Lower Fox River Operable Unit 1 Remedial Action
2005 Remedial Summary Report

Prepared for

GW Partners, LLC

January 2007

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Acronyms and Abbreviations

AOC	Administrative Order on Consent
BMP	Best Management Practice
CD	Consent Decree
CQAPP	Construction Quality Assurance Project Plan
cy	cubic yards
DMU	Dredge Management Unit
ESD	Explanation of Significant Differences
ft	feet
HPR	Former Huber Property
IDW	inverse distance weighted
lb	pound
LFR	Lower Fox River
LLBdM	Little Lake Butte des Morts
LLC	limited liability corporation
MG	million gallons
NTU	nephelometric turbidity units
O&M	Operation and Maintenance
OU	Operable Unit
PCB	polychlorinated biphenyl
ppm	parts per million
QA	quality assurance
QC	quality control
RA	Remedial Action
RAL	Remedial Action Level
RAWP	Remedial Action Work Plan
RD	Remedial Design
ROD	Record of Decision

SOW	Statement of Work
SWAC	Surface Weighted Average Concentration
TSS	total suspended solids
UCS	Unconfirmed Compressive Strength
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
WDNR	Wisconsin Department of Natural Resources
WTP	water treatment plant

SECTION 1

Introduction

CH2M HILL, Foth & Van Dyke and STS Consultants, Ltd. (STS) prepared this Lower Fox River (LFR) Operable Unit 1 (OU1) 2005 Remedial Action (RA) Summary Report on behalf of GW Partners, LLC, (GW Partners) as part of the LFR OU1 RA. GW Partners is a limited liability company formed by WTM I Company and the P.H. Glatfelter Company to jointly perform the RA.

The 2005 RA Summary Report is a deliverable required by the 2005 RA Work Plan, dated August 2005. The RA Work Plan was a requirement of the Consent Decree (CD) for the LFR OU1 RA, which was entered into by WTM I Company and the P.H. Glatfelter Company; the U.S. Environmental Protection Agency (USEPA); and the State of Wisconsin, through the Wisconsin Department of Natural Resources (WDNR). The U.S. District Court for the Eastern District of Wisconsin entered the CD on April 12, 2004.

1.1 2005 Goals

The objective of the 2005 RA Summary Report is to present the data obtained during the 2005 RA. The 2005 RA activities were intended to achieve the following goals as stated in the 2005 RA Work Plan:

- Conduct 2005 Remedial Action to further comply with the December 2002 Record of Decision.
- Modify the water treatment plant (WTP) to accommodate two 8-inch dredges operating simultaneously 24 hours per day, 5 days per week;
- Complete the expansion of the geotextile tube dewatering pad;
- Complete operational modifications to the piping manifold system and site access routes to accommodate increased dredging activities;
- Dredge Sub-areas A, C, D2S (portion of Sub-area D south of the railroad trestle) and POG1 while optimizing dredging operations to minimize turbidity, overdredging, and residual PCB concentrations;
- Dewater sediment in geotextile tubes, optimizing dewatering to maximize dewatered percent solids prior to dewatered sediment load-out;
- Operate the WTP to meet treatment expectations; and,
- Monitor RA activities and their impacts (sediment removal verification, water treatment, and air/water quality).

This 2005 RA Summary Report addresses all of these issues.

1.2 Project Background

The LFR, defined as the 39-mile portion of the Fox River beginning at the outlet of Lake Winnebago and terminating at the river's mouth into the bay of Green Bay, is the most industrialized river in Wisconsin. The LFR has experienced water quality problems since the early 1900s. Polychlorinated biphenyls (PCBs) were discovered in the LFR in the 1970s.

The LFR's most southerly section, from the outlet of Lake Winnebago to the Upper Appleton Dam, is Little Lake Butte des Morts (LLBdM), also known as OU1. USEPA and WDNR signed a Record of Decision (ROD) encompassing OU1 in December 2002. The ROD established a RAL of 1-ppm PCBs for the cleanup effort in OU1, and estimated that the removal of 784,200 cubic yards (cy) of sediment containing 3,770 pounds (lbs) of PCBs would be required to achieve this RAL. The ROD provides that pre-remediation sampling and characterization efforts will define a spatial footprint of sediment containing PCB concentrations greater than 1 ppm. This footprint is targeted for removal by dredging. If sampling shows that the 1-ppm PCB RAL is not achieved after completing sediment removal (dredging) for OU1, the ROD allows for a surface weighted average concentration (SWAC) of 0.25-ppm PCBs to be used to assess the effectiveness of PCB removal at LLBdM. If the SWAC is not achieved, then the ROD provides for either further dredging or the placement of a sand cover over dredged areas.

The ROD also permits the use of in situ capping as a contingent remedy, which may be employed to supplement sediment removal if the ROD and Statement of Work requirements are achieved, as determined by USEPA and WDNR. Evaluation and selection of the contingent remedy, or an OU1-specific contingent remedy, would be evaluated and documented by the Agencies in an Explanation of Significant Differences (ESD) or a ROD Amendment, based on a determination by DNR and EPA as to whether the changes are "fundamental" or "significant".

1.3 LFR OU1 Remedial Action

During the 2005 RA, GW Partners intended to implement full-scale dredging operations in OU1, dewater the dredged sediment, perform water treatment activities using the expanded water treatment facility, and complete associated activities necessary to accomplish those primary goals.

This section provides an overview of the LFR OU1 RA for 2005.

1.3.1 Remedial Action in LLBdM

Based on LLBdM's existing sediment PCB data and its hydrodynamic and bathymetric properties, GW Partners decided, with the Agencies' concurrence, that sediment removal would occur in 2005 in portions of Sub-areas A, C, D2S (portion of Sub-area D2 south of the railroad trestle), and Sub-area POG1. These sub-areas are located upstream of the other sub-areas and were chosen for remediation before the other OU1 sub-areas containing PCBs in excess of the 1-ppm RAL.

1.3.2 Remedial Action in 2005

The 2005 remedial activities included the following activities:

- Expanded dewatering pad from approximately 2.5 acres to 5 acres to accommodate additional geotextile tubes.
- Expanded water treatment facility capacity from approximately 2,000 gpm to 3,000 gpm to accommodate two 8-inch dredges simultaneously working 24 hours per day, 5 days per week.
- Prepared dredge piping manifold to accommodate two dredges discharging to the geotextile tubes.
- Completed site access modifications for dewatered sediment hauling and truck decontamination.
- Conducted dredging activities in Sub-areas A, C, and D2S, using two dredges.
- Added a third dredge in October 2005 dedicated to dredging Sub-area POG1.
- Extended dredging into Saturday and Sunday in November 2005.
- Dewatered dredged sediment utilizing 60-foot, 80-foot, and 100-foot circumference geotextile tubes.
- Loaded and hauled dewatered TSCA and non-TSCA sediment to contracted landfill disposal sites: Onxy Hickory Meadows Landfill in Chilton, Wisconsin for the non-TSCA sediment and Wayne Disposal in Belleville, Michigan for the TSCA sediment.
- Managed chemical additions to enhance dewatering and to meet water treatment expectations.
- Operated and maintained water treatment facilities to meet water treatment expectations.
- Monitored RA activities (sediment removal, dewatering, and water treatment) to determine their effectiveness and impacts (sediment removal verification, water treatment effectiveness, and air/water quality).

SECTION 2

Project Management

2.1 Project Organization

CH2M HILL managed the LFR OU1 2005 RA on behalf of GW Partners. Figure 2-1 (the organization chart) presents the project team structure. The RA project responsibilities and authorities for various organizations and project team members are outlined in the following subsections.

2.1.1 GW Partners, LLC

GW Partners, LLC, is a limited liability company formed by WTM I Company and P.H. Glatfelter Company, which have jointly entered into the LFR OU1 CD and performed the RA.

2.1.2 CH2M HILL

CH2M HILL was the Supervising Contractor for the 2005 RA. As such, CH2M HILL managed and performed the LFR OU1 2005 RA on behalf of GW Partners. Technical Specifications were developed for the 2005 RA work by Foth & Van Dyke and STS Consultants, Ltd. based on the CH2M HILL RA design documents. CH2M HILL was selected after a conventional bidding process. CH2M HILL was responsible for preparing construction submittals in accordance with the Technical Specifications.

2.1.3 CH2M HILL Subcontractors

The subcontractors selected by CH2M HILL and approved by GW Partners were as follows:

- Starnet Technologies, Inc. - Instrumentation
- J.F. Brennan Co. Inc. - Marine construction operations, dewatering physical operations, and dewatered sediment load-out
- Infrastructure Alternatives Inc. - Geotextile tube layout/filling assistance
- Ciba Specialty Chemicals – Chemical supply and consulting services
- Miratech and Bradley – Geotextile tube manufacturers and providers
- Relyco, Inc. – Site preparation and earthwork services
- Town & Country Electric – Electrical, instrumentation and control supply, and installation
- August Winter & Sons – Installation of process mechanical systems
- Clean Air and Water Systems, Inc. – Dewatering pad liner installation

2.1.4 Frederickson Trucking

Frederickson Trucking, as a direct contractor to GW Partners, provided trucks for non-TSCA sediment hauling to the Onyx Hickory Meadows Landfill Facility in the Town of Chilton, Wisconsin, for disposal.

2.1.5 Onyx Hickory Meadows Landfill, LLC.

Onyx Hickory Meadows Landfill, LLC, as a direct contractor to GW Partners, provided for non-TSCA sediment disposal at its Onyx Hickory Meadows Landfill Facility in the Town of Chilton, Wisconsin.

2.1.6 Wayne Disposal

Wayne Disposal, as a direct contractor to GW Partners, provided transportation and disposal services for TSCA sediment at the Wayne Disposal Landfill site in Belleville, Michigan.

2.1.7 Foth & Van Dyke

Foth & Van Dyke, as a direct contractor to GW Partners, provided construction quality assurance/quality control (QA/QC) engineering functions except for the geotextile tube dewatering pad liner. Foth & Van Dyke performed environmental monitoring and confirmation of sediment removal. They also contributed to the preparation of this 2005 RA Summary Report.

2.1.8 STS Consultants, Ltd.

GW Partners retained the engineering firm of STS Consultants, Ltd. (STS) as the Construction Management and Contract Administration (CM/CA) Engineer to provide an independent engineering oversight function. STS also performed QA/QC construction monitoring on the geotextile tube dewatering pad expansion. They also contributed to the preparation of this 2005 RA Summary Report.

2.1.9 U.S. Environmental Protection Agency

The USEPA provided oversight, including review of technical deliverables, review of progress reports and weekly production reports, and periodic site observations and meetings.

2.1.10 Wisconsin Department of Natural Resources

The WDNR provided oversight, including review of technical deliverables, review of progress reports and weekly production reports, and periodic site observations and meetings. WDNR provided the guidance and concurrence that enabled the development of the applicable substantive requirements. WDNR also provided oversight utilizing their subcontractor, Boldt. WDNR representatives attended weekly meetings onsite to offer guidance and observation.

2.1.11 Boldt Oversight Team

The Boldt Oversight Team provided technical oversight support under contract to WDNR.

2.2 Schedule of Activities

The 2005 RA Preliminary Design Report submitted to the Agencies for review on February 9, 2005 anticipated signing the contract between GW Partners and the 2005 RA Supervising Contractor on April 25, 2005, with dredging to begin on June 1, 2005. The bidding process to select the 2005 RA Supervising Contractor extended this schedule so that the effective date of the 2005 RA contract between GW Partners and CH2M HILL was June 30, 2005. However, in order to minimize the impact of the delay in signing the contract, GW Partners and CH2M HILL agreed to a change order under their existing 2004 RA contract that allowed limited notice to proceed on a number of time critical items (i.e., mobilization, site preparation, dewatering pad expansion, QC reports submittals, project management, health & safety, insurance, and water treatment expansion).

The 2005 RA Work Plan schedule targeted the dewatering pad expansion to occur between May 31 and July 22, 2005, the water treatment plant expansion to occur between June 13 and July 15, 2005, and dredging of Sub-area A to begin on July 7, 2005.

The 2005 RA dredging operation began on July 7, 2005.

The 2005 RA schedule, as completed, is presented in Figure 2-2.

SECTION 3

Dredging

3.1 Removal Areas

3.1.1 Sub-areas A, C/D2S, and POG1

Three sub-areas within LLBdM were selected for sediment removal in 2005: Sub-areas A, C/D2S, and POG1. These sub-areas were selected based on LLBdM's existing sediment PCB data and its hydrodynamic and bathymetric properties. They are located upstream of all other sub-areas and contained relatively high concentrations of PCBs. Figure 3-1 shows the planned removal areas for 2005.

From the 2005 Basis of Design Report (BODR), the surface areas and associated sediment removal volumes for the three sub-areas were estimated as follows:

Table 3-1
Planned 2005 Dredge Removal Areas and Volumes

Description	Sub-area A	Sub-area C/D2S	Sub-area POG1	Total
BODR Volume to 1.0 ppm target elevation(cy)	50,070	25,115	25,374	100,559
6-inch Overcut Allowance (cy)	38,394	19,022	NA*	NA*
Subtotal (cy)	88,464	44,137	25,374	157,975
Planned Surface Area (ft2 /acres)	2,073,247/47.6	966,226/22.2	251,392/5.8	3,290,865/75.5

* The 2005 Final Design provided for the removal of all wood-chip material in Sub-area POG1 to native clay, meaning that no overcut volume was anticipated for Sub-area POG1.

The "BODR Volume to the 1.0 ppm target elevation" for Sub-area A and Sub-area C/D2S was the targeted volume for removal based on the PCB modeling work identifying the 1.0 ppm PCB delineation, or dredge prisms, in these sub-areas. In Sub-area POG1 (the wood chip deposit), the entire area and volume of wood chips was planned for removal due to the anticipated heterogeneous occurrence of PCBs in the sub-area. The "BODR Volume to 1.0 ppm target elevation" for Sub-area POG1 represented the estimate of the total surface area and volume of Sub-area POG1 to the native lake bed.

The "6-inch Overcut Allowance" is the estimated overcut volume the General Contractor was allowed to remove without incurring a contractual penalty under the 2005 Technical Specifications. The 2005 Technical Specifications account for the fact that current dredging technology cannot remove contaminated sediments with the desired accuracy. The size of the equipment, the marine work environment, and operator constraints all mean that a dredge cut necessarily varies in its accuracy to an established cutline or modeled dredge target elevation. To ensure that the targeted contaminated sediment is actually removed, the dredging contractor must dredge below (or "overcut") the 1.0 ppm PCB cutline.[1] GW Partners selected a 6-inch overcut in the 2005 Technical Specifications for Sub-areas A and C/D2S based on experience from the 2004 RA dredging and feedback from dredging contractors on the expected accuracy of dredging the 2005 RA OU1 sediments.

3.1.2 Sub-area POG1 Delineation

Additional characterization of Sub-area POG1 was conducted during September and October 2005. The additional characterization was performed because low lake levels allowed it and the initial excavation in Sub-area POG1 indicated a need to modify the approved dredge plan in the dry southern and eastern areas of Sub-area POG1, meaning the area of POG1 that was not underwater at that time. The initial plan stated that excavation/dredging would be done to the native lake bed. Upon excavation in the southeastern dry area of Sub-area POG1, Foth & Van Dyke discovered considerably more removal would need to occur to remove to the native clay layer. In addition, the distinctive brown wood chips associated with PCB contamination in Sub-area POG1 did not always extend to the native clay, thus general removal to native clay could unnecessarily remove material with less than 1.0 ppm PCBs. Therefore, a delineation was performed in the dry areas to better define PCB extent.

The additional characterization work in the dry area consisted of two sampling events. During the first sampling event, four soil samples (POG1-29 through 32) were collected from shallow test pits at three locations within Sub-area POG1. The intent of this first event was to determine PCB concentrations of the layer of larger wood chips encountered overlying native material. The second sampling event consisted of the excavation of 17 test pits and the collection of thirty-nine soil samples from the test pits for subsequent PCB concentration analysis. The objective of this sampling event was to better define the horizontal and vertical extent of PCBs in Sub-area POG1. The field work was performed by Foth & Van Dyke and the laboratory analysis was performed by Pace Analytical. Test pits were excavated and surveyed by Brennan. Additional samples for PCB delineation in POG1 shoreline areas (POG1-33 through 38) are discussed in

[1] The LFR OU1 ROD sets forth the RAL variously as 1 ppm and 1.0 ppm. The distinction between these terms is statistically significant. GW Partners and the governments have agreed that, for the time being, GW Partners will set the target elevation based upon a 1.0 RAL, subject to P.H. Glatfelter Company's and WTMI Company's reservation of all of their rights to dispute this interpretation. Nothing in the performance of the 2005 RA or this Report waives or diminishes these reservations of rights.

Section 3.1.4. The sample and test pit locations are shown in Figure 3-2. The PCB concentration results and the logs of the test pits are summarized in Appendix A.

To further delineate the TSCA region of Sub-area POG1, on September 1, 2005, six core samples were collected from the sub-area (POG1-20 through POG1-25). Three of the six cores were tested for PCBs. Prior to this additional core sampling, the Sub-area POG1 TSCA region had been identified and delineated by samples from only two core locations (samples POG1-8 and FR3007). The results of the PCB testing from these cores are as follows:

Table 3-1A
POG1 TSCA Area Delineation Sample Results

Sample ID	Sample Depth Interval	Total PCB Concentration (ppm)
POG1-20	0-2.7′	170
POG1-21	0-4.2′	71
POG1-22	0-2.8′	34
POG1-8	0-2.65′	49.8
FR3007	0-3.5′	190.0

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Checked by: DMR

Note: For POG1-20 through 22, the depth represents the sediment core penetration; however, the sediment core length recovered, which was homogenized and analyzed for PCBs, was less for each sample: 2.21′, 1.19′, and 1.46′, respectively. For POG1-8, the sample depth interval and recovery were the same value. Recovery information for core FR3007 was not available.

TSCA delineation core sample locations are presented on Figure 3-2.

The determination of whether sediment must be disposed of at a TSCA-licensed landfill was based on the average sediment PCB concentration over an interval from 12 inches above to 12 inches below the sample interval(s) containing greater than or equal to 50 ppm PCBs. Only samples with PCB concentration data were used to calculate the average sediment PCB concentration for a given sample core. Thus, for locations with no sediment above the sample interval(s) containing greater than or equal to 50 ppm PCBs, only that interval and deeper zones were included in the determination. Similarly, if there is no sediment below sample interval(s) containing greater than or equal to 50 ppm, only the zone that had sediment present was considered in the determination. This vertical core averaging process was agreed upon with the Agencies.

The result of the additional 2005 characterization was to modify the dredge plan in the dry areas from what was proposed in the 2005 BODR and to also slightly modify the TSCA area footprint to the limits shown on Figure 3-3.

The revised remedial action plan for the area of POG1, that was not underwater, was to remove brown woodchip material and not to remove the soils/rock/silty material beneath the brown woodchips, because this underlying material was typically found to contain less than 1.0 ppm PCBs. A visual relationship between soil types encountered and PCB concentration in the dry areas was developed to give the dredging contractor a guide to follow when removing soils.

Excavation activities in the dry areas of Sub-area POG1 were then carried out to the depth at which clay soils, rock, or a dark brown silty material were encountered, rather than a pre-determined elevation. This excavation endpoint was possible because of the lower water levels during September and October, 2005. The endpoint for dredging in the submerged western and northern areas of Sub-area POG1 was the native lake bed, as originally planned.

3.1.3 Actual Removal Areas

In 2005, a total of 88,243 cubic yards were dredged in Sub-areas A, C/D2S, and POG1. All of Sub-area A was completed by the end of the 2005 season. Dredging to the target elevation (1.0 ppm cutline or documented high subgrade elevation) was achieved in more than 98% of Sub-area A, which exceeded the design objective of 95% removal.

The southern portion of Sub-areas C/D2S (area south of the gas pipeline) was also completed in 2005. GW Partners was not able to dredge the northern portion of Sub-area C/D2S (area north of the gas pipeline) in 2005 due to ice forming on LLBdM. This northern area will be dredged in 2006. Again, the target elevation was achieved in more than 98% of the sub-area.

Finally, the dredging of Sub-area POG1 was also completed in 2005. In the submerged portions of Sub-area POG1, dredging was done to the native subsurface. Because this sub-area predominantly contained woodchips, the original plan in this sub-area was to dredge to the native subsurface in the entire sub-area, rather than to 1.0 ppm PCB elevations. However, conditions found in the field resulted in a need for additional characterization work to be performed before dredging could be completed in Sub-area POG1 dry areas. A discussion of the 2005 characterization work performed in Sub-area POG1 to better define the limits of dredging in the dry areas was previously described in Section 3.1.2.

Figure 3-4 shows the 2005 actual removal areas. Figures 3-5, 3-6 and 3-7 show a more detailed summary for each of the three sub-areas.

Table 3-1B details adjustments to the planned dredge prism horizontal footprints resulting from updated survey information and operational constraints. Table 3-2 summarizes the actual 2005 dredge removal surface areas and volumes.

Table 3-1B
2005 Dredge Area Adjustments from Plan
(all values in acres)

Description	Sub-area A	Sub-area C/D2S	Sub-area POG1	Total
Actual 1.0 ppm Perimeter Area Adjusted by 2005 Shoreline Survey	48.4	23.6	7.8	79.8
C/D2S DMUs Not Dredged (north of pipeline)		7.5		7.5
Footprint deductions				
♦ No dredge areas				
-East Central Region (A)	4.1			4.1
-Northern Region (A)	1.4			1.4

-Southern Region (D2S)		1.6		1.6
-Northern Region (C)		0.9		0.9
♦ Slopes steeper than 5:1	0.3			0.3
♦ Shallow water areas	1.2	0.3		1.5
♦ Void areas	0.7			0.7
♦ Water Intake/Pipeline Setbacks	0.1	2.3		2.4
♦ Portion of Sub-area A DMU 9A/15A not dredged in 2005 (dredged to completion in 2004)	2.9			2.9
Total Area Dredged in 2005	37.7	11.0	7.8	56.5

Prepared by: JRB2
Checked by: DMR

Table 3-2
Actual 2005 Dredge Removal Areas and Volumes

Description	Sub-area A	Sub-area C/D2S	Sub-area POG1	Total
Actual Volume Removed to 1.0 ppm Target (cy)	41,574	12,039	17,701	71,314
Actual Overcut Volume (cy)	11,673	4,992	NA	16,665
Total 2005 Removal Volume (cy)	53,581	16,961	17,701	88,243
Surface Area Dredged (ft^2/acres)	1,642,343/37.7	481,077/11.0	338,374/7.8	2,461,794/56.5

Prepared by: TMK1
Checked by: DMR

Table 3-3 provides removal data for each sub-area, which includes DMU specific data on area and volumes removed and percent of each DMU dredged to target elevation.

Table 3-3
OU1 2005 Remedial Action Dredging Summary

Area	QA Survey Date	DMU Area (Acres)	Area Dredged At or Below Target Elevation (Acres)	Confirmed High Sub-Grade Area (Acres)	Percent of DMU at or Below Target Elevation	DMU Volume of 6" Planned Overcut (Cubic Yards)	Volume of Planned Overcut Dredged (Cubic Yards)	Volume of Sediment Removed Below Planned 6" Overcut (Cubic Yards)	Volume between 2005 Existing Conditions Survey and GMS 1 ppm Model (Cubic Yards)	Amount of Sediment Dredged to Target Elevation (Cubic Yards)	Amount of Material Remaining above Target Elevation (Cubic Yards)	Total Amount of Sediment Removed (Cubic Yards) [2]
Sub-Area A												
DMU-1A	11/2/2005	0.504	0.466	0.038	100% [1]	407	236	18	925	917	8	1,171
DMU-2A	8/16/2005	1.074	1.070	0.000	99.6%	866	663	65	2,300	2,299	1	3,027
DMU-3A	8/16/2005	1.659	1.600	0.000	96.2%	1,338	711	19	870	858	12	1,588
DMU-4A	8/5/2005	0.459	0.456	0.000	99.3%	370	280	45	1,136	1,135	1	1,460
DMU-5A	8/5/2005	0.175	0.175	0.000	99.9%	141	106	4	400	400	0	510
DMU-6A	8/16/2005	1.593	1.516	0.000	95.2%	1,285	842	76	2,413	2,402	11	3,320
DMU-7A	9/26/2005	3.033	2.074	0.901	98.1% [1]	2,447	851	43	4,833	4,442	391	5,336
DMU-8A	9/12/2005	1.756	0.920	0.836	100% [1]	1,417	236	2	1,175	992	183	1,230
DMU-9A [3,4]	10/7/2005	0.472	0.465	0.000	98.5%	381	290	8	152	149	3	447
DMU-10A	11/2/2005	4.489	4.025	0.464	100% [1]	3,621	2,114	261	7,384	7,287	97	9,662
DMU-11A	10/19/2005	2.147	1.360	0.776	99.5% [1]	1,732	489	29	3,675	3,444	231	3,962
DMU-12A	10/5/2005	1.065	0.878	0.179	99.2% [1]	859	428	30	2,427	2,357	70	2,815
DMU-13A	10/19/2005	3.354	1.978	1.365	99.7% [1]	2,706	620	8	5,833	5,120	713	5,748
DMU-14A	11/10/2005	3.509	1.681	1.751	97.8% [1]	2,831	505	22	2,711	2,238	473	2,765
DMU-15A [3,4]	10/21/2005	0.221	0.142	0.077	99.1% [1]	178	40	0	42	4	38	44
DMU-16A	11/10/2005	3.527	2.606	0.790	96.3% [1]	2,845	1,014	97	2,863	2,617	246	3,728
DMU-17A	11/10/2005	2.657	0.586	1.964	96.0% [1]	2,143	198	9	1,619	675	944	882
DMU-18A	11/12/2005	2.359	0.828	1.531	100.0% [1]	1,903	248	18	1,805	980	825	1,246
DMU-19A	11/15/2005	1.768	1.174	0.594	100.0% [1]	1,426	369	5	452	219	233	593
DMU-20A	11/8/2005	1.882	1.179	0.696	99.6% [1]	1,518	597	77	3,596	3,039	557	3,713
Sub-area Total		37.703	25.179	11.962	98.5%	30,414	10,837	836	46,611	41,574	5,037	53,247
Sub-Area												
DMU-1C	11/8/2005	1.144	0.473	0.642	97.5% [1]	923	145	57	887 [5]	677	210	879
DMU-2C	11/23/2005	1.162	0.502	0.656	99.7% [1]	937	174	6	1244 [5]	996	248	1,176
DMU-3C	11/29/2005	0.882	0.450	0.429	99.7% [1]	711	168	33	1053 [5]	899	154	1,100
DMU-4C	11/29/2005	1.010	0.854	0.114	95.8% [1]	815	355	9	823 [5]	785	38	1,149
DMU-5C	12/1/2005	1.034	0.676	0.358	100.0% [1]	834	324	81	1333 [5]	1,230	103	1,635
DMU-6C	12/2/2005	0.953	0.766	0.182	99.5% [1]	769	297	32	1,155	1,105	50	1,434
DMU-7C	12/2/2005	1.148	0.945	0.203	100.0% [1]	926	448	157	1,266	1,232	34	1,837
DMU-8C	12/2/2005	0.952	0.860	0.092	100.0% [1]	768	500	183	1,041	1,016	25	1,699
DMU-9C	12/1/2005	0.957	0.816	0.101	95.8% [1]	772	466	74	1,449	1,397	52	1,937
DMU-10C	12/1/2005	0.990	0.561	0.427	99.8% [1]	799	249	78	2,190	2,069	121	2,396
DMU-2D2S	11/22/2005	0.812	0.805	0.000	99.1%	655	644	442	634	633	1	1,719
Sub-area Total		11.044	7.708	3.204	98.8% [1]	8,909	3,770	1,152	13,075	12,039	1,036	16,961
Sub-Area POG1	10/31/2005	7.768 [6]	NA	NA	NA	NA	NA	NA	NA	NA	NA	17,701 [6]
Sub-area Total		7.768	NA	NA	NA	NA	NA	NA	NA	NA	NA	17,701
2005 Total		**56.515**	**32.887**	**15.166**	**98.6%**	**39,323**	**14,607**	**1,988**	**59,686**	**53,613**	**6,073**	**87,909**

Special Dredging

Area	QA Survey Date	DMU Area (Acres)	Total Amount of Sediment Removed (Cubic Yards) [2]
DMU-4A to clay	11/10/2005	0.459	334

Total Volume Dredged 87,909 + 334 = 88,243 cubic yards

Prepared by: JRB2
Checked by: DMR

[1] Includes Confirmed High Sub-Grade Areas.
[2] Includes Sediment Dredged to Target Elevation and all overcut. Based on existing conditions survey and final post-dredge QA survey for each DMU.
[3] DMU Volume equals volume within DMU areas above target elevation as of June 2005 Pre-Dredge survey. This DMU was previously dredged in 2004.
[4] DMU Area is area within the DMU that is above target elevation as of the June 2005 Pre-Dredge survey. This DMU was previously dredged in 2004.
[5] Existing conditions survey not conducted in 2005. Volume presented is same as BODR volume.
[6] Quantity is actual volume removed based on difference between existing condition surveys and post-dredge QA surveys. Includes 1501 cubic yards of TSCA material.

Actual removal volumes for the sub-areas were lower than the planned removal volumes for several reasons. Select regions of Sub-areas A and C/D2S were removed from the dredge prism and designated as "No Dredge Regions." These regions were designated by the Agencies in correspondence dated October 4, 2005, and November 1, 2005, as having the following characteristics:

- All samples in these areas have PCB concentrations less than 2 ppm, just above the RAL of 1ppm.
- The contaminated sediment deposit is relatively thin (0.5 feet or less) with underlying sand and gravel. Thus dredging these areas would be inefficient.
- Not dredging these areas would have a positive effect on the project schedule.
- Dredging these areas provides a relatively small environmental benefit relative to the effort required.

The "No Dredge Regions" contain 7,605 cubic yards of sediment (including the associated 6-inch overcut volumes). Section 3.3.3 discusses these "No Dredge Regions" in more detail. Copies of the October 4, 2005, and November 1, 2005, agency correspondence are included in Appendix B.

In addition, high subgrade locations in Sub-areas A and C/D2S further reduced the volume of material that needed to be removed compared to the modeled volume. High subgrade locations are areas where less than 4 inches of targeted soft sediment are present above a hard subgrade (including areas where native clay or rock was actually encountered above the target dredge elevations). High subgrade areas significantly reduced actual dredge volumes in two ways. First, the targeted BODR volume to the 1.0 ppm PCB cutline was less because high subgrade areas were actually present. Second, in high subgrade areas, there was no overcut at all, which significantly reduced the overall actual overcut volume from the 6-inch Overcut Allowance. Section 3.3.4 discusses the High Subgrade Areas in more detail.

In Sub-areas A and C/D2S, the Dredging Contractor was also able to achieve less of an overcut than the 6-inch Overcut Allowance set forth in the 2005 Technical Specifications, as discussed in Section 3.3.2.

In Sub-area POG1, the actual removal volume differed from the planned volume for the reasons outlined in Section 3.1.2. Again, no overcut was specified for Sub-area POG1 given the area-specific conditions.

Figures 3-8 and 3-9 show contours of the thickness of sediment (isopachs) remaining relative to the 1.0 ppm PCB target elevation, for Sub-areas A and C/D2S. It should be noted that the majority of the areas not reaching target elevation were documented high-subgrade areas as described in Section 3.3.4.

To further document the 2005 removal, Figures 3-10, 3-11, and 3-12 depict the thickness of sediment removed in each of the three 2005 RA removal areas. Dredge cuts ranged in

thickness from less than 6 inches to approximately five feet, with the deepest cuts occurring in Sub-area POG1. Average dredge cuts included:

- Sub-area A – 0.88 ft.
- Sub-area C/D2S – 0.95 ft.
- Sub-area POG1 – 1.41 ft.

Figures 3-13, 3-14, and 3-15 depict the final post-dredge surface elevations in each of the 2005 RA removal areas.

3.1.4 Levee Area Adjacent to POG1

The excavation of the dry area on the eastern edge of POG1 was performed to the tree drip line at the base of the levee of the Menasha Lock and Channel. Excavation activities were halted at the tree drip line because of concern that further excavation could impact the stability of the levee. In November 2005, additional characterization work was performed at the base of the levee to determine the extent of wood chips remaining there and the PCB content of the remaining wood chips. CH2M HILL performed a survey of the base and levee area by collecting samples throughout the area and describing the type of material sampled, as shown on Figure 3-16. Foth & Van Dyke collected six grab samples (POG1-33 through 38) of fine brown wood chips along the base of the levee and analyzed the samples for PCBs. The PCB results ranged from 3.7 to 12.0 ppm and are presented in Appendix A.

Based on the results of the additional characterization work, CH2M HILL estimated the PCB mass in the wood chips remaining at the base of the levee at 0.6 kg. The estimate is based on the following:

- CH2M HILL's field survey of the wood chips on the levee indicated that
  - 12,000 cubic feet of wood chips in the northern area designated on the figure (12,000 ft2 estimated at 1 ft thick), and
  - 6,250 cubic feet of wood chips in the remaining areas on the levee (estimated 50 ft x 500 ft X 0.25 ft thick).
- The average PCB content of the remaining wood chips was estimated at 5 ppm.
- The wood chip dry density was estimated at 13.8 lb/ft3.

To address the remaining wood chips on the bank of the levee (an area described as "Deposit POG1-B") and to provide further protection of the shoreline at the base of the levee, STS prepared a Work Plan for Deposit POG1-B Bank Riprap and General Shore Protection, which was submitted to the agencies for review and comment. The Work Plan is included as Appendix C. The work outlined in the Work Plan includes:

- Tree removal and placement of clean chipped wood over the contaminated wood chips

- Placement of geotextile and riprap along the bank to support the bank and act as a sediment trap
- Placement of geotextile and riprap along the base of the levee

Phase I of the work was completed in January 2006, in order to secure Deposit POG1-B before high water flooded the area during spring thaw. The work was completed in general accordance with the Work Plan. An exception was that riprap was not placed along the portion of the levee slope because such placement was not deemed necessary for immediate protection before the spring thaw.

Phase 2 of the Work Plan was completed in November 2006.

3.2 Dredge System

The dredge system used to remediate Sub-area A and the southern part of Sub-area C/D2S during the 2005 RA included the following components: two 8-inch swinging ladder dredges (Dredging Supply Company), two 8-inch diesel engine driven boosters, four miles of 8-inch SDR 17 HDPE pipeline, and various shallow draft barges and boats. Both dredges utilized articulating cutterhead technology, which allows for better dredge cut accuracy without compromising dredge production. Movement through the dredge cuts was achieved by way of a pivoting spud system at the rear of each dredge. The pivoting spud system allows the dredge to avoid downtime associated with more traditional dredge movement methods, such as anchors and cables. Finally, each dredge used for operations in Sub-areas A and C/D2S used real-time kinetic GPS in conjunction with Dredgepack for positioning purposes.

In order to increase production, a third dredge was added to the system in October 2005, solely to work in Sub-area POG1. The dredge system dedicated to activities in Sub-area POG1 included: one 8-inch swinging ladder dredge (Dredging Supply Company), one mile of 8-inch SDR 17 HDPE pipeline, and a 325 Caterpillar amphibious excavator with a 2.5 cubic yard bucket. Additionally, over 1,000 feet of Gunderboom PCS non-permeable turbidity barrier was installed around the northern border of Sub-area POG1 to contain suspended solids generated by excavation and dredging operations. Similar to the dredges used for Sub-areas A and C/D2S, the dredge used for the underwater operations in Sub-area POG1 moved through the various dredge cuts by way of a pivoting spud at the rear of the dredge. However, the Sub-area POG1 dredge did not utilize articulating cutterhead technology as the submerged western and northern areas of Sub-area POG1 were to be dredged to the native clay lake bottom. The targeted dry areas of Sub-area POG1 (i.e. the brown woodchip materials) were excavated using the Caterpillar 325 amphibious excavator equipped with a 2.5 cubic yard bucket. The excavation bucket was used to pull the wood chip material that was on the upland portions of POG1 to the dredge so that it could be removed and properly disposed.

3.3 Dredge Results

The following sections detail the process by which documentation of sediment removal occurred in LLBdM in 2005. Processes addressed include pre- and post-dredge bathymetry, high subgrade documentation and documentation of "No Dredge Regions".

3.3.1 QA Bathymetric Surveys

In June 2005, a pre-dredge bathymetric survey was conducted by the Dredging Contractor with oversight provided by Foth & Van Dyke. The results of the pre-dredge bathymetric survey were compared to the sub-area information contained in the LFR OU1 BODR to better document actual material removal and subsequent removal progress.

During project operations, post-dredge QA bathymetric surveys were performed in those DMUs that the Supervising Contractor indicated had attained the target elevations or encountered high subgrade areas. The DMUs provided a means to divide a larger sub-area into discrete dredging units. The post-dredge QA bathymetric surveys were performed as requested by the Supervising Contractor, at a minimum, at the end of every two-week period of dredging.

Post-dredge QA bathymetric surveys were conducted by the Dredging Contractor with oversight provided by Foth & Van Dyke, who was on board the survey vessel for all pre- and post-dredge QA surveys. Equipment calibration, survey check to benchmarks, and hydrographic surveying procedures were observed and documented by Foth & Van Dyke. At the completion of each QA survey, the Dredging Contractor provided Foth & Van Dyke with the complete unedited data files.

A Real Time Kinetic (RTK) Global Positioning System (GPS) (Trimble 5700) capable of locating stations with an absolute and repeatable horizontal accuracy of ± 1 meter (m) and a vertical accuracy of ± 5 cm was used to position all sampling locations. The RTK GPS was referenced to onshore, WDNR-established survey monuments to ensure accuracy in the station location determination. The coordinate system used during the sampling activities was the NAVD 88 Datum (vertical) and Geodetic (WGS/NAD83) Datum (horizontal).

During the post-dredge surveys, poling was performed to verify the accuracy of the hydrographic survey procedure. The poling was conducted in QA survey areas at random locations at an approximate frequency of four locations per acre with depths recorded to the nearest 0.1 feet. The pole was fitted with a standard 6-inch diameter poling disc to limit sinking into soft sediments. Depth readings from poling were immediately compared to readings being recorded by the fathometer on the hydrographic survey boat at the time of poling. The coordinates of each poling location were obtained from the HYPACK/GPS system and recorded by Foth & Van Dyke.

The calibration techniques used for the QA surveys were in accordance with the U.S. Army Corps of Engineer, Engineering and Design Hydrographic Surveying Manual No. 1110-2-1003 (January 2002).

An initial calibration check included verifying the GPS system accuracy. The GPS survey equipment used for the hydrographic survey was checked against land-based WDNR benchmarks located along OU1. The coordinates and elevations of the benchmark were

checked against published values. Discrepancies outside of normal survey tolerances were addressed prior to proceeding. This check to known benchmarks occurred at the start and at the end of each QA survey day.

A latency test was also performed prior to each QA survey to align sonar depth soundings with the horizontal GPS coordinates. This calibration technique basically ensures that sonar depth soundings being recorded are at the same horizontal location being tracked by the GPS.

Finally, bar checks were performed daily at the start and at the end of each QA survey. A steel plate (bar) was lowered below the sonar transducer to a known depth below the water surface. The fathometer provided depth was then recorded for agreement with the bar depth. If there was a discrepancy, an adjustment was made to the HYPACK system to calibrate the fathometer reading to match the bar depth. This procedure was performed at two depths: one at the anticipated typical depth to sediment and one a few feet deeper. Foth & Van Dyke recorded the initial bar check and adjusted readings, if necessary.

Following the field survey and processing of the survey data, Foth & Van Dyke determined whether the required dredge prism elevations had been attained by the Dredging Contractor. The following processing procedures were implemented by Foth & Van Dyke:

- For each DMU, a modeled surface was created of post-dredge elevations using the post-dredge QA survey data.
- An isopach (sediment thickness contour) drawing was developed for each DMU, comparing the post-dredge QA survey modeled surface elevations (as the upper surface) and the 1.0 ppm targeted surface elevations (as the lower surface).
- Using the isopach drawing, ninety-five (95) percent or more of the DMU area must be at or below the targeted 1.0 ppm elevation for the dredging to have achieved the design target elevations at the DMU. Confirmed high subgrade areas within a DMU were considered to have achieved the target elevation.

The survey data was also used to calculate the volume of sediment removed in a DMU and to evaluate actual dredge overcuts to planned overcuts.

3.3.2 Dredge Overcut Results

The target elevations provided to the Dredging Contractor were the modeled elevation of the 1.0 ppm dredge cut for Sub-areas A and C/D2S. For Sub-area POG1, the Dredging Contractor was directed to dredge to a native sub-surface as provided in the 2005 BODR, and then later adjusted through the use of the 2005 Sub-area POG1 recharacterization data. An overcut allowance of 6 inches was planned for Sub-areas A and C/D2S. The 2005 RA contract provided a financial incentive to the Dredging Contractor to minimize the overcut below the 1.0 ppm target elevation, in order to reduce the overcut sediment volume for dewatering, transport and disposal. The actual overcut achieved during 2005 dredging was measured by comparing the post-dredge bathymetric survey elevations to the target 1.0 ppm elevations.

Table 3-4 summarizes the overcut by sub-area and DMU. The overcut presented excludes all documented high subgrade areas. The average dredge overcut per DMU was calculated by adding the volume of planned overcut actually dredged to the volume of sediment removed below the 6-inch Overcut Allowance and dividing by the area dredged at or below target elevation. The average overcut in Sub-area A was 3.5 inches and, in C/D2S, it was 4.7 inches.

Table 3-4
Summary of 2005 Dredge Overcut

Dredge Management Unit	Average Dredge Overcut[1] (Inches)	Dredge Management Unit	Average Dredge Overcut[1] (Inches)
Sub-Area A		**Sub-Area C/D2S**	
DMU-1A	4.1	DMU-1C	3.2
DMU-2A	5.1	DMU-2C	2.7
DMU-3A	3.4	DMU-3C	3.3
DMU-4A (TSCA)	5.3	DMU-4C	3.2
DMU-5A	4.7	DMU-5C	4.5
DMU-6A	4.5	DMU-6C	3.2
DMU-7A	3.2	DMU-7C	4.8
DMU-8A	1.9	DMU-8C	5.9
DMU-9A	4.8	DMU-9C	4.9
DMU-10A	4.4	DMU-10C	4.3
DMU-11A	2.8	DMU-2D2S	10.0
DMU-12A	3.9	**Sub-area Average**	**4.7**
DMU-13A	2.4		
DMU-14A	2.3	**Sub-Area POG1**	
DMU-15A	2.1	**Sub-Area Average**	**NA**
DMU-16A	3.2		
DMU-17A	2.6		
DMU-18A	2.4		
DMU-19A	2.4		
DMU-20A	4.3		
Sub-Area Average	**3.5**		

[1] Dredge overcut excludes all confirmed high subgrade areas.

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Figures 3-8 and 3-9 illustrate the specific locations in Sub-areas A and C/D2S where overcuts occurred in OU1 in 2005. There was no calculated overcut in Sub-area POG1 because of the plan to dredge to the native lake bed.

3.3.3 No Dredge Regions

After consultation with the Agencies, GW Partners removed portions of Sub-areas A and C/D2S from the BODR dredge prisms for the 2005 dredge operation because dredging them would have provided a relatively small environmental benefit relative to the effort required. The "No Dredge Regions" characteristics are discussed in Section 3.1.3. The areas designated as "No Dredge Regions" in Sub-area A were referred to as the East-Central Region and the Northern Region and are shown on Figure 3-5. Two "No Dredge Regions" were also identified in Sub-area C/D2S, namely the Southern Region of D2S and a Northern Region of C, with both regions shown on Figure 3-6.

Removing the two "No Dredge Regions" from the Sub-area A, dredge prisms resulted in dredging an estimated 6,256 cubic yards less sediment in Sub-area A. Removing the two "No Dredge Regions" from Sub-area C/D2S resulted in dredging an estimated 1,740 cubic yards less sediment in the southern portion of Sub-area D2S in 2005 and will result in dredging an estimated 1,130 fewer cubic yards in the northern portion of Sub-area in 2006. All of the "No Dredge Region" cubic yard estimates provided above includes the 6-inch overcut allowance.

Table 3-5 summarizes the pre-design data from the East-Central Region of Sub-area A.

Table 3-5
East-Central Region of Sub-area A Characteristics

Location	PCB Concentration	In-Situ Percent Solids
DAO1S	1.4 ppm	64%
A-02	1.2 ppm	67%
DAO1S	1.4 ppm	74%
A-18	1.9 ppm	54%
LLBM-A-71	1.6 ppm	NA

The East-Central Region is 177,158 square feet in size. In addition to an average PCB concentration of less than 2 ppm, the PCB mass within this East-Central Region is low in comparison to the entire Sub-area A. Sediment PCB concentrations in the adjacent area to the west of the East-Central Region range between 2 and 6 ppm.

Table 3-6 is a summary of PCB mass metrics for the East-Central Region.

Table 3-6
PCB Mass Estimation - East-Central Region

Location of Interest	PCB Mass in 1 ppm Isopach
Sub-area A Total	222 kg
East-Central Region	1.7 kg

The influence or percentage of the estimated PCB mass from the East-Central Region is a little less than 0.8% of the total estimated PCB mass within the 1.0 ppm PCB isopach of Sub-area A.

Following the approval to designate the East-Central Region as a "No Dredge Region", additional regions in Sub-areas A and C/D2S were proposed for removal from the dredge prism; these regions being the Northern Region of Sub-area A, the Southern Region of Sub-area D2S, and a Northern Region of Sub-area C.

Table 3-7 contains specific characteristics of these additional regions, with the associated pre-design sample location from within that region identified.

Table 3-7
Additional 2005 No Dredge Regions Characteristics

Region and Sample ID	PCB Concentration	Region Area	In-Situ Percent Solids
Sub-area A: Northern Region (A-36)	2.0 ppm	59,400 sq.ft.	66%
Sub-area C: Northern Region (C-16)	1.2 ppm	39,800 sq.ft.	79%
Sub-area D2S: Southern Region (D2-19)	1.1 ppm	80,300 sq.ft.	76%

Table 3-8 is a summary of the PCB mass contained in the additional "No Dredge Regions".

Table 3-8
PCB Mass Estimates
Additional 2005 No Dredge Regions

Location of Interest	PCB Mass in 1 ppm Isopach
Sub-area A Total	222 kg
Northern Region	0.5 kg
Sub-area C Total	34 kg
Northern Region	0.5 kg
Sub-area D2S Total	4 kg
Southern Region	0.8 kg

As in the East-Central Region, not only are the PCB concentrations within these three regions low (2 ppm or less), but the PCB mass for each region is significantly low in comparison to the entire respective sub-area. For example, the influence or percentage of the estimated PCB mass from the Northern Region is approximately 0.2% of the total estimated PCB mass within the 1.0 ppm PCB isopach of Sub-area A; approximately 1.5% from the Northern Region of Sub-area C and approximately 20% from the Southern Region of Sub-area D2S.

3.3.4 High Subgrade Areas

Dredging removal operations in 2004 indicated the presence of high subgrade areas within LLBdM. High subgrade areas for OU1 were defined as areas where 4 inches or less of soft sediment are present above an underlying hard subgrade consisting of clay, rock, or dense sand/gravel, and the surface elevation of the sediment lies above the 1.0 ppm PCB target elevation.

During the 2005 RA, the Dredging Contractor initially attempted to dredge strictly to the 1.0 ppm PCB target elevation, removing all material above the target elevation. Starting in September 2005, a high subgrade policy was implemented that allowed an area to be excluded from attaining the 1.0 ppm target elevation if a high subgrade region had been identified and verified. The high subgrade policy was implemented as described below.

As planned, when high subgrade areas were encountered, the Dredging Contractor provided GPS coordinates of potential high subgrade areas to Foth & Van Dyke, who placed the survey data on DMU project drawings that depicted post-dredge sediment thickness using the target elevations as the base elevation. Proposed poling and core sample collection locations were then identified by Foth & Van Dyke for high subgrade verification testing. A minimum of three sediment cores from each of the proposed high subgrade areas were required for verification. Additional core locations were identified if the high subgrade area was significant in size.

Foth & Van Dyke, with assistance from the Dredging Contractor, performed the probing and coring activities associated with verifying high subgrade areas. Once on location, a range pole fitted with a 1-foot long, 0.5-inch diameter threaded rod at the end, was used to probe the river bottom to estimate the soft sediment thickness. In many cases, the probed depth was also taken to refusal to determine the consistency of the underlying material. Water depth was also obtained using a survey rod with a 6-inch diameter plate attached to the end.

At probing locations, if the soft sediment thickness was 4 inches or greater, a core sample using 0.75-inch diameter core tubes was obtained for visual confirmation of the probing results. Where discrepancies between probing and coring results occurred, the coring result was used as the record of soft sediment thickness. If a sample could not be retained after two coring attempts, it was assumed that no soft sediment existed at that location.

Following poling and core sample collection in a DMU, the high subgrade area information was incorporated into the QA Bathymetry post-dredge isopach drawings. For designation as a high subgrade area, all core samples (or poling in the absence of core samples) needed to indicate less than 4 inches of soft sediment above an underlying hard subgrade. Areas containing 4 inches or more of soft sediment were located on project drawings and provided to the Dredging Contractor to perform clean-up passes in the specified areas.

After the completion of clean-up passes, post-dredge verification procedures were again conducted to determine whether areas were either dredged to target elevations or could be designated as high subgrade areas. In all clean-up pass situations in 2005, the first clean-up pass was sufficient and no additional clean-up passes were necessary.

As required by the RAWP, at least 95% of the area in a DMU had to be dredged to target elevation for the target elevation to have been considered met for that DMU. Therefore, in limited cases, minimal areas with 4 inches or more of soft sediment above the 1.0 ppm target elevation surface remained at the completion of dredging. Figures 3-17A and 3-17B indicate estimated areas with 4 inches or more of soft sediment remaining above the 1.0 ppm RAL elevation in Sub-areas A and C/D2S, respectively.

Appendix D contains high subgrade poling and core sample collection information for 2005. Documentation includes sample point locations, soft sediment thicknesses based on probing, and soft sediment thicknesses based on core sample measurements.

3.4 Post-Dredge Sampling Procedures

The following sections contain a description of the procedures used for the 2005 RA project regarding the collection, processing, and documentation of post-dredge sediment samples. Procedures were in accordance with Appendix D and E of the 2005 RAWP.

3.4.1 Post-Dredge PCB Sampling Locations

Following a QA bathymetric survey indicating that targeted dredge elevations were achieved for a DMU, post-dredge verification sediment sampling for PCB analysis was performed in that DMU by Foth & Van Dyke. In accordance with the 2005 RAWP, sediment sample collection was based on a 230-ft (Sub-area A and C) or 345-ft (Sub-area D2S) triangular grid unit. Two types of samples, primary and secondary, were collected from the grid limits.

The post-dredge primary PCB sampling locations were located at a pre-design sample location nearest the center of each triangular grid unit. If a pre-design sample did not exist within a triangular grid unit, then the core sample was taken at the center of the grid unit. If the center of the grid unit fell outside of the 1.0 ppm dredge cut limit of the sub-area, then the primary sample location was selected randomly inside of the 1.0 ppm RAL limit within that grid unit. Locating primary samples at or near pre-design core locations enabled an evaluation of the GMS model (Sections 3.5.3 and 3.5.4).

Secondary samples typically consisted of four individual core samples, which were homogenized to form one composite sample. The number of secondary samples was proportional to the area of each grid unit. Typically grid units were split into four equal quadrants, though some grid units had less than four complete quadrants. One secondary sample was collected from each quadrant. The locations of the individual secondary samples were randomly selected within a quadrant.

Figures 3-18, 3-19, and 3-20 show the proposed primary and secondary post-dredge sample locations for Sub-areas A, C/D2S, and POG1, respectively. Actual sample locations are included in Tables E-1 through E-3 of Appendix E.

3.4.2 Sediment Collection Procedures

Sediment sampling stations were located using RTK GPS. Once a sampling station was located, the sampling platform (boat) was anchored in place. The coordinates of the sample location and the water surface elevation were obtained and recorded in the core collection

and processing field log. The actual sampling location was typically within 3 feet of the proposed sampling location. Water depth was obtained using a surveyor's rod attached to a 6-inch diameter metal plate. Thickness of the soft sediment was estimated using a range pole fitted with 0.5-inch diameter threaded rod. Water depth and sediment thickness were recorded on the field log.

Hand-coring techniques were used to obtain the post-dredge core samples. The coring device consisted of a 2-foot long, 2-inch inside diameter core barrel with a T-bar (push rod). The core barrel was pushed into the sediment until refusal with an attempt to obtain a clay plug. Once the core tube was pushed to refusal, the depth of core penetration was noted and documented on field logs.

The thickness of the sediment recovered in the core tube was measured and recorded, and the contents of the core tube were described, measured, and documented on the field log. Since it was not considered in the post-dredge elevation confirmation measurements, the majority of the light, low-percent solids surficial sediment layer (sometimes referred to as a fluff layer) was removed with the water on top of the sediment in the core and was not included in the total sediment thickness recorded. The core was then secured in an upright position until processed.

If sampling activities did not yield at least 4 inches of sediment inside the core on the first attempt, a second attempt was made to obtain a sediment core by relocating the vessel between 5 and 10 feet from the location of the first attempt. At times, the collection vessel was moved as far as 25 feet from the proposed location in an attempt to obtain a sample with the intent to keep the second sampling effort within the same triangular grid unit as the first attempt. If the second attempt failed to yield at least 4 inches of sediment, this information was recorded on the core collection and processing field log and no additional attempts were made to sample this location.

The PCB concentration value assigned to locations where less than 4 inches of soft sediment recovery occurred after two attempts was 0.0168 mg/kg, which is the average PCB concentration of 12 native clay samples from different Sub-areas within OU1 collected during pre-design sampling in 2003/2004. The locations of these 12 samples are shown on Figure 3-20A, and the analytical results are summarized in Table 3-8A.

Table 3-8A

OU1 Native Clay Sample Analytical Results

Sample ID	Average Depth (ft bgs)	PCB Value (ppm)	Percent Solids
E3-Clay1	-0.25	0.0135	75
E3-Clay2	-0.25	0.035	77
E4-Clay1	-0.25	0.032	65
E4-Clay2	-0.25	0.0135	73
E6-15	-0.16	0.0135	70
E6-16	-0.07	0.0135	77
F-Clay1	-0.25	0.0135	75
F-Clay2	-0.25	0.0135	76

POG2-22	-0.16	0.0135	71
POG4-Clay1	-0.25	0.0135	64
POG4-Clay2	-0.25	0.0135	68
POG4-Clay3	-0.25	0.0135	68
Average Values	0.22	0.0168	72

Note: The analytical data was compiled from the March 2005 BODR.

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3.4.3 Sample Processing

Sediment core samples were processed as soon as possible after the sampling event. If cores could not be processed immediately after sampling, they were kept at 4° C, or if the sample was not to be analyzed for PCBs within the holding time of 14 days the sample was frozen.

During core processing, remaining liquid above the top of sediment material was removed from the sediment core by either decanting the liquid or using a stainless steel spoon. An estimate of the thickness of liquid removed was made and recorded. The sediment thickness was measured, while the sample tube was vertical, and recorded on a core collection and processing field log.

The sample tube was then cut in half, length-wise. The description and measurements of the entire soil/sediment core were recorded on the field log. The description of the soil/sediment units typically included the following: color; soil/sediment type (visual soil classification); moisture content; plasticity; and density.

For primary sediment core samples, the top four inches were removed from the core, homogenized, and placed in a sample jar for delivery to Pace Analytical for PCB analysis. The minimum sample weight required was 100 grams wet. The remainder of the sample was discarded.

For secondary composite samples, the top 4 inches of each sample were removed and also homogenized as described above. Typically four secondary core samples (sometimes less, depending on the sample grid area) were needed to prepare the secondary composite sample. The secondary composite sample was prepared for laboratory analysis by taking equal amounts of each of the four homogenized secondary samples and compositing the four samples into one sample. If all secondary samples were not yet available to generate the composite sample, each discrete secondary sample was placed into double zip lock plastic bag, labeled, and frozen until the remaining secondary samples were available. Individual splits of each secondary sample were also retained in the event future discrete secondary sample analysis was warranted.

All primary and secondary samples were kept on ice during shipment to the laboratory.

Sediments were analyzed for PCBs by Pace Analytical using the modified USEPA SW-8468082 procedure commonly referred as the "Fox River Method", which includes an air-drying step so that samples contain between 5- and 10-percent moisture prior to extraction. The sediment samples were then extracted by USEPA SW 846 Method 3541C, automated Soxlet (Soxtherm), followed by gas chromatography analysis using an electron capture detector (GC/ECD). The initial calibration includes an analysis of a five-point calibration curve of Aroclors 1242 and 1254, both prominent PCBs found in the Lower Fox River. A

duplicate sample for every 10 primary samples and for every 10 secondary samples were also processed and delivered to Pace Analytical for PCB analysis. All post-dredge PCB results, including duplicate values, are presented in Tables E-1 through E-3 in Appendix E.

3.4.4 Sediment Collection Documentation

Observations and quantitative data collected during implementation of the sediment sampling procedures (e.g., DMU sampled, time sampling began and ended, sample IDs, order of sample locations completed, number of sample attempts, etc., were recorded in the field notebook. Core collection and processing field logs were completed for each core location.

3.4.5 Sub-area A TSCA Sampling

Three separate sampling events occurred in DMU-4A, the Sub-area A TSCA location, during 2005 dredging operations. Sampling and processing procedures for the first round of post-dredge verification sampling in DMU-4A were the same as described above. The post-dredge sediment verification plan included one primary sample (95P) and four secondary samples (95C, 95D, 96D, and 97B). Consistent with the Sediment Removal Verification Plan, secondary samples were frozen for subsequent compositing and PCB analysis.

Since the primary sample 95P produced a PCB residual concentration of 33 ppm, it was decided to collect nine additional cores from DMU4A to characterize the remaining sediments.

At each of the nine locations, an attempt was made to collect sediment to the native clay interface. Samples collected were then processed and segmented into 10 cm sections for PCB analysis. The PCB data from this sampling event were used to better estimate the overall average PCB surface concentration in this area.

Due to elevated PCB concentrations following the first dredging event, DMU-4A was re-dredged, and following the re-dredging the same nine locations were re-sampled on November 17, 2005. The same procedures were employed in DMU-4A during this third round of sampling. All results of DMU-4A sampling are provided in Section 3.5.2.

3.4.6 Sediment Sampling on Ice

In late November and early December 2005, it became no longer feasible to sample from a boat due to freezing conditions and ice buildup. As a result, the sampling team waited for safe ice conditions so that sampling could resume, using the ice as the sampling platform.

The same general procedures as previously described were followed in the collection of samples through the ice. Once a sampling station was located using RTK GPS, an ice auger was used to produce two 7-inch-diameter boreholes through the ice approximately one foot apart – one borehole for obtaining water depth and sediment thickness, and one for collecting the core sample. If a sample could not be retained on the first attempt, a second sampling location was attempted approximately 5 to 10 feet in a random direction from the original location.

3.5 Post-Dredge PCB Results

Post-dredge PCB sediment results for the 2005 project are discussed and summarized in this section of the report. The PCB data are presented as sub-area surface concentrations, averaged over the 2005 dredge prism areas. Data of this type are also referred to as Average Surface Concentrations. The Average Surface Concentrations are presented only for the 2005 dredge prisms 1.0 ppm PCB area of a sub-area. Sub-areas contain regions which are less than 1.0 ppm PCBs. Including these lower PCB concentration regions would lower the Average Surface Concentrations.

The term "Average Surface Concentration" refers to surface weighted average concentration (SWAC) of the top four inches of remaining sediment as given by the post-dredge sediment bed interpolation model. Details of estimating Average Surface Concentration as well as PCB mass from the sediment bed model are discussed in the following section 3.5.1, and further in Appendix F "GMS Modeling and SWAC Calculation Methodologies." Note that if the remaining sediment thickness was less than four inches and a post-dredge residual sample was collected and analyzed, the resultant PCB value was used in the calculation of the Average Surface Concentrations.

3.5.1 Summary of PCB Data

A total of 133 primary and 429 secondary core samples were obtained in 2005. In addition to the presentation of the post-dredge results on Figures 3-21, 3-22, and 3-23, all post-dredge PCB results are presented in Tables E-1 through E-3 in Appendix E.

Table 3-9 presents the PCB mass and Average Surface Concentrations results for 2005 dredging by sub-areas in order to evaluate the PCB removal efficiency of dredging. Also presented are the pre-dredge and post-dredge ranges for PCB samples collected from the top core interval.

Table 3-9
2005 Post Dredge PCB Results Summary
(Dredge Prism Only)

Sub-area [a]	Metric	Pre-Dredge	Post-Dredge	Percent Reduction	Pre-Dredge Surface Sample PCB Range	Post-Dredge Surface Sample PCB Range
A	PCB Mass (Kg)	205.5	17.5	91%	-	-
	PCB Average Surface Concentrations (ppm)	13.3	2.9	78%	0.09-280	0.02-33
C/D2S	PCB Mass (Kg)	24.4	1.7	93%	-	-
	PCB Average Surface Concentrations (ppm)	7.2	1.2	84%	3.0-20.0	0.02-6.6
POG1	PCB Mass (Kg)	36.2	0.5	99%	-	-
	PCB Average Surface Concentrations (ppm)	13.7	2.0	85%	0.08-63.0	0.02-41

[a] The PCB concentrations and mass are for the area in the dredge prisms only, not for the entire sub-area.

Overall in the sub-areas targeted for dredging in 2005, the PCB mass reduction ranged from 91% to 99% and the Average Surface Concentration reduction ranged from 78% to 85%.

Post-dredge PCB sample results for Sub-area A, Sub-area C/D2S, and POG1 are illustrated in Figures 3-21, 3-22, and 3-23, respectively. Primary sample results are denoted with a triangle, while secondary sample results are denoted with a circle. Consistent with the Average Surface Concentrations, results show post-dredge conditions near 1.0 ppm PCBs with the majority of the 2005 dredge regions at or below 1.0 ppm PCBs. Select areas in Sub-area A and POG1 are above the 1.0 ppm target elevation, thus influencing the entire Average Surface Concentrations result.

PCB Average Surface Concentrations were calculated from the interpolated concentrations of the three-dimensional nodes, restricted to the top four inches of sediment. Thiessen polygon areas surrounding the mesh nodes were used for surface weights.

Secondary composite samples in the post-dredge analysis received a weighting equal to the number of samples comprising the composite (i.e., a heavier weighting than the primary samples). When re-modeling the post-dredge data, each secondary sample location was given the value of the composite because a composite sample effectively represents more sampled material than a single primary sample location.

To calculate PCB mass, the GMS model was used with a representative volume at each three dimensional mesh node derived from the Thiessen polygon area (horizontal) and multiplied by the mesh layer thickness (vertical). For each node volume, the PCB mass (kg) was found through multiplying the volume by the interpolated node PCB concentration and sediment dry density.

Because post-dredge results did not include data with depth (the top 10 cm were analyzed as per the RAWP), an additional assumption that PCB concentrations decreased to non-detectable levels at the point of native clay contact was also made in calculating post-dredge mass. This was based on observed post-dredge data taken at depth in DMU-4A. The nine core sample results collected from DMU-4A following the first dredge attempt are illustrated in Figure 3-23A. As can be seen, PCB concentrations drop rapidly to low levels vertically over the four-inch sample intervals. Given this data, the assumption may be conservative in that a faster than linearly decreasing rate vertically is likely to be observed.

This assumption was applied to all post-dredge sample core locations where post-dredge sediment depth exceeded four inches. (Post-dredge sediment depth was obtained from post-dredge core logs.) A post-dredge model data set was constructed as follows:

1. If no soft sediment was obtained as a core location, a value of 0.0168 ppm was defined at the river bottom elevation.

2. If a sample was obtained at a core location, but four inches or less of soft sediment existed, the sample result was defined at an elevation equal to the soft sediment vertical midpoint.

3. If a sample was obtained at a core location, and greater than four inches of soft sediment existed, the sample result was defined at an elevation of two inches below the soft sediment surface, and a value of 0.0168 was defined at an elevation of clay

surface. For example, in Subarea A at core location 4P the top four-inch interval gave a sample result of 0.39 ppm. The sample core indicated 7.5 inches of remaining soft sediment. Therefore, the post-dredge model at this location was given a value of 0.39 ppm at an elevation of two inches below the soft sediment surface, and a value of 0.0168 at an elevation of 7.5 inches below the soft sediment surface.

A three dimensional interpolation (post-dredge sediment bed model) was then constructed using only post-dredge data, i.e., PCB concentration data, percent solids data, and sediment thickness data. The interpolations were run under the same parameterization as the pre-dredge (BODR) model. Remaining sediment mass was evaluated from this model.

The dry density used in PCB mass calculations was derived uniquely at each post-dredge interpolation model node. For instance, the post-dredge percent solids data was interpolated to the three-dimensional post-dredge sediment bed model under the BODR parameterization. (Unlike the post-dredge interpolation for PCB concentrations, no assumptions were made as to percent solids interpolation trends over depth.) At each post-dredge model node, the dry density (lbs./ft.^{3}) is given by

$$Dry\ Density = \frac{62.4}{1/G_s + 100/PS - 1}$$

where PS is the model node estimate of percent solids and G_s is the assumed specific gravity of 2.5. The PCB mass calculated at each model node is then given by the dry density multiplied by the representative cubic feet and unit-less concentration for that node. Summing over desired model nodes gives resulting PCB mass.

3.5.2 Evaluation of Redredging - TSCA (DMU-4A) Results

This section provides considerable detail on the sediment removal efforts in 2005 at the Sub-area A TSCA location (DMU-4A). The additional detail is provided since this specific OU1 location was the only area where the dredge reoccupied a location for additional dredging following the receipt of post-dredge PCB data. The two separate dredge removal events at DMU-4A resulted in removing 98.5% of the PCB mass and reducing the Average Surface Concentration from 178.2 ppm to 4.8 ppm PCBs. 96% of the PCB mass was removed during the first dredging event and an additional 2.5% of the PCB mass was removed during the second event.

As previously described, two dredging events and three separate sampling events occurred in DMU-4A during 2005 dredging operations. Initial dredging of DMU-4A occurred on August 2, 3 and 4, 2005 (Dredge Event One). The QA bathymetric survey, performed on August 5, 2005, indicated that the target 1.0 ppm PCB elevations had been achieved in 99.3% of the DMU-4A area (Figure 3-24). This dredging resulted in 1,135 cy of sediment removed above the target 1 ppm elevations with an additional 325 cy removed below the target elevations. The average overcut in DMU-4A was 4.5 inches.

Table 3-10 is a summary of the Dredge Event One sediment removal data for DMU-4A. Volumes were calculated using the QA June 2005 pre-dredge survey, the August 5, 2005 post-dredge survey, and pre-dredge sediment bed model top of clay elevations.

Table 3-10
DMU-4A - Dredge Event One Volume Summary

Removal Summary:	Results
Volume Removed to 1.0 ppm Elevation (cubic yards)	1135
Volume Remaining to 1.0 ppm Elevation (cubic yards)	1
Percent Volume Removed to 1.0 ppm Elevation	99.9%
Volume Removed in Overcut (cubic yards)	325
Total Volume Removed (cubic yards)	1460
Estimated Soft Sediment Remaining Above Clay (cubic yards)	520

The first post-dredge sampling event occurred on August 8, 2005. The post-dredge sediment verification plan included one primary sample (95P) and four secondary samples 95C, 95D, 96D, and 97B (Figure 3-25). Post-dredge residual PCB sampling from the one primary location (95P) showed a PCB concentration of 33 ppm. Consistent with the Sediment Removal Verification Plan, secondary samples were frozen for subsequent compositing and later PCB analysis.

Soft sediment remaining above the native clay after Dredge Event One varied in a west to east direction across DMU-4A from approximately 1.5 feet to no soft sediment (Figure 3-26). Residual soft sediment, following dredging to target elevations, was expected as the OU1 Pre-design characterization work repeatedly shows that soft sediment, with PCB concentrations less than 1.0 ppm, exist above the native clay in many areas of LLBdM.

Although the Sub-area A TSCA location represented a small percentage of the entire sub-area A dredge prism (0.46 acres), post-dredge PCB data beyond Sediment Removal Verification Plan requirements were obtained for this location to better characterize the post-dredge surface and to gain a better understanding of dredge capabilities. As such, following the initial dredging and sampling event, a second sampling event consisting of nine additional core samples was performed in DMU-4A on September 21, 2005 (Figure 3-26).

At each sampling location an attempt was made to collect sediment down to the native clay interface. Samples collected were processed into 10 cm sections and analyzed for PCBs using the Fox River Method. The post-dredge PCB results for samples collected on September 21, 2005, are provided in Table 3-11 (sampling event two). The maximum PCB concentration occurring at any post-dredge core location are bolded in Table 3-11 and the results are illustrated on Figure 3-26. Note that data from this second sampling event were used to update the top of clay surface for sediment volume calculations.

Table 3-11
DMU-4A – Post-Dredge Characterization Sampling Summary

Sample ID	Collection Date	Actual Y (SPC)	Actual X (SPC)	Percent Solids	PCB Results (ppm)
1-RA-05-000A-4A-C1, 0"-4"	**9/21/05**	**134237.2**	**2339207.3**	**30**	**8.1**
1-RA-05-000A-4A-C1, 4"-8"	9/21/05	134237.2	2339207.3	47	0.2
1-RA-05-000A-4A-C1, 8"-12"	9/21/05	134237.2	2339207.3	59	0.053
1-RA-05-000A-4A-C1, 12"-16"	9/21/05	134237.2	2339207.3	58	0.12
1-RA-05-000A-4A-C1, 16"-18"	9/21/05	134237.2	2339207.3	58	0.25
1-RA-05-000A-4A-C2, 0"-4"	**9/21/05**	**134221.8**	**2369231.2**	**27**	**31**
1-RA-05-000A-4A-C2, 4"-8"	9/21/05	134221.8	2369231.2	55	0.72
1-RA-05-000A-4A-C2, 8"-12"	9/21/05	134221.8	2369231.2	63	0.086
1-RA-05-000A-4A-C3, 0"-4"	**9/21/05**	**134192.1**	**2369204.5**	**20**	**31**
1-RA-05-000A-4A-C3, 4"-8"	9/21/05	134192.1	2369204.5	28	19
1-RA-05-000A-4A-C3, 8"-12"	9/21/05	134192.1	2369204.5	45	0.9
1-RA-05-000A-4A-C3, 12"-16"	9/21/05	134192.1	2369204.5	60	0.36
1-RA-05-000A-4A-C4, 0"-4"	9/21/05	134199.8	2369237	21	33
1-RA-05-000A-4A-C4, 4"-8"	**9/21/05**	**134199.8**	**2369237**	**32**	**39**
1-RA-05-000A-4A-C4, 8"-12"	9/21/05	134199.8	2369237	59	2.8
1-RA-05-000A-4A-C4, 12"-16"	9/21/05	134199.8	2369237	61	0.16
1-RA-05-000A-4A-C5, 0"-4"	**9/21/05**	**134270.3**	**2369325.1**	**55**	**6.7**
1-RA-05-000A-4A-C5, 4"-8"	9/21/05	134270.3	2369325.1	63	2.3
1-RA-05-000A-4A-C5, 8"-12"	9/21/05	134270.3	2369325.1	58	0.089
1-RA-05-000A-4A-C6, 0"-4"	**9/21/05**	**134267.7**	**2369386**	**60**	**1.7**
1-RA-05-000A-4A-C6, 4"-8"	9/21/05	134267.7	2369386	62	0.2
1-RA-05-000A-4A-C7, 0"-4"	**9/21/05**	**134226.1**	**2369328.8**	**54**	**7.8**
1-RA-05-000A-4A-C7, 4"-8"	9/21/05	134226.1	2369328.8	57	4.2
1-RA-05-000A-4A-C7, 8"-12"	9/21/05	134226.1	2369328.8	52	0.23
1-RA-05-000A-4A-C8, 0"-4"	**9/21/05**	**134187.5**	**2369313.9**	**46**	**4.8**
1-RA-05-000A-4A-C8, 4"-8"	9/21/05	134187.5	2369313.9	63	0.11
1-RA-05-000A-4A-C9, 0"-4"	**9/21/05**	**134183.5**	**2369366.4**	**49**	**11**
1-RA-05-000A-4A-C9, 4"-8"	9/21/05	134183.5	2369366.4	63	0.61
1-RA-05-000A-4A-C9, 8"-12"	9/21/05	134183.5	2369366.4	60	0.073

Prepared by: TMK1
Checked by: DMR

The PCB mass in sediment removed during Dredge Event One was estimated at 35 kg, with approximately 1.5 kg of PCBs remaining in DMU-4A. As such, an estimated 96% of the PCB mass from DMU-4A was removed during Dredge Event One. Table 3-12 compares the DMU4A Dredge Event One mass removal data to pre-dredge conditions.

Table 3-12
DMU-4A - Dredge Event One PCB Mass Reduction

PCB Mass	
Pre-Dredge DMU-4A	36.5 kg
Post Dredge DMU-4A	1.5 kg
PCB Mass Removed	
Dredge Event One	35.0 kg
Percent Total PCB Mass Removed	
Dredge Event One	96 %

Prepared by: TMK1
Checked by: DMR

The DMU-4A pre-dredge Average Surface Concentration was estimated at 178 ppm PCBs and 11 ppm PCBs following Dredge Event One. Hence, dredging resulted in an Average Surface Concentration reduction of 94%. Table 3-13 summarizes sediment PCB concentration data obtained following Dredge Event One and compares data to the pre-dredge conditions. Average Surface Concentrations are calculated from the top four-inches of the sediment bed interpolation model as discussed in the previous section, and in Appendix F "GMS Modeling and SWAC Calculation Methodologies."

Table 3-13
DMU-4A – PCB Concentration Reduction Following Dredge Event One

Sample Location ID	Pre-Dredge PCB Concentration (ppm)	September 2005 Post-Dredge PCB Concentration (ppm)	Soft Sediment Remaining[b]
4AC1	130[a]	8.10	7.5″
4AC2		31.00	7.0″
4AC3		31.00	10.5″
4AC4		33.00	10.0″
4AC5	280[a]	6.70	9.0″
4AC6		1.70	3.0″
4AC7		7.80	8.0″
4AC8		4.80	3.0″
4AC9		11.00	3.0″
DMU-4A Average Surface Concentrations	**178.2**	**11.30**	

[a] Pre-design locations, approximately located at 4AC1 and 4AC5.
[b] Average soft sediment thickness remaining is 6.7 inches.

Prepared by: SGL
Checked by: TMK1

Data collected through the second sampling event showed that after Dredge Event One, the sediment thickness remaining above the native clay varied from approximately 0.3 feet in

the south and northeast portions of DMU-4A to approximately 1 foot in the southwest and central portions of DMU-4A. This is correlated with the higher PCB values, in that higher PCB concentrations were located in the thicker residual sediment.

Even though 96% of the PCB mass was removed in Dredge Event One, DMU-4A was re-dredged on November 8 and 9, 2005, with the intent to remove all sediment remaining above clay (Dredge Event Two). This decision was prompted by localized high residual PCB concentrations (39 ppm maximum).

For Dredge Event Two, the estimated volume of sediment removed was 334 cy. The sediment thickness remaining above clay after the re-dredging is illustrated in Figure 3-27. The estimated sediment volume remaining above clay is 235 cy. Table 3-14 is a summary of the Dredge Event Two sediment removal data. Volumes were calculated using the nine post-Dredge Event One samples, the November 10, 2005 Dredge Event Two post-dredge survey, and the August 5, 2005 Dredge Event One post-dredge survey.

Table 3-14
DMU-4A - Dredge Event Two Volume Summary

Removal Summary:	Results
Estimated Volume Removed (cubic yards)	334
Estimated Volume Remaining to Clay (cubic yards)	235

Prepared by: SGL
Checked by: DMR

Post-Dredge Event Two core samples were collected on November 17, 2005 (third round of sampling in DMU-4A), in approximately the same locations as the previous 9 samples. The PCB results for this third sampling event were consistently lower than those from the previous event (exception was location C5). The results of the third sampling event are summarized in Table 3-15, with the highest PCB concentration at each core location bolded. Based on the PCB results in Table 3-15, PCB concentration exceeded the 1 ppm RAL in 7 of the 9 core locations following one clean-up dredging pass. The maximum PCB concentrations occurring at each post-dredge core location are shown on Figure 3-27.

Table 3-15
DMU-4A – Final Post Dredge Sampling Summary

Sample ID	Collection Date	Actual Y (SPC)	Actual X (SPC)	Percent Solids	PCB Results (ppm)
1-RA-05-000A-4A-C1R, 0"-4"	11/17/05	134239.4	2369209.5	42.1	**6.8**
1-RA-05-000A-4A-C2R, 0"-4"	**11/17/05**	**134222.6**	**2369233.2**	**38**	**9.8**
1-RA-05-000A-4A-C2R, 4"-8"	11/17/05	134222.6	2369233.2	52.7	2.9
1-RA-05-000A-4A-C3R, 0"-4"	11/17/05	134195.8	2369206	47.2	**2.6**
1-RA-05-000A-4A-C4R, 0"-4"	**11/17/05**	**134199.9**	**2369238.7**	**38.7**	**8.7**
1-RA-05-000A-4A-C4R, 4"-8"	11/17/05	134199.9	2369238.7	56.7	1.4
1-RA-05-000A-4A-C5R, 0"-4"	11/17/05	134207.7	2369234.5	44.4	**11**

1-RA-05-000A-4A-C5R, 4"-8"	11/17/05	134207.7	2369234.5	58.9	2.2
1-RA-05-000A-4A-C6R, 0"-4"	11/17/05	134265.9	2369389.8	61.4	**0.72**
1-RA-05-000A-4A-C7R, 0"-4"	11/17/05	134229.1	2369331.7	33.1	**0.68**
1-RA-05-000A-4A-C7R, 0"-4" Dup	11/17/05	134229.1	2369331.7	32.1	0.71
1-RA-05-000A-4A-C8R, 0"-4"	11/17/05	134185.1	2369313.4	48.3	**4**
1-RA-05-000A-4A-C8R, 4"-8"	11/17/05	134185.1	2369313.4	61.4	0.31
1-RA-05-000A-4A-C9R, 0"-4"	11/17/05	134188.4	2369366	50.3	**2.3**
1-RA-05-000A-4A-C9R, 4"-8"	11/17/05	134188.4	2369366	54	0.28

Prepared by: TMK1
Checked by: DMR

An additional 1.0 kg of PCBs was removed in Dredge Event Two (compared to 35.0 kg in Dredge Event One). The PCB mass was calculated based on the QA post-dredge November 10, 2005 survey and the nine post-Dredge Event Two samples. Table 3-16 compares Dredge Event One and Two results.

Table 3-16
DMU-4A - Dredge Event One and Two Results Comparison

PCB Mass Remaining	
Pre-Dredge DMU-4A	36.5 kg
Post Dredge Event One	1.5 kg
Post Dredge Event Two	0.5 kg
PCB Mass Removed	
Dredge Event One	35.0 kg
Dredge Event Two	1.0 kg
Total DMU-4A	36.0 kg
Percent Total PCB Mass Removed	
Dredge Event One	96%
Dredge Event Two	2.7 %
Total % Removed	98.7 %

Prepared by: SGL
Checked by: DMR

After Dredge Event Two, the post-dredge Average Surface Concentration in DMU-4A was estimated at 4.8 ppm. Dredge Event Two resulted in a further concentration reduction of approximately 6.5 ppm following Dredge Event One, or an additional 4% reduction in PCB Average Surface Concentration compared to pre-dredge conditions. Table 3-17 summarizes the sediment PCB concentration data obtained during the November 2005 sampling event and compares the pre-redredge to the post-redredge PCB results.

Table 3-17
DMU-4A – PCB Concentration Reduction Following Dredge Event Two

Sample Location ID	Pre-Redredge Conditions	November 2005 Post-Redredge PCB Concentration (ppm)	Soft Sediment Remaining [b]
4AC1	130[a]	6.80	5.0″
4AC2		9.80	5.8″
4AC3		2.60	3.0″
4AC4		8.70	8.0″
4AC5	280[a]	11.00	8.5″
4AC6		0.72	1.0″
4AC7		0.68	0.0″
4AC8		4.00	3.0″
4AC9		2.30	2.5″
DMU-4A Average Surface Concentrations	**178.2**	**4.50**	

[a] Pre-design locations, approximately located at 4AC1 and 4AC5.
[b] Average soft sediment thickness remaining is 4.1 inches.

Prepared by: SGL
Checked by: TMK1

Redredging in DMU4A was undertaken to address high residuals. Other aspects of the redredging were also evaluated to assess the effectiveness of redredging in deposits similar to Sub-area A with the type of cutterhead dredge in use in OU1 during 2005. While the incremental PCB mass removal of 2.7% was relatively low, the Average Surface Concentration reduction in PCBs went from 11.3 pm to 4.8 ppm. While the concentration reduction is approximately 57%, the 1 ppm RAL was not attained, and additional action may have to be taken in the DMU 4A area to meet ROD requirements.

The decision to redredge needs to be evaluated on a case-by-case basis taking into account PCB residual levels, sediment thickness, substrate composition, proximity to ongoing dredging operations, the type of dredge to be deployed, and other planned actions such as sand covering or cap placement. All of these factors need to be assessed to determine if redredging is the most effective method for residuals management.

3.5.3 Post-Dredge Primary Sample Evaluation

To assist in the evaluation of post-dredge residual data, an analysis of the post-dredge PCB results at primary core locations was conducted for Sub-areas A and C. Note that one sample collected for Sub-area D2S was not included in the analysis. As part of the project design, pre-design core sample became the primary core sample locations for post-dredge sampling. As such, the primary locations transversed or cut through the 1.0 ppm PCB target elevations such that these locations are independent of the model derived dredge prism. Because the modeling component is removed, evaluation of post-dredge data at these locations provides a sub-set of information on the effectiveness of the dredging operation.

Figure 3-28 shows the locations of the pre-design samples and corresponding post-dredge primary core sample locations. Figure 3-29 shows similar pre-design and primary sample locations for Sub-area C/D2S.

3.5.3.1 Sub-area A

Sub-area A (Figures 3-30 and 3-31) show post-dredge primary core samples where percent solids values from the pre-design cores showed low in situ solids. At these locations, the post-dredge PCB concentrations exceeded the 1.0 ppm target elevation, even though the elevations from the samples were sufficient. Figures 3-32 and 3-33 show primary core samples with high percent solids for Sub-area A. In contrast, the PCB post-dredge data was below the 1.0 ppm target elevation.

These data indicate that at locations in Sub-area A with lower percent solids, the post-dredge percent solids was significantly less than the model-predicted percent solids (closer to the pre-dredge surface percent solids) and resulting PCB concentrations are greater than the 1.0 ppm target elevation. At higher percent solids locations in Sub-area A, post-dredge percent solids were closer to the model-predicted post-dredge percent solids and resulting PCB concentrations were less than the 1.0 ppm target elevation. Additional core figures which depict pre-design and primary post-dredge core data are located in Appendix G. Table 3-18 shows all primary core PCB results for Sub-area A, relative to percent solids content.

Table 3-18
Post-Dredge PCB Results Compared to Increasing Pre-Dredge Percent Solids for Sub-Area A Primary Samples

Post-dredge Sampling Station	Pre-Dredge Surface PCB Results (ppm)	Pre-Dredge Surface Percent Solids	Post-Dredge Surface PCB Results (ppm)	Post-Dredge Surface Percent Solids	PCB Results vs 1 ppm RAL	
114P	8.80	12.1	0.10	63.8		<
34P	4.70	17.3	0.43	68.8		<
106P	23.00	19.7	6.50	26.0	>	
107P	10.00	19.9	1.40	69.9	>	
117P	4.50	20.0	12.00	32.8	>	
41P	13.00	20.1	1.70	21.8	>	
61P	48.00	23.0	0.16	58.3		<
59P	2.00	23.0	0.69	25.4		<
42P	12.00	23.0	9.40	23.6	>	
67P	20.00	23.1	10.00	25.0	>	
112P	3.30	23.1	0.96	29.4		<
84P	0.36	23.1	0.03	70.1		<
113P	15.00	23.1	0.08	59.1		<
60P	0.29	23.1	0.06	60.4		<
70P	4.20	23.2	1.50	47.0	>	
82P	0.92	23.4	1.40	28.0	>	
94P	11.00	23.4	0.05	62.0		<
93P	30.00	23.7	4.10	23.0	>	
80P	9.90	23.7	4.80	21.5	>	
83P	1.70	24.1	3.20	60.1	>	
71P	3.40	24.6	0.53	57.6		<
111P	22.00	24.9	0.30	25.0		<
105P	23.00	25.0	15.00	19.0	>	
51P	2.00	25.0	2.60	21.4	>	
95P	130.00	25.1	33.00	33.4	>	
96P	68.00	25.1	0.82	58.4		<
52P	9.40	25.2	7.90	24.0	>	
19P	8.60	25.3	2.60	45.1	>	
62P	8.50	25.8	0.71	58.0		<
91P	7.60	25.9	2.70	46.0	>	
78P	31.00	25.9	0.46	64.8		<
79P	15.00	26.2	9.00	22.5	>	
63P	1.00	26.8	0.79	64.0		<
57P	22.00	27.2	6.60	38.3	>	
58P	25.00	28.1	1.00	51.1	>	
104P	13.00	28.3	4.80	21.0	>	
102P	22.00	28.9	5.60	23.9	>	
33P	20.00	29.0	5.50	26.5	>	
97P	9.70	29.2	13.00	58.9	>	
98P	5.60	31.6	1.10	78.6	>	
85P	5.50	32.5	5.10	49.8	>	
11P	0.96	36.0	0.37	70.2		<
73P	5.40	39.6	22.00	61.0	>	
72P	2.50	41.8	1.90	65.6	>	
21P	4.40	45.0	0.73	59.8		<
49P	35.00	47.0	14.00	22.4	>	
99P	12.00	48.7	1.30	73.4	>	
64P	2.30	53.5	0.23	73.1		<
17P	2.43	61.1	0.05	68.0		<
45P	6.70	65.6	0.22	63.0		<
44P	0.76	67.3	0.44	72.0		<
56P	10.63	68.0	0.18	65.7		<
54P	1.30	68.0	3.00	58.4	>	
22P	4.13	68.9	0.98	58.5		<
110P	1.60	80.1	4.00	79.3	>	
87P	2.30	87.5	0.43	73.3		<

Note: The transition between post-dredge PCB results being greater than the 1 ppm RAL and post-dredge PCB results being less than the 1 ppm RAL occurs at approximately 50 percent solids (pre-dredge surface).

Prepared by: TMK1
Checked by: TRV

3.5.3.2 Sub-area C

For Sub-area C, post-dredge primary core samples (Figure 3-34) show a similar situation to Sub-area A, in that a pre-design location from an area of lower percent solids generally had PCB residual concentrations greater than the 1.0 ppm target RAL. However, more efficient removal of lighter material appeared to have occurred in Sub-area C compared to Sub-area A, and Sub-area C obtained the 1.0 ppm PCB target RAL objective. Appendix G contains additional core figures for Sub-area C. Table 3-19 shows all primary samples for Sub-area C, relative to percent solids content.

Table 3-19
Post-Dredge PCB Results Compared to Increasing Pre-Dredge Percent Solids for Sub-Area C Primary Samples

Post-dredge Sampling Station	Pre-Dredge Surface PCB Results (ppm)	Pre-Dredge Surface Percent Solids	Post-Dredge PCB Results (ppm)	Post-Dredge Percent Solids	PCB Results vs 1 ppm RAL	
3P	4.2	22.0	2.70	22.7	>	
12P	8.8	23.1	2.50	27.7	>	
17P	6.4	24.9	0.20	33.7		<
5P	13.0	27.0	0.44	55.9		<
10P	4.7	27.0	1.00	22.8	>	
22P	20.0	27.0	0.66	49.2		<
1P	3.0	27.1	0.73	43.6		<
27P	9.1	28.8	0.09	55.7		<
8P	5.1	29.2	0.61	43.1		<
26P	8.5	31.9	2.90	25.8	>	
18P	5.8	33.2	0.69	26.7		<
20P	12.0	41.8	2.50	29.2	>	
15P	7.1	43.8	0.87	25.7		<

Note: No correlation seen in the data between pre-dredge surface percent solids and post-dredge PCB results.

Prepared by: TMK1
Checked by: TRV

3.5.4 Post-Dredge Variance Components Analysis

A preliminary evaluation of the post-dredge residual data is provided in this section using a variance component statistical technique. The results of this analysis will be important in understanding post-dredge residual data which exceeded the 1.0 ppm PCB RAL target concentrations. Preliminary conclusions indicate that dredge prism model factors and as well as dredging operations and/or the presence of low in-situ solids contributed to not achieving the target concentrations at specific removal locations.

Post-dredge PCB residual data collected from Sub-areas A and C are further evaluated by performing a variance components analysis. Note that the one sample collected for Sub-area D2S was not included in the analysis. The objective of this analysis is to compare observed post-dredge data with the model predicted PCB concentrations, and identify the components that most influenced the variance from the 1.0 ppm PCB target or model

predictions. In addition, the relationship between percent solids and the given components of variation are investigated, to further describe the post-dredge data.

The variance components analysis compares the observed post-dredge PCB result to a model predicted result. The model predicted PCB result used in the analysis was the projected PCB concentration at depth. Because the majority of dredging locations resulted in a dredge overcut, the projected modeled concentration would, by design, be less than 1.0 ppm PCB. The objective is to identify variation sources, and the levels to which they contribute to residual PCB concentrations differing from the target 1.0 ppm PCB target concentration.

Three variation sources were considered in the data: analytical testing (or laboratory) variation, variation due to sediment dredging operation, and variation due to model uncertainty. These three sources can be analyzed by categorizing the data into the following groups:

- Laboratory duplicate results
- "Near" data, or post-dredge data collected near pre-dredge data (e.g., primary samples)
- "Far" data, or post-dredge data collected further distant from pre-dredge data (e.g., secondary samples)

Laboratory duplicate analysis can be used to determine the level of variation entering the data from analytical testing. Although this source is generally small, it is included for comparison purposes.

As previously discussed, the sample collection design as depicted in Figures 3-18, 3-19, and 3-20 consists of primary and secondary sample locations. Primary sample locations were located very near pre-dredge sample locations. Post-dredge data collected near pre-dredge data can be used to determine the level of variation entering due to sediment dredge operations. Because there is little modeling error at locations very near observed pre-design data locations, differences between post-dredge and modeled concentrations in this category would indicate variation as a combined result of laboratory testing and sediment dredging operations.

Conversely, post-dredge data collected at a further distance from pre-dredge samples can be used to determine differences due to model uncertainty. In this case, secondary samples served as the data sets. Uncertainty in any interpolated model concentration is highly dependant on the distance from an observed data point. As such, more error in the model predicted concentrations will often occur at distances further away from known points. Given the observed variance due to laboratory analysis and dredging operations, additional variance measured at distant locations from pre-dredge samples would be attributed to model uncertainty.

A summary of the variance components results is presented in Figure 3-35. In all cases, variation in the data due to laboratory analysis is minimal. In Sub-area A, distinct results were observed between regions of lighter material (percent solids < 40%), as compared to regions of denser material (percent solids > 40%). In the dredging regions of lighter material, variation between the modeled concentrations and post-dredge residuals appears

equally related to model uncertainty and the dredging operation. In regions of denser material in Sub-area A, both sources of variation dropped, however, variation from the dredging process dropped significantly more than variation from model prediction.

In Sub-area C, no significant additional variation was added to the residuals as a result of either the dredging process or model uncertainty. Observed post-dredge residual results closely matched model predicted results at locations both near to and far from pre-dredge sample locations.

Histograms of pre-dredge percent solids at the sediment surface are illustrated in Figure 3-36. The data consist of pre-dredge surface percent solids at post-dredge sample locations. The average of the Sub-area A data is approximately 40% with a noticeable higher number of pre-dredge data less than 30%. The Sub-area C pre-design data consists of material all less than 45%.

Dividing the data into lighter and heavier material in the analysis appears to be important. The primary core data evaluation presented in Section 3.5.3 indicates that post-dredge percent solids at times were lighter than predicted in areas where surface pre-dredge percent solids also were light. This was particularly the case for Sub-area A, perhaps implying sediment re-suspension and deposition during dredging.

The variance component of the laboratory source is calculated as the average mean squared differences between the original and duplicate samples. This is calculated as

$$Var_{Dup} = \frac{\sum_{i=1}^{n} \frac{\left(Original\ Sample_i - Duplicate_i\right)^2}{2}}{n}$$ where n = number of duplicate samples

The variance components of the sediment dispersion and model uncertainty sources were developed by calculating the sample variance of observed and modeled PCB differences. For instance, define the difference between a post-dredge sample result and it's correspondingly modeled (three dimensional pre-dredge) result as e_i. The variance from these two sources is found by calculating the following:

$$Var_{near} = \frac{\sum_{i=1}^{n} \left(e_i - \bar{e}\right)^2}{n-1}$$ where n is the number of observed PCB samples (primary).

$$Var_{far} = \frac{\sum_{i=1}^{n} m_i \left(e_i - \bar{e}\right)^2}{n-1}$$ where m_i is the number of samples in a comprising a secondary composite sample, and n is the number of secondary composite samples.

The variance components for the above sources are cumulative in that the variance of the "near" data group is comprised of the laboratory component and the dredging operation

component, and the variance for the "far" data group is comprised of all three components. Using the variance to estimate the components gives:

- Laboratory component = Var_{Dup}
- Sediment dispersion component = Var_{Near} - Var_{Dup}
- Model uncertainty component = Var_{Far} – Var_{Near}

The variance estimates for Sub-areas A and C are illustrated in Figure 3-37. The calculation of the variance components are also illustrated. For Sub-area A the higher variance estimates for the near and far groups is apparent as compared to Sub-area C. The lower variance estimates in Sub-area C result in the low dredging operation and model uncertainty variance components.

In the analysis, the data were further classified by percent solids. Two groups were used, areas with surface pre-dredge solids of less than 40 percent, and areas greater than 40 percent. The variance estimates for Sub-area A are illustrated in Figure 3-38 and the analysis detail provided in Appendix H. The variance estimates for Sub-area C are illustrated in Figure 3-39, with detail also provided in Appendix H.

As shown on Figure 3-38, the variance in Sub-area A with lighter material of the near group variance estimate is approximately one-half that of the far group variance estimate, resulting in variance components for the two sources of about equal magnitude. In Figure 3-39, a low variance for Sub-area C is evident in all cases. Hence as stated, neither dredging operation nor model uncertainty added significantly to the observed variances between the model and post-dredge data.

SECTION 4

Geotextile Tube Dewatering

4.1 Description & Process Flow

The sediment dewatering system consisted of a manifold system, the geotextile tubes, dewatering pad, and carriage water sump. The process flow diagram for the sediment dewatering system is shown on Figure 4-1. A conditioning chemical (polymer) was added to the sediment slurry prior to discharge into the geotextile tubes based on the dredge slurry flow rate, the slurry solids content, and resulting visual floc characteristics. Carriage water from the geotextile tubes weeped through the filter fabric, percolated through the dewatering pad gravel, and flowed to the carriage water sump before being pumped to the water treatment system.

The geotextile tubes were laid out on both sides of the north-south center haul road on an east-west axis. Geotextile tubes were placed up to three-high in a long row of geotextile tubes lying side by side. The first layer geotextile tubes were 80 feet in circumference and either 200 feet in length (on the west side) or 188 feet in length (on the east side). The second layer geotextile tubes were 80 feet in circumference and varied in length between 150 feet to 188 feet in length. All third layer geotextile tubes were 80 feet in circumference and 116 feet in length. Fifty-four of the sixty-nine geotextile tubes were manufactured by Miratech. The remaining geotextile tubes were Spiral geotextile tubes manufactured by Bradley. The Bradley Spiral geotextile tubes used were either 80 feet or 100 feet in circumference and either 150 or 200 feet in length, depending on which layer the geotextile tube was installed. The 100 foot circumference geotextile tubes were primarily used for dewatering sediments from Sub-area POG1.

4.2 Chemical Addition

During the 2005 RA, a cationic polymer was fed to the dredge slurry to aid the geotextile tube dewatering process. The dewatering system was also designed to deliver both a cationic polymer and ferric sulfate to the slurry; however, ferric sulfate was not used during the 2005 RA. The initial polymer dosage was determined by hanging bag tests just prior to startup of the system. The actual polymer dosage was adjusted based on the dewatered sediment slurry's characteristics and the resulting characteristics of the floc that was formed and the weep water's TSS concentration throughout the duration of the 2005 work.

Target dosages were tracked as the amount of polymer per unit weight of dry sediment solids. The polymer was fed with adjustable rate progressive cavity pumps. Flow rate and density of the slurry paced the chemical feed rate. A flow meter and online density meter fed signals to a programmable logic controller, which in turn adjusted the feed rates. A total of approximately 100,000 pounds of polymer were used for the geotextile tube dewatering system.

The range of target dosages and the corresponding project averages were as follows:

- 1.5-4.0 lbs of neat polymer/ton dry solids (overall project average 2.5 lbs neat polymer/ton dry solids)

4.3 Dewatering Pad Management

The dewatering pad was expanded as part of the 2005 RA. A north-south haul road was constructed down the center of the pad with ramps on each end to enter and exit the pad. The dewatering pad expansion included construction of a PVC-lined truck decontamination area where the haul road exits the pad. The report entitled "Construction Certification for Dewatering Pad Liner Expansion" is included in Appendix I.

Dewatering activities in the pad began on July 7, 2005, in conjunction with Sub-area A dredging operations. Sub-area A sediment was placed into geotextile tubes on either side of the north-south center haul road on an east-west axis. Initially, Sub-area A sediment was placed into a single layer of geotextile tubes on the western half of the pad then placed into geotextile tubes up to three layers high on the eastern half of the pad as dredging operations progressed in Sub-area A. Dredging of TSCA material began in Sub-area A on August 2, 2005 and was completed on August 4, 2005. This material was placed into separate geotextile tubes located in the northwest section of the pad set physically apart from geotextile tubes containing non-TSCA material. On October 17, 2005, Sub-area A TSCA material began to be loaded and hauled to the TSCA-approved landfill. On November 1, 5005, Sub-area A TSCA load-out activities were completed which provided additional pad space in the northwest portion of the pad.

In late September 2005, blinding of a portion of the pad was observed where a majority of the geotextile tube filtrate flow was received (i.e., the area between the haul road and eastern rows of geotextile tubes). The blinding of the pad caused filtrate water to flow over the surface of the haul road. On October 3, 2005, the haul road was elevated utilizing gravel material from the sides of the haul road.

On September 29, 2005, sediment began to be loaded and hauled to the landfill for disposal and is scheduled for completion in late March 2006. Sediment load-out activities began with geotextile tube 1 in the southwestern quadrant of the pad so that additional geotextile tubes could be installed on the western half of the pad in order to complete the 2005 dredging. A backhoe with a clam shell bucket was used to load the majority of sediment into the trucks. At times, such as when the clam shell was out-of-service, a separate backhoe loaded the trucks.

As load-out operations progressed on the western half of the pad, additional geotextile tubes manufactured by Bradley were installed in the southwest section of the pad beginning on October 15, 2005, to accommodate Sub-area POG1 sediment. These geotextile tubes were stacked up to two layers high. On November 4, 2005, dredging of TSCA material began in Sub-area POG1 and was completed on November 18, 2005. This material was placed into separate geotextile tubes located approximately 20 feet east of the pad sump. On November 15, 2005, dredging operations began in Sub-area C/D2S. This material was

placed into Miratech and Bradley tubes located in the northwest section of the pad. These tubes were stacked up two layers high.

During the 2005 RA, five of the sixty-nine geotextile tubes utilized for sediment dewatering experienced some type of failure releasing sediment into the dewatering pad, which increased the magnitude of pad blinding previously observed in September 2005. Each tube failure is described in detail in Section 4.4 below.

4.4 Geotextile Tube Operations

Figure 4-2 shows the final geotextile tube layout. Geotextile tube operation began on July 7, 2005, in conjunction with hydraulic dredging of sediment in Sub-area A and continued until November 15, 2005. Sub-area A sediment was placed in geotextile tubes 1 to 24, B1 to B12, and C1 to C8. The geotextile tubes were lined up on either side of the north-south center haul road on an east-west axis. The geotextile tubes given a "B" and "C" designation were the second and third layers in a stacked configuration, respectively. Dredging of Sub-area POG1 material began on October 12, 2005, and continued until December 1, 2005. The Sub-area POG1 sediment was placed in geotextile tubes Brad-1 to Brad-5, B-B1, B-B2, and B-M3 in the southwest quadrant of the dewatering pad. Dredging of Sub-area C/D2S sediment began on November 15, 2005, and continued until December 2, 2005. The Sub-area C/D2S sediment was placed in geotextile tubes Brad-6, Brad-9, Brad-10, M7, M8, B-M4, B-M5, BM-6, and BM-7 in the northwest quadrant of the dewatering pad. The area south of the natural gas pipeline in Sub-area C/D2S was completed as part of the 2005 RA.

Dredging of TSCA material in Sub-area A began on August 2, 2005, and was completed on August 4, 2005. This material was placed into two separate Miratech geotextile tubes located in the northwest corner of the dewatering pad. Dredging of TSCA material in Sub-area POG1 began on November 9, 2005, and was completed on November 18, 2005. This material was placed into two designated Bradley geotextile tubes located in the western half of the pad immediately east of the dewatering pad sump.

During the feeding of the Miratech and Bradley geotextile tubes, the height of the geotextile tube was monitored utilizing laser survey equipment and allowed to rise to 8 and 10 feet, respectively. At this point, the geotextile tube was taken offline and allowed to drain and consolidate before it was refilled again with the dredge slurry. The second and subsequent fillings were considered topping off the geotextile tubes. These frequent fill cycles were required to maximize the effective volume of each geotextile tube. The topping off operation involved filling full or nearly filled geotextile tubes with a relatively small portion of the dredge slurry while the bulk of the dredge slurry was directed to geotextile tubes that were being initially filled. This operation was accomplished through the valving of the dredge slurry manifold header system.

On September 20, 2005, a breach occurred in the eastern half of geotextile tube 12 in the northeast corner of the dewatering pad releasing approximately 50 cy of thickened sediment slurry material (estimated to be on the order of 20% solids) near the failure location. Investigations of the breach by the geotextile tube manufacturer (Miratech) concluded that the cause of the breach was not operational but from the installation of holes in the geotextile tube

for wick drain installation and sediment sampling activities. On October 24, 2005, a breach occurred on the western end of geotextile tube Brad-1 in the southwest corner of the pad. Dilute sediment slurry material was released inside (estimated 150,000 gallons) and outside (estimated 100 gallons) the dewatering pad as a result of this failure. The material that spilled outside the containment of the berm was cleaned up within 24 hours, and a spill report was filed with the Wisconsin DNR. Investigations of the breach by the manufacturer (Bradley) concluded that the cause of the breach was likely due to a "mound" of consolidated material in front of the flow path of the geotextile tube. However, even though the tube was designed to be pumped much higher then its 15 feet height at the time of the breach, it was decided after this tube failure to restrict the maximum filling height of the Bradley tubes to 10 feet.

On November 15, 2005, a small tear occurred in the center and west end of geotextile tube B11. No sediment was released from the tear. Subsequently, the geotextile tube was punctured with the off-road forklift during catwalk removal/installation activities and approximately 2 cy of sediment was released onto the pad.

On November 22, 2005, a breach occurred on the under side of geotextile tube Brad-11. An estimated 150,000 gallons of dilute sediment slurry was released onto the northeast quadrant of the pad as a result of this failure. Investigations of the breach by the geotextile tube manufacturer (Bradley) concluded that the geotextile fabric had been snagged or torn, either during production, packaging, transport, or during initial geotextile tube installation/rollout activities, which caused the geotextile tube to fail once sediment slurry began filling the geotextile tube.

On December 1, 2005, a breach occurred on the underside of geotextile tube BM-6. An estimated 150,000 gallons of dilute sediment slurry was released onto the open area around the northwest quadrant of the pad as a result of this failure. Initial investigations of the breach by the geotextile tube manufacturer (Miratech) suggest that the breach was caused by a deeper than normal "notch" or "valley" created by the geotextile tubes on which the geotextile tube was stacked. However, this breach will be further investigated when this geotextile tube is loaded out. (See Appendix J for details relating to the breaches of the geotextile tubes).

Prior to the 2006 RA operations, the portions of the dewatering pad affected by the geotextile tube failures will be investigated and cleaned.

4.5 Dewatered Sediment Sampling Procedures and Results

Dewatered sediment was sampled from the geotextile tubes to determine free liquids, percent solids (moisture content), PCB concentration, and landfill required geotechnical data.

4.5.1 Sampling Overview

Dewatered sediment was sampled from geotextile tubes in order to obtain specific information required prior to landfill disposal and to evaluate the performance of the geotextile tubes. These parameters include: percent solids (moisture content) (ASTM D2216); PCB concentration (Fox River Method); free liquids content (Paint Filter Test in

accordance with EPA Method 9095B Revision 2); and geotechnical strength characteristics (field vane shear [ASTM D 2573-01]; unconfined compressive strength (cohesive soils only) [ASTM D2166]; consolidated-undrained triaxial compressive strength [ASTM D4767]; consolidated-drained direct shear strength [ASTM D3080]; Atterberg limits [ASTM D4318]; and, grain size distribution (gradation) [ASTM D422 and D6913]).

Undrained shear strength testing was originally required by the Onyx Hickory Meadows Landfill Plan of Operation Modification and the WDNR; however, since the dredged sediment was predominantly non-cohesive, consolidated-drained direct shear strength and consolidated-undrained triaxial compressive strength were tested alternatively.

Depending on the volume of sediment in a geotextile tube, 3 to 10 grab samples were obtained from randomly selected uniformly-spaced locations within a geotextile tube by hand-augering through the top of the tubes. (The correlation between the number of grab samples and the volume of sediment in a geotextile tube is discussed in the following section.) For individual grab samples, each sample was homogenized; then equal volumes were composited and homogenized to form a single composite sample per geotextile tube.

Sampling of the geotextile tubes occurred in one of two ways depending on dewatering and/or load-out conditions - either PCBs and final percent solids were sampled for and analyzed in the same sampling event or during two separate events.

In cases where two separate sampling events occurred at a geotextile tube, the first event consisted of collecting samples for PCB concentration along with initial percent solids as soon as possible after each geotextile tube was retired. During second sampling events, samples for final percent solids, free liquids, and geotechnical strength characteristics were collected approximately one week prior to load-out to allow time for lab analysis. When only one sampling event was performed, PCB concentration, final percent solids, free liquids, and geotechnical strength characteristics were analyzed from samples collected approximately one week prior to load-out.

4.5.2 Sampling Frequency

Analyses for percent solids, PCB concentration, gradation, and free liquids content were completed for each geotextile tube. Vane shear testing was also performed for each geotextile tube.

As discussed in the previous section, in cases where two separate sampling events occurred at a geotextile tube, the first event consisted of collecting samples for PCB concentration along with initial percent solids as soon as possible after each geotextile tube was retired. [A single composite of 5 grab samples or less of dewatered sediment from each geotextile tube was tested for PCB concentration and percent solids. The remainder of each grab sample (not used in the composite sample) was used by the Supervising Contractor for QC percent solid analyses.]

During second sampling events, samples for final percent solids, free liquids, and geotechnical strength characteristics were collected approximately one week prior to load-out to allow time for lab analysis. Ten individual grab samples or less of dewatered sediment (depending on geotextile tube volume) were tested for percent solids and free liquids from each geotextile tube. A single composite of the 10 or less individual grab

samples was analyzed for geotechnical strength characteristics (unconfined compressive strength [for cohesive soils only], consolidated-drained direct shear strength, consolidated-undrained triaxial compressive strength, and Atterberg limits). The frequency of these analyses was initially one composite for each geotextile tube, which was modified in December 2005, to one composite for every 5,000 cy. The laboratory testing was performed as a check against the field vane shear tests. Initially, 10 samples per geotextile tube were collected for gradation; then the geotechnical laboratory (STS) composited sample numbers 1&2, 3&4, 5&6, 7&8, and 9&10 in the lab so that 5 samples per geotextile tube were actually analyzed. This sampling frequency was modified in December 2005, to one composite sample tested per geotextile tube (composited in the field).

When only one sampling event was performed, the process was the same as above but the composite formed from the 10 or less grab samples was also analyzed for PCBs. Vane shear testing was also performed in the same manner as above.

Variable sizes of geotextile tubes were utilized for dewatering on the dewatering pad; therefore, the volume of sediment contained within the geotextile tubes varied. The number of grab samples collected per geotextile tube depended on the volume of sediment in the tube. In 2005, on the east side of the pad, geotextile tubes typically contained three different volumes of sediment at the time of sampling ~1,400 cy in first level tubes, ~1,300 cy in second level tubes, and ~900 cy in third level tubes. When sampling only PCBs, regardless of the size of the tube, 5 grab samples were collected. However, size of the tube did affect the number of grab samples collected for final percent solids analysis: typically 10 grab samples from first level tubes; 8 from second level tubes; and 5 from third level tubes. On the west side of the pad, geotextile tube volumes varied from 300 cy to over 3,000 cy throughout the 2005 RA activities. Typically, for final percent solids analysis, 10 samples were collected from geotextile tubes containing 1,200 cy or more, and the number of samples collected for tubes with less volume was scaled down proportionately.

4.5.3 Geotextile Tube Sampling Procedure (Non-TSCA Sediment)

At the start of the sampling process, the geotextile tubes to be sampled were measured for total length. Sample locations were randomly placed over the width of each geotextile tube and equally spaced over the length. The sample locations were marked on the top of each geotextile tube to be sampled, and the locations were recorded on a field form. A small hole and a small slit were cut in the top of the geotextile tube at each sample location, one approximately 6 inches from the other. In the small slit, an in-situ vane shear test was performed, typically at the approximate midpoint of the geotextile tube thickness, and then the sediment probing rod was inserted to determine the total thickness of the geotextile tube at that location. The vane shear result and depth, and geotextile tube thickness were recorded on the field form. In the small hole, a stainless steel hand auger was used to obtain a sample of a minimum of 75 percent of the total sediment thickness in each geotextile tube at each location (in most cases, 100 percent of the geotextile tube thickness was sampled). Two different types of hand-augers were used to collect dewatered sediment samples: a hollow stem clay auger for drier sediment and a bucket-type auger for saturated sediment that could not be retained in the former. Because super-saturated material was often difficult to retain, even in the bucket-type auger, one auger-full of sediment was taken to represent every foot of depth in the geotextile tube.

Grab samples from each borehole were placed into a separate durable plastic bag and homogenized within the bag. During sample processing activities, each homogenized grab sample was tested for free liquids using the Paint Filter test, and the results were recorded on the field form. A visual description of each grab sample was also documented on the field form. For final percent solids analysis, a portion of each of the homogenized grab samples was placed into individual 4-oz clear glass jars. Portions of the homogenized samples were also prepared for QC percent solids analysis and for laboratory grain size distribution analysis. An equal volume of sediment from each homogenized sample bag was placed into a stainless steel bowl for homogenization to produce one composite sample for PCB and percent solids analyses (placed in an 8-oz amber glass jar) and one for geotechnical strength characteristics per geotextile tube (or per 5,000 cy). The composite sample for geotechnical strength analyses was placed in a durable plastic bag within a 5-gallon bucket for delivery to the geotechnical lab. A composite sample was also tested for free liquids in the field.

The samples for PCB analysis were placed into a cooler with ice for delivery to Pace Analytical. Field duplicates were collected for every 10 samples collected.

4.5.4 Geotextile Tube Sampling Procedure (TSCA Sediments)

Geotextile tubes containing TSCA sediments were sampled using the same procedures as non-TSCA sediments; however, the sediment samples collected were tested for additional analytical parameters which included the following TCLP parameters: herbicides, pesticides, inorganics (metals), volatiles, and semi-volatiles. Table 4-6 summarizes the analytical results for these parameters.

4.5.5 Dewatered Sediment Sampling Results

4.5.5.1 Free Liquids, Percent Solids and PCB Concentrations

The dewatered sediment sampling results for PCB concentrations and percent solids obtained from Sub-areas A, C/D2S, and POG1 are provided below in Table 4-1. Table 4-2 summarizes the data.

Table 4-1
Dewatered Sediment Free Liquids, Percent Solids, and PCB Results

Geotextile Tube Number	Circumference (ft) x Length (ft)	Contained Sub-Area(s)	Date Taken Out of Service	Percent Solids Sample Date	Paint Filter Test (Free Liquids) (1)	Percent Solids (2)	PCB Concentration (ppm) (3)
1	80 x 200	A	8/11/05	9/23/05	Pass	50.0	5.4
2	80 x 200	A	8/11/05	9/23/05	Pass	50.8	6.2
2.5	80 x 200	A	8/11/05	10/6/05	Pass	46.6	6.0
3	80 x 200	A	8/11/05	10/6/05	Pass	56.4	4.9
4	80 x 200	A	8/11/05	10/10/05	Pass	51.6	4.4
5	80 x 200	A	8/26/05	10/10/05	Pass	51.5	4.2

6	60 x 49	A	8/18/05	10/18/05	Pass	39.1	5.7
7	60 x 118	A	8/26/05	10/18/05	Pass	41.5	1.5
8	60 x 131	A	8/23/05	10/18/05	Pass	43.0	4.5
9	60 x 131	A	8/23/05	10/18/05	Pass	48.7	4.8
10	80 x 200	A	8/30/05	10/25/05	Pass	50.0	2.9
11	80 x 200	A	9/2/05	10/25/05	Pass	60.6	6.2
11.5	60 x 131	A	9/20/05	11/4/05	Pass	42.1	4.5
12	80 x 188	A	9/8/05	11/4/05	Pass	49.2	3.9
13	80 x 188	A	9/8/05	11/18/05	Pass	48.0	5.1
14	80 x 188	A	9/14/05	12/14/05	Pass	50.5	4.2
15	80 x 188	A	9/14/05	1/4/06	Pass	49.6	8.4
16	80 x 188	A	9/14/05	1/16/06	Pass	51.6	13.0
17	80 x 188	A	9/14/05	1/23/06	Pass	52.3	8.9
18	80 x 188	A	9/15/05	1/30/06	Pass	45.3	12.0
19	80 x 188	A	9/15/05	2/8/06	Pass	49.1	13.0
20	80 x 188	A	9/23/05	2/22/06	Pass	50.4	15.0
21	80 x 188	A	9/23/05	2/28/06	Pass	44.0	12.0
22	80 x 200	A	11/2/05	3/8/06	Pass	53.4	7.3
23	80 x 200	A	11/3/05	1/24/06	Pass	52.2	2.5
24	60 x 116	A	11/10/05	1/17/06	Pass	45.1	1.8
TSCA 1	80 x 200	A	8/4/05	10/4/05	Pass	54.0	19.0
TSCA 2	80 x 200	A	8/4/05	10/4/05	Pass	48.0	15.0
B1	80 x 173	A	9/20/05	11/4/05	Pass	36.6	30.0
B2	80 x 173	A	10/26/05	11/8/05	Pass	46.0	6.1
B3	80 x 173	A	10/15/05	12/14/05	Pass	64.4	5.6
B4	80 x 173	A	10/15/05	12/22/05	Pass	53.7	2.6
B5	80 x 173	A	10/12/05	1/4/06	Pass	50.0	3.0
B6	80 x 173	A	10/19/05	1/16/06	Pass	58.6	2.0
B7	80 x 173	A	10/20/05	1/23/06	Pass	59.6	1.4
B8	80 x 173	A	10/28/05	1/30/06	Pass	55.6	1.4
B9	80 x 173	A	11/6/05	1/31/06	Pass	43.2	2.4
B10	80 x 173	A	11/10/05	1/31/06	Pass	41.4	2.7

B11	80 x 173	A	11/10/05	1/24/06	Pass	41.8	4.4
B12	80 x 116	A	11/20/05	1/17/06	Pass	35.1	1.3
C1	80 x 116	A, C/D2S	11/21/05	12/14/05	Pass	48.9	1.1
C2	80 x 116	A, C/D2S	11/21/05	12/22/05	Pass	33.6	2.0
C3	80 x 116	A, C/D2S	11/20/05	1/4/06	Pass	29.8	1.8
C4	80 x 116	A, C/D2S	11/28/05	1/16/06	Pass	29.0	2.1
C5	80 x 116	A, C/D2S	11/20/05	1/23/06	Pass	30.6	2.8
C6	80 x 116	A, C/D2S	11/20/05	1/23/06	Pass	33.3	2.3
C7	80 x 116	A, C/D2S	11/20/05	1/24/06	Pass	35.8	2.1
C8	80 x 116	A, C/D2S	11/15/05	1/24/06	Pass	34.6	1.6
Brad-1	100 x 200	POG1	10/24/05	11/28/05	Pass	38.4	0.59
Brad-2	100 x 200	POG1	11/12/05	12/6/05	Pass	36.6	0.73
Brad-3	100 x 200	POG1	11/12/05	12/6/05	Pass	32.8	13.1
Brad-4	100 x 200	POG1	11/18/05	12/29/05	Pass	26.2	32.0
Brad-5	100 x 200	POG1	12/1/05	12/30/05	Pass	39.5	1.1
Brad-6	100 x 200	C/D2S	12/1/05	2/3/06	Pass	27.5	3.0
M7	80 x 203	C/D2S	11/29/05	2/3/06	Pass	29.5	2.3
M8	80 x 203	C/D2S	11/29/05	2/2/06	Pass	32.4	2.4
Brad-9	80 x 150	C/D2S	12/1/05	2/2/06	Pass	32.6	2.8
Brad-10	100 x 200	C/D2S	11/29/05	2/8/06	Pass	27.7	2.3
Brad-11	80 x 200	C/D2S	11/22/05	1/19/06	Pass	31.2	3.9
B-M4	80 x 174	C/D2S	12/2/05	2/3/06	Pass	26.4	1.7
B-M5	80 x 188	C/D2S	12/1/05	2/3/06	Pass	23.8	1.2
B-M6	80 x 116	C/D2S	12/1/05	2/2/06	Pass	30.5	1.6
B-M7	80 x 116	C/D2S	12/2/05	2/8/06	Pass	28.6	2.1
B-B1	100 x 150	POG1	12/1/05	12/7/05	Pass	26.2	3.0
B-B2	100 x 150	POG1	11/30/05	12/29/05	Pass	34.6	12.0
B-M3	80 x 174	POG1	12/1/05	12/29/05	Pass	29.8	1.2
TSCA-1B	80 x 150	POG1	11/18/05	12/7/05	Pass	25.2	7.2
TSCA-2B	80 x 150	POG1	11/18/05	12/7/05	Pass	25.9	9.4
Haul Road Geotextile tube	60 x 116	POG1	12/1/05	*	**NA**	*	*

Notes: * Under sampling action limit. NA – Not Available

(1) The pass/fail result is based on free liquids from the composite samples.

(2) Percent solids results presented are the results for the composite samples (not the average of discrete samples).

(3) In some cases, material from a geotextile tube was analyzed for PCBs on two occasions. The PCB concentration reported is the average of the composite samples from the two sampling events. Refer to Appendix K for detailed PCB and percent solids results from the geotextile tubes.

Prepared by: CH2M Hill or STS
Checked by: TMK1

Table 4-2
Dewatered Sediment Data Summary

Sub-area	Paint Filter Test (Free Liquids)	Percent Solids Average	Percent Solids Range	PCB Average (ppm)	PCB Range (ppm)
A	Pass	46.6	29.0 – 64.4	5.9	1.1 – 30.0
C/D2S	Pass	29.0	23.8 – 32.6	2.3	1.2 – 3.9
POG1	Pass	31.5	25.2 – 39.5	8.0	0.6 – 32.0

Notes: The values presented are the ranges and averages of the composites for percent solids and PCB concentrations. The pass/fail result is based on free liquids from the composite samples.

Prepared by: TMK1
Checked by: DMR

4.5.5.2 Geotechnical Test Results (Non-TSCA Sediments)

In accordance with the WDNR *Conditional Plan of Operations Approval Modification - Special Waste Acceptance Plan for Dredged Material Disposal at the Onyx Hickory Meadows Landfill*, dated September 29, 2005, dewatered sediment from OU1 must be tested for: 1) percent solids/moisture content (ASTM D2216 or 2974); and 2) Unconfined Compressive Strength (UCS) (cohesive soils only) (ASTM D2166 or pocket penetrometer) or Undrained Shear Strength (ASTM D2573 or D4648). Appendix H of the 2005 Remedial Action Work Plan *"2005 RA Dewatering Plan"*, required dewatered sediment to be tested for gradation (ASTM D422 and D1140) and if determined to be fine grained (> 50% passing P-200 sieve), Atterberg Limits (ASTM D4318) testing. Furthermore, Onyx Hickory Meadows Landfill required dewatered sediment landfilled as "normal strength" material to be > 50% solids and have an UCS > 0.40 tsf.

During geotextile tube filling operations, larger sand and gravel particles tended to deposit or drop-out beneath the fill ports, while finer sand, silt and clay particles tended to migrate and accumulate between the ports. Somewhat better particle distribution occurred during filling operations when three-fill port geotextile tubes were replaced by five fill port geotextile tubes.

Gradation analysis was performed for dewatered sediments from Sub-areas A, POG1 (not wood chips) and C/D2S. Referring to Table 4-3 below, it is noted that materials from the three areas are predominately non-cohesive. Sub-area POG1 sediment is slightly less cohesive with approximately 88 percent sands, silts and gravel, while Sub-area A had approximately 83 percent and Sub-area C/D2S approximately 80 percent non-cohesive

material. Sediment samples contained clay, silt, sand, and gravel size particles, with clay content ranging between 2.7 and 41.4 percent, silt content from 13.0 to 56.5 percent, sand content from 19.7 to 73.9 percent, and gravel content ranging from zero to 23.0 percent.

Table 4-3
Dewatered Sediment Gradation

		P200 (%) D422	Clay (%) D422	Silt (%) D422	Sand (%) D6913	Gravel (%) D6913
Sub-Area A	Average Value	49.5	17.0	32.5	45.9	4.2
	Maximum Value	74.2	37.4	49.1	73.9	23.0
	Minimum Value	20.1	2.7	13.0	25.8	0.0
Sub-Area POG1	Average Value	47.5	11.7	35.8	47.7	4.9
	Maximum Value	69.1	28.5	43.2	55.4	13.2
	Minimum Value	39.9	4.3	28.6	30.9	0.0
Sub-Area C/D2S	Average Value	69.6	19.7	49.9	29.9	0.5
	Maximum Value	80.3	41.4	56.5	36.9	3.2
	Minimum Value	61.2	12.2	38.9	19.7	0.0

Note: Refer to Appendix K for a complete listing of gradation test results.

Prepared by: TMK1
Checked by: DMR

Atterberg limit testing was also performed on dewatered sediment samples. As indicated in Table 4-4, high Atterberg limit test results [Liquid Limit (LL) and Plastic Limit (PL)] occurred in sediment from both Sub-area A and Sub-area POG1, with the higher results coming from Sub-area POG1. Based on the Atterberg limits, the average sediment characteristics for all three sub-areas would be that of a high plasticity organic silt.

Table 4-4
Dewatered Sediment Atterberg Limits

		Liquid Limit (LL) D4318	Plastic Limit (PL) D4318	Plasticity Index (PI) D4318
Sub-Area A	Average Value	108	55	54
	Maximum Value	142	81	86
	Minimum Value	58	32	15
Sub-Area POG1	Average Value	207	197	14
	Maximum Value	267	275	24
	Minimum Value	114	105	4
Sub-Area C/D2S	Average Value	173	75	99
	Maximum Value	189	84	105
	Minimum Value	157	65	92

Note: High Atterberg Limit results in the absence of cohesive material, is an indication of high organic content. Refer to Appendix K for a complete listing of Atterberg Limit test results.

Prepared by: TMK1
Checked by: DMR

Following a period of dewatering within a geotextile tube, sediment was sampled from predetermined locations within each geotextile tube and field tested for strength. Sample location, and frequency within each geotextile tube was based upon geotextile tube size and associated sediment volume (refer to Section 4.5.1 Dewatered Sediment Sampling). In-situ Field Vane Shear tests were performed at each sample location in accordance with ASTM D2573. Testing for this project was performed with a calibrated GEONOR H-60 Field Vane. A brief summary of the Field Vane Shear test results is provided in Table 4-5.

Table 4-5
Dewatered Sediment Field Vane Shear Tests

		Vane Shear ASTM D2573 (kPa)	Vane Shear ASTM D2573 (tsf)
Sub-Area A	Average Value	55.5	0.6
	Maximum Value	125.8	1.3
	Minimum Value	24.3	0.3
Sub-Area POG1	Average Value	60.3	0.6
	Maximum Value	80.3	0.8
	Minimum Value	39.6	0.4
Sub-Area C/D2S	Average Value	41.2	0.4
	Maximum Value	60.4	0.7
	Minimum Value	20.8	0.2

Note: Refer to Appendix K for a complete listing of Field Vane Shear test results.

Prepared by: TMK1
Checked by: DMR

Unconfined Compressive Strength (UCS) testing (ASTM D2166) was required to further characterize the dewatered sediment. To perform this test, a sample to be tested is molded into a cylindrical shape with height equal to twice the cylinder's diameter. Dewatered sediment collected for UCS testing ranged from 41.5% to 60.6% solids. Test results ranged from less than 0.20 tsf to sediment not capable of retaining its shape under its own weight. Unconfined compressive strength results are included in Table K-2 in Appendix K. Unconfined compressive strength can also be estimated by doubling the result of the field vane shear (tsf). Table K-1 in Appendix K shows the estimated results.

4.5.5.2.1 Dewatered Sediment Test Results vs. Landfill Geotechnical Criteria

The Onyx Hickory Meadows Landfill, LLC is permitted to accept normal and low strength dewatered sediment for disposal. Normal strength dewatered sediment should be 50% solids or greater, UCS > 0.4 tsf, and have an undrained shear strength > 400 psf. Low strength dewatered sediment should be 20-50% solids, UCS > 0.1 tsf, and have an undrained shear strength > 85 psf. In addition, because of the uncertainty regarding the physical properties of the dewatered river sediment from LFR, Onyx and GW Partners agreed to a workability standard that requires the sediment to have the ability to support its own weight, support the weight of material placed over it, be capable of holding a 3H:1V slope under dynamic conditions, and be capable of being worked and managed by the landfill's low ground pressure bulldozer to be considered workable.

While there were samples tested that exceeded the required percent solids, none of the samples exceeded the UCS for normal strength dewatered sediment. As a result, almost all of the dewatered river sediment was required to be handled and disposed of as low strength dewatered sediment.

4.5.5.2.2 Amendment Evaluation

The majority of dewatered sediment from OU-1 in 2005 was unworkable material that required special handling and disposal at the landfill. Because of the increased cost of disposing of unworkable material, GW Partners evaluated the feasibility and cost of amending the unworkable sediments to make them workable. In the fall of 2005, three amendment studies were undertaken to assess the viability of proposed amendments to improve strength and decrease plasticity such that the sediment would be deemed workable. Lime kiln dust, pelletized quick lime, and Dolocrete were all evaluated.

The amendment evaluation concluded that with an amendment of 5% quicklime and 20% lime kiln dust, the amended dewatered sediment would be expected to meet workability criteria as defined by the Landfill, thereby avoiding the surcharge for unworkable material. However, when the surcharge for unworkable material was compared to the costs associated with amendment (the cost of the amendment materials, the cost to incorporate the amendment in dewatered sediment, and higher transportation and disposal costs due to the added weight of amendments), the amendment process was determined not to be cost effective. For 2005 it was further believed that amendment of the sediment on-site would not be feasible because the amendment process could not be performed on the existing pad due to intensive on-going routine dewatered sediment testing and space constraints. While another location for performing the amendment process could possibly be located, the costs associated with handling the amendment at a second location would only add to the costs of an amendment process. The results of these three amendment studies were previously provided to the Agencies.

4.5.6 Analytical Results- TSCA Sediments

Table 4-6 summarizes the analytical test data for the 3,083 of TSCA sediment hauled to EQ Waste Disposal in Belleville, Michigan, for the 2005 RA. Additionally the TSCA Sediments as loaded for transport had no free liquids.

Table 4-6
TSCA Dewatered Sediment TCLP Results

Parameter	Sub-area A (TSCA-1-COMP-DS104) Result	Sub-area A (TSCA-2-COMP-DS115) Result	Sub-area POG1 (COMP-DS311) Result
TCLP Metals			
Arsenic (mg/L)	0.063	0.061	ND
Barium (mg/L)	0.64	0.74	0.27
Cadmium (mg/L)	ND	ND	ND
Chromium (mg/L)	ND	ND	ND
Copper (mg/L)	NA	NA	ND
Lead (mg/L)	0.21	0.24	ND
Mercury (ug/L)	ND	ND	ND

Table 4-6
TSCA Dewatered Sediment TCLP Results

Parameter	Sub-area A (TSCA-1-COMP-DS104) Result	Sub-area A (TSCA-2-COMP-DS115) Result	Sub-area POG1 (COMP-DS311) Result
Nickel (mg/L)	NA	NA	ND
Selenium (mg/L)	ND	ND	ND
Silver (mg/L)	ND	ND	ND
Zinc (mg/L)	NA	NA	0.37
Cyanide, Reactive (mg/kg)	ND	ND	NA
Sulfide, Reactive (mg/kg)	ND	ND	NA
% Moisture	NA	NA	73.7
% Solids	54	48	NA
TCLP Volatiles	ND	ND	NA
1,1-Dichloroethene (mg/L)	ND	ND	NA
1,2-Dichloroethane (mg/L)	ND	ND	NA
2-Butanone (mg/L)	ND	ND	NA
Benzene (mg/L)	ND	ND	NA
Carbon Tetrachloride (mg/L)	ND	ND	NA
Clorobenzene (mg/L)	ND	ND	NA
Chloroform (mg/L)	ND	ND	NA
Tetrachloroethene (mg/L)	ND	ND	NA
Trichloroethene (mg/L)	ND	ND	NA
Vinyl Chloride (mg/L)	ND	ND	NA
TCLP Semivolatiles			
1,4-Dichlorobenzene (mg/L)	ND	ND	NA
2,4,5-Trichlorophenol (mg/L)	ND	ND	NA
2,4,6-Trichlorophenol (mg/L)	ND	ND	NA
2,4-Dinitrotoluene (mg/L)	ND	ND	NA
Cresol, Total (mg/L)	ND	ND	NA
Hexachlorobenzene (mg/L)	ND	ND	NA
Hexachlorobutadiene (mg/L)	ND	ND	NA
Hexachloroethane (mg/L)	ND	ND	NA
Nitrobenzene (mg/L)	ND	ND	NA
Pentachlorophenol (mg/L)	ND	ND	NA
Pyridine (mg/L)	ND	ND	NA
PCBs			
Aroclor 1016 (ppm)	ND	ND	NA
Aroclor 1221 (ppm)	ND	ND	NA
Aroclor 1232 (ppm)	ND	ND	NA
Aroclor 1242 (ppm)	17	14	NA
Aroclor 1248 (ppm)	ND	ND	NA

Table 4-6
TSCA Dewatered Sediment TCLP Results

Parameter	Sub-area A (TSCA-1-COMP-DS104) Result	Sub-area A (TSCA-2-COMP-DS115) Result	Sub-area POG1 (COMP-DS311) Result
Aroclor 1254 (ppm)	1.4	ND	NA
Aroclor 1260 (ppm)	0.79	0.81	NA
Total PCBs (ppm)	19	15	NA
TCLP Herbicides			
2,4,5-TP (Silvex) (ug/L)	ND	ND	NA
2,4-D (ug/L)	ND	ND	NA
TCLP Pesticides			
Clordane, Technical (ug/L)	ND	ND	NA
Endrin (ug/L)	ND	ND	NA
gamma-BHC (Lindane) (ug/L)	ND	ND	NA
Heptachlor (ug/L)	ND	ND	NA
Heptachlor Epoxide (ug/L)	ND	ND	NA
Methoxychlor (ug/L)	ND	ND	NA
Toxaphene (ug/L)	ND	ND	NA

ND = Non-Detect
NA=Not Applicable, analysis not completed

Prepared by: TMK1
Checked by: SVF

SECTION 5

Dewatered Sediment Load-out, Transportation and Disposal

5.1 Dewatered Sediment Load-out, Transportation and Disposal

The load-out, transportation and disposal (LTD) of the dewatered sediment removed during the 2005 dredging season began on September 29, 2005. The load-out, which involved the removal of both TSCA and non-TSCA sediments, was contracted to J.F. Brennan Company (Brennan) of La Crosse, Wisconsin. Transportation of dewatered non-TSCA sediment was contracted with Gene Frederickson Trucking of Kaukauna, Wisconsin. Non-TSCA sediment was disposed of at Onyx Hickory Meadows Landfill in the Town of Chilton, Wisconsin. The transportation and disposal of TSCA sediment was contracted with Wayne Disposal of Belleville, Michigan.

During 2005, Brennan had three pieces of equipment onsite for the load-out activities. These include: one 950 Case excavator with a clamshell, which was the main piece of equipment used for load-out. The clamshell bucket had a capacity of approximately 2.5 cubic yards and had proven capable of removing the sediment from the geotextile tubes in an effective and efficient manner. Brennan also had onsite one 450 Hyundai excavator with a standard bucket. This piece of equipment was used as a backup, should mechanical issues develop with the Case excavator, as well as being used, at times, in conjunction with the Case excavator to add efficiency to the LTD operation. The third piece of equipment that was used is a 950 Caterpillar loader. The loader was used primarily to maintain the haul road located within the dewatering pad, but had also been used in the loading of the sediment.

The load-out of dewatered sediments began on September 29, 2005, with the load-out of geotextile tube 1 on the southwest corner of the dewatering pad. Once this geotextile tube and its contents were removed, the operator proceeded north along the west side of the dewatering pad, until all of the geotextile tubes and their contents were removed. Upon completion of the west side, the operator began removing material from the northeast side of the dewatering pad. The progression was continued south along the east side of the dewatering pad.

Dredging for 2005 was completed on December 2, 2005. At that time the sampling and load-out plans, which had been 2 distinct plans, were combined to ensure that the material on the dewatering pad would be properly sampled and removed in an appropriate timeframe so as not to delay the start up of the 2006 remedial activities. During load-out operations, this plan was evaluated by GW Partners, Brennan, and Foth & Van Dyke on a weekly basis and was modified, as needed.

While the LTD activities began on September 29, 2005, a more comprehensive re-evaluation of the amount of sediment still on the pad was performed during the first week of January 2006. At that time a daily goal of 1,000 tons/day removed was established. This

value was based on an overall estimate of tons on the dewatering pad versus the number of days available to perform the LTD activities. It was also determined that, in order to achieve the goal of beginning 2006 dredging activities on May 1, 2006, all of the sediment would have to be removed from the pad by March 31, 2006. It was felt that accomplishing this would allow adequate time to perform any repair of the pad that was required, and also allow time to install any equipment that would need to be located on the pad for the 2006 RA activities.

5.1.1 Load-out and Sampling Plan

The original load-out plan determined that the material on the east side of the dewatering pad would be removed from the pad first. This was because the geotextile tubes on the east side of the pad had been offline longer than the geotextile tubes on the west side. This additional time that the material sat in the geotextile tubes was assumed to have aided dewatering. However, the geotextile tubes on the east side of the dewatering pad had been stacked 3 high and this posed problems for sampling the sediment in the tubes, specifically the tubes on the bottom row. After discussing the layout with the Foth & Van Dyke sampling team, the load-out and sampling plan was created.

The second and third level geotextile tubes were accessible, but the majority of tubes on the first level were not. Because of this, the plan was developed such that the operator of the clamshell was to remove a "set" of geotextile tubes. This set consisted of a first level geotextile tube, a second level geotextile tube and sections of two geotextile tubes on the third level. Removing this set exposed the next first level geotextile tube, allowing the sampling crew to conduct the required sampling. While these samples were being collected, the operator of the excavator would move to the west side of the pad and remove material from the geotextile tubes situated in southwest area of the pad. Once the necessary results were received for the material recently collected from the first level geotextile tube on the northeast side, the operator would move back to the east to remove the next set of geotextile tubes.

This strategy continued until the end of January. At this time, load-out efforts were focused on the southwest corner of the dewatering pad. The approach was undertaken to remove all of the sediment located to the south of the two geotextile tubes that contained TSCA material, which were located near the middle of the western half of the pad, north of the sump area. Once this occurred, the operator continued to follow the initial strategy of removing material from the tubes located on the east side of the dewatering pad. However, as identified above, in order to keep on schedule with the LTD activities, while the samples were collected and analyzed for the sediment from the first level geotextile tubes on the east side, the load-out operation would move to the northwest side of the dewatering pad to load-out Sub-area C/D2S material.

5.1.2 Loading and Transport of Non-TSCA Sediment

Frederickson Trucking of Kaukauna, Wisconsin was contracted by GW Partners to perform the non-TSCA transportation phase of the 2005 RA activities. Trucks that were used for the transportation activities were outfitted with permanent liners, tarps to cover the sediment during transport, and tailgates with rubber seals and turnbuckles.

Initially, load-out of the sediment contained in the geotextile tubes began daily at 6:30 a.m. and continued until approximately 3:00 p.m. In January 2006, this schedule was re-evaluated, and it was determined that the hours could be extended due to longer periods of daylight hours. The extension of the schedule allowed a few extra truck loads to be hauled each day.

Once dredging was over, and load-out was in full-scale operation, a total of eight trucks were designated to haul OU1 materials. Due to the need to reach the goal of removing the sediment from the dewatering pad by March 31, 2006, a decision was made, in early January 2006, to add two additional trucks. A ninth truck was put online on January 12, 2006 and a tenth truck joined the fleet on January 23, 2006.

Onsite, trucks entered the south entrance and proceeded along the marine access road and turned north to enter the dewatering pad. The trucks proceeded along the berm until they again turned north and entered the haul road in the center of the dewatering pad. The trucks then continued on to the area where they were loaded. For the loading of geotextile tubes 1 and 2, the trucks parked on the haul road, which runs south to north through the center of the pad. For the majority of the other geotextile tubes, temporary mats were placed (when needed) adjacent to the tube being loaded and the trucks backed into position adjacent the geotextile tubes, via the mats. After the trucks were loaded they proceeded forward and exited the pad to the west along the north berm. Prior to leaving the site, the trucks were cleaned in the decontamination area..

A decontamination building was erected during December 2005. This building was constructed over the decontamination pad located on the northwest side of the site. The decontamination staff sprayed the trucks as they entered the decontamination building to remove any sediment placed on the trucks by the loading process. The tires were also decontaminated. Once the trucks were sprayed off, they were stopped inside the decontamination building. Scaffolding was positioned on each side of the building, which allowed staff to clean the top rails of the truck before a tarp was positioned and fastened into place. Once the trucks were decontaminated, the trucks left the decontamination building and proceeded to the landfill.

Disposal of the OU1 non-TSCA sediment was contracted to Onyx Hickory Meadows Landfill in the Town of Chilton, Wisconsin. Once arriving at the landfill, trucks were weighed and then proceeded into the landfill. During 2005, unworkable materials were disposed of in specified monofills. Monofill 1 was determined to be full as of December 12, 2005, and additional unworkable material was placed in Monofill 2. All workable material was disposed of in specific areas on the landfill's working face and co-mingled with municipal waste as directed by Onyx.

After disposing of the sediment, the trucks proceeded to the landfill decontamination area. The trucks were again sprayed to remove any sediment that may have been placed on the truck or tires during the disposal process. After decontamination, the trucks would leave the landfill and return to the OU1 site.

5.1.3 Loading and Transport of TSCA Sediment

The disposal of TSCA sediments has been contracted to EQ Wayne Disposal of Belleville, Michigan. TSCA sediments were removed from two Sub-areas (A and POG1). LTD

activities for the TSCA material from Sub-area A began Monday, October 17, 2005 and proceeded until all of the TSCA material had been removed from the pad. Onsite loading hours for the TSCA material varied daily due to the LTD activities associated with the non-TSCA sediment. Although the dewatered sediments had no free liquids as loaded at the OU1 sites, concerns with free water on top of the sediment when the trucks arrived at the disposal facility required that amendment material and drying agents be added before the trucks containing the TSCA sediment left the pad.

The LTD activities associated with the Sub-area POG1 TSCA sediment began on February 20, 2006. Load-out occurred Monday through Friday at approximately 3:30 p.m., once the non-TSCA trucks were done hauling for the day. Up to ten trucks were employed to transport the material to the EQ Wayne Disposal site in Belleville, Michigan.

5.1.4 LTD Schedule

The LTD activities associated with the 2005 RA were completed by March 21, 2006.

SECTION 6

Water Treatment Plant

6.1 Process Description

The sediment dewatering system consisted of the manifold system, geotextile tubes, dewatering pad, and carriage water sump. This system was also described in Section 4. Water from the carriage water sump was pumped to the water treatment plant (WTP), which consisted of a chemical conditioning system, a Krofta Sandfloat SAF-BP unit (combined dissolved air flotation [DAF] clarifier and sand media bed filter), GAC vessels, a sludge tank, and a non-potable water tank. The process flow diagram for the WTP is shown on Figure 6-1.

The plant influent was pumped from the dewatering pad into the Sandfloat unit, where suspended solids were removed with dissolved air flotation and sand filtration. Effluent from the Sandfloat was pumped directly through the GAC vessels for final treatment before discharge into the river. A portion of the effluent from the GAC vessels was stored in the non-potable water tank for plant use for dry polymer makeup water, and backwash cycles.

Sludge from the DAF portion of the Sandfloat was sent to the sludge tank before being pumped back into the geotextile tubes. GAC backwash water was discharged directly to the geotextile tube dewatering pad.

Through the majority of the 2005 RA, the treatment plant was operated on a 24 hour/day, 5 day a week (24/5) schedule. In the month of November 2005, the treatment plant began operating on a 24 hour/day, 6 day a week (24/6) schedule and eventually operated on a 24 hour/day, 7 day a week schedule (excluding the Thanksgiving holiday weekend) to coincide with the operation of the dredges.

The treatment plant was designed to remove suspended solids and dissolved organics such as PCBs. Table 6-1 shows the average TSS concentrations throughout the 2005 RA at various locations in the treatment system based on QC sampling performed by the Supervising Contractor.

Table 6-1
Water Treatment System
Average Total Suspended Solids

Krofta Influent Composite (mg/L)	Krofta Effluent Composite (mg/L)	WTP Effluent Composite (mg/L)
6.94	2.94	1.17

mg/L = milligrams per liter

6.2 Sandfloat Operation

During the majority of the 2005 RA, two 8-inch hydraulic dredges operated on a 24/hour day, 5 day per week (24/5) schedule. As a result, the Sandfloat operated continuously (as per its design). On October 12, 2005, a third dredge began operating in Sub-area POG1 in order to meet project schedule milestones. Prior to operating all three dredges simultaneously, 2005 RA flow rates of the WTP were evaluated. It was determined that the total dredge discharge to maintain material velocities would be 3,000 gpm or less. The Sandfloat unit was designed for a 4,000 gpm flow rate.

The Sandfloat experienced solids loading during the 2005 RA which resulted in decreased performance. On September 3, 2005, a "boil out" procedure was performed on the Sandfloat utilizing 35% hydrogen peroxide and water in order to restore the unit to its peak hydraulic capacity. A slight, if any, increase in hydraulic capacity was observed after the "boil out" procedure. Subsequently, several geotextile tube failures occurred in the dewatering pad which resulted in additional solids loading in the unit. A summary of each geotextile tube failure is presented in the technical memorandum located in Appendix J.

By the end of October 2005, fouling had decreased the hydraulic capacity of the Sandfloat to approximately 2,400 gpm. On October 28 and 29, 2005, the filter media in the Sandfloat was removed and replaced with new media. Once the filter media change-out occurred in the Sandfloat, the flow rate of the unit increased 25% from 2,400 to 3,000 gpm. It should be noted that the carbon media in two of the lead GAC vessels were also changed out concurrently with the Sandfloat media change-out to prevent additional WTP down time. Details of the GAC media change-out are discussed in the next section.

Samples of the Sandfloat media that was removed from the unit were collected and analyzed in a certified off-site laboratory to determine what was plugging the media. The results of these analyses indicated that the media was being plugged by a combination of residual polymer from the de-watering process, biological growth, and clay and other fine particles from the dredging operation.

6.3 Granular Activated Carbon Operation

Prior to beginning 2005 RA treatment operations, an additional set of two GAC contactors were installed in the WTP to increase the total plant capacity to 3,000 gpm. The anticipated flow to the WTP during the 2005 was 2,400 gpm, which was based on the operation of two 8-inch hydraulic dredges.

The GAC units operated from the beginning of startup with minimum pressure loss through the units. As 2005 operations progressed, high pressure loss in the east and middle lead vessels occurred on a more frequent basis. The east and middle set of vessels were used during the 2004 RA. Although vigorous backwashing was performed on these vessels, the high pressure loss occurred on a more frequent basis which resulted in the vessels being backwashed daily. The daily backwashing of the vessels resulted in carbon media being discharged to the dewatering pad.

Beginning on October 12, 2005, a third dredge began operating in Sub-area POG1. The flows from dredging Sub-area POG1 were greater than had been anticipated with the total

flow to the WTP reaching up to 3,000 gpm. In order to bring the GAC hydraulic capacity back to design capacity, the carbon media in these vessels was removed and replaced concurrently with the Sandfloat media change-out on October 28 and 29, 2005. The GAC media change-out eliminated the high pressure loss across the GAC units and flows up to 3,000 gpm could be maintained.

Samples of the removed carbon media were collected and analyzed in a certified off-site laboratory and in a Glatfelter laboratory. Analyses concluded that the carbon media had fouled with polymer and biological growth, with small amounts of clay present.

6.4 Chemical Addition

During the 2005 RA, white foam accumulated on the water surface of the Sandfloat. Investigation of the foam by the polymer supplier concluded that the foam was due to the presence of biological material (bio-film) in the system. Chlorine dosing to control bacterial growth in the WTP system was performed utilizing sodium hypochlorite in the dewatering sump. A field colorimeter test kit was used to monitor residual chlorine in the system. Sodium bisulfite was staged on-site in the event that overdosing of chlorine occurred.

6.5 Performance

The water treatment plant was designed to remove suspended solids and dissolved organics such as PCBs. WDNR's performance expectations of the plant are listed in Table 6-2. All WDNR performance expectations were met during the 2005 RA, except mercury. The average 2005 RA effluent mercury concentrations were within 1 ng/L (one part per trillion) of the detection limit. These effluent mercury concentrations were significantly lower than previous Lower Fox River demonstration projects (Deposit N and 1999 SMU 56/57), except for the second year (2000) of the SMU 56/57 demonstration project. The 1999 SMU 56/57 project used the same basic treatment technology as was used for OU1 (clarification, filtration, and GAC). The second year of SMU 56/57 also had bag filters before and after the GAC units. GW Partners has agreed to install bag filters at the water treatment plant in 2006, and will coordinate the design and installation schedule with the Agencies. See Section 8.1.3 for a detailed discussion of effluent quality for the water treatment plant.

Table 6-2
Water Treatment Plant Effluent Expectations

Parameter	WDNR Performance Expectation
TSS (mg/L)	5 (monthly average) 10 (daily peak)
BOD (mg/L)	10
PCB (µg/L)	<0.1-0.5
Flow (mgd)	1.2-1.7
Ammonia (mg/L)	67
Mercury (ng/L)	<0.2-0.5

SECTION 7

Productivity

7.1 Percent Uptime

Percent uptime is a key measure of productivity for the project as a whole and for its individual operations -- dredging, dewatering, and water treatment. Percent uptime is the percentage of time operating compared to the time available for operations (not including scheduled off days such as holidays and most weekends). Table 7-1 (Refer to the "Tables" tab following the text of this report.) "Figures" tab of this report.) uses information from the daily reports to calculate percent uptime for the project and each of its three individual operations. The load-out, transport, and disposal operations did not impact the other operations and were not included in the percent uptime evaluation.

The total project percent uptime (equal to the dredge percent uptime) was 82.6%. The 82.6% uptime calculation includes the negative impact of the 3.3% combined downtime for the dewatering and water treatment plant operations. If adjusted to remove the effect of the dewatering and water treatment operations, the total project percent uptime (also dredge percent uptime) would have been 85.9%. The dredging operations achieved their percent uptime without the need for a standby dredge and with two of the dredges pumping through booster pumps for the entire project.

The actual percent uptime of the dewatering and water treatment plant operating was 96.7%. Given the high percent uptimes dewatering and water treatment plant operations achieved during the 2005 RA, dredging percent uptime was the controlling factor in determining total project percent uptime.

The 2005 RA Work Plan was modified in order to add a third dredge to increase overall project dredge production and, in particular, to remediate Sub-area POG1 in 2005. Water treatment plant capacity issues related to treating increased flows from the third dredge caused two-thirds of the combined dewatering and water treatment plant operations downtime of 3.3%. Greater than anticipated flows from the third dredge (Block Island) caused the influent flow to the water treatment plant to exceed its reduced operating capacity. This water treatment plant capacity restriction caused a one percent reduction in the total dredge uptime as the dredging operations had to be restricted to reduce flow to the plant until the water treatment plant's fouled media was replaced. The other one percent reduction in total dredge uptime was related to the time needed to actually change out the media. The timing of this media replacement did not affect overall schedule as the dredges would have had to shutdown for at least one day whenever the media was replaced. The cost of changing and disposing of the water treatment plant media was borne by CH2M HILL.

7.2 Sediment Removal Efficiency

J.F. Brennan Co., Inc. prepared a dredge production analysis to analyze the efficiency of the dredging operation in Sub-areas A and C/D2S. The analysis focuses on the square footage of production of each dredge to identify potential causes for lower than anticipated production during certain periods in the 2005 season.

Production levels from 2005 were summarized as follows:

Table 7-2
Monthly and Project Production Level Calculations

J.F. Brennan Co., Inc. Dredge Production Analysis for the 2005 Remedial Operations			
Fox River OU1 Little Lake Buttes des Morts			
Total Average Project Production (sq. ft.)	**Project Total**	**Grand Calumet**	**Fox River**
July through November Average Production	**26,198**	**12,735**	**13,694**
Total Average July Production	**16,350**	**7,147**	**11,250**
Total Average August Production	**25,733**	**10,610**	**15,123**
Total Average September Production	**29,353**	**14,982**	**14,371**
Total Average October Production	**28,270**	**16,696**	**11,574**
Total Average November Production	**27,330**	**13,041**	**14,289**

The following provides Brennan's explanation of data collected throughout the project as it relates to production in square footage terms.

July 2005
Operations for the dredge Grand Calumet began on July 8, 2005, and the dredge Fox River began on July 9, 2005. Production levels for both dredges were lower than expected during the month of July for the following reasons:

- Dredge Grand Calumet
  - The dredge was extracted from the lake for three days in mid-July to add additional flotation in response to lower than expected lake levels. The additional flotation was beneficial because it allowed the dredge to move in most parts of Area A, throughout the drier than expected summer. During the reconfiguration of the dredge for flotation, the dredge Grand Calumet was also recalibrated. An error in the mathematics was found that caused the translation of the ladder angle to incorrectly correlate with the elevation of the dredge intake mouth. Overall, both fixes for the dredge were extremely beneficial for the project and allowed for the operations to be conducted with little concern for draft considerations and computer efficiency.
  - The viscous cutterhead was found to blind itself with clay, thereby not allowing for full suction pressure to be exerted on the sediment. The blinding of the cutterhead had the overall effect of not allowing the dredge to efficiently and

effectively remove material from the lake bottom. The viscous cutterhead was replaced with a non-aggressive cutterhead for the remainder of the 2005 work.

  - High sub-grade was consistently encountered during operations in July 2005, which had a severe detrimental effect on the production of the dredge. The rock and clay encountered during the month had the effect of not allowing the cutterhead to move through the material freely. Therefore, production slowed tremendously as the dredge encountered rock and clay. Virtually all of the area dredged in July 2005 by the dredge Grand Calumet required re-dredging at some point during the project.

- Dredge Fox River
  - The dredge Fox River's production was lower than expected due to problems with the viscous cutterhead that were previously experienced with the dredge Grand Calumet. Originally, it was thought that the low percent in-situ solids material would work better with the viscous cutterhead, due to the material density. When the viscous cutterhead proved to be less effective, the cutterhead was switched to a more traditional model.

August 2005
During the month of August 2005, the production for the dredge Fox River was within J.F. Brennan Co., Inc.'s level of expectations. However, the dredge Grand Calumet did not meet production goals during August 2005. The primary reasons are as follows:

- Dredge Grand Calumet:
  - Areas of high subgrade slowed dredge production considerably. Furthermore, the dredge encountered shale rock that caused the clay knife to bind the cutterhead. At no time were dredge operators moving more slowly due to fear of over-cut. Even with the dredge exerting a large amount of force on the bottom of the lake bed, a dredge could not over-cut by more than six inches.
  - It should be noted that during this month, J.F. Brennan did not perform any appreciable clean up pass operations with the dredge Grand Calumet.

Finally, during the middle of August 2005, CH2M HILL representatives approached J.F. Brennan and asked about the viability of bringing in a third dredge, because calculations showed there would not be enough time in the season to finish Sub-area POG1.

September 2005
During the month of September 2005, both the dredges, Grand Calumet and Fox River, produced at expected levels. Furthermore, production during this month was exceptional given the following facts:

- Grand Calumet:
  - The dredge Grand Calumet performed clean up and production operations, and still maintained a 14,982 square foot average. Much of the area that was cut in August 2005 was subject to clean up passes in September 2005.

- During September 2005, an extensive poling operation began. J.F. Brennan Co., Inc. personnel, in conjunction with Foth and Van Dyke, worked to better characterize areas that were covered by the dredge. High sub-grade specifications required all areas to be dredged, but not re-dredged if 4 inches of soft sediment remained. High subgrade poling methods proved to be very effective on the overall production of the dredge.

October 2005
During the month of October, the dredge Fox River had lower than expected production, while the dredge Grand Calumet continued to produce at expected or higher than expected levels. The dredge Fox River production rates were due to logistical difficulties.

- Dredge Fox River:
  - During the month of October 2005, the dredge Fox River's lower than normal production rates can be predominantly traced to clean up pass operations. Clean up passes were required due to areas not passing the high sub-grade specification and to dredge operators missing material on their first pass through a dredge cut. During October 2005, the dredge Fox River was designated as the clean up dredge. This designation was given to the Fox River because both dredges were working in close proximity to one another and the dredge pipelines could have become entangled with the dredges. As the clean up dredge, the Fox River was responsible for cleaning all areas that remained high while the dredge Grand Calumet focused on production. Finally, it should be noted that the poling operations continued to distinguish areas that needed a clean up pass from those that did not.

November 2005
During the month of November 2005, production levels were normal overall. However, closer inspection of the data shows that during the later stages of the month, production was intermittent as operations came to a close for the season. The decision was made shortly after Thanksgiving not to dredge north of the pipeline in Sub-area C/D2S in 2005. Due to the nature of the high subgrade poling method, it took time to catch up to the dredges with post-dredge poling data. As the poling data caught up with the dredged areas, both dredges sat idle for periods of time, as expected. Finally, temperatures in late November 2005 were much cooler than expected, and the lake froze over several weeks earlier than normal.

Summary
Sub-aqueous conditions found during the 2005 dredge season resulted in lower than expected dredge rates early in the season. Both high subgrade areas and the presence of rock slowed production. When poling procedures were used to identify high subgrade areas starting in September 2005, production rates improved because high subgrade areas were then excluded from sweeping operations.

Although the agreement for the 2005 RA work contained penalties and rewards associated with overcut performance, the General Contractor received no appreciable economic benefits for producing at slower than anticipated rates. Simply put, dredging at a slower rate to achieve the overcut incentives would not make up for the loss of revenue for

dredging the design quantities. Furthermore, the penalties associated with overcut were not a concern to dredge production. Based upon field conditions, it was not possible with the machinery used during the 2005 operations to dig six inches deeper than design grade in the majority of Sub-areas A and C/D2S.

7.3 Sediment Load-Out Rates

Sediment LTD activities were originally scheduled to begin on September 12, 2005, but the start of the 2005 LTD was delayed due to high moisture content in the sediments of the first geotextile tubes to be loaded. These activities began on September 29, 2005, when a total of approximately 137 tons of sediment was disposed at the Onyx Hickory Meadows landfill in the Town of Chilton, Wisconsin. LTD activities continued through the end of 2005 and into 2006. The amounts of sediment loaded on a daily basis gradually ramped up. In October 2005, a total of 9,629 tons of dewatered material was disposed, with the maximum daily amount reaching approximately 715 tons. This rate continued through the end of 2005.

Towards the latter part of December 2005, it was determined that dredging associated with the 2006 RA remediation would begin on or around May 1, 2006. In an effort to coordinate and optimize the LTD work, the mass of sediments remaining on the pad from the 2005 work was estimated. This estimate produced a value of approximately 61,500 tons. Based upon a 5 day/week LTD schedule, it was determined that about 1,000 tons/day would need to be loaded to achieve the March 31, 2006 target date for 2006 mobilization.

In early January 2006, it was determined that the daily load rate would have to be increased to achieve this target date. To accomplish this, two additional trucks were added and the daily duration of the loading activities was extended an additional ½ hour at the site, as was the length of time for disposal at the landfill. This allowed the LTD daily values to exceed 1,300 tons. Table 7-3 shows the daily and monthly totals through the end of March 2006.

Table 7-3
Load-Out Rates for Sediments Remediated in 2005

	Maximum Daily Tonnage	Average Daily Tonnage	Total Tons Removed
September 2005	184.4	160.7	321.40
October 2005	712.1	512.5	10,762.50
November 2005	727.0	593.2	6,524.97
December 2005	914.9	582.4	9,900.52
January 2006	1,325.3	1,006.6	20,132.51
February 2006	1,195.8	956.1	19,122.80
March 2006	1,198.7	1,027.1	16,434.05
Total:			83,198.75

SECTION 8

Environmental Monitoring

8.1 Surface Water Quality

8.1.1 Turbidity

During dredging operations, surface water turbidity, reported as nephelometric turbidity units (NTUs), was continuously measured in the river at three locations, one upstream and two downstream of in-river RA activities. The upstream monitoring location was between 100 and 500 feet from the RA activities. The goal for the downstream locations was within 500 feet or less of RA activities; however, if the dredge pipelines or other obstacles prevented this, the locations were kept as close to the dredges as conditions allowed. The monitoring locations were adjusted as needed to reflect the changing locations of the RA activities.

Turbidity was measured using in-stream, real-time turbidity meters which took 30 successive readings per hour. Average turbidity data were collected in the base station every 15 minutes. The data was digitally recorded and stored with time and date for downloading via radio modem to an onsite PC.

The limit for dredging-induced increases in surface water total suspended solids (TSS) was an 80 ppm increase above background. Surface water turbidity was used as a surrogate for TSS based on a correlation developed from the 2004 RA. The Foth & Van Dyke Environmental Data Packet sent to the Agencies on December 14, 2004, presented a TSS/turbidity correlation, whereby, TSS = 2.108 + 0.995*(Turbidity) with (Correlation) r = 0.88. This correlation was based on surface water data from OU1 collected between October 30, 2004, and December 1, 2004. Using this correlation, an action level was set at 38 NTU (comparable to 40 TSS) difference between upstream and downstream conditions.

The 2006 River Turbidity Monitoring Communications Plan is presented in Section 4.4 of Appendix G of the 2006 RA Work Plan.

The three real-time, in-stream turbidity meter rafts were the primary trigger for detecting exceedances of the action level of a difference of greater than 38 NTU between upstream (background) and downstream turbidity. Foth & Van Dyke monitored the readings collected by the real-time turbidity meters and confirmed the real-time monitoring results 2-3 times weekly by collecting hand-held field turbidity measurements at each turbidity meter location. Also, visual observations of turbidity, dredging near intakes, or other circumstances required the collection of additional hand-held turbidity readings by Foth & Van Dyke. When on-site at the time of high turbidity events, Foth & Van Dyke used the hand-held turbidity meter to further delineate any visible turbidity downstream of the dredge. The readings were documented in a field book.

If turbidity readings significantly higher than background were noted from the real-time turbidity data, hand-held turbidity data, or by visual inspections, the General Contractor's

Site Manager was notified, with follow-up notifications to the General Contractor's Project Manager, GW Partners' representative Project Coordinator and a representative from the Agencies/Oversight team. The same procedure was used if high turbidity was detected by other members of the project team. Once the General Contractor's Site Manager was notified, he contacted the Dredging Contractor's Project Manager who, in turn, contacted the leverman on the dredge. Once the leverman was notified, he implemented procedures to minimize the turbidity. All steps taken by the leverman to control the turbidity were recorded and summarized in the daily production report. Any observations or turbidity readings collected by Foth & Van Dyke during turbidity events were also documented and summarized in the daily production reports.

8.1.2 Total Suspended Solids (TSS)

Grab samples of surface water for TSS measurements were obtained 2-3 times weekly at the same location and time as the turbidity field measurements. The grab samples were collected from a boat utilizing a discrete grab sampler (Kemmerer Water Sampler). During each sampling event, one water sample was collected at the approximate mid-point of the total water depth at each sampling location. Relevant information collected during sampling was documented in the field notebook and on field forms including weather conditions, raft ID and location, water depth, sample time, turbidity reading, and water temperature. Field duplicates and rinsate blanks were collected for every 10 water samples collected.

When the action level was exceeded (difference between upstream [background] and downstream turbidity greater than 38 NTU), it was usually during dredging in high subgrade areas where clay was being disturbed; however, steps were taken to monitor and minimize the high turbidity. During typical dredging activities, there were no significant increases in turbidity (or TSS). Table 8-1 summarizes the turbidity and TSS data obtained at the turbidity raft locations.

Table 8-1
Summary of Turbidity Readings and TSS Results Obtained at Raft Locations

	Minimum	Maximum	Average	Standard Deviation
Hand-Held Turbidity (NTU)	2.2	103.7	31.7	17.887
Telemetric Turbidity (NTU)	1.7	80.2	27.0	14.897
TSS (mg/L)	5.1	160.0	35.9	22.817

Prepared by: TMK1
Checked by: TRV

Table L-1 of Appendix L contains laboratory TSS results with corresponding hand-held and telemetric turbidity readings. Table L-2 contains all hand-held field turbidity readings collected during the 2005 remedial activities, including readings collected during the delineation of high turbidity events. Table L-2 also includes telemetric readings that correspond to hand-held readings collected at turbidity meter raft locations.

8.1.3 Water Treatment Plant Effluent Quality

Treated effluent water was sampled prior to discharge to the Lower Fox River using a 24-hour, flow-proportional, composite sampler. The composite samples were collected daily during operation of the WTP and analyzed for PCBs, ammonia, TSS, and BOD. Field duplicates were collected for every 10 samples collected by replicating the sample collection from the composite sampler.

Samples of river, geotextile tube weep, and effluent water were also collected for low-level mercury analysis once per week during WTP operation. On November 3, 2005, the sampling plan for low-level mercury was modified so that only effluent and carriage water from the dewatering pad sump were sampled once per week. On December 2, 2005, dredging operations were complete, and the WTP ceased to operate continuously. Starting on December 15, 2005, the sampling plan was again changed so that low-level mercury sampling was only required on days when the plant ran (maximum once per week).

The effluent water samples for low-level mercury analysis were collected from a spigot in the discharge pipe just outside of the WTP. The river water sample was collected off the dock at the Optimist Paddle Center, located in the southwest corner of Sub-area A. The weep sample was collected from the direct discharge of water from the geotextile tubes.

Low-level mercury sampling procedures were utilized during sampling events. A field blank was collected with each low-level mercury sample. In addition, field duplicates were collected for every 10 low-level mercury samples collected.

Beginning on August 8, 2005, at each sample collection point for low-level mercury, water was also collected for QC TSS analysis in order to compare the results of the two analyses and determine if a relationship existed. The analysis looked for a correlation of mercury to TSS within river water, effluent, tube weep, and carriage water. One correlation was found – within river water only, as TSS increased low-level mercury also increased. No correlation was indicated for effluent, tube weep, or carriage water.

Water samples were sent to Pace Analytical for PCB, ammonia, TSS, BOD, and low-level mercury analyses. Tables L-3 and L-4 of Appendix L contain a complete data set for these parameters.

PCB, ammonia, TSS, and BOD effluent concentrations consistently met the WDNR's performance expectations of <0.1-0.5 ug/L, 67 mg/L, 5 mg/L (monthly average, 10 mg/L daily peak), and 10 mg/L, respectively. Table 8-2 summarizes the QA analytical results for WTP effluent.

Table 8-2
Summary of Laboratory Analytical Results for Water Treatment Plant Effluent

	Minimum	Maximum	Average	Standard Deviation
TSS (mg/L)	0.14	5.40	1.22	0.914
BOD (mg/L)	1.00	4.50	1.23	0.630
Ammonia Nitrogen (mg/L)	0.10	2.10	0.44	0.382
Total PCBs (ug/L)	0.12	0.18	0.12	0.007

Note: For values less than the detection limit, half the detection limit value was used for minimum, maximum, average and standard deviation calculations.

Prepared by: TMK1
Checked by: SVF

Although the low-level mercury concentrations in the effluent generally exceeded the WDNR's performance expectation of <0.2 -0.5 ng/L, it was significantly less than low-level mercury concentrations in the weep, river, and carriage water samples. The average low-level mercury concentration in the effluent was 1.31 ng/L, compared to an average low-level mercury concentration in the weep of 10.1 ng/L, in the river water of 42.7 ng/L and in carriage water of 2.53 ng/L. Table 8-3 summarizes the low-level mercury results.

Table 8-3
Summary of WTP Low-Level Mercury and QC TSS Results

	Minimum		Maximum		Average		Standard Deviation	
	LL Hg (ng/L)	QC TSS (mg/L)	LL Hg (ng/L)	QC TSS (mg/L)	LL Hg (ng/L)	QC TSS (mg/L)	LL Hg (ng/L)	QC TSS (mg/L)
Effluent	0.324	0.0	4.46	2.6	1.31	0.8	0.876	0.801
Carriage Water	1.24	1.5	5.01	10.2	2.53	4.3	1.484	3.437
Geotube Weep	0.921	1.7	44.90	156.0	10.05	20.9	11.645	41.805
River Water	4.89	5.0	131.00	89.0	42.69	40.0	34.357	23.933

Note: For values less than the detection limit, half the detection limit value was used for calculations.

Prepared by: TMK1
Checked by: SVF

GW Partners has agreed to install bag filters at the water treatment plant in 2006 and will coordinate the design and installation schedule with the Agencies.

While this remediation project's primary function was the removal of significant PCB contaminated sediment, a secondary benefit was the removal of mercury suspended within the water column near sediment removal areas. Laboratory analysis shows that the average mercury concentration found within the Fox River's near surface water is 42.69 ng/L, and 1.31 ng/L within the treated effluent returned to the river. Effluent water returned to the Fox River was thirty-three times cleaner than near ambient surface water, when comparing low-level mercury averages.

During the 2005 Lower Fox River OU1 remediation project, from July 12, 2005 through January 30, 2006, there were 43 field blanks decanted while sampling treated effluent, river

water and geotextile tube weep for low-level mercury. Low-level mercury laboratory analysis of the field blanks revealed that 19 of the 43 field blanks had non-detectable levels of mercury less than 0.180 ng/L. More than half of the field blanks resulted in low-level mercury detection averaging 0.365 ng/L.

Low-level mercury contamination of field blanks may have come from many sources, most of which are likely to be airborne. Airborne mercury may have come from factories – both near and far, metallic objects near the sampling location, dust, upwind smokers or even the breath of the sampling crew (mercury/amalgam fillings in teeth).

Field sampling and field blank decanting procedures were established and approval prior to beginning 2005 sampling and did not change during the project. Clean and dirty areas were established prior to sampling as well as clean-hand/dirty hand assignments for the sampling team.

8.2 Air Quality

Air samples were collected and analyzed for PCBs to assess possible airborne concentrations of PCBs when dewatered sediment was being removed from the geotextile tubes during loading for off-site disposal. Air sampling was limited to periods of excavation and load-out since PCBs were not detected at any of the four air samplers during the 2004 remedial activities.

Four high-volume samplers were placed on and adjacent to the site, based on residential receptors, site topography, site operations, and prevailing wind directions, to measure possible PCB emissions leaving the site. Three of the high-volume samplers were located in close proximity to the dewatering pad: on the north berm of the pad, east of the pad between the pad and the river, and west of the pad between the pad and the house on-site (O'Keefe House). The fourth high-volume sampler was located between the dewatering pad and the house adjacent to the former Huber property on North Lake Street (Mills House). Figure 8-1 shows the locations of the air monitors.

Monitoring commenced on September 24, 2005, and approximately one week of baseline PCB monitoring data was gathered before removal of dewatered sediment began. PCB ambient air was continuously sampled during baseline sampling and when dewatered sediment was being removed from the site. Sampling was discontinued on November 22, 2005, as sample data showed consistent non-detect results, including during the period of Sub-area A TSCA sediment load-out.

All PCB samples were collected using a high-volume sampler (Tisch Environmental TE-PUF) loaded with a combination quartz filter and Polyurethane Foam (PUF) cartridge, following EPA TO-4A protocols. Air was drawn through the sampler at about 8 cubic feet (226 L) per minute. Sampling periods were 72 hours in length to allow for sufficient sample and volume to permit detection of PCBs at low concentrations.

During each sampling event, the starting and ending magnehelic readings, elapsed time indicator readings, and real times for each monitor were documented on field forms. A single-point operational flow rate calibration check was performed prior to the start of each sampling period and after its completion. The post-sampling calibration check served as the

pre-test calibration check for the next sample. The calibration results were also documented on the field forms.

During each 72-hour sample interval, operational status was observed and magnehelic gauge readings, elapsed time indicator readings, and real times were documented daily on the field forms.

Following collection of the sample, the filter and PUF cartridge was packed in hexane-rinsed aluminum foil and shipped to Pace Analytical for analysis. In the laboratory, PUF cartridges and filters were extracted with 5 percent ethyl ether/hexane and brought to a final volume of 10 mL. The extracts were then analyzed by gas chromatography with an electron capture detector to determine the presence of PCB compounds. At least one filter/PUF cartridge per 20 samples was shipped to the field and returned to the laboratory unused to serve as a field/handling blank.

Sample results from the laboratory, field data with respect to flow and sample collection times, and meteorological conditions during sample collection were used to calculate PCB concentrations. The calculation equations outlined in USEPA Method TO-4A were used to determine the concentrations.

Meteorological data was obtained from the National Oceanic Atmospheric Administration (NOAA) weather station at the Appleton airport. It was assumed that data from this location was representative of the meteorological conditions encountered at the OU1 site. The following average meteorological data was obtained: barometric pressure, temperature, and wind speed.

Twenty rounds of air sampling were completed, which covered the period from the end of September 2005 through the end of November 2005, and consisted of 80 samples plus field blanks. The laboratory reported that all samples for this period were below the limit of detection for PCBs, which is 0.5 micrograms per sample cartridge. For purposes of developing airborne concentration values, it was assumed that all concentrations were at the limit of detection. Although air volumes vary slightly from sample to sample, this cartridge concentration translates into a calculated PCB concentration that is approximately <0.0005 µg/m3 at each sampler for each sampling event. Refer to Table 8-4 for a summary of the air monitoring results.

Table 8-4
Air Monitoring Results Summary

	Minimum	Maximum	Average	Standard Deviation
Total Air Volume Sampled (Total m^3)	767.92	1184.75	1094.30	58.44
Calculated PCB Conc'n ($\mu g/m^3$)	≤ 0.00042	≤ 0.00065	≤ 0.00046	≤ 2.9247E-05

Table L-5 in Appendix L shows the laboratory PCB results, the total air volumes sampled, and calculated PCB concentrations for each air sample (calculated at the limit of detection).

As discussed in this section, PCB ambient air was continuously sampled during baseline sampling and when dewatered sediment was being removed from the site. Within this time period, from the end of September 2005 through the end of November 2005, twenty rounds of sampling were completed, consisting of 80 samples plus field blanks. Sampling was discontinued on November 22, 2005, as sample data showed consistent non-detect results, including during the period of Sub-area A TSCA sediment load-out. Due to the consistency of non-detect results over this entire period and during the 2004 remedial activities, it is recommended that the level of air sampling be reduced for the 2006 remedial activities.

8.3 Data QA/QC

8.3.1 Data Reduction, Validation and Reporting

Foth & Van Dyke performed QA activities to ensure that the collected data were scientifically defensible, of known quality, properly documented, and met the project objectives. Once a final data package containing laboratory results was received by Foth & Van Dyke, the package was logged into a data tracking table. The final analytical data package was then sent to MAKuehl Co. for third party validation and verification.

Ten percent of the analytical data was verified and validated by MAKuehl Co. to ensure that the laboratory performed sound QC practices and to assess the possible effects of each deviation from the QAPP on the usability of associated data, the contribution to the quality of reduced and analyzed data, and on the decision. The following steps were used:

- The completeness, correctness, and contractual compliance of the data were evaluated against the USEPA or other reference method, or laboratory- or field-specific SOP.
- The qualification of data was extended beyond method and procedural compliance (i.e., data verification) to determine the data's analytical quality.
- Individual data sets were evaluated to identify the measurement permanence/ usability issues or problems affecting the ultimate achievement of project data quality objectives (DQOs).
- An overall evaluation of all project data was performed.
- Project-specific measurement performance criteria and data validation criteria were evaluated to determine if they appropriately met project DQOs.
- Additionally, Foth & Van Dyke performed a forms review on one hundred percent of the analytical data.

8.3.2 Reconciliation with Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements that clearly define the objectives of the project, define the most appropriate type of data, determine the appropriate procedures for data collection, and specify acceptable decision error limits that establish the quantity and quality of data needed for decision making. The technical

planning team developed project-specific DQOs in accordance with USEPA's Guidance for Data Quality Objectives Process (EPA QA/G-4).

The final data validation activity consisted of assessing whether the data met the planned DQOs for the unit-specific project. The final results, as adjusted for the findings of any data validation/data evaluation, were checked against the DQOs. The data acquired during the environmental monitoring fulfilled the project objectives to support remedial activities in the Lower Fox River OU1.

Data validation technical memoranda received to date from MAKuehl are contained in Appendix M.

SECTION 9

Summary

9.1 Project Performance Versus Objectives

The following narrative summarizes the project performance versus the 2005 objectives by objective.

Objective No. 1: Modify the WTP to accommodate two, 8-inch dredges operating simultaneously 24 hours per day, 5 days per week.

- The WTP was modified to include the installation of two GAC units, with associated electrical and mechanical upgrades, so that it can now accommodate two dredges operating simultaneously 24 hours per day, 5 days per week.
- The modified WTP became operational on July 15, 2005, prior to beginning operations of the second dredge.

Objective No. 2: Complete the expansion of the geotextile tube dewatering pad.

- The expansion of the dewatering pad from 1.8 acres to 5.3 acres was completed on July 22, 2005, without impacting the dredging schedule.

Objective No. 3: Complete operational modifications to the piping manifold system and site access routes to accommodate increased dredging activities.

- The operational modifications to the piping manifold system and site access routes were completed on July 8, 2005, prior to increased dredging activities.
- Modifications were made to the site access roads to accommodate truck decontamination, access and egress.

Objective No. 4: Dredge Sub-areas A, C/D2S, and POG1 while optimizing dredging operations to minimize turbidity, overdredging, and residual PCB concentrations.

- All of the sub-areas targeted for dredging were completed except for the northern portion of Sub-area C/D2S; 90% of the targeted surface area (as revised during the 2005 RA) was completed.
- 90% of the total PCB mass was removed from the sub-areas dredged in 2005.
- Surface water turbidity downstream of the dredges never exceeded the 78 NTU project limits above background turbidity.
- Dredging of Sub-area A was completed on November 14, 2005.
    - Sub-area A targeted dredge area was revised to eliminate coarse-grained, low PCB concentration material.
    - Sub-area A had OU1's second highest average PCB concentration prior to dredging.

        - 91% of the PCB mass was removed from the Sub-area A dredge prisms.
        - The PCB Average Residual Concentration from the Sub-area A dredge prisms was reduced by 78%.
    - Sub-area A had one of three OU1 areas containing in situ TSCA material. Over 98% of the PCB mass was removed from this TSCA location.
    - Average overdredge (excluding high subgrade areas) was 3.5 inches compared to 6-inch target.
- Dredging 59% of Sub-area C/D2S was completed on December 2, 2005.
    - Sub-area C/D2S targeted dredge area was revised to eliminate coarse-grained, low PCB concentration material.
    - Sub-area C/D2S had OU1's fourth highest average PCB concentration prior to dredging.
        - 93% of the PCB mass was removed from the Sub-area C/D2S dredge prisms.
        - The PCB Average Residual Concentration from the Sub-area C/D2S dredge prisms was reduced by 84%.
    - Average overdredge (excluding the high subgrade areas) was 4.7 inches compared to 6-inch target.
- Dredging of Sub-area POG1 was completed on December 1, 2005.
    - Sub-area POG1 had OU1's highest average PCB concentration prior to dredging.
        - 99% of the PCB mass was removed from the Sub-area POG1 dredge prisms.
        - The PCB Average Residual Concentration from the Sub-area POG1 dredge prisms was reduced by 85%.
    - Sub-area POG1 had one of three OU1 areas containing in situ TSCA material.

Objective No. 5: Dewater sediment in geotextile tubes, optimizing dewatering to maximize dewatered percent solids prior to dewatered sediment load-out.

- Reduced chemical usage overall in 2005, providing for better sediment slurry conditioning and lower residual polymer in the water treatment influent.
- Blended coarse-grained and fine-grained sediment during slurry transport to increase dewatering potential and reduce variability of percent solids between tubes. However, since the volume of fine-grained sediment was much greater than the coarse-grained sediment, and the coarse-grained sediment had a tendency to separate once introduced into the tube, the blending of the sediments had little measurable impact on the dewatering performance.

- Stacked geotextile tubes, which probably enhanced dewatering resulting from compression of lower tubes and lengthening dewatering period.
- Tested enhanced geotextile tube dewatering techniques (e.g., wick drains and wells).

Objective No. 6: Operate the WTP to meet treatment expectations.

- Effluent water quality for PCBs, TSS, BOD and ammonia was well within WDNR treatment expectations.
- Effluent water quality for mercury did not meet WDNR performance expectations; however, 2005 RA effluent low-level mercury concentrations were on average an order of magnitude less than background river water concentrations.
- GW Partners has agreed to install bag filters at the water treatment plant in 2006 and will coordinate the design and installation schedule with the Agencies.

Objective No. 7: Monitor RA activities and their impacts (sediment removal verification, water treatment, and air/water quality).

- Dewatered sediment paint filter tests were performed on materials from each geotextile tube.
- Dewatered sediment was sampled and analyzed for PCB concentrations and percent solids within each geotextile tube.
- Sediment removal verification.
    - Bathymetric surveys were performed to confirm whether the 1.0 ppm PCB target dredge elevation had been met.
    - Dredged areas were sampled and analyzed for residual PCB concentrations.
- Air quality was sampled and analyzed for PCBs.
- WTP effluent was sampled and analyzed for PCBs, TSS, BOD, ammonia, and mercury.
- Surface water quality real-time turbidity testing was performed downstream of dredges.
- A secure website was utilized to communicate environmental and production data requested by Agencies/Oversight Team and GW Partners.

9.2 Challenges Encountered and Lessons Learned

As shown above, the 2005 RA successfully attained its goals in terms of achievement of target elevations, protection of the environment during removal operations and a number of other metrics. The following discussion of challenges encountered and lessons learned is provided in an effort to strengthen the collaboration on the project moving forward and to help ensure future success with the OU1 RA activities.

Some of the challenges described below are unavoidable consequences of the nature of the work being performed and the physical reality of dredging Little Lake Butte des Morts;

some appear avoidable in the future. GW Partners does not believe that any of the challenges described below had a material and demonstrable impact on the cost-effectiveness of the project.

Challenge 1: Clay and high subgrade areas have a significant impact on productivity.

- Clay slows dredging production rates (clogging of the cutterhead), interferes with dewatering in geotextile tubes, and decreases workability of dewatered sediment.
- High subgrade areas slow dredging production rates, and result in the need for sweeping unless the areas are identified and excluded from redredging.

2006 Strategy:

1. Continue to evaluate dredge equipment modifications that would minimize clay dredging.
2. Implement a poling plan prior to dredging to better define high subgrade areas. See August 16, 2006 Boldt memorandum regarding "LFR OU1 – POG Clarification on Defining Dredge Neat Line Using GMS" included in Appendix B.
3. Continue using the high subgrade policy implemented in September 2005 with respect to re-dredging.
4. Evaluate the possibility of excluding very thin deposits over clay from initial dredging. Very thin deposits are soft sediment less than 4-inches thick.

Challenge 2: The dredging of laterally extensive, thin layers of coarse-grained deposits within sub-areas was more difficult than anticipated.

- The benefits of dredging large areas of coarse-grained deposits meeting the "No Dredge Region" criteria (as defined in Section 3.1.3) do not outweigh the costs.
- It is not practical to dredge all shoreline areas due to shallow water depths and the presence of rocks, riprap, etc.

2006 Strategy:

1. Continue the policy of excluding coarse grained deposits meeting the "No Dredge Region" criteria as approved by the Agencies and defined in Section 3.1.3.
2. Dredge only shoreline areas that are reasonably accessible with a hydraulic dredge.
3. Continue weekly GW Partners/Agency management meetings initiated in October to identify key issues and work collaboratively on solutions.

Challenge 3: A dredge start date of July 7, 2005 required cold weather dredging at the end of the year.

- 2005 bid preparation and contract negotiations delayed the initiation of dredging beyond the June 1 target outlined in the design documents.

2006 Strategy:

1. The contracting process is more streamlined in 2006, making it achievable to start dredging in May 2006.
2. Even if production falls behind schedule, the 2006 plan is to shut down dredging before Thanksgiving.

Challenge 4: The ability to impact the final percent solids in the geotextile tubes is limited.

- Time on the dewatering pad seems to be a major factor influencing dewatering effectiveness in the geotextile tube.
- The impact of increased pressure on geotextile tubes with regard to maximizing percent solids is still under debate; but, in any event, stacking is critical to extending sediment dewatering time and is therefore an important design criterion.
- Enhanced geotextile tube dewatering techniques are labor intensive and have not been shown to be cost effective.
- Proper chemical dosing increases resulting percent solids while eliminating polymer carryover and increasing WTP efficiency.

2006 Strategy:

1. Continue to stack geotextile tubes and maximize geotextile tube dewatering time on the pad.
2. Modify the dewatering system for the 2006 RA by installing screens/thickeners ahead of the geotextile tubes. The rotary screens will remove debris larger than 1/8 inch and separate it for immediate disposal. The thickeners will increase the sediment slurry solids content before it is pumped to the geotextile tubes. The increased solids content should reduce the amount of labor needed to help the tubes dewater during their filling phase, reduce the time needed for the tubes to dewater before stacking of the tubes can proceed, reduce the impact of a tube failure, and, possibly, enhance the polymer addition process control.
3. Ensure proper chemical dosing.
4. Use 60′ circumference geotextile tubes. The 2006 Remedial Action will use the 60′ tubes in lieu of the 80′ tubes to provide a greater dewatering surface area per volume compared to the previous tubes. The geotextile tubes will be constructed of Geolon GT500, which was used during the 2004 RA.

Challenge 5: Unworkability of dewatered sediment is driving disposal costs upward.

- Blending workable and non-workable sediment from the geotextile tubes is not an effective method to achieve workability of the sediment.
- Meeting 50% solids has not been shown to automatically result in workable material. Reducing water content results in less tonnage to the landfill; and, therefore reduces landfill disposal costs, but the 2005 RA has not shown workability to be improved by breaking the 50% solids barrier.
- Overdosing of polymer has not been shown to be the root cause of the unworkable material in 2004, but may have exacerbated unworkability.
- Working the bags more aggressively did not enhance the workability of the sediment.
- The amount of clay and organic matter in the sediment greatly affects the workability of the sediment.
- Amendment of sediments to achieve workability is not cost-effective. In addition, amendment can not be performed at either the staging area or at Hickory Meadows Landfill without creating logistical issues.

2006 Strategy:

1. Continue to evaluate the timing and capacity of existing monofills to accept the non-workable sediment, and authorize additional monofill capacity as needed to continue the loading and hauling of non-TSCA material.
2. Use a screen prior to the thickener to segregate workable material before the geotextile tubes.

Challenge 6: Several geotextile tubes ruptured on the dewatering pad.

- The causes of the ruptures have been analyzed and are discussed in Appendix J to this report.

2006 Strategy:

1. Bag quality should be checked through careful visual inspection.
2. Discontinue the use of geotextile tube wicks.
3. Evaluate storage/handling techniques for geotextile tubes.
4. Thickening prior to the geotextile tubes will decrease the likelihood of a rupture and the magnitude of the cleanup on the pad if a rupture occurs.
5. Assure that an appropriate base is in place before stacking tubes.
6. Continue monitoring the fill height of the geotextile tubes as they are being filled.
7. Manual striking of the geotextile tubes will be employed to help breakup the filter cake at the exterior of the tubes to aid in dewatering.

Challenge 7: Blinding of the dewatering pad occurred.

- 2004 and/or 2005 activities appear to have caused blinding in several areas of the dewatering pad and this condition will need to be evaluated.

2006 Strategy:

1. Investigate magnitude and extent of dewatering pad blinding by solids in preparation for 2006 operations.
2. Clean solids from dewatering pad as necessary to ready the pad for 2006 operations.
3. Consider potential solutions to dewatering pad blinding during detailed design of 2006 dewatering operations.

Challenge 8: The geotextile bag placement and loadout needs to be proactively managed.

- A dynamic and logical pad management plan is required.
- The transport and landfill operations are separately contracted directly to GW Partners and are not under the General Contractor's supervision; GW Partners must provide coordination/interface/communication between these contractors and the General Contractor handling load-out.
- The coordination of load-out for TSCA and non-TSCA sediment on the same dewatering pad using different subcontractors for hauling requires distinct and independent load-out schedules.

2006 Strategy:

1. A dynamic proactive pad management plan will be developed for 2006.
2. A water mass balance will be developed in conjunction with the pad management plan.
3. GW Partners will proactively manage the loadout, transport, and disposal of dewatered sediment.
4. A contingency plan will be developed in the event of a tube failure in 2006.
5. Contingency plans will be developed for 2006 to include thickener unit bypass, trammel screen bypass, and thickener unit consolidation.

Challenge 9: The planning and reporting mechanisms did not meet all stakeholder needs and expectations.

- Differing expectations and needs by stakeholders have led to the need to generate multiple reports. Streamlining of reporting and a common understanding of key metrics for realtime reporting will result in cost effectiveness and consistent expectations.
- GW Partners and the Agencies/Oversight Team may have different perspectives on the need for expedited reporting and on the reporting priorities for the project. Data receipt times and laboratory turnaround times need to be better communicated to stakeholders to ensure a common understanding of reporting issues and priorities.

- Planning and evaluation requests from stakeholders were not clearly provided for in 2005 RA contracts.
- GW Partners and the Agencies/Oversight Team did not have complete alignment on project objectives in 2005.

2006 Strategy:

1. GW Partners and the Agencies/Oversight Team should continue to meet before the dredging begins to consider and ensure a common understanding of objectives, reporting needs, priorities, and timing.
2. Continue the weekly GW Partners and Agencies/Oversight Team management meetings during the 2006 RA to help ensure good communications and decision-making.
3. Contingency planning and analytical needs should be developed and prioritized, and roles and responsibilities for the contingency planning should be identified.
4. A detailed schedule will be developed which will include rehabilitation of the dewatering pad, installation and start-up of the thickening units along with planned dredging areas and durations.
5. A communications plan will be developed for 2006 which will include monthly progress reports, quarterly reports, management meetings, weekly status meetings, and daily progress meetings.

Figures

Tables

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