamination above acceptable levels. Tables 4-10 and 4-11 list the non-TSCA and TSCA re-dredge areas, respectively, and the additional volume removed from each of those areas. JFB was paid only for the volumes in the design area and 6 inches below the design. Therefore, the volume listed as CY previously removed below overcut represents CY that could not initially be invoiced because these CY had been removed below the allowable 6-inch overcut during initial dredging operations. When areas were re-dredged based on confirmatory sampling results, no design surface was present to which to dredge. Instead, material was removed until a hard bottom was found or the material appeared to be clean. The re-dredge volume was calculated by comparing post-dredge surveys and re-dredge surveys plus any CY previously removed below the overcut.

Table 4-10 Non-TSCA Re-Dredge Areas

DMU	Additional Volume Removed (CY)	CY Previously Removed Below Overcut	Total Invoiced CY
2B	456	33	489
2B	385	16	401
2B	2,014	168	2,182
2C	242	0	242
2C	2,004	161	2,165
4X1	88	4	92
4Y*	164	6	170
4Y**	118	-	118
Total	**5,471**	**388**	**5,859**

* First re-dredge of 4Y
** Second re-dredge of 4Y

Table 4-11 TSCA Re-Dredge Areas

TSCA Area	Additional Volume Removed (CY)	CY Previously Removed Below Overcut	Total Invoiced CY
3K1	62	38	100
3M1	172	6	178
3M2	65	4	69
3N1	124	23	147
Total	**423**	**71**	**494**

Notes:

CY Cubic yards
TSCA Toxic Substances Control Act

Table 4-12 lists the total paid volume removed from TSCA and non-TSCA areas, including re-dredge areas discussed earlier. The total non-TSCA sediment volume removed eligible for payment is 215,764 CY; the total TSCA sediment volume removed eligible for payment is 13,992 CY.

Table 4-12 Total Dredge Volumes

	Volume Removed to Design	Volume Removed to Overcut	Total Removed
Non-TSCA	192,944	209,905	221,681
TSCA	12,210	13,498	14,097
Non-TSCA Re-dredge	6,442	5,859	5,471
TSCA Re-dredge	540	494	423
Total Non-TSCA	**199,386**	**215,764**	**227,152**
Total TSCA	**12,750**	**13,992**	**14,520**
TOTAL	**212,136**	**229,756**	**241,672**

Notes:

All values are volumes in cubic yards (CY).
TSCA Toxic Substances Control Act

<u>Dredge Progress Tracking</u>

On a daily basis, JFB recorded and submitted to SulTRAC all areas dredged during the previous 24-hour period (midnight to midnight). A drawing showing each dredge and its advancement within each DMU was also included for a graphical reference in the daily reports.

Estimated dredge quantities were also presented in daily reports to track yardage quantities removed during the course of that particular day. These estimates were based on the area covered by each dredge and the average cut thickness or "face." QC surveys were performed daily to compare logged dredge volumes to actual volumes removed. These volumes were communicated intermittently during daily meetings, and the week ending survey volumes were presented in weekly reports. Survey methods are discussed in Section 3.4.1.

<u>Production Rate and Schedule</u>

The production rate for the Ottawa River Sediment Remediation Project varied depending on the dredge that was operating and within which reach that dredge was operating. The 8-inch dredges had production rates ranging from 15 CY/hour to 27 CY/hour. JFB's "Ottawa River Sediment Remediation Project

Completion Report (JFB 2011) further describes the project's production rates and delays; Appendix B of JFB's report analyzes the delays by specific cause and individual dredge. In general, the dredging delays were evenly dispersed over all causes and dredges.

Table 4-13 lists the overall project percent downtime. In order to maintain the estimated production required to meet the project schedule, waterside (dredging), landside (water treatment and dewatering), and combined delays needed to result in less than 10% of the scheduled production hours. As shown in Table 4-13, percent downtime was well below these goals. Total project delays were less than 4%, substantially less than project requirements. Figure 4-2 shows that the delays and associated downtime did not reduce overall dredging production. The volumes dredged each week conformed closely to the volumes initially forecasted.

Table 4-13 Project Downtime

Responsible Party	Percent of Downtime
Waterside Delays	
J.F. Brennan	1.10%
Total Waterside Delays	**1.10%**
Landside Delays	
Water Treatment Plant	0.31%
Thickeners	1.13%
Bag Field	0.34%
Total Landside Delays	**1.78%**
Combined Delays	
Startup-Shutdown	0.81%
Weather/Misc.	0.12%
Total Combined Delays	**0.92%**
Total Project Downtime	**3.80%**
Total Project Uptime	**96.20%**

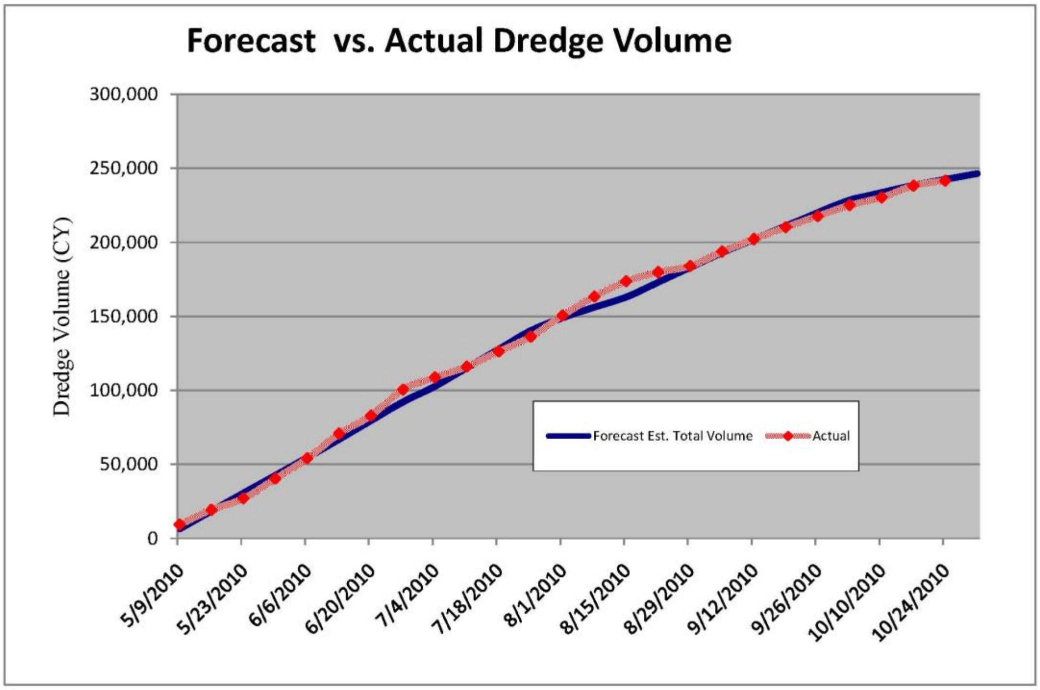


Figure 4-2. Actual Volume Dredged Versus Forecasted Volume

Dredging occurred 24 hours a day, 6 days a week. JFB used Sundays to perform maintenance not possible during operating hours. This maintenance included oil changes, cutterhead maintenance, or any non-critical repairs to machinery. Appendix A to the "Ottawa River Sediment Remediation Project Completion Report" (JFB 2011) includes charts showing production goals versus realized production, estimated and realized production by week, and 1st pass square foot coverage versus estimated. The project took up 3,472 gross operational hours (GOH) and 3,340 net operational hours (NOH). GOHs represent the number of hours the dredge would have operated with no delays—assuming operations 24 hours 6 days a week, and two dredges operating during all those times. NOHs are the actual number of hours during which dredges were pumping sediment. A total of 241,672 CY was removed during the project, equivalent to an average of 69.6 CY/GOH. Table 4-14 shows the production rate and efficiency of each dredge operating during the project.

Table 4-14 Production Rates and Efficiency

	Volume Removed	Hours		Production Rate (CY/hour)		Efficiency
	Cubic Yards	Gross	Net	Gross	Net	(NOH/GOH)
Michael	121,141	1747.75	1573.25	69.3	77.0	90%
Fox River (Reach 3)	41,660	1830.00	1669.75	22.8	24.9	91%
Fox River (Reach 4)	11,690	942.00	814.00	12.4	14.4	86%
Block Island	40,454	1203.00	1087.75	33.6	37.2	90%
Grand Calumet (Areas 4X/4Y)	5,136	364.00	281.00	14.1	18.3	77%
Grand Calumet (Reach 3)	21,590	862.25	782.00	25.0	27.6	91%

Notes:

CY Cubic yards
NOH Net operational hours
GOH Gross operational hours

4.5 TSCA LOAD OUT

As discussed in the previous sections, TSCA Areas within DMUs—where the sediment contained PCB concentrations equal to or greater than 50 mg/kg—were delineated in the design phase. During dredging operations, 14,520 CY of TSCA sediment and 227,152 CY of non-TSCA sediment were removed from the Ottawa River and pumped to separate dewatering pads at HRLF. At completion of the project, dewatered sediment in geotubes on the non-TSCA dewatering pad was covered with soil, while disposal of the TSCA sediment and other materials occurred off site to EQ's TSCA-permitted WDI facility located at 49350 North I-94 Service Drive, Belleville, MI. The load out process, evaluation and application of dewatering additives, final load out results, and site restoration are discussed below.

4.5.1 TSCA Load Out Process

The initial route planned for the trucks hauling TSCA material was through HRLF and exiting at the front gate. This route was not feasible because leachate tanks present under the road may not have been able to handle the loading from the trucks. In order to provide an adequate haul out route, the existing roads around the TSCA pad were improved by removing unstable material and placing geotextile and stone; this provided a stable road with room for truck turnaround and staging (see Photo 4-17).

Photo 4-17. TSCA Haul Road Improvements

During load out, each truck was driven onto a geotextile fabric to prevent contact with the ground of any inadvertently spilled TSCA material during loading with long-reach excavators. A plastic liner was also placed on the inside of the truck trailer, and super absorbent polymer (SAP) was placed at the tailgate to ensure no free liquid left the trucks while in transport. After the truck was loaded and before it left the site, any spilled material was cleaned up and placed back in the TSCA pad, and an inspection checklist was completed for each truck to ensure the trucks were clean, contained proper placards, and were otherwise ready to enter the public roadways. Before trucks left the site, appropriate manifests and any other transport documentation were also properly completed.

4.5.2 Dewatering Issues and Additives

Before the TSCA load out began, samples of the sediment in the geotubes were collected and tested to determine whether the material had been sufficiently dewatered to pass the paint filter test (PFT), as required by the landfill for disposal. It was determined that the material had not been sufficiently dewatered. This was a result of adding DMUs and associated TSCA Areas to the project after dredging had begun. These additional areas extended the dredging schedule, thus inducing a reduction of the time allowed for dewatering in the geotubes before TSCA load out in order to meet the project schedule. The unanticipated additional TSCA sediment and associated geotubes apparently also resulted in inadequate drainage within the TSCA dewatering pad. Backwash material pumped to the TSCA dewatering pad from the WTP on a few occasions also inhibited proper drainage.

To address this problem, it was initially decided to add SAP in order to absorb free water and make the material suitable for disposal. SAP was selected as a drying additive because it is not a bulking material, does not cause an exothermic reaction, and poses fewer dust concerns than other additives. Based on initial estimates, a 0.25% mixture of SAP (approximately 44 tons) would be applied by hand to treat the estimated 15,000 tons of TSCA material. Photo 4-18 shows the material encountered when the initial geotubes were opened, as well as the application of SAP.

However, as load out continued and additional geotubes were opened at other areas of the dewatering pad, the material encountered was much wetter than initially anticipated (see Photo 4-19). Improper drainage in the TSCA pad further compounded the problem. To improve the drainage, a channel was created along the north edge of the pad, but wet material treated with 0.25% SAP still did not meet PFT requirements for landfill disposal.

Photo 4-18. Application of SAP

Increasing the SAP dosage to meet PFT rendered the material unfit to meet landfill material strength requirements. It was determined that SAP was not cost-effective and did not improve the sediment sufficiently at an application rate that was acceptable to the project team or the landfill.

Photo 4-19. Wet TSCA Material

The inability of SAP to sufficiently dewater the material led the project team to try other measures and evaluate other additives necessary to render the material suitable for disposal. After additional improvements to the drainage within the dewatering pad and unsuccessful implementation of measures to stack and re-stack the sediment to further dewater it, need for application of an alternative additive to meet landfill acceptance criteria was evident. After several options were considered, applying lime kiln dust (LKD) from super-sacks was found to be the most efficient and economical material and method. Bench-scale tests were performed on site in coordination with regulatory authorities to determine whether the LKD would raise the temperature of the TSCA sediment high enough to volatilize the PCBs (a significant concern). The following two types of material were tested at 3% and 7% LKD application rates (above and below the anticipated 5% application rate required for dewatering): (1) the wettest material encountered in the pad and (2) a mixture of wet and drier material within the pad that would most accurately represent material to be loaded out. As shown in Table 4-15, resulting temperature increases during bench-scale tests were less than 15 degrees Fahrenheit (°F), and final temperatures were less than 60°F at the higher application rate—not high enough to volatilize the PCBs. Also, use of super sacks was an effective way to deliver, store, and apply the LKD without releasing unacceptable amounts of the dust that would violate air permit requirements.

Table 4-15 Bench Scale Test Results for Temperature of Amended TSCA Sediment

	TEMPERATURE		
	Initial	3% LKD	7% LKD
Mixed Material	43.7°F	50.0°F	58.1°F
Wet Material	47.3°F	n/a	59.9°F

Notes:
°F Degrees Fahrenheit
LKD Lime kiln dust
n/a Not applicable
TSCA Toxic Substances Control Act

Because the EQ's landfill's permit specified different strength criteria for cohesive and non-cohesive materials, a soil classification study was also performed on the material. The results showed that the material was non-cohesive and therefore was required to pass a 2-inch slump test per the landfill's permit. In order to meet this requirement, the material was mixed with LKD to a near 0 slump (<0.5 inch) at the site. After mixing began, a second round of soil classification tests confirmed that the addition of LKD did not change the material classification as non-cohesive; therefore, the 2-inch slump test would still apply. Photo 4-20 shows the TSCA material passing the slump test on site.

Photo 4-20. 2-Inch Slump Test of TSCA Material

4.5.3 Load Out Completion and Site Restoration

After the dewatering additive issues were resolved, the load out resumed with a goal of transporting 30 truckloads or approximately 1,350 tons of material per day off site. However, setbacks such as landfill shutdown due to high wind velocities and long delays at railroad crossings increased the difficulty of meeting this goal. The load out start time was scheduled earlier to reduce delays at the railroad crossings. Delays due to high winds could not be avoided, but the weather was constantly monitored to avoid additional costs incurred by the trucks sitting at the landfill waiting for the high winds to pass so they could unload.

As the load out operation proceeded toward the sump in the pad, the liner was pulled back in sections from which sediment had been removed, thus allowing collection of verification soil samples. Once verification sampling results confirmed that the area was not contaminated, the area was re-graded to a minimum of a 1% slope; seeding was to occur the following spring.

The load out was completed on January 12, 2011, after 2.5 months, and re-grading of the TSCA pad area was completed the following day. Table 4-16 lists the estimated quantities of materials disposed of during the TSCA load out. Note that the approximate weight of dewatered TSCA sediment presented in the table is based on total quantity of material disposed of minus the estimated weights of non-sediment material added, and also includes an undetermined quantity of backwash material from the WTP. Also, no LKD was added to the first 3,344 tons of sediment removed from the project.

Table 4-16 Estimated Quantities of TSCA Material Loaded Out

TSCA Material	Quantity (U.S. tons)
TSCA Sediment	23,966
SAP Super Absorbent Polymer	44
Lime Kiln Dust	1,036
Backwash Material	1,000
Clay	120
Mats	39
Liner	14
Geocomposite	32
Geotubes	14
Total	**26,265**

Notes:

SAP Super absorbent polymer
TSCA Toxic Substances Control Act

4.6 RESTORATION ACTIVITIES

Restoration activities during the RA included initial turf restoration at HRLF, restoration of four disturbed areas used to access the river, and final restoration of the TSCA dewatering pad area at HRLF. These activities are discussed in more detail in the following sections.

4.6.1 Initial Turf Restoration of Disturbed Areas at HRLF

Photo 4-21. Interim Turf Restoration at HRLF

After MBC had constructed access roads, TSCA dewatering pads, and non-TSCA dewatering pads, and had conducted all other required contract work at HRLF, MBC restored approximately 8 acres of interim turf (see Photo 4-21). Hydroseeding equipment was used to spread grass seed, fertilizer, and straw mulch on all disturbed areas during May 2010. All materials used for the restoration met contract specifications. Additional restoration on the TSCA dewatering pad area is discussed further in Section 4.6.3. ORG was responsible for other restoration at HRLF.

4.6.2 Restoration of Access Areas Required for Dredging

The City of Toledo allowed JFB to access the river via Beatty Park near the Auburn Street Bridge in order to perform dredging within added DMUs 4X and 4Y. SulTRAC had coordinated with the City of Toledo through ORG to obtain access to this property. After all dredging operations at those DMUs had been completed and approved, this property was restored by seeding grass, spreading fertilizer, mulching disturbed earth, and reinstalling a fence that had been removed and salvaged along the river. After completion of the restoration, Tim Burns of the City of Toledo inspected the property and approved the restoration activities (City of Toledo 2010a).

The City of Toledo also allowed use of its property along the Ottawa River between LaGrange Street and Stickney Avenue. Referred to as the “Sheet Pile Wall” site, this area was used by EPA and JFB to launch required vessels; the property was also the site of a marine plant and Booster #3. SulTRAC had coordinated with the City of Toledo through ORG to obtain access to this property. After all dredging activities had been completed and approved, JFB removed the marine plant, booster, and a security fence that had been installed for the project. Turf restoration on this property was not required; only grading of the gravel parking lot was deemed necessary. After restoration of this property had been completed, Tim Burns of the City of Toledo inspected the property and approved the restoration activities (City of Toledo 2010b).

ODOT property located at Berdan Avenue and I-75 was used by JFB to assemble the dredge slurry pipeline prior to deploying it in the Ottawa River. The parcel was also the location for Booster #4. SulTRAC coordinated with ODOT directly to obtain access to this property (ODOT 2010). After all dredging activities had been completed and approved, JFB removed the booster; no restoration was required on this property. SulTRAC notified ODOT after all equipment had been removed and offered to meet ODOT for a final inspection of the property, but ODOT did not conduct a final inspection (SulTRAC 2011a).

A parcel of private property known as the "Enchanted Forest" located on Matzinger Road, just east of Stickney Avenue, was used by JFB to deploy the 10-inch dredge. This property also served as the site for a second marine plant and was the location of Booster #2. JFB had coordinated with the property owner directly to obtain access to this property. The only restoration activity required at this property was removal of a wooden stairway built to access the marine plant. After subsequent removal of the 10-inch dredge, marine plant, and the booster, JFB coordinated with the property owner regarding inspection of the site and approval of the restoration activities in accordance with their access agreement.

4.6.3 Final Restoration of the TSCA Dewatering Pad Area at HRLF

Final restoration activities of the TSCA dewatering pad area at the HRLF included the following:

- Grading the TSCA dewatering pad area to a minimum 1% grade after all TSCA material had been hauled off site
- Placing and grading topsoil
- Installing salvaged north perimeter fence
- Replacing approximately 800 square feet of the existing asphalt interpretive trail that had been removed to construct the TSCA dewatering pad
- Restoring 4 acres of turf.

JFB was initially responsible for all dewatering pad area site restoration work at HRLF. However, all of the TSCA dewatering pad restoration could not be completed until spring 2011 (completion had been planned for fall/winter 2010). Therefore, to accommodate the schedule change and to save project costs, JFB conducted only the following restoration activities before demobilizing from the site in January 2011: (1) grading the TSCA dewatering pad area and berms, and (2) placing and fine-grading topsoil.

In January 2011, American Fence & Supply (AFS) installed the north perimeter fence. In June 2011, Buckeye Asphalt Paving Co. (Buckeye) replaced the asphalt interpretive trail, and Stante Excavating (Stante) restored turf and addressed all punch list items for the site restoration (see Section 5.2).

4.7 PROJECT ACCOMPLISHMENTS AND LESSONS LEARNED

The most significant project accomplishments of the Ottawa River RA are (1) achievement of the project cleanup goals and (2) completion of the project according to an aggressive schedule. Meeting the schedule avoided significant dredging, water treatment, and dewatering activities that would have been more difficult or would have resulted in a temporary shutdown during freezing winter months, thus significantly increasing the project duration and associated costs. Other significant project accomplishments of the RA included the following:

- More than 241,600 CY of contaminated sediment removed from the Ottawa River in 145 days
- More than 95% project uptime
- SWAC within the project area met post-cleanup, as well as long-term remedial goals
- More than 66,000 man-hours worked without a recordable safety incident
- Project schedule met despite unanticipated additional dredge areas
- Project completed about $1.9 million (8%) under budget.

Nonetheless, several challenges arose over the course of the RA, and overcoming these challenges was key to project accomplishments. The means by which the challenges were overcome, or better understood after project completion, provide solutions and lessons learned applicable to other similar RA projects. These challenges and the associated solutions and lessons learned are summarized in Table 4-17.

Table 4-17 Summary of Remedial Action Challenges, Solutions, and Lessons Learned

Challenges	Solutions	Lessons Learned
Aggressive schedule and multiple contractors – EPA and ORG had their own prime contractors responsible for dredging and water treatment, respectively. In addition, the project needed to be completed according to an aggressive schedule to avoid operational difficulties or a temporary shutdown during freezing winter months, thus significantly increasing the project duration and costs.	• Conducted dredging activities on 24 hour per day, 6 day per week schedule. • Daily shift meetings were held at the beginning of each 12-hr shift to discuss and coordinate planned activities. • Weekly meetings were held with contractors and EPA, ORG and other decision-makers to resolve issues. • Contractors were equipped with two-way radios on a common frequency, as appropriate, to maintain a direct line of communication between the dredging and water treatment plant operators. • Dewatering pad construction and dredging subcontracts included schedule and performance-based incentives, including penalties.	• Communication and coordination between contractors and stakeholders regarding project schedule and resources, supplemented by performance-based contracting mechanisms, was important to meeting the project schedule and contributed to overall project success.
Water level and flow direction changes – Winds caused seiche (flow reversal) effects from Lake Erie and the water levels to fluctuate more than 1 foot multiple times a day; 27 bridges in the project area (many with low clearance) made equipment movement even more challenging under low water level conditions.	• An acoustic Doppler current profiler (ADCP) was installed to monitor river velocity and detect of a seiche event. • Multiple dredges, including a standby dredge, were used on the project to accommodate flexibility required in the schedule because of low water levels or if one of the other dredges was inoperable because of logistical or mechanical issues.	• ADCP was an effective means of monitoring seiche events and important in evaluating turbidity during flow reversals. • Having standby equipment available allowed schedule flexibility to maintain project uptime.
Accelerated design schedule did not allow for delineation of pipelines and other utilities – Utilities and pipelines were encountered during dredging activities, which required modifications to the project approach and schedule.	• Utility and pipeline locates were conducted during dredging operations and dredging offsets were established where appropriate. • Utility and pipeline locates were supplemented by sampling and poling efforts to more accurately refine the dredging offsets areas.	• A thorough delineation of utilities and pipelines within the project area should be conducted during remedial design.

Table 4-17 Summary of Remedial Action Challenges, Solutions, and Lessons Learned (Continued)

Challenges	Solutions	Lessons Learned
Varying sediment thickness and material – The sediment thickness ranged from less than a foot to nine feet and the material included silt, sand, gravel, and clay; and contained varying levels of debris depending on the location in the river.	• The dredge slurry was run through the "thickener" or mobile dewatering plant before going into the geotubes. The thickener included vibratory screen, velocity box, rectangular tanks with underflow pumps, and control center. • The dredge slurry was also dosed with polymer during the thickening process. • Multiple dredge lines were combined into a common line.	• The thickener plant was an effective means of removing debris, properly dosing the slurry with polymer, reducing plugging of the dewatering pad header system, and increasing percent solids going into the geotextile tubes. • Combining multiple dredge lines reduced the amount of equipment for the transport pipeline and simplified polymer dosing.
Adding DMU 4X and 4Y – High PCB levels were found further upstream of the originally designed dredging areas. The water depths in this area were too low to hydraulically dredge and the sediment would have to be pumped over five miles to HRLF.	• A temporary dam was installed to raise the water levels and allow the additional DMUs to be hydraulically dredged. • An additional dredge was mobilized so the dredging schedule would not be delayed. • An additional booster pump was added to the line to ensure the sediment would reach the dewatering pads given the increased distance.	• A temporary dam (Portadam) system can be an effective means of temporarily raising water levels without significant permitting requirements and associated delays.
TSCA sediment was not sufficiently dewatered for off-site disposal – Due to project schedule changes, unanticipated additional DMUs and the associated increase sediment volume, and other factors, TSCA sediment was not dewatered as expected; therefore, additives were required to meet the TSCA landfill acceptance criteria.	• Material stabilization additives such as super absorbent polymer (SAP) and lime kiln dust (LKD) were added to the sediment to meet the moisture content and strength requirements of the off-site permitted disposal facility. • Bench-scale testing was conducted to determine the most effective additive type and percent addition. • On-site testing of stabilized sediment was conducted to confirm compliance with landfill requirements before off-site transport.	• Provide adequate time for dewatering in the geotubes before load out. • Include contingency area in the dewatering pad design to allow adequate drainage if dredge quantities increase. • Collect enough samples of the dewatered sediment in the center and exterior of the geotubes to adequately characterize the moisture content and other properties that may affect disposal facility acceptance. • Conduct bench-scale tests of the dewatered sediment and potential dewatering additives as needed to determine the type and percentage of additive required for disposal. . • SAP is an effective, low-bulking additive to reduce free water content in sediment prior to disposal, but can compromise material strength.

Notes:
DMU = Dredge Management Unit
EPA = U.S. Environmental Protection Agency
HRLF = Hoffman Road Landfill
ORG = Ottawa River Group
PCB = Polychlorinated biphenyl
TSCA = Toxic Substances Control Act

5.0 FINAL INSPECTION

Pre-final RA inspections were conducted after completion of MBC's dewatering pad construction activities and after completion of JFB's dredging and TSCA load out activities. These inspections were to identify deficient or uncompleted items prior to demobilization by MBC and JFB. The final RA inspection occurred after completion of final restoration of the TSCA dewatering pad area at HRLF. For each of these inspections, punch lists items were identified during initial site walks, and confirmations of their completions occurred during final site walks. Inspection findings and corrective actions are discussed in the following sections.

5.1 DEWATERING PAD CONSTRUCTION PRE-FINAL INSPECTION

After MBC substantially completed construction of the non-TSCA and TSCA dewatering pads, a pre-final inspection was performed on April 16, 2010, by representatives from SulTRAC and ORG, including de maximis and the HRLF. The inspection was considered pre-final because (1) final restoration of the non-TSCA dewatering pad area was to be performed by ORG after completion of dredging operations, and (2) final restoration of the TSCA dewatering pad area was to be performed by JFB and other SulTRAC subcontractors after completion of the TSCA load out. Major items found deficient or needing completion during the April 2010 pre-final inspection included the following:

- Demonstrating opening and closing of all valves
- Testing 24-inch-diameter HDPE drain line
- Testing 18-inch-diameter backwash line
- Installing aggregate around valve locations
- Completing backfill of anchor trenches
- Addressing erosion area of ramp of access road by 48-inch culvert
- Addressing steep berm slope at monitoring well location
- Addressing erosion channel just west of monitoring well area and installing check dams
- Fine-grading and seeding all disturbed work areas
- Removing silt fence after establishment of vegetation
- Restoring landfill work areas—haul roads, stockpile.

MBC addressed the above items by installing aggregate around valves and opening and closing all valves in the presence of a SulTRAC and ORG representatives. Per the specifications, MBC also performed a pressure and hydrostatic test of the 24-inch-diameter and 18-inch-diameter HDPE lines, and completed backfilling and compaction of the anchor trenches around the TSCA and non-TSCA dewatering pads.

After the monitoring wells had been raised, MBC re-graded and added large aggregate to prevent washouts. MBC also re-graded and installed check dams west of the 48-inch access road culvert to prevent future washouts. All disturbed areas no longer in use were fine-graded and hydroseeded, as were areas that MBC had used for material storage, haul roads, and the HRLF clay stockpile area. The areas were inspected for restoration during a final site walk-through on May 5, 2010.

5.2 DREDGING AND TSCA LOAD OUT PRE-FINAL INSPECTION

As discussed in Section 4.6.2, following restoration of each required access area, inspections were conducted by SulTRAC and the respective property owners. In addition, after JFB completed TSCA load out activities, a pre-final inspection of the TSCA dewatering pad area was conducted on January 13, 2011, by representatives of SulTRAC, JFB, and ORG, including de maximis and HRLF (represented by Hull & Associates, Inc. [Hull]). JFB was initially responsible for all dewatering pad area site restoration work at HRLF. However, as discussed in Section 4.6.3, all of the TSCA dewatering pad restoration could not be completed until spring 2011 (instead of fall/winter 2010 as originally planned). Therefore, to accommodate the schedule change and to save project costs, JFB conducted only the following restoration activities before demobilizing from the site in January 2011: (1) grading the TSCA dewatering pad area and berms, and (2) placing and fine-grading topsoil. Major items found deficient or incomplete during the January 2011 pre-final inspection included the following:

- Remove erosion control silt fence along TSCA haul road and retention pond.
- Remove straw bales between TSCA haul road and north perimeter fence.
- Repair deficient erosion control silt fence along proposed bike path.
- Place topsoil and grade on disturbed areas of TSCA pad.
- Place, grade, and compact ODOT 304 aggregate on TSCA haul road.
- Complete topographic survey of TSCA pad area.

To address these items, JFB and its subcontractor (Stante) removed all erosion control silt fence and straw bales that had been used for erosion control around the retention pond. Stante also graded topsoil that had been delivered to the TSCA pad site by ORG, and Stante placed, graded, and compacted ODOT 304 aggregate on the TSCA haul road. JFB also (1) repaired the existing silt fence along the interpretive trail, given that final restoration work would not be completed until spring 2011 (when weather would allow), and (2) conducted a topographic survey of the TSCA pad area and haul road.

5.3 FINAL REMEDIAL ACTION INSPECTION

A final inspection of the completed Ottawa River RA was conducted at HRLF on July 6, 2011. The following attendees representing EPA GLNPO and ORG participated in the final inspection:

- Scott Cieniawski, EPA GLNPO
- Paul Syring, City of Toledo
- John Hairston, HRLF
- Karen Okonta and Trent Hathaway, Hull (representing HRLF)
- Stan Baker, de maximis
- Jack Brunner, SulTRAC.

The goal of this final inspection was to determine whether the following punch list items had been addressed adequately. These items had been identified during an initial site walk for the final inspection on June 3, 2011 (conducted by SulTRAC, de maximis, and Hull):

- Repair washout at the downstream end of the 18-inch culvert that crosses the non-TSCA access road.
- Repair washouts along the north slope of the TSCA access road.
- Remove chain-link fence that had been staged between the non-TSCA and TSCA access roads.
- Regrade and permanently restore turf on all disturbed areas.
- Remove tree that had fallen and partially blocked the trail.
- Turn in key to access gate.
- Remove security fence at the entrance of the trail.

Photo 5-1. Restored TSCA Dewatering Pad Area During Final RA Inspection

As observed by the inspection participants, the TSCA pad and areas along the restored bike path that had been seeded in spring 2011 were doing well: establishment of the vegetation was continuing, despite the lack of rain. In addition, inspection participants observed that all punch list items listed above had been completed and were acceptable. The inspection participants agreed that no additional work by SulTRAC or its subcontractors would be required (SulTRAC 2011c).

6.0 CERTIFICATION THAT REMEDY IS OPERATIONAL AND FUNCTIONAL

As discussed in Section 3.0, the following primary cleanup goals of the RA had been established on the basis of SWAC and were used as performance standards to assess sufficiency of the RA activities:

- 1.5 mg/kg for total PCBs
- 30 mg/kg for total PAHs
- 180 mg/kg for lead.

Post-dredging sampling confirmed attainment of the SWAC goals for all performance standards within all three reaches. Additional statistical analysis of results of the post-dredging sampling further reinforced the conclusion that the overall project remedy had been successful. Table 6-1 lists results discussed in Section 3.1.3, which show that the SWAC results for the project as a whole were well below the cleanup goals established for the project.

Table 6-1 Overall Project SWACs

Overall Project SWACs			
	Lead (mg/kg)	Total PCBs (mg/kg)	Total PAHs (mg/kg)
$SWAC_{estimate}$	**80.33**	**0.71**	**3.26**
Cleanup Goal	180	1.5	30
Cleanup Goal Met	**Yes**	**Yes**	**Yes**

Notes:

mg/kg Milligrams per kilogram
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SWAC Surface weighted average concentration

In addition to meeting project cleanup goals, the remedy was implemented in accordance with the design plans and specifications, unless otherwise approved by EPA GLNPO and/or ORG, and is therefore fully operational and functional.

7.0 OPERATION AND MAINTENANCE

SulTRAC's RA activities met the cleanup goals and did not include capping or other features requiring operation and maintenance. EPA GLNPO, Ohio EPA, and the U.S. Fish & Wildlife Service will coordinate regarding long-term monitoring of the overall Ottawa River system recovery.

8.0 SUMMARY OF PROJECT COSTS

Final RA costs for the EPA-funded activities conducted by SulTRAC and its subcontractors were approximately $1.9 million (8 percent) under the cost estimate included in the project work plan. Table 8-1 lists these costs, including detail on RA subcontract costs.

Table 8-1 Remedial Action Cost Summary

Activity/Subcontract	Estimated Cost	Actual Cost	Estimated vs. Actual Cost
Dewatering Pad Construction	$3,580,000	$2,737,000	($843,000)
Dredging and TSCA Load Out	$12,570,000	$12,643,000	$73,000
Geotextile Tubes	$1,660,000	$1,430,000	($230,000)
Polymer	$1,000,000	$1,342,000	$342,000
Sample Analysis	$95,000	$95,000	$0
TSCA Restoration – Fence Replacement	$0	$13,000	$13,000
TSCA Restoration – Bike Path	$0	$17,000	$17,000
TSCA Restoration – Seeding	$0	$14,000	$14,000
Engineering, Resident Inspection, and G&A/Fees	$6,128,000	$4,761,000	($1,367,000)
TOTAL	**$25,033,000**	**$23,052,000**	**($1,980,000)**

Notes:

All costs rounded to nearest $1,000.
G&A General and administrative expense.
TSCA Toxic Substances Control Act

Estimated subcontract costs included in the cost estimate were based on the design engineering estimates provided by ORG (dewatering pad construction and polymer), as well as the apparent low bidder (dredging) or average bid price (geotextile tubes) available at the time that the cost estimate was prepared.

TSCA restoration costs were not included as separate items in the cost estimate because those activities were originally included in the Dredging and TSCA Load Out subcontract. Based on the project schedule, these activities were removed and associated costs of $48,000 were deducted from the original Dredging and TSCA Load Out subcontract through a change order.

REFERENCES

J.F. Brennan (JFB). 2011. "Ottawa River Sediment Remediation Project Completion Report." January 25.

City of Toledo. 2010a. E-mail Regarding Approval of Restoration Activities at Beatty Park. From Timothy Burns, Manager – Parks and Forestry. To Robert Rule, de maximis, inc. September 30.

City of Toledo. 2010b. E-mail Regarding Approval of Restoration Activities at the Sheet Pile Wall Area. From Timothy Burns, Manager – Parks and Forestry. To Tyler Lee, JFB. December 22.

Conestoga Rovers and Associates (CRA) 2009. "Ottawa River Cleanup Plan Design Report." Prepared for The Ottawa River Group. January 2009. Reissued August 2010.

CRA. 2010. "Ottawa River Cleanup Project Dredge Monitoring Plan." Prepared for The Ottawa River Group. July 2009. Reissued February 2010.

de maximis, inc. (de maximus). 2011. "Ottawa River Land Side Report, Ottawa River Cleanup." Draft. February.

The Mannik & Smith Group, Inc. (MSG). 2010a. "Construction Quality Assurance Report, Ottawa River Dewatering Facility Sediment Containment Area, Hoffman Road Landfill, Toledo, Ohio." May.

MSG. 2010b. "Construction Quality Assurance Plan, Ottawa River Dewatering Facility Sediment Containment Area, Hoffman Road Landfill, Toledo, Ohio." February.

Natural Resource Technology, Inc. (NRT). 2010. "Contractor Quality Assurance Plan, Ottawa River Sediment Remediation, Dredging and Dredging QC Operations, Toledo, Ohio." Prepared by NRT for JFB. Submitted to SulTRAC. February 12.

Ohio Department of Transportation (ODOT). 2010. Permit No. 0200222010 for Work within State's Right of Way. Issued February 8.

SulTRAC. 2010a. "Remedial Action Sampling Quality Assurance Project Plan, Ottawa River Lucas County, Ohio (Revision 1)." Prepared for U.S. Environmental Protection Agency (EPA) Great Lakes National Program Office (GLNPO). April.

SulTRAC. 2011a. E-mail Regarding Inspection of ODOT Property at Berdan Avenue and I-75. From Aaron Stanton, Resident Engineer. To Steve Colony, District Real Estate Engineer. January 11.

SulTRAC. 2011b. "Data Validation Summary Report, Ottawa River, Lucas County, Ohio." Prepared for EPA GLNPO. June.

SulTRAC. 2011c. "Final Inspection Report for Ottawa River Remedial Action." Inspection Conducted July 6, 2011. Report Submitted July 21.

U.S. Army Corps of Engineers (USACE). 2002. *Engineering and Design Hydrographic Surveying Manual* No. 1110-2-1003.

U.S. Environmental Protection Agency (EPA). 1992. "Remedial Action Report, Documentation for Operable Unit Completion," Publication 9355.0-39FS. June.

EPA. 2008. "National Functional Guidelines for Superfund Organic Methods Data Review." Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, D.C. USEPA-540-R-08-01. June.

EPA. 2010. "National Functional Guidelines for Inorganic Superfund Data Review." Office of Emergency and Remedial Response. Washington, D.C. EPA-540-R-10-011. January.

APPENDIX A

CONTAMINANT CONCENTRATION MAPS

(See electronic files on CD under Appendix A subdirectory)

APPENDIX B

STATISTICAL ANALYSIS MEMO

ST SulTRAC

MEMO

To: Scott Cieniawski, U.S. Environmental Protection Agency (EPA)
Great Lakes National Program Office (GLNPO)

From: Jack Brunner, SulTRAC

Date: June 23, 2011

Subject: Exploratory Statistical Analysis of Post-Cleanup Verification Data
Ottawa River Sediment Remediation, Toledo, Ohio

SulTRAC has completed the requested additional exploratory statistical analysis of post-cleanup verification data for the Ottawa River Sediment Remediation Project in Toledo, Ohio. This memo presents the cleanup goals and verification activities conducted during project dredging activities, discusses the methodology used for the additional exploratory statistical analysis of post-cleanup verification data, and summarizes the results of the statistical analysis. References cited in the memo are listed at the end of the memo, and tables showing detailed results of the statistical analysis are attached.

CLEANUP GOALS AND VERIFICATION ACTIVITIES DURING DREDGING

Project Cleanup Goals and Confirmatory Sampling Approach

The following project post-cleanup goals were established on the basis of Surface Weighted Average Concentrations (SWAC) and used as performance standards to determine if dredging activities were sufficient:

- 1.5 milligrams per kilogram (mg/kg) for total polylchlorinated biphenyls (PCB)
- 30 mg/kg for total polynuclear aromatic hydrocarbons (PAH)
- 180 mg/kg for lead.

The project area included Reaches 2, 3, and 4 of the Ottawa River, within which Dredge Management Units (DMU) were established. For post-cleanup verification, the SWAC was calculated across each entire reach, including dredge and non-dredge areas.

1 S. Wacker Drive, 37th Floor, Chicago, IL 60606
Tel 312.201.7700 Fax 312.201-0031

Once sediment was dredged to design depths, confirmatory surface sediment samples (0 to 4 inches from top of sediment) were collected at predetermined locations that were generally at 50-foot intervals on transects spaced 250 feet apart. The samples were analyzed for total PCBs, total PAHs, and lead. The confirmatory sample results and the resulting SWAC calculation were evaluated versus the cleanup goals to determine whether the individual DMUs could be "cleared" (released from further dredging or other remedial activities).

Total PCB and PAH values were calculated for each sample by summing their individual aroclors (PCBs) and compounds (PAHs). Calculation of total PCB values with nondetect results involved summing half the detection limits for, respectively, Aroclor 1242, Aroclor 1254, and Aroclor 1260 only. Based on historical sampling results, the project team determined that the remaining aroclors were not likely to be present in Ottawa River sediment, and that including half the respective detection limits of these aroclors in the summation would result in estimates for total PCBs biased high. To calculate total PAH values with nondetect results, half the detection limit was used for all PAH compounds.

SWAC Calculation for Cleanup Verification

A 95% Upper Confidence Limit (95%UCL) was calculated using ProUCL software for total PCBs, total PAHs, and lead in each DMU and entered in the SWAC calculator—a MS Excel spreadsheet that included SWAC for non-dredge areas and fields for entering 95%UCL results for each DMU (see Attachment A). Field duplicates were treated as unique samples and were included in the calculation of the 95%UCL. For some DMUs, not enough samples were available to use parametric methods in ProUCL. In these cases, Chebyshev Inequality, a non-parametric method, was used to calculate the 95%UCL. This was the most appropriate method to use with the limited sample sizes. In cases where the 95%UCL calculated by Chebyshev resulted in a higher value than the maximum value of the sample results, the maximum sample result was the default value used for the SWAC calculation.

The SWAC calculator was updated as post-dredge 95%UCL values were calculated for each DMU. The Ottawa River Cleanup Plan Design Report prepared by Conestoga Rovers and Associates (2009) determined that cutlines projected to contain concentrations greater than or equal to 5 mg/kg total PCBs, 30 mg/kg total PAHs, and 200 mg/kg lead would be sufficient to achieve SWAC concentrations meeting the cleanup goals. These cutline projection values were temporarily used in the SWAC calculator to represent DMUs for which post-dredge verification sampling results were not yet available.

EPA GLNPO and Ottawa River Group (ORG) representatives considered the overall SWAC calculator, 95%UCL, and mean values for each DMU when determining whether a DMU could be cleared. DMUs that were not cleared based on post-dredge verification sampling results were re-dredged and re-sampled in the original sample locations. The re-sample values replaced the original confirmatory samples in the SWAC calculation process. This process was repeated until cleanup goals were met and the DMU was cleared by EPA and ORG representatives. Attachment A contains the final SWAC calculator with the 95%UCL values used to evaluate each DMU, which shows that the concentrations remaining in all three reaches are less than the cleanup goals.

Based on sediment sampling results that were not available during design, three more DMUs in Reach 4 (DMUs 4X, 4Y, and 4G) were added to the dredging scope. The 95%UCL, mean, and maximum concentrations for contaminants of concern within these DMUs were evaluated versus the cleanup goals by EPA, ORG, and other project partners for cleanup verification; however, these additional DMUs were not included in the SWAC calculator.

ADDITIONAL STATISTICAL ANALYSIS

After completion of sediment remediation activities, SulTRAC conducted additional exploratory statistical analysis of the post-cleanup verification data based on discussions with EPA. The primary goals of this additional analysis were to calculate a more robust 95%UCL, mean, and standard deviation (SD) in dredged areas for each of the three contaminants of concern for (1) each of the Reaches 2, 3, and 4; and (2) the combination of the three reaches to encompass the project area. The mean and 95%UCL values within the dredge areas were also then entered into the SWAC calculator to determine an overall SWAC that included non-dredge areas. This section discusses the statistical approach and methodology used, as well as any required alterations to the data set required when compiling the data for this analysis.

Statistical Approach and Methodology

After a post-cleanup verification sampling data set was compiled, a detailed statistical analysis was performed—first by reach and then for the project area as a whole. The 95%UCL, mean, and SD were calculated for total PCBs, total PAHs, and lead within each reach. In order to enter the 95%UCL calculated in this analysis into the SWAC calculator and meet the goals of the statistical analysis specified above, Reach 4 required two separate analyses: one with and one without DMU 4X, 4Y, and 4G samples. A 95%UCL that includes DMUs 4 X, 4Y, and 4G samples was not appropriate to include in the SWAC calculator because the original SWAC calculator did not account for the changes in surface area and sample results for non-dredge DMU areas based on available information.

A hierarchical approach to performing calculations for individual constituents, total PAHs, and total PCBs employed optimized methods currently recommended in the technical literature and guidance. All calculations were conducted using the JMP (SAS Institute) statistical software package, following the same methods and decision rules recommended in the technical documentation for ProUCL (EPA 2010). ProUCL includes models that explicitly account for varying proportions of censored (nondetect) results, as well as goodness-of-fit (GOF) tests for determining the underlying distribution of the data. Information on the distribution, degree of skewness, sample size, and detection frequency are used to select optimal models for calculation of the mean, SD, and 95%UCL.

Formal GOF tests (Shapiro Wilk W, Cramer-von Mises W^2, Anderson-Darling, and Kolmogorov-Smirnov) were used to determine if the data followed a normal, gamma, or lognormal distribution. Tests were conducted for all constituents or totals with at least eight detected results. Nonparametric assumptions were used for all constituents or totals not following one of the three parametric distributions, or in cases of too few detected results to perform the GOF tests.

Total PAHs were calculated using a Kaplan-Meier (KM)-based approach (i.e., KM mean X number of constituents being summed) for samples with at least three detected constituents (Helsel 2009). The KM approach relies on a well-established model for handling censored data in statistical calculations, and is the primary method used by ProUCL. Simple substitution of one-half the detection limit was used to calculate totals for samples with one or two detected results. Totals with no detected results were treated as zeros in all calculations. Simple substitution of one-half the detection limit was the only approach used to calculate total PCBs, as most samples only had one or two detected constituents. A sensitivity analysis was conducted to evaluate the impact of using different substitution options (zero, one-half the detection limit, and the detection limit) in the calculation of summary statistics for total PCBs. Table B7 in Attachment B presents the sensitivity analysis results.

Calculations of the mean, SD, and 95%UCL for lead (all results detected) in individual reaches followed distribution-dependent approaches recommended in ProUCL. For individual PAH and PCB constituents and totals (all with censored results), the KM mean and SD were calculated; calculations for the 95%UCL were performed using the specific KM-based models recommended by ProUCL. Calculations were performed only for individual constituents or totals with at least four detected results. Because estimates for total PCBs included mostly censored constituents, the nonparametric Chebyshev model was used as the default model for calculation of the 95%UCL. Results for total PCBs have higher uncertainty and may overestimate PCB concentrations because of the confounding influence of mostly nondetect constituents. Because Aroclor 1242 was the predominant contributor to total PCBs in most samples, results for Aroclor 1242 may be a more accurate reflection of PCB concentrations in sediment.

The mean, SD, and 95%UCL were also calculated using the surface-weighted results for individual reaches following methods described in Gilbert (1987). The arithmetic mean and SD were calculated for the combined data, with and without samples from DMUs 4X, 4Y, and 4G in Reach 4. Because overall project area summary statistics included only three reaches, the 95%UCL was calculated using both a parametric (Student's *t*-statistic) and nonparametric (Chebyshev) approach.

Considerations for Data Compilation

For the additional statistical analysis, all validated post-dredge cleanup verification sediment sample data obtained during the RA for each reach were combined into one data set considering the following:

- TSCA Samples – Some DMUs included sub-areas with PCB concentrations greater than 50 mg/kg, making these sediments subject to Toxic Substances Control Act (TSCA) regulations. Generally, these sub-areas were dredged for TSCA sediment to a pre-set depth and sampled to confirm TSCA material had been removed (mean total PCB concentration less than 25 mg/kg and no individual sample concentration greater than 40 mg/kg); additional dredging in the DMU was then conducted to the pre-set depth for non-TSCA sediment, and confirmatory samples were collected in the same location as the TSCA samples. In these cases, the post-TSCA dredging samples were not included in the data set because the area was re-dredged after these samples were obtained and new samples were collected.

  However, DMUs 4X and 4Y included areas in which the entire sediment depth was considered TSCA material, and these areas were not re-dredged for non-TSCA sediment. Therefore, the TSCA confirmatory samples for DMUs 4X and 4Y were included in the data set.

- Re-Dredge Samples – In cases where the DMUs were re-dredged in order to sufficiently meet the cleanup goals, the original confirmatory samples were not included in the data set because additional confirmatory samples were collected in the same locations after the area had been re-dredged.

- Field Duplicates – All field duplicates were included in the data set and treated as unique samples.

- Additional Investigative Samples – Additional investigative samples were collected during sediment remediation activities to delineate DMU 4G, which had been added to the project scope in June 2010. These samples were not a part of any DMU, and the investigative sample locations within DMU 4G were re-sampled after DMU 4G was dredged; therefore, these additional investigative samples were not included in data set.

- Utility Offset Samples – Utilities that intersected many of the DMUs required dredging offsets to ensure no damage was done to the utility. Therefore, sediment samples were collected within these offsets and both inside and outside the DMU boundaries to determine levels of contaminants. Samples collected outside of the DMU boundaries were not included in the data set, but samples collected inside the DMU boundaries were included in the data set.

  Some of the utility offsets were reduced after the utility samples were collected because more accurate locations of the utilities were determined. In these cases, if post-dredge confirmatory samples were collected in the same locations as the original utility offset samples in the DMU, the original offset samples were replaced in the data set by the post-dredge confirmatory samples.

SUMMARY AND STATISTICAL ANALYSIS RESULTS

During dredging operations, confirmatory samples were collected at each DMU for cleanup verification. The results of the confirmatory samples were used to determine the 95%UCL, mean, and maximum values for lead, total PAHs, and total PCBs for each DMU, and the 95%UCL values were used to calculate the SWAC for each reach. EPA and ORG representatives used the SWAC, mean, and maximum values as decision-making tools to confirm a DMU had successfully met the post-cleanup goals. At completion of the dredging activities, the SWAC for all three reaches met the post-cleanup goals.

To further evaluate the post-cleanup verification data, additional exploratory statistical analysis was performed per the methods described in the previous section. Attachment B contains the detailed statistical analysis results, including summary tables for individual reaches (Tables B1-B4), surface-weighted average results for all reaches combined (Tables B5 and B6), and the sensitivity analysis performed on total PCBs (Table B7).

The SWAC was also updated with the statistical analysis results. Specifically, the mean for lead, total PAHs, and total PCBs within each reach were incorporated into the SWAC calculator. Table 1 shows the SWAC calculator results using the mean calculated for each reach, and Table 2 shows the resulting SWAC for the overall project area (Reaches 2, 3, and 4). The 95%UCL for lead, total PAHs, and total PCBs within each reach were also incorporated into the SWAC calculator for each reach and for the overall project area; these results are included in Attachment C.

The SWAC values based on the results of this additional analysis meet the post-cleanup goals for all reaches. Also, the overall project SWAC values for lead, total PAHs, and total PCBs are well below the post-cleanup goals, as shown in Table 2.

Table 1
Updated SWAC – Reaches 2, 3, and 4

Reach 2				
	Lead (mg/kg)	Total PCBs (mg/kg)	Total PAHs (mg/kg)	Surface Area (acres)
Total for DMUs - Mean [(a)]	111.00	1.52	4.64	23.89
Total for non-DMUs - Area Weighted Average	80.10	0.39	2.00	78.24
$SWAC_{estimate}$ (mg/kg)	87.33	0.66	2.62	

Reach 3				
	Lead (mg/kg)	Total PCBs (mg/kg)	Total PAHs (mg/kg)	Surface Area (acres)
Total for DMU - Mean [(a)]	84.70	1.02	2.75	13.43
Total for non-DMU - Area Weighted Average	29.86	0.56	2.38	12.14
$SWAC_{estimate}$ (mg/kg)	58.66	0.80	2.57	

Reach 4				
	Lead (mg/kg)	Total PCBs (mg/kg)	Total PAHs (mg/kg)	Surface Area (acres)
Total for DMU - Mean [(a)]	104.00	1.29	6.47	3.39
Total for non-DMU - Area Weighted Average	45.95	0.25	4.03	21.36
$SWAC_{estimate}$ (mg/kg)	53.90	0.40	4.37	

Notes:

(a) Mean obtained from additional statistical analysis shown in Appendix B, Tables B1, B2, and B4.
(b) Area weighted average for areas not dredged. Values provided by Conestoga Rovers and Associates.

mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl
PAH Polynuclear aromatic hydrocarbon
DMU Dredge management unit
SWAC Surface weighted average concentration

Table 2
Updated SWAC – Overall Project Area

Overall Project SWAC				
	Lead (mg/kg)	**Total PCBs (mg/kg)**	**Total PAHs (mg/kg)**	**Surface Area (acres)**
Total for DMU - Weighted Mean [(a)]	102.00	1.34	4.17	40.71
Total for non-DMU - Area Weighted Average [(b)]	68.11	0.38	2.43	111.74
$SWAC_{estimate}$	**77.16**	**0.64**	**2.89**	
Cleanup Goal (mg/kg)	180	1.5	30	
Cleanup Goal Met	**Yes**	**Yes**	**Yes**	

Notes:

(a) Weighted mean obtained from additional sample analysis shown in Appendix B, Table B6.
(b) Area weighted average for areas not dredged as part of RA. Area weighted averages calculated from average concentrations and non-dredged areas found in Table 1 provided by Conestoga Rovers and Associates.

mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl
PAH Polynuclear aromatic hydrocarbon
DMU Dredge management unit
SWAC Surface weighted average concentration

REFERENCES

Conestoga Rovers and Associates. 2009. *Ottawa River Cleanup Plan Design Report.* Prepared for Ottawa River Group. Reissued August 2009.

Gilbert, R. O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. John Wiley & Sons, Inc., New York, NY.

Helsel, D.R. 2009. "Summing Nondetects: Incorporating Low-Level Contaminants in Risk Assessments." *Integrated Environmental Assessment and Management* 6(3): 361-366. © 2009 SETAC.

U.S. Environmental Protection Agency (EPA). 2010. "ProUCL Version 4.00.05 Technical Guide (Draft)." EPA/600/R-07/038. Prepared by A. Singh, N. Armbya, and A.K. Singh. Office of Research and Development, Washington, DC. May.

ATTACHMENT A
SWAC CALCULATOR FOR REACHES 2, 3, AND 4

(Three Pages)

REACH 2				
	Surface Area (acres)	**Lead** average concentration (mg/kg)	**Total PCBs** average concentration (mg/kg)	**Total PAHs** average concentration (mg/kg)
2G	1.560	177.60	0.33	2.25
2E	5.060	132.30	1.63	9.08
2D	2.140	135.80	1.84	7.36
2C	2.180	145.40	1.30	24.76
2B	4.550	109.20	3.55	18.18
2A	8.395	151.00	1.82	4.05
Total Reach 2 DMU Area	23.885			
Area Weighted Avg		138.94	1.96	9.88

	Surface Area (acres)	**Lead**	**Total PCBs**	**Total PAHs**
2-Area1	62.055			
Average Concentration		84.3	0.35	1.97
2-Area2	16.182			
Average Concentration		64	0.56	2.10
Total Reach 2 non-DMU Areas	78.24			
Area Weighted Average		80.10	0.39	2.00

	Lead	**Total PCBs**	**Total PAHs**
Surface Area (acres)	102.12	102.12	102.12
$SWAC_{estimate}$ (mg/kg)	93.86	0.76	3.84
Acceptable Concentration (mg/kg)	**180**	**1.5**	**30**
Concentration Met	**YES**	**YES**	**YES**

REACH 3					
		Surface Area (acres)	**Lead** average concentration (mg/kg)	**Total PCBs** average concentration (mg/kg)	**Total PAHs** average concentration (mg/kg)
Reach 3 (DMU) Areas	3R	0.72	105.60	1.20	2.57
	3Q	1.01	402.30	2.48	2.39
	3P	1.55	95.78	0.55	9.83
	3O	2.26	131.80	3.06	17.03
	3N	1.33	73.26	0.77	4.86
	3M	0.52	97.90	11.50	11.55
	3L	0.37	109.00	1.00	12.70
	3K	0.32	97.50	1.62	3.68
	3J	0.57	217.00	3.70	3.52
	3I	0.60	218.10	0.93	6.21
	3H	0.34	276.00	1.13	8.54
	3G	0.22	334.00	0.34	4.58
	3F	0.39	140.60	0.31	9.50
	3E	0.89	171.00	0.77	4.40
	3D	0.81	221.70	2.16	4.56
	3C	0.64	75.10	0.54	0.81
	3B	0.54	256.00	0.94	2.39
	3A	0.35	133.20	0.34	4.97
	Total Reach 3 DMU Area	13.43			
	Area Weighted Avg		163.05	1.49	6.30

		Surface Area (acres)	**Lead**	**Total PCBs**	**Total PAHs**
Reach 3 (non-DMU) Areas	3-Area1	0.324			
	Average Concentration		179.8	0.28	15.95
	3-Area2	0.44			
	Average Concentration		165.8	3.14	8.38
	3-Area3	2.193			
	Average Concentration		14.54	0.05	0.27
	3-Area4	0.418			
	Average Concentration		17.46	0.03	1.35
	3-Area5	0.739			
	Average Concentration		33.14	0.1	3.61
	3-Area6	0.705			
	Average Concentration		7.92	0.03	0.25
	3-Area7	0.234			
	Average Concentration		5.82	0.04	0.53
	3-Area8	0.355			
	Average Concentration		22.53	0.12	1.51
	3-Area9	0.446			
	Average Concentration		54.43	0.31	4.33
	3-Area10	0.809			
	Average Concentration		9.37	0.15	5.86
	3-Area11	5.477			
	Average Concentration		22.05	0.87	1.59
	Total Reach 3 non-DMU Areas	12.14			
	Area Weighted Average		29.86	0.56	2.38

		Lead	**Total PCBs**	**Total PAHs**
Reach 3 Overall	Surface Area (acres)	25.57	25.57	25.57
	$SWAC_{estimate}$ (mg/kg)	99.82	1.05	4.44
	Acceptable Concentration (mg/kg)	**180**	**1.5**	**30**
	Concentration Met	**YES**	**YES**	**YES**

REACH 4

Reach 4 (DMU) Areas	Surface Area (acres)	Lead average concentration (mg/kg)	Total PCBs average concentration (mg/kg)	Total PAHs average concentration (mg/kg)
4F	0.33	230.20	0.26	2.38
4E	1.06	168.70	1.65	9.01
4D	0.60	236.70	2.53	37.91
4C	0.18	80.99	1.06	9.30
4B	0.91	200.60	3.30	27.67
4A	0.31	178.00	2.67	5.51
Total Reach 4 DMU Area	3.39			
Area Weighted Avg		191.38	2.17	18.18

Reach 4 (non-DMU) Areas	Surface Area (acres)	Lead	Total PCBs	Total PAHs
4-Area1	4.046			
Average Concentration		12.84	0.07	7.28
4-Area2	5.412			
Average Concentration		74.24	0.23	5.61
4-Area3	2.625			
Average Concentration		90.49	0.74	4.89
4-Area4	1.269			
Average Concentration		70.68	0.35	6.04
4-Area5	6.718			
Average Concentration		21.1	0.1	0.67
4-Area6	1.294			
Average Concentration		45.5	0.66	1.00
Total Reach 4 non-DMU Areas	21.364			
Area Weighted Average		45.95	0.25	4.03

Reach 4 Overall	Lead	Total PCBs	Total PAHs
Surface Area (acres)	24.76	24.76	24.76
$SWAC_{estimate}$ (mg/kg)	65.88	0.52	5.97
Acceptable Concentration (mg/kg)	**180**	**1.5**	**30**
Concentration Met	**YES**	**YES**	**YES**

Notes:

mg/kg	Milligrams per kilogram
PCB	Polychlorinated biphenyl
PAH	Polynuclear aromatic hydrocarbon
DMU	Dredge management unit
SWAC	Surface weighted average concentration

ATTACHMENT B
STATISTICAL ANALYSIS RESULTS

(13 Pages)

TABLE B1 - SUMMARY STATISTICS FOR SEDIMENT IN REACH 2

Analyte Group	Analyte	Detection Frequency(a)	Number of High ND Results(b)	Distribution(c)	Range(d)		Mean(e)	Standard Deviation(e)	95UCL(e)	Method(f)
					Min	Max				
Metal	**Lead**	**154 / 154**	**0**	**Nonparametric**	**5.96**	**649**	**111**	**82**	**140**	**(4)**
PAH	**Total PAHs**	**154 (71)**	**0**	**Nonparametric**	**0.556**	**100**	**4.64**	**10.7**	**8.385**	**(13)**
	2-Methylnaphthalene	4 / 154	27	Nonparametric	0.057	0.884	0.064	0.085	0.085	(17)
	Acenaphthene	7 / 154	3	Nonparametric	0.041	1.26	0.058	0.148	0.082	(17)
	Acenaphthylene	4 / 154	88	Nonparametric	0.052	0.160	0.054	0.016	0.057	(12)
	Anthracene	17 / 154	1	Nonparametric	0.039	5.03	0.094	0.429	0.157	(17)
	Benzo(a)anthracene	54 / 154	1	Nonparametric	0.040	4.13	0.202	0.449	0.269	(17)
	Benzo(a)pyrene	59 / 154	1	Nonparametric	0.040	5.08	0.242	0.571	0.332	(17)
	Benzo(b)fluoranthene	58 / 154	1	Nonparametric	0.040	4.52	0.264	0.572	0.339	(17)
	Benzo(g,h,i)perylene	53 / 154	1	Nonparametric	0.046	2.68	0.179	0.381	0.232	(17)
	Benzo(k)fluoranthene	55 / 154	0	Nonparametric	0.042	6.41	0.216	0.602	0.300	(16)
	Chrysene	66 / 154	0	Nonparametric	0.046	8.25	0.312	0.820	0.426	(17)
	Dibenz(a,h)anthracene	16 / 154	1	Nonparametric	0.051	1.60	0.089	0.215	0.124	(17)
	Fluoranthene	82 / 154	0	Nonparametric	0.071	20.7	0.686	1.83	1.33	(13)
	Fluorene	8 / 154	1	Nonparametric	0.051	3.63	0.083	0.316	0.138	(17)
	Indeno(1,2,3-cd)pyrene	55 / 154	1	Nonparametric	0.045	3.18	0.207	0.462	0.269	(17)
	Naphthalene	4 / 154	2	Nonparametric	0.047	1.35	0.059	0.131	0.106	(13)
	Phenanthrene	60 / 154	0	Nonparametric	0.049	22.5	0.385	1.860	0.674	(17)
	Pyrene	77 / 154	0	Nonparametric	0.076	13.3	0.552	1.31	0.723	(17)
PCB	**Total PCBs**	**168 (62)**	**0**	**Nonparametric**	**0.237**	**9.6**	**1.52**	**1.83**	**2.14**	**(4)**
	Aroclor 1016	0 / 168	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1221	0 / 168	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1232	0 / 168	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1242	103 / 168	0	Gamma	0.067	9.01	1.02	1.50	1.23	(17)
	Aroclor 1248	0 / 168	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1254	3 / 168	9	N/A	0.085	0.530	N/A	N/A	N/A	N/A
	Aroclor 1260	3 / 168	10	N/A	0.071	0.401	N/A	N/A	N/A	N/A

Notes: Units are milligrams per kilogram
A KM-based approach (KM mean X number of congeners) was used to calculate total PAH congeners and total PCB congeners for individual sampling locations with at least three detected congeners. For locations with one or two detected congeners, totals are the sum of all congeners, where 1/2DL was used for nondetect congeners. Results for totals with no detected congeners were treated as zero in statistical calculations.

BCa Bias-corrected accelerated
DL Detection limit
KM Kaplan-Meier product limit estimator
Max Maximum
Min Minimum
MVUE Minimum variance unbiased estimate
N/A Not applicable.
ND Nondetect (synonym for censored or below detection limit results)
PAH Polynuclear aromatic hydrocarbon
95UCL One-sided 95 percent upper confidence limit of the mean

a Number of detected results/total number of results. For total PAHs and PCBs, this is the sample size, and the number in parentheses is the number of samples where all congeners were nondetect (these totals were not used in the distribution tests, and were treated as nondetect for the purpose of calculating the KM mean, standard deviation, and KM-based 95UCL).

b Number of high censored results (nondetect results that exceeded the maximum detected result). These results were excluded from all calculations performed using KM-based methods.

c Tested for detected data only using the Shapiro-Wilk W test (normal and lognormal distributions) and the Cramer-von Mises W^2, Anderson-Darling, or Kolmogorov-Smirnov test (gamma distributions). A 5 percent level of significance was used in all tests. Distributions not confirmed as normal, lognormal, or gamma, or not tested were treated as nonparametric in all statistical calculations. No tests were conducted for analytes with fewer than eight detected results. Nonparametric was also used as the default model for total Aroclors.

d The minimum and maximum detected result.

e The mean, standard deviation, and 95UCL were calculated using the KM approach for analytes with at least four detected results. Estimates are reported as N/A for analytes with three or fewer detected results. For lead (all detected results), parametric estimates are provided based on the best-fit distribution. The nonparametric Chebyshev model was the default for calculating the 95UCL for total Aroclors.
Note that EPA (2010) recommends a minimum of 8-10 detected results for stable and reliable estimates.

f Method Codes (Methods from EPA[2010]):

(1)	Maximum detected concentration
(2)	95 percent UCL calculated using Student's *t* distribution
(3)	95 percent UCL calculated using Land's H statistic
(4), (5), (6)	95, 97.5, or 99 percent UCL, respectively, calculated using the nonparametric Chebyshev method
(7), (8), (9)	95, 97.5, or 99 percent UCL, respectively, calculated using the MVUE Chebyshev method
(10)	95 percent UCL calculated using the approximate gamma method
(11)	95 percent UCL calculated using the adjusted gamma method
(12)	95 percent UCL calculated using the KM mean and Student's t cutoff for the UCL
(13), (14), (15)	95, 97.5, or 99 percent UCL, respectively, calculated using the KM mean and the nonparametric Chebyshev method to estimate the UCL
(16)	95 percent UCL calculated using the KM mean and a percentile bootstrap to estimate the UCL
(17)	95 percent UCL calculated using the KM mean and a BCa bootstrap to estimate the UCL
(18)	Hall's bootstrap

References

U.S. Environmental Protection Agency (EPA). 2010. "ProUCL Version 4.00.05 Technical Guide (Draft)." EPA/600/R-07/038. Prepared by A. Singh, N. Armbya, and A.K. Singh. Office of Research and Development, Washington, DC. May.

TABLE B2 - SUMMARY STATISTICS FOR SEDIMENT IN REACH 3

Analyte Group	Analyte	Detection Frequency(a)	Number of High ND Results(b)	Distribution(c)	Range(d)		Mean(e)	Standard Deviation(e)	95UCL(e)	Method(f)
					Min	Max				
Metal	**Lead**	**109 / 109**	**0**	**Gamma**	**2.9**	**350**	**84.7**	**85.9**	**101**	**(10)**
PAH	**Total PAHs**	**111 (30)**	**0**	**Lognormal**	**0.041**	**35**	**2.75**	**4.3**	**4.5**	**(13)**
	2-Methylnaphthalene	12 / 106	0	Lognormal	0.041	0.880	0.060	0.107	0.090	(16)
	Acenaphthene	21 / 106	0	Gamma	0.035	0.320	0.047	0.039	0.054	(12)
	Acenaphthylene	16 / 106	0	Nonparametric	0.033	0.370	0.040	0.037	0.049	(16)
	Anthracene	52 / 106	0	Nonparametric	0.033	1.50	0.095	0.166	0.125	(16)
	Benzo(a)anthracene	70 / 106	0	Lognormal	0.035	3.10	0.222	0.373	0.289	(17)
	Benzo(a)pyrene	71 / 106	0	Lognormal	0.034	2.60	0.210	0.323	0.267	(17)
	Benzo(b)fluoranthene	72 / 106	0	Gamma	0.031	2.10	0.200	0.283	0.251	(16)
	Benzo(g,h,i)perylene	64 / 106	0	Lognormal	0.034	1.10	0.130	0.162	0.158	(17)
	Benzo(k)fluoranthene	71 / 106	0	Gamma	0.034	2.20	0.201	0.285	0.254	(16)
	Chrysene	72 / 106	0	Gamma	0.037	2.70	0.250	0.353	0.314	(16)
	Dibenz(a,h)anthracene	44 / 106	0	Lognormal	0.036	0.600	0.069	0.076	0.081	(16)
	Fluoranthene	79 / 106	0	Gamma	0.045	6.50	0.533	0.835	0.887	(13)
	Fluorene	30 / 106	0	Gamma	0.038	1.00	0.069	0.109	0.087	(12)
	Indeno(1,2,3-cd)pyrene	63 / 106	0	Gamma	0.033	1.20	0.124	0.164	0.151	(12)
	Naphthalene	12 / 106	0	Gamma	0.031	0.270	0.039	0.032	0.044	(12)
	Phenanthrene	74 / 106	0	Lognormal	0.034	4.80	0.296	0.555	0.531	(13)
	Pyrene	78 / 106	0	Gamma	0.039	4.70	0.407	0.615	0.515	(16)
PCB	**Total PCBs**	**106 (42)**	**0**	**Nonparametric**	**0.185**	**17**	**1.02**	**2.12**	**1.92**	**(4)**
	Aroclor 1016	0 / 106	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1221	0 / 106	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1232	0 / 106	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1242	64 / 106	0	Lognormal	0.050	8.70	0.489	1.14	0.972	(13)
	Aroclor 1248	0 / 106	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1254	2 / 106	15	N/A	0.081	0.280	N/A	N/A	N/A	N/A
	Aroclor 1260	2 / 106	31	N/A	0.061	0.130	N/A	N/A	N/A	N/A

Notes: Units are milligrams per kilogram

A KM-based approach (KM mean X number of congeners) was used to calculate total PAH congeners and total PCB congeners for individual sampling locations with at least three detected congeners. For locations with one or two detected congeners, totals are the sum of all congeners, where 1/2DL was used for nondetect congeners. Results for totals with no detected congeners were treated as zero in statistical calculations.

BCa Bias-corrected accelerated
DL Detection limit
KM Kaplan-Meier product limit estimator
Max Maximum
Min Minimum
MVUE Minimum variance unbiased estimate
N/A Not applicable.
ND Nondetect (synonym for censored or below detection limit results)
PAH Polynuclear aromatic hydrocarbon
95UCL One-sided 95 percent upper confidence limit of the mean

a Number of detected results/total number of results. For total PAHs and PCBs, this is the sample size, and the number in parentheses is the number of samples where all congeners were nondetect (these totals were not used in the distribution tests, and were treated as nondetect for the purpose of calculating the KM mean, standard deviation, and KM-based 95UCL).

b Number of high censored results (nondetect results that exceeded the maximum detected result). These results were excluded from all calculations performed using KM-based methods.

c Tested for detected data only using the Shapiro-Wilk W test (normal and lognormal distributions) and the Cramer-von Mises W^2, Anderson-Darling, or Kolmogorov-Smirnov test (gamma distributions). A 5 percent level of significance was used in all tests. Distributions not confirmed as normal, lognormal, or gamma, or not tested were treated as nonparametric in all statistical calculations. No tests were conducted for analytes with fewer than eight detected results. Nonparametric was also used as the default model for total Aroclors.

d The minimum and maximum detected result.

e The mean, standard deviation, and 95UCL were calculated using the KM approach for analytes with at least four detected results. Estimates are reported as N/A for analytes with three or fewer detected results. For lead (all detected results), parametric estimates are provided based on the best-fit distribution. The nonparametric Chebyshev model was the default for calculating the 95UCL for total Aroclors.
Note that EPA (2010) recommends a minimum of 8-10 detected results for stable and reliable estimates.

f Method Codes (Methods from EPA[2010]):

(1)	Maximum detected concentration
(2)	95 percent UCL calculated using Student's *t* distribution
(3)	95 percent UCL calculated using Land's H statistic
(4), (5), (6)	95, 97.5, or 99 percent UCL, respectively, calculated using the nonparametric Chebyshev method
(7), (8), (9)	95, 97.5, or 99 percent UCL, respectively, calculated using the MVUE Chebyshev method
(10)	95 percent UCL calculated using the approximate gamma method
(11)	95 percent UCL calculated using the adjusted gamma method
(12)	95 percent UCL calculated using the KM mean and Student's t cutoff for the UCL
(13), (14), (15)	95, 97.5, or 99 percent UCL, respectively, calculated using the KM mean and the nonparametric Chebyshev method to estimate the UCL
(16)	95 percent UCL calculated using the KM mean and a percentile bootstrap to estimate the UCL
(17)	95 percent UCL calculated using the KM mean and a BCa bootstrap to estimate the UCL
(18)	Hall's bootstrap

References

U.S. Environmental Protection Agency (EPA). 2010. "ProUCL Version 4.00.05 Technical Guide (Draft)." EPA/600/R-07/038. Prepared by A. Singh, N. Armbya, and A.K. Singh. Office of Research and Development, Washington, DC. May.

TABLE B3 - SUMMARY STATISTICS FOR SEDIMENT IN REACH 4 (INCLUDING DMUs 4G, 4X, AND 4Y)

Analyte Group	Analyte	Detection Frequency(a)	Number of High ND Results(b)	Distribution(c)	Range(d) Min	Range(d) Max	Mean(e)	Standard Deviation(e)	95UCL(e)	Method(f)
Metal	**Lead**	**85 / 85**	**0**	**Gamma**	**6.60**	**376**	**81**	**84**	**97**	**(10)**
PAH	**Total PAHs**	**85 (37)**	**0**	**Lognormal**	**0.319**	**50**	**4.13**	**8.48**	**8.14**	**(13)**
	2-Methylnaphthalene	3 / 85	1	N/A	0.037	0.901	N/A	N/A	N/A	(1)
	Acenaphthene	10 / 85	5	Lognormal	0.031	0.802	0.061	0.149	0.090	(17)
	Acenaphthylene	8 / 85	44	Gamma	0.035	0.160	0.042	0.025	0.049	(12)
	Anthracene	21 / 85	0	Nonparametric	0.035	1.28	0.089	0.179	0.128	(16)
	Benzo(a)anthracene	32 / 85	0	Lognormal	0.048	3.38	0.220	0.430	0.297	(17)
	Benzo(a)pyrene	36 / 85	0	Lognormal	0.033	3.79	0.249	0.534	0.358	(17)
	Benzo(b)fluoranthene	37 / 85	0	Lognormal	0.038	2.60	0.244	0.444	0.330	(17)
	Benzo(g,h,i)perylene	28 / 85	1	Nonparametric	0.031	1.68	0.118	0.233	0.166	(16)
	Benzo(k)fluoranthene	33 / 85	0	Nonparametric	0.044	4.59	0.233	0.565	0.367	(17)
	Chrysene	32 / 85	0	Lognormal	0.051	3.45	0.239	0.450	0.329	(17)
	Dibenz(a,h)anthracene	17 / 85	44	Gamma	0.041	0.300	0.057	0.044	0.069	(12)
	Fluoranthene	47 / 85	0	Lognormal	0.044	12	0.715	1.62	1.48	(13)
	Fluorene	12 / 85	16	Nonparametric	0.033	0.700	0.053	0.087	0.079	(16)
	Indeno(1,2,3-cd)pyrene	31 / 85	0	Nonparametric	0.031	2.43	0.168	0.388	0.248	(17)
	Naphthalene	1 / 85	44	N/A	0.110	0.110	N/A	N/A	N/A	(1)
	Phenanthrene	39 / 85	0	Nonparametric	0.051	8.85	0.436	1.20	0.652	(17)
	Pyrene	44 / 85	0	Lognormal	0.034	8.47	0.538	1.21	1.11	(13)
PCB	**Total PCBs**	**85 (26)**	**0**	**Nonparametric**	**0.183**	**34**	**1.98**	**4.01**	**3.88**	**(4)**
	Aroclor 1016	0 / 85	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1221	0 / 85	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1232	0 / 85	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1242	59 / 85	0	Lognormal	0.049	19	1.26	2.37	2.38	(13)
	Aroclor 1248	0 / 85	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1254	1 / 85	64	N/A	0.094	0.094	N/A	N/A	N/A	N/A
	Aroclor 1260	0 / 85	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes: Units are milligrams per kilogram
A KM-based approach (KM mean X number of congeners) was used to calculate total PAH congeners and total PCB congeners for individual sampling locations with at least three detected congeners. For locations with one or two detected congeners, totals are the sum of all congeners, where 1/2DL was used for nondetect congeners. Results for totals with no detected congeners were treated as zero in statistical calculations.

BCa Bias-corrected accelerated
DL Detection limit
KM Kaplan-Meier product limit estimator
Max Maximum
Min Minimum
MVUE Minimum variance unbiased estimate
N/A Not applicable.
ND Nondetect (synonym for censored or below detection limit results)
PAH Polynuclear aromatic hydrocarbon
95UCL One-sided 95 percent upper confidence limit of the mean

a Number of detected results/total number of results. For total PAHs and PCBs, this is the sample size, and the number in parentheses is the number of samples where all congeners were nondetect (these totals were not used in the distribution tests, and were treated as nondetect for the purpose of calculating the KM mean, standard deviation, and KM-based 95UCL).
b Number of high censored results (nondetect results that exceeded the maximum detected result). These results were excluded from all calculations performed using KM-based methods.
c Tested for detected data only using the Shapiro-Wilk W test (normal and lognormal distributions) and the Cramer-von Mises W^2, Anderson-Darling, or Kolmogorov-Smirnov test (gamma distributions). A 5 percent level of significance was used in all tests. Distributions not confirmed as normal, lognormal, or gamma, or not tested were treated as nonparametric in all statistical calculations. No tests were conducted for analytes with fewer than eight detected results. Nonparametric was also used as the default model for total Aroclors.
d The minimum and maximum detected result.
e The mean, standard deviation, and 95UCL were calculated using the KM approach for analytes with at least four detected results. Estimates are reported as N/A for analytes with three or fewer detected results. For lead (all detected results), parametric estimates are provided based on the best-fit distribution. The nonparametric Chebyshev model was the default for calculating the 95UCL for total Aroclors.
Note that EPA (2010) recommends a minimum of 8-10 detected results for stable and reliable estimates.

f Method Codes (Methods from EPA[2010]):

(1)	Maximum detected concentration
(2)	95 percent UCL calculated using Student's *t* distribution
(3)	95 percent UCL calculated using Land's H statistic
(4), (5), (6)	95, 97.5, or 99 percent UCL, respectively, calculated using the nonparametric Chebyshev method
(7), (8), (9)	95, 97.5, or 99 percent UCL, respectively, calculated using the MVUE Chebyshev method
(10)	95 percent UCL calculated using the approximate gamma method
(11)	95 percent UCL calculated using the adjusted gamma method
(12)	95 percent UCL calculated using the KM mean and Student's t cutoff for the UCL
(13), (14), (15)	95, 97.5, or 99 percent UCL, respectively, calculated using the KM mean and the nonparametric Chebyshev method to estimate the UCL
(16)	95 percent UCL calculated using the KM mean and a percentile bootstrap to estimate the UCL
(17)	95 percent UCL calculated using the KM mean and a BCa bootstrap to estimate the UCL
(18)	Hall's bootstrap

References

U.S. Environmental Protection Agency (EPA). 2010. "ProUCL Version 4.00.05 Technical Guide (Draft)." EPA/600/R-07/038. Prepared by A. Singh, N. Armbya, and A.K. Singh. Office of Research and Development, Washington, DC. May.

TABLE B4 - SUMMARY STATISTICS FOR SEDIMENT IN REACH 4 (EXCLUDING DMUs 4G, 4X, AND 4Y)

Analyte Group	Analyte	Detection Frequency(a)	Number of High ND Results(b)	Distribution(c)	Range(d)		Mean(e)	Standard Deviation(e)	95UCL(e)	Method(f)
					Min	Max				
Metal	**Lead**	**43 / 43**	**0**	**Gamma**	**8.81**	**376**	**104**	**97**	**132**	**(10)**
PAH	**Total PAHs**	**43 (26)**	**0**	**Gamma**	**1.29**	**50**	**6.47**	**11**	**9.32**	**(12)**
	2-Methylnaphthalene	1 / 43	1	N/A	0.901	0.901	N/A	N/A	N/A	N/A
	Acenaphthene	1 / 43	4	N/A	0.802	0.802	N/A	N/A	N/A	N/A
	Acenaphthylene	0 / 43	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Anthracene	2 / 43	0	N/A	0.081	1.28	N/A	N/A	N/A	N/A
	Benzo(a)anthracene	6 / 43	0	Nonparametric	0.073	3.38	0.234	0.620	0.646	(13)
	Benzo(a)pyrene	9 / 43	0	Gamma	0.080	3.79	0.338	0.748	0.530	(12)
	Benzo(b)fluoranthene	10 / 43	0	Normal	0.076	2.6	0.341	0.612	0.498	(12)
	Benzo(g,h,i)perylene	5 / 43	1	Nonparametric	0.054	1.68	0.135	0.318	0.240	(17)
	Benzo(k)fluoranthene	7 / 43	0	Nonparametric	0.081	4.59	0.312	0.818	0.856	(13)
	Chrysene	6 / 43	0	Nonparametric	0.100	3.45	0.273	0.629	0.452	(17)
	Dibenz(a,h)anthracene	1 / 43	38	N/A	0.061	0.061	N/A	N/A	N/A	(1)
	Fluoranthene	16 / 43	0	Gamma	0.180	11.6	1.046	2.21	1.61	(12)
	Fluorene	0 / 43	0	N/A	N/A	N/A	N/A	N/A	N/A	(1)
	Indeno(1,2,3-cd)pyrene	8 / 43	0	Normal	0.048	2.43	0.237	0.549	0.378	(12)
	Naphthalene	0 / 43	0	N/A	N/A	N/A	N/A	N/A	N/A	(1)
	Phenanthrene	10 / 43	0	Gamma	0.110	8.85	0.597	1.69	1.030	(12)
	Pyrene	13 / 43	0	Gamma	0.150	8.47	0.791	1.67	1.22	(12)
PCB	**Total PCBs**	**43 (15)**	**0**	**Nonparametric**	**0.264**	**5.25**	**1.29**	**1.31**	**2.16**	**(4)**
	Aroclor 1016	0 / 43	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1221	0 / 43	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1232	0 / 43	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1242	28 / 43	0	Gamma	0.076	4.58	0.97	1.21	1.33	(16)
	Aroclor 1248	0 / 43	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1254	1 / 43	38	N/A	0.094	0.094	N/A	N/A	N/A	N/A
	Aroclor 1260	0 / 43	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes: Units are milligrams per kilogram

A KM-based approach (KM mean X number of congeners) was used to calculate total PAH congeners and total PCB congeners for individual sampling locations with at least three detected congeners. For locations with one or two detected congeners, totals are the sum of all congeners, where 1/2DL was used for nondetect congeners. Results for totals with no detected congeners were treated as zero in statistical calculations.

BCa Bias-corrected accelerated
DL Detection limit
KM Kaplan-Meier product limit estimator
Max Maximum
Min Minimum
MVUE Minimum variance unbiased estimate
N/A Not applicable.
ND Nondetect (synonym for censored or below detection limit results)
PAH Polynuclear aromatic hydrocarbon
95UCL One-sided 95 percent upper confidence limit of the mean

a Number of detected results/total number of results. For total PAHs and PCBs, this is the sample size, and the number in parentheses is the number of samples where all congeners were nondetect (these totals were not used in the distribution tests, and were treated as nondetect for the purpose of calculating the KM mean, standard deviation, and KM-based 95UCL).

b Number of high censored results (nondetect results that exceeded the maximum detected result). These results were excluded from all calculations performed using KM-based methods.

c Tested for detected data only using the Shapiro-Wilk W test (normal and lognormal distributions) and the Cramer-von Mises W^2, Anderson-Darling, or Kolmogorov-Smirnov test (gamma distributions). A 5 percent level of significance was used in all tests. Distributions not confirmed as normal, lognormal, or gamma, or not tested were treated as nonparametric in all statistical calculations. No tests were conducted for analytes with fewer than eight detected results. Nonparametric was also used as the default model for total Aroclors.

d The minimum and maximum detected result.

e The mean, standard deviation, and 95UCL were calculated using the KM approach for analytes with at least four detected results. Estimates are reported as N/A for analytes with three or fewer detected results. For lead (all detected results), parametric estimates are provided based on the best-fit distribution. The nonparametric Chebyshev model was the default for calculating the 95UCL for total Aroclors.
Note that EPA (2010) recommends a minimum of 8-10 detected results for stable and reliable estimates.

f Method Codes (Methods from EPA[2010]):

(1)	Maximum detected concentration
(2)	95 percent UCL calculated using Student's *t* distribution
(3)	95 percent UCL calculated using Land's H statistic
(4), (5), (6)	95, 97.5, or 99 percent UCL, respectively, calculated using the nonparametric Chebyshev method
(7), (8), (9)	95, 97.5, or 99 percent UCL, respectively, calculated using the MVUE Chebyshev method
(10)	95 percent UCL calculated using the approximate gamma method
(11)	95 percent UCL calculated using the adjusted gamma method
(12)	95 percent UCL calculated using the KM mean and Student's t cutoff for the UCL
(13), (14), (15)	95, 97.5, or 99 percent UCL, respectively, calculated using the KM mean and the nonparametric Chebyshev method to estimate the UCL
(16)	95 percent UCL calculated using the KM mean and a percentile bootstrap to estimate the UCL
(17)	95 percent UCL calculated using the KM mean and a BCa bootstrap to estimate the UCL
(18)	Hall's bootstrap

References

U.S. Environmental Protection Agency (EPA). 2010. "ProUCL Version 4.00.05 Technical Guide (Draft)." EPA/600/R-07/038. Prepared by A. Singh, N. Armbya, and A.K. Singh. Office of Research and Development, Washington, DC. May.

TABLE B5 - SUMMARY STATISTICS FOR SURFACE-WEIGHTED AVERAGE SEDIMENT RESULTS FOR ALL REACHES COMBINED (INCLUDING DMUs 4G, 4X, AND 4Y)

Analyte Group	Analyte	Sample Size (a)	Mean - Range(b)		Weighted Mean(c)	Weighted Standard Deviation(c)	Weighted 95UCL(d)	
			Min	Max			Student's *t*	Chebyshev
Metal	**Lead**	3	81.2	111	99	4.7	107	111
PAH	**Total PAH**	**3**	**2.75**	**4.64**	**3.98**	**0.510**	**4.84**	**5.27**
	2-Methylnaphthalene	3	0.060	0.064	0.054	0.005	0.063	0.068
	Acenaphthene	3	0.047	0.061	0.055	0.007	0.067	0.073
	Acenaphthylene	3	0.040	0.054	0.048	0.002	0.051	0.052
	Anthracene	3	0.089	0.095	0.094	0.020	0.127	0.144
	Benzo(a)anthracene	3	0.202	0.222	0.211	0.024	0.251	0.271
	Benzo(a)pyrene	3	0.210	0.249	0.233	0.029	0.281	0.305
	Benzo(b)fluoranthene	3	0.200	0.264	0.241	0.028	0.288	0.312
	Benzo(g,h,i)perylene	3	0.118	0.179	0.156	0.018	0.187	0.202
	Benzo(k)fluoranthene	3	0.201	0.233	0.213	0.029	0.263	0.288
	Chrysene	3	0.239	0.312	0.283	0.039	0.348	0.381
	Dibenz(a,h)anthracene	3	0.057	0.089	0.078	0.010	0.095	0.104
	Fluoranthene	3	0.533	0.715	0.643	0.089	0.793	0.867
	Fluorene	3	0.053	0.083	0.075	0.015	0.099	0.112
	Indeno(1,2,3-cd)pyrene	3	0.124	0.207	0.176	0.022	0.213	0.231
	Naphthalene	3	0.039	0.059	0.045	0.006	0.055	0.060
	Phenanthrene	3	0.296	0.436	0.364	0.087	0.511	0.583
	Pyrene	3	0.407	0.552	0.505	0.064	0.613	0.666
PCB	**Total PCBs**	**3**	**1.02**	**1.98**	**1.43**	**0.117**	**1.62**	**1.72**
	Aroclor 1016	3	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1221	3	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1232	3	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1242	3	0.489	1.26	0.887	0.081	1.02	1.09
	Aroclor 1248	3	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1254	3	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1260	3	N/A	N/A	N/A	N/A	N/A	N/A

Notes: Units are milligrams per kilogram
Calculations were weighted based on the relative surface area of each reach, with DMU 4G, 4X, and 4Y in Reach 4 included

DL	Detection limit
DMU	Decision management unit
Max	Maximum result
Min	Minimum result
N/A	Not applicable.
PAH	Polynuclear aromatic hydrocarbon
95UCL	One-sided 95 percent upper confidence limit of the mean

a The sample size is the number of reaches evaluated.

b The minimum and maximum unweighted mean results calculated for individual reaches.

c The weighted arithmetic mean and standard deviation calculated using equations 5.3 and 5.5 from Gilbert (1987).

d The 95UCL was calculated using both Student's *t* statistic and the nonparametric Chebyshev method, following EPA (2010).

References

Gilbert, R.O. 1987. *Statistical Methods for Environmental Pollution Monitoring* . John Wiley & Sons, Inc., New York, NY.

U.S. Environmental Protection Agency (EPA). 2010. "ProUCL Version 4.00.05 Technical Guide (Draft)." EPA/600/R-07/038. Prepared by A. Singh, N. Armbya, and A.K. Singh. Office of Research and Development, Washington, DC. May.

TABLE B6 - SUMMARY STATISTICS FOR SURFACE-WEIGHTED AVERAGE SEDIMENT RESULTS FOR ALL REACHES COMBINED (EXCLUDING DMUs 4G, 4X, AND 4Y)

Analyte Group	Analyte	Sample Size (a)	Mean - Range(b)		Weighted Mean(c)	Weighted Standard Deviation(c)	Weighted 95UCL(d)	
			Min	Max			Student's *t*	Chebyshev
Metal	**Lead**	3	84.7	111	102	4.9	110	114
PAH	**Total PAH**	**3**	**2.75**	**6.47**	**4.17**	**0.541**	**5.08**	**5.53**
	2-Methylnaphthalene	3	0.060	0.064	0.057	0.006	0.067	0.071
	Acenaphthene	3	0.047	0.058	0.050	0.007	0.062	0.068
	Acenaphthylene	3	0.040	0.054	0.045	0.002	0.048	0.049
	Anthracene	3	0.094	0.095	0.086	0.021	0.122	0.139
	Benzo(a)anthracene	3	0.202	0.234	0.211	0.026	0.255	0.276
	Benzo(a)pyrene	3	0.210	0.338	0.239	0.030	0.291	0.316
	Benzo(b)fluoranthene	3	0.200	0.341	0.249	0.030	0.299	0.324
	Benzo(g,h,i)perylene	3	0.130	0.179	0.160	0.019	0.192	0.208
	Benzo(k)fluoranthene	3	0.201	0.312	0.219	0.032	0.272	0.298
	Chrysene	3	0.250	0.312	0.288	0.041	0.357	0.392
	Dibenz(a,h)anthracene	3	0.069	0.089	0.075	0.010	0.092	0.101
	Fluoranthene	3	0.533	1.046	0.666	0.095	0.826	0.904
	Fluorene	3	0.069	0.083	0.071	0.015	0.097	0.110
	Indeno(1,2,3-cd)pyrene	3	0.124	0.237	0.182	0.024	0.222	0.241
	Naphthalene	3	0.039	0.059	0.048	0.006	0.058	0.063
	Phenanthrene	3	0.296	0.597	0.373	0.092	0.529	0.605
	Pyrene	3	0.407	0.791	0.524	0.068	0.639	0.696
PCB	**Total PCBs**	**3**	**1.02**	**1.52**	**1.34**	**0.11**	**1.52**	**1.61**
	Aroclor 1016	3	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1221	3	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1232	3	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1242	3	0.489	1.02	0.842	0.079	0.97	1.04
	Aroclor 1248	3	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1254	3	N/A	N/A	N/A	N/A	N/A	N/A
	Aroclor 1260	3	N/A	N/A	N/A	N/A	N/A	N/A

Notes: Units are milligrams per kilogram

Calculations were weighted based on the relative surface area of each reach, with DMUs 4G, 4X, and 4Y in Reach 4 excluded

DL	Detection limit
DMU	Decision management unit
Max	Maximum result
Min	Minimum result
N/A	Not applicable.
PAH	Polynuclear aromatic hydrocarbon
95UCL	One-sided 95 percent upper confidence limit of the mean

a The sample size is the number of reaches evaluated.
b The minimum and maximum unweighted mean results calculated for individual reaches.
c The weighted arithmetic mean and standard deviation calculated using equations 5.3 and 5.5 from Gilbert (1987).
d The 95UCL was calculated using both Student's *t* statistic and the nonparametric Chebyshev method, following EPA (2010).

References

Gilbert, R.O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. John Wiley & Sons, Inc., New York, NY.

U.S. Environmental Protection Agency (EPA). 2010. "ProUCL Version 4.00.05 Technical Guide (Draft)." EPA/600/R-07/038. Prepared by A. Singh, N. Armbya, and A.K. Singh. Office of Research and Development, Washington, DC. May.

TABLE B7 - SENSITIVITY ANALYSIS FOR CALCULATION OF SUMMARY STATISTICS FOR TOTAL PCBs

River Reach	Analyte	Detection Frequency(a)	Calculations Using Three Substitution Methods for Nondetect Congeners (ND=0, ND= 1/2DL, ND= DL)								
			Mean(b)			Standard Deviation(b)			95UCLs (b)		
			ND= 0	ND= 1/2DL	ND= DL	ND= 0	ND= 1/2DL	ND= DL	ND= 0	ND= 1/2DL	ND= DL
Reach 2	Total PCBs	168 (62)	1.00	1.61	2.21	1.51	1.77	2.14	1.51	2.20	2.93
Reach 3	Total PCBs	106 (42)	0.475	1.02	1.56	1.14	2.12	3.10	0.96	1.91	2.87
Reach 4*	Total PCBs	85 (26)	1.24	2.03	2.82	2.37	3.98	5.64	2.36	3.91	5.49
Reach 4**	Total PCBs	43 (15)	0.948	1.35	1.75	1.23	1.26	1.29	1.76	2.18	2.61

Notes: Units are milligrams per kilogram
DL Detection limit
DMU Decision management unit
KM Kaplan-Meier product limit estimator
N/A Not applicable.
ND Nondetect (synonym for censored or below detection limit results)
95UCL One-sided 95 percent upper confidence limit of the mean.

* Reach 4 including DMU 4G, 4X and 4Y
** Reach 4 excluding DMU 4G, 4X and 4Y
a The sample size followed by the number of samples where all congeners were nondetect (in parentheses).
b The arithmetic mean and standard deviation. 95UCL calculated using the nonparametric Chebyshev method following EPA (2010).
Note that calculations performed using the arithmetic mean and standard deviation can be compared to estimates using the KM method in the tables for individual reaches to evaluate the impact of using simple-substitution methods.

References

U.S. Environmental Protection Agency (EPA). 2010. "ProUCL Version 4.00.05 Technical Guide (Draft)." EPA/600/R-07/038. Prepared by A. Singh, N. Armbya, and A.K. Singh. Office of Research and Development, Washington, DC. May.

ATTACHMENT C
UPDATED SWAC USING 95%UCL FOR LEAD, TOTAL PAHs, AND TOTAL PCBs

(Two Pages)

Table C1
Updated SWAC – Reaches 2, 3, and 4

Reach 2				
	Lead (mg/kg)	Total PCBs (mg/kg)	Total PAHs (mg/kg)	Surface Area (acres)
Total for DMUs- 95%UCL [(a)]	140.00	2.14	8.39	23.89
Total for non-DMU - Area Weighted Average [(b)]	80.10	0.39	2.00	78.24
$SWAC_{estimate}$	**94.11**	**0.80**	**3.49**	

Reach 3				
	Lead (mg/kg)	Total PCBs (mg/kg)	Total PAHs (mg/kg)	Surface Area (acres)
Total for DMUs - 95%UCL [(a)]	101.00	1.92	4.50	13.43
Total for non-DMU - Area Weighted Average [(b)]	29.86	0.56	2.38	12.14
$SWAC_{estimate}$	**67.23**	**1.27**	**3.49**	

Reach 4				
	Lead (mg/kg)	Total PCBs (mg/kg)	Total PAHs (mg/kg)	Surface Area (acres)
Total for DMUs - 95%UCL [(a)]	132.00	2.16	9.32	3.21
Total for non-DMU - Area Weighted Average [(b)]	45.95	0.25	4.03	21.36
$SWAC_{estimate}$	**57.74**	**0.52**	**4.76**	

Notes:

(a) 95%UCL obtained from additional statistical analysis shown in Appendix B, Tables B1, B2, and B4.
(b) Area weighted average for areas not dredged. Values provided by Conestoga Rovers and Associates.

mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl
PAH Polynuclear aromatic hydrocarbon
DMU Dredge management unit
SWAC Surface weighted average concentration

Table C2
Updated SWAC – Overall Project Area

Overall Project SWAC				
	Lead (mg/kg)	Total PCBs (mg/kg)	Total PAHs (mg/kg)	Surface Area (acres)
Total for DMU - Weighted 95%UCL [(a)]	114.00	1.61	5.53	40.71
Total for non-DMU - Area Weighted Average [(b)]	68.11	0.38	2.43	111.74
$SWAC_{estimate}$	**80.37**	**0.71**	**3.26**	
Cleanup Goal (mg/kg)	180	1.5	30	
Cleanup Goal Met	**Yes**	**Yes**	**Yes**	

Notes:

(a) Weighted 95%UCL using Chebyshev method obtained from additional sample analysis shown in Appendix B, Table B6.
(b) Area weighted average for areas not dredged as part of RA. Area weighted averages calculated from average concentrations and non-dredged areas found in Table 1 provided by Conestoga Rovers and Associates.

mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl
PAH Polynuclear aromatic hydrocarbon
DMU Dredge management unit
SWAC Surface weighted average concentration

APPENDIX C

DEWATERING PAD TESTING REQUIREMENTS AND QUALITY CONTROL STANDARDS

Table C-1: Subbase and Structural Pre-Qualifying Tests

Test	Standard
Maximum Dry Density	ASTM D1557
Grain Size	ASTM D422
Atterberg Limits	ASTM D4318
Soil Classification	ASTM D2487

Table C-2: Subbase and Structural Fill Compaction Requirements

Test	Specification
Relative density (ASTM D 1557)	95.0% of maximum dry density (subbase); 90.0% of maximum dry density (structural fill)
Lift thickness	Maximum of 8-inch loose (subbase); 12-inch compacted (structural fill)
In-place moisture density testing frequency	5 tests/lift/acre
Number of passes with compactor	Minimum required to meet specifications

Table C-3: LLDPE Liner/Geomembrane Properties

Property	Unit	Test Method	Minimum Average Value
Thickness • Lowest of 10 coupon values • Lowest of 8 of 10 coupon values	mil	ASTM D5994	40 34 36
Density	g/cm^3	ASTM D1505/D792	0.939 (maximum)
Tensile strength at break	lb/in	ASTM D638 Type IV Dumbell, 2 ipm	60
Asperity height	mil	GRI test method GM12	10
Elongation at break	percent	ASTM D638 Type IV Dumbell, 2 ipm, Gage lengths of 50 mm	250
Carbon black content	percent	ASTM D1603	2 to 3 (range)
Carbon black dispersion for 10 different views • 9 in Categories 1 or 2 and 1 in Category 3		ASTM D5596	Category 1 or 2
Puncturing Resistance	pound	ASTM D4833	44
Tear Resistance	pound	ASTM D1004	22
Oxidation induction time (OIT) standard High pressure	minute minute	ASTM D3895 ASTM D5885	100 400
Oven aging at 85 degrees C standard OIT retained after 90 days; or High pressure OIT retained after 90 days	NA percent percent	ASTM D5721 ASTM D3895 ASTM D5885	NA 35 60
UV resistance High pressure OIT retained after 1,600 hours	percent	ASTM D5885	35

Table C-5: Seam Field Test Requirements

Test	Standard	Shear/Peel Strength	Shear/Peel Separation
Trial seam testing & Destructive seam testing	ASTM D6392	60 lb/in (min)/50 lb/in (min) (hot wedge); 60 lb/in (min)/44 lb/in (min) (extrusion)	50 % (max)/25 % (max) (hot wedge & extrusion)
Test	**Standard**	**Maximum Change in Pressure**	
Non-Destructive seam testing	ASTM D5820	3.0 psi for minimum 30 psi 5 minute pressure test	

Table C-6: Requirements of Drainage Geocomposite

Drainage Geocomposite Nonwoven Geotextile Properties			
Property	**Unit**	**Test Method**	**Acceptable Value**
Fabric Weight	Ounces per sq yd	ASTM D5261	5.6 (min)
Thickness	mil	ASTM D5199	55 (min)
Grab Strength	pound	ASTM D4632	140 (min)
Grab Elongation	percent	ASTM D4632	50 (min)
Permeability, k	cm/s	ASTM D4491	0.7 (min)
Apparent opening size, mm	Sieve size 0.210 (max)	ASTM D4751	70 (max)
Drainage Geocomposite Geonet Properties			
Property	**Unit**	**Test Method**	**Acceptable Value**
Density	g/cc	ASTM D1505	0.94 (min)
Carbon black content	percent	ASTM D1603	2.0 (min)
Tensile Strength in machine direction	ppi	ASTM D5035	30 (min)
Drainage Geocomposite Properties			
Property	**Unit**	**Test Method**	**Acceptable Value**
Ply adhesion	ppi	ASTM D413	1.0 (min)

APPENDIX D

GEOTUBE PERFORMANCE AND QUALITY CONTROL STANDARDS

Table D-1: Performance Quality Control Standards for Geotubes

Property	Test Method ASTM	Target Property	Testing Frequency
Physical			
Tube Circumference (True Value)	Measured	75, 80, 85 foot	N/A
Fill Port (diameter)	Measured	18" to 21" long by 14" to 16" wide	N/A
Thickness	D5199	65 mil	
Mass / unit Area	D5261	585 (17.3)	g/m^2 (oz/yd^2)
Mechanical			
Wide Width Tensile Strength	D4595	400 x 550 lb/in	10,000 yd^2
Wide Width Elongation (max.)	D4595	20% (max)	10,000 yd^2
Trapezoidal Tear Strength	D4533	250 x 300 lb	10,000 yd^2
Puncture Strength	D4833	260 lb	10,000 yd^2
Seam Strength (factory)	D4884	400 lb/in	50,000 yd^2
Hydraulic			
Apparent Opening Size (AOS)	D4751	No. 40 Sieve(min.)	50,000 yd^2
Water Flow Rate	D4491	20 gpm/ft^2	50,000 yd^2
Endurance			
Accelerated UV Resistance (% retained after 500 hr)	D4355	80%	Month