Report

2007 Remedial Action Summary Report

Lower Fox River Operable Unit 1

Project I.D.: 07G007

Prepared for:

GW Partners, LLC
Neenah, Wisconsin

May 2008

Foth

BRENNAN "Marine Professionals" La Crosse, WI

STS CONSULTANTS

GW PARTNERS, LLC

Please Reply to:
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Little Lake Cleanup Team
1475 North Lake Street
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May 12, 2008

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Mr. Greg Hill
Project Coordinator
Wisconsin Department of Natural Resources
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Madison WI 53703

Dear Jim and Greg:

RE: *2007 Remedial Action Summary Report - Lower Fox River Operable Unit 1*

On behalf of GW Partners, LLC, attached is the *2007 Remedial Action Summary Report - Lower Fox River Operable Unit 1.*

This report summarizes remedial action construction and operations completed during 2007, as well as quality assurance test results, and provides an assessment of the project's 2007 performance versus the objectives established at the start of the construction season.

If you have any questions, please contact Mr. Bill Hartman, GW Partner's Project Manager, at (920) 886-2955.

Sincerely,

GW Partners, LLC

Bill Hartman
Project Manager

Foth Infrastructure & Environment, LLC

Denis Roznowski, P.E.
CQA Officer

J.F. Brennan Company, Inc.

Vic Buhr
Project Manager

2007 Remedial Action Summary Report

Lower Fox River Operable Unit 1

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Project ID: 07G007

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GW Partners, LLC

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Prepared by

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J.F. Brennan Company, Inc.

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May 2008

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Lower Fox River Operable Unit 1

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List of Abbreviations, Acronyms, and Symbols

ac	acres
ACH	aluminum chlorohydrate
AOC	Administrative Order on Consent
ASTM	American Society of Testing Materials
BOD	biochemical oxygen demand
BODR	Basis of Design Report
Boldt	The Boldt Company
Brennan	J.F. Brennan Company, Inc.
CH	fat clay
CH2M HILL	CH2M HILL, Inc.
cm	centimeters
CQA	Construction Quality Assurance
CQAPP	Construction Quality Assurance Project Plan
cy	cubic yards
°C	degrees Celsius
DAF	dissolved air flotation
DMU	Dredge Management Unit
DQO	data quality objectives
ft	foot/feet
Foth	Foth Infrastructure & Environment, LLC
GAC	granular activated carbon
GMS	Groundwater Modeling Software
GOH	gross operational hours
gph	gallons per hour
gpm	gallons per minute
GPS	global positioning system
IDW	inverse distance weighted
kg	kilogram
kPa	kilo Pascal
lbs	pound(s)
LFR	Lower Fox River
LLBdM	Little Lake Butte des Morts
LL	liquid limit
LLC	Limited Liability Company
LLHg	low-level mercury
LOD	Limit of Detection
MAKuehl	MAKuehl Company, Inc.
MF	monofill
mg	milligram
mgd	million gallons per day
mg/l	milligrams per liter
MH	elastic silt

mL	milliliter
mph	miles per hour
ng/L	nanogram per liter
NOH	net operational hours
NTU	nephelometric turbidity unit
OH	organic silt
OU1	Operable Unit 1
Pace	Pace Analytical Services, Inc.
PCB	polychlorinated biphenyl
PL	plastic limit
ppm	parts per million
psf	pounds per square foot
PUF	polyurethane foam
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	Remedial Action
RAL	Remedial Action Level
RD	Remedial Design
RDMU	Residual Dredge Management Unit
ROD	Record of Decision
RTK	real-time kinematic
SCU	Sand Certification Unit
sf	square foot (feet)
SMU	Sand Management Unit
sqft	square foot
sqrt	square root
STS	STS Consultants, Ltd.
su	standard units
SWAC	surface weighted average concentration
tds	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
UCS	unconfined compressive strength
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
USEPA	U.S. Environmental Protection Agency
Veolia	Veolia Environmental Services
WDNR	Wisconsin Department of Natural Resources
WTP	water treatment plant

1 Introduction

J.F. Brennan Co., Inc. (Brennan) and Foth Infrastructure & Environment, LLC (Foth) prepared this *2007 Remedial Action (RA) Summary Report - Lower Fox River (LFR) Operable Unit 1 (OU1),* 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.

This 2007 Remedial Action Summary Report is a deliverable required by the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a). The RA Work Plan was a requirement of the Consent Decree 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 Consent Decree on April 12, 2004.

1.1 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. The USEPA and WDNR signed a Record of Decision (ROD) encompassing OU1 in December 2002. The ROD established a Remedial Action Level (RAL) of 1.0 parts per million (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 PCB9 concentrations greater than 1. This footprint was targeted for removal by dredging. If sampling shows that the 1.0 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.

1.2 LFR OU1 2007 Remedial Action

The remedy selected in the LFR OU1 ROD specifies the removal and landfill disposal of PCB-impacted sediment exceeding the RAL of 1.0 ppm PCBs. Dredging of PCB impacted sediment began in OU1 in 2004. The 2007 RA continued with removal of PCB-impacted sediment by dredging, sediment dewatering, water treatment, and sediment landfilling as necessary to meet the requirements of the ROD.

The marine support area, sediment dewatering area, and water treatment occurred in the same location as the 2006 RA – the former Huber property (Lots 1 and 2 CSM 5305) located in the town of Menasha, in Winnebago County, Wisconsin.

Consistent with the objectives presented in the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a), 2007 remedial activities included the following:

- Re-dredge areas with PCBs greater than or equal to 5.0 ppm to reduce the SWAC;
- Re-dredge residential dock areas with PCBs greater than 1.0 ppm that are too shallow to place a 6 inch-thick sand cover (i.e., pre-cover water depth less than 6 inches) to reduce the SWAC;
- Re-dredge residential dock areas with PCBs greater than 1.0 ppm that are too shallow to place a 6 inch-thick sand cover (i.e., pre-cover water depth less than 3.5 feet) to reduce the SWAC;
- Dredge areas with PCBs greater than 1.0 ppm surface concentration and less than 2.0 ppm maximum concentration with pre-cover water depth less than 3.5 feet
- Dredge areas with PCBs greater than 2.0 ppm with pre-cap water depth less than 7.08 feet;
- Dredge select small or isolated areas with PCBs greater than 1.4 ppm;
- Dredge areas with PCBs greater than 1.0 ppm where future activities (e.g., bridge construction) would likely impede implementation of alternative remedies;
- Optimize dredging and re-dredging operations to minimize turbidity, over dredging, and residual PCB concentrations;
- Sand cover select dredged and re-dredged areas with PCBs less than 5.0 ppm to reduce the SWAC and to test sand placement operations;
- Optimize dewatering and water treatment operations to maximize dewatered percent solids, while minimizing operations costs and meeting environmental standards;
- Dispose of non-Toxic Substance Control Act (non-TSCA) dewatered sediment at the Veolia Environmental Services (Veolia) Hickory Meadows Landfill, in the town of Chilton, Wisconsin; and
- Monitor RA activities and their impacts (sediment removal verification, sand placement verification, water treatment effluent, surface water quality, and air quality).

2 2007 Remedial Action Project Team

2.1 Project Organization, Responsibility and Authority

Brennan was the Supervising Contractor managing the implementation of the LFR OU1 2007 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. Additional information regarding project responsibilities and authorities is provided in the Construction Quality Assurance Project Plan (CQAPP) included in Appendix B of the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a).

2.2 GW Partners, LLC

GW Partners is a limited liability company formed by WTM I Company and P.H. Glatfelter Company, to implement the LFR OU1 RA.

2.2.1 GW Partners' 2007 RA Project Coordinator/Remedial Design Project Coordinator—Mike Jury, CH2M HILL

Mike Jury, GW Partners' 2007 RA Project Coordinator/Remedial Design Project Coordinator, performed the following tasks during the 2007 RA:

- Monitored overall progress and compliance with the 2007 remedial design and evaluated the need to perform design changes, as necessary, during the 2007 remedial activities;
- Informed the representatives of GW Partners regarding significant issues during the 2007 remedial activities and worked with GW Partners, GW Partners' Project Manager, and Contractors to resolve these issues;
- Communicated with USEPA and WDNR on an ongoing basis regarding significant issues during the 2007 RA Work and responded to Agency concerns (after consultation with GW Partners' Project Manager and with GW Partners when needed);
- Prepared and submitted the RA Monthly Progress Reports, required by the Consent Decree, with the assistance of Bill Hartman, Greg Smith, and others as needed;
- Assisted in preparing quarterly reports required by the Consent Decree;
- Made recommendations to GW Partners regarding proposed changes in the implementation of the design and means to reduce costs and/or make the project more effective; and,
- Assisted with public and government affairs as needed.

2.2.2 GW Partners' Project Manager/2007 Remedial Action Alternate Project Coordinator—Bill Hartman, P.H. Glatfelter

Bill Hartman, GW Partners' Project Manager/2007 RA Alternate Project Coordinator, performed the following tasks during the 2007 RA:

- Monitored progress of the 2007 RA project activities and provided oversight of daily operations during the 2007 RA project activities;
- Informed representatives of GW Partners of project progress and any significant issues, and worked with GW Partners, the Project Coordinator and Contractors to resolve significant issues;
- Communicated with USEPA and WDNR on an ongoing basis regarding day to day operations during the 2007 remedial activities and responded to Agency concerns (after consultation with GW Partners' Project Coordinator and with GW Partners when needed);
- Notified USEPA and WDNR of releases or threatened releases when required by the Consent Decree and served as a point of contact for Agency officials and contractors regarding actions to address the release or threatened release;
- Provided necessary project-related approvals as authorized by GW Partners;
- Reviewed and approved monthly RA progress reports prepared by the Project Coordinator, as required by the Consent Decree;
- Assisted in preparing quarterly reports required by the Consent Decree;
- Reviewed and approved invoices directed to GW Partners, subject to authority granted by GW Partners;
- Coordinated RA activities between the Supervising Contractor (Brennan) and other GW Partners' contractors (Gene Frederickson Trucking, Veolia, and EQ Wayne Disposal);
- Monitored Construction Quality Assurance Officer activities;
- Assisted with public and government affairs as appropriate, including acting as a spokesman and community liaison for GW Partners; and
- Contributed to this 2007 Remedial Action Summary Report.

2.2.3 GW Partners' Engineer—Foth Infrastructure and Environment, LLC

Foth Infrastructure and Environment, LLC served as GW Partner's Engineer for the LFR OU1 2007 RA.

Foth performed the following activities during the 2007 RA:

- Prepared relevant portions of the *2007 Pre-Final Design Report and Remedial Action Work Plan;*
- Responsible for implementation of the CQAPP and the Quality Assurance Project Plan (QAPP) for Operation and Maintenance, including providing the Construction Quality Assurance Officer;
- Performed environmental monitoring, including surface water (turbidity), air quality, and sediment removal verification sampling;
- Performed environmental monitoring and residual sand cover thickness verification during residual sand cover placement operation;
- Coordinated on-site sampling activities in accordance with Appendices D and E of the *2007 Pre-Final Design Report and Remedial Action Work Plan*;
- Maintained laboratory test data and results and developed and maintained a Sharepoint Site for data access by GW Partners, the Agencies, and the Agency/Oversight Team;
- Provided technical support to GW Partners; provided 2007 project contract administration, including review and initial approval of Contractor's invoices, change orders, estimates of cost to complete, and pay requests;
- Provided operational liaison services for GW Partners relative to sediment disposal at the Veolia Hickory Meadows Landfill;
- Reported directly to GW Partners' Project Manager and communicated and coordinated their activities with Brennan's Project and/or Site Manager;
- Assisted GW Partners in ongoing communication with USEPA and WDNR regarding project performance and other issues as requested; and,
- Contributed major sections of and produced this 2007 Remedial Action Summary Report.

Quality Assurance Bathymetric Survey

In addition to the activities described above, Foth was also responsible for the Quality Assurance (QA) bathymetric survey to verify attainment of the modeled 1.0 ppm PCB RAL elevation. A baseline existing conditions (or pre-dredge) QA bathymetric survey was conducted prior to dredging by Brennan with direct oversight by Foth in areas anticipated for dredging in 2007. This survey was the basis for volume computations for the 2007 dredging work.

Following completion of dredging in sub-areas or dredge management units (DMU), a QA bathymetric survey of the sediment surface was performed by Brennan with direct oversight by Foth for confirmation that the design target elevations were achieved. This survey was also used

by Foth to document the post-dredge sediment bed elevation and, in conjunction with the baseline existing conditions survey, used to calculate the sediment volumes removed during dredging.

QA bathymetric surveys were performed following the general procedures described by Engineering and Design – Hydrographic Surveying (USACE Manual No. 1110-2-1003, 2004), and were integrated with Brennan's dredging process.

2.2.4 GW Partners' Geotechnical/Disposal Support—STS Consultants, Ltd.

STS performed the following tasks during the 2007 RA:

- Provided technical support and assistance in geotechnical sampling and coordination related to the geotextile tubes;
- Provided technical assistance in coordinating disposal of non-TSCA sediment at the Veolia Hickory Meadows Landfill, including sediment placement at the landfill; and,
- Contributed to this 2007 Remedial Action Summary Report.

2.2.5 GW Partners' Subcontractors

2.2.5.1 Gene Frederickson Trucking

Gene Frederickson Trucking, as a Direct Contractor to GW Partners, provided trucks for non-TSCA sediment hauling to the Veolia Hickory Meadows Landfill Facility for disposal.

2.2.5.2 Schroeder Environmental Cleaning Services

Schroeder Environmental Cleaning Services, as a subcontractor to Gene Frederickson Trucking, provided decontamination services for the trucks that hauled the sediment.

2.2.5.3 Veolia Environmental Services Hickory Meadows Landfill, LLC

Veolia Environmental Services, as a direct contractor to GW Partners, provided for non-TSCA sediment disposal at its Veolia Hickory Meadows Landfill facility.

2.2.5.4 EQ Wayne Disposal

EQ Wayne Disposal, as a direct contractor to GW Partners, was available for transportation and disposal services for TSCA sediment at the EQ Wayne Disposal Landfill site in Belleville, Michigan. There were no TSCA sediments identified during the 2007 RA.

2.3 J.F. Brennan

Brennan was the Supervising Contractor for the 2007 RA. As such, Brennan managed on-site activities and performed the 2007 RA on behalf of GW Partners. The following subsections summarize the responsibilities of key Brennan personnel who performed the RA.

2.3.1 Brennan Project Manager—Vic Buhr

Vic Buhr, Brennan's Project Manager, performed the following tasks during the 2007 RA:

- Provided overall direction and management of 2007 RA project activities on site (except transport and disposal of dewatered sediment which was outside the scope of the Brennan contract);
- Communicated to GW Partners' Project Coordinator and Project Manager regarding project progress and issues needing their involvement for resolution;
- Prepared and implemented contingency plans for health and safety emergencies;
- Prepared and implemented contingency plans for emergencies involving a potential release of waste materials as described in the Consent Decree;
- Managed Brennan's subcontractors' work;
- Performed administrative and decision-making activities;
- Implemented health and safety plans;
- Assisted in preparing monthly RA progress reports;
- Maintained updates to the construction schedule;
- Prepared and submitted monthly invoices to GW Partners;
- Assisted GW Partners, as requested, with communication with the public and press;
- Assisted GW Partners, as requested, with coordination of ongoing activities with neighbors and addressed neighbor concerns;
- Facilitated RA coordination between Brennan and external organizations, such as subcontractors and regulatory agencies;
- Coordinated with the Construction Quality Assurance Officer;
- Monitored geotextile tube, Water Treatment Plant (WTP), and dredging optimization; and,
- Assisted GW Partners in ongoing communication with USEPA and WDNR regarding project status and technical issues, as requested.

2.3.2 Brennan Site Manager—Greg Smith

Greg Smith, Brennan's Site Manager, performed the following tasks during the 2007 RA:

- Managed RA on-site activities;
- Instructed and coordinated activities with field staff;
- Coordinated subcontractor and Brennan schedules;
- Ensured that field activities were conducted in accordance with the *2007 Pre-Final Design Report and Remedial Action Work Plan;*
- Ensured that field staff were properly trained to perform field activities in accordance with the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a), possessed proper certification (e.g., current Hazardous Waste Operations and Emergency Response [HAZWOPER] training), and complied with medical monitoring requirements;
- Inspected and accepted supplies and equipment;
- Communicated construction and operations issues to the project team;
- Performed oversight of subcontractor activities;
- Notified Engineer when QA bathymetric surveys were required; and
- Contributed to the preparation of the *2007 Pre-Final Design Report and Remedial Action Work Plan*.

2.3.3 Brennan Operations Manager—Kevin Zenke

Kevin Zenke, Brennan's Operational Manager, performed the following tasks during the 2007 RA:

- Managed RA operational activities on site;
- Coordinated subcontractor work;
- Performed oversight of all operations on site with regards to safety and quality; and,
- Interacted with GW Partners and the Agencies to ensure that all parties are properly briefed on operations.

2.3.4 Brennan Subcontractors

The main Brennan subcontractors were as follows:

- **Ciba Specialty Chemicals Corporation** provided chemicals and associated consulting services for dewatering and water treatment processes.
- **Miratech** provided the geotextile tubes.
- **Earth Tech** operated the WTP**.**
- **STS Consultants, Ltd.** assisted Brennan in preparing the *2007 Pre-Final Design Report and Remedial Action Work Plan* and contributed to this 2007 Remedial Action Summary Report.

2.4 U.S. Environmental Protection Agency

2.4.1 USEPA Project Coordinator—Jim Hahnenberg

Jim Hahnenberg performed the following tasks during the 2007 RA:

- Reviewed all project deliverables and plans and/or approved project strategies;
- Reviewed and approved the *2007 Pre-Final Design Report and Remedial Action Work Plan;*
- Provided technical assistance to WDNR and GW Partners' Project Coordinator;
- Reviewed progress reports detailing work accomplished;
- Reviewed and provided comments on all reports in draft version prior to their finalization; and,
- Provided USEPA approval of final reports.

2.4.2 USEPA Quality Assurance Reviewer—Richard Byvik

Richard Byvik reviewed the Operations and Maintenance QAPP. (Appendix C, *2007 Pre-Final Design Report and Remedial Action Work Plan* [Foth, et al., 2007a])

2.5 Wisconsin Department of Natural Resources

2.5.1 WDNR's Project Coordinator—Greg Hill

Greg Hill performed the following tasks during the 2007 RA:

- Reviewed all project deliverables and plans and/or approved project strategies;
- Directed *2007 Pre-Final Design Report and Remedial Action Work Plan* review and approval;

- Provided technical assistance to USEPA and GW Partners' Project Coordinators;
- Reviewed progress reports detailing work accomplished;
- Reviewed and provided comments on all reports in draft version prior to their finalization; and,
- Provided WDNR approval of final reports.

2.5.2 WDNR's Oversight Contractor—The Boldt Company

The Boldt Company (Boldt) and its subcontractors, Boldt Oversight Team, is the WDNR's designated Oversight Contractor. They provided technical assistance to WDNR during the 2007 RA.

2.6 Communications

2.6.1 Monthly Progress Reports

As required by the Consent Decree, the Project Coordinator provided written progress reports to USEPA and WDNR by the 10th day of every month.

2.6.2 Quarterly Reports

As required by the Consent Decree, GW Partners provided written quarterly reports to USEPA and WDNR according to the schedule listed in the Consent Decree. Quarterly reports were submitted as follows: the first quarter report by May 1, 2007, the second quarter report by August 1, 2007, the third quarter report by November 1, 2007, and the fourth quarter report by February 1, 2008.

2.6.3 Meetings

2.6.3.1 Management Meetings

The Project Coordinators held progress report meetings/telephone conferences at least monthly.

Project management meetings were held at the site weekly or according to a schedule agreed to by GW Partners' representatives, Brennan's Project Manager, and the WDNR and USEPA Project Coordinators. At a minimum, Brennan's Site Manager; GW Partners' Project Manager, GW Partners' Project Coordinator, Foth and representatives from USEPA, WDNR, and/or its Oversight Contractor attended the meetings. The purpose of the project management meetings was to:

- Provide a brief summary of weekly coordination meetings, as needed.
- Identify significant issues during the 2007 remedial activities, such as issues with significant cost implications (greater than $10,000), circumstances that may require a change in the *2007 Pre-Final Design Report and Remedial Action Work Plan*, or that impact the schedule, or issues that affect the work anticipated for 2007 and beyond.

- Discuss a framework and schedule for resolving significant issues.

- Discuss any communications issues or concerns with reporting to the Agency/Oversight Contractor and potential solutions.

2.6.3.2 Weekly Status Meetings

Weekly coordination meetings were held at the site and included representatives of Brennan, Foth, GW Partners, CH2M HILL, and regulatory agencies. GW Partners was responsible for recording and distributing meeting minutes.

The purpose of coordination meetings was to:

- Review the current activities and accomplishments;
- Review environmental monitoring;
- Discuss existing or potential problems and solutions; and,
- Review plans for the upcoming period.

2.6.3.3 Daily Meetings

Daily progress meetings were held at the project site and included representatives of Brennan, Foth, and GW Partners. In addition to representatives of GW Partners, Foth, and Brennan, each subcontractor, supplier, or other entity concerned with current operations or involved in planning, coordination, or performance of future activities were represented at these meetings. Brennan, in conjunction with GW Partners, conducted the meeting and provided a brief summary of the meeting highlights in their daily report.

3 2007 RA Project Schedule

The 2007 RA schedule is depicted on Figure 3-1. Key schedule milestone dates were as follows:

- March 12, 2007 – Initiate mobilization
- April 2, 2007 – Initiate dredging
- July 9, 2007 – Initiate dewatered sediment load out
- November 2, 2007 – Complete dredging
- December – Complete dewatered sediment load out for the year
  (Note: Some sediment remains on the pad to increase percent solids prior to loading and disposal. Hauling in 2008 will allow the pad to be emptied in time for the start of 2008 dewatering operations).

The 2007 RA scheduled key milestone dates were achieved as follows:

- 2007 RA dredging was initiated on April 2, 2007, with one dredge *(Grand Calumet*) in Sub-area A and the other dredge *(Fox River)* in Sub-area D1. A booster pump system was utilized while dredging south of the trestle bridge in Sub-areas A and C. Sediment removal south of the trestle bridge was completed on May 24, 2007.

- After Sub-area C operations concluded on May 24, 2007, the dredge was moved to Sub-area D1. On June 21, 2007, the dredge, *Grand Calumet*, moved into Sub-area E3S and continued to move to the north into Sub-areas E1, E2, E6, E5, and finally back to E3S.

- The dredge*, Fox River,* began the dredging season in Sub-area D1 concentrating on the shore line areas that could only be dredged during high water. Once these areas were complete, the dredge was moved to Sub-area POG1 to dredge the shoreline areas. Once these areas were completed on May 21, 2007, the dredge moved north into Sub-area POG3 South, continuing north into POG3 North. POG3 North was completed on June 28, 2007, and the dredge was then moved back to Sub-area D1 where it had been dredging prior to moving to POG1.

- The dredge, *Fox River,* completed dredging in Sub-area D1 on September 7, 2007 and then moved into Sub-area E3S where it remained until the winter shutdown.

- Sediment load-out began on July 9, 2007 and is planned to be completed by the end of February 2008. Dewatered sediments will be removed from the pad in advance of any preparation work that needs to be accomplished prior to dredging during the 2008 season.

The WTP operated on a 24 hour/day basis 5 days/week until the dredging was completed. The WTP then operated intermittently to treat water collected from the dewatering and decontamination operations as well as stormwater that accumulated on the dewatering pad. A Photo Log containing photographs of 2007 field activities is provided as Appendix A.

4 Dredging

4.1 Dredge Areas

Fifteen sub-areas within LLBdM were identified for potential sediment removal in 2007: Seven sub-areas, A, C, POG1, POG2, POG3 North, POG3 South, and POG4 South, had been previously dredged in 2004, 2005, or 2006 and contained residual PCBs or included shoreline areas not previously dredged due to inadequate water depth. Eight sub-areas, D1, E1, E2, E3S, E3N, E5, E6, and F, were dredged for the first time in 2007. Sub-area POG3 North contained residual dredge areas as well as first time dredge areas. The planned removal limits for 2007 are shown on Figures 4-1 and 4-2, and the actual removal limits are shown on Figures 4-3 and 4-4. These sub-areas were delineated based on LLBdM's existing sediment PCB data and its hydrodynamic and bathymetric properties. Due to changes to the 2007 dredge plan, summarized in Appendix G and M of the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a), no dredging was completed within Sub-areas E3N, POG2 or POG4 South during the 2007 dredge season. A schedule of the completed 2007 dredging is provided in Table 4-1.

Table 4-1
2007 Dredge Schedule

Area	Start	Completion
A	2-April	11-May
C	11-May	24-May
D1	2-April	7-Sept
E1	12-July	2-Aug
E2	27-July	29-Oct
E3S	14-June	2-Nov
E5	11-Sept	12-Sept
E6	15-Aug	14-Sept
F	1-Oct	18-Oct
POG1	7-May	21-May
POG3 South	21-May	22-May
POG3 North	22-May	26-June

Prepared by: TRL
Checked by: GMS

The surface areas and associated sediment removal volumes for the 12 sub-areas dredged in 2007 were estimated based upon approved methodologies presented in the *2005 Basis of Design Report* (BODR) (CH2M HILL, 2005). The modeling procedure used to generate the OU1 dredge prisms, including the 2007 dredge areas, was fully described in the January 2005 Foth White Paper titled, *Development of Sediment Prisms in Lower Fox River OU1* (BODR, Appendix D), as well as in the June 13, 2007 Foth memorandum to Bill Hartman titled *Proposed OU1 Dredge Prism Model Recharacterization for 2007 RA* (Appendix L of the *2007 Pre-Final Design Report and Remedial Action Work Plan* [Foth, et al., 2007a]). The nature of the modeling

process results in conservative estimates of the 1.0 ppm PCB RAL dredge limits as confirmed in the August 7, 2006 joint WDNR Oversight Contractor/Foth memorandum regarding *Clarification on Defining Dredge Neat Line Using GMS.* This memorandum is included as Attachment B-4, in Appendix B of the *LFR OU1 Remedial Action and 2006 Remedial Summary Report* (Foth, et al., 2007b).

These estimates along with the actual 2007 dredge volumes are summarized in Table 4-2. Table 4-3 provides a more detailed accounting of the dredge areas and volumes by DMU.

Table 4-2
2007 Dredge Removal Areas and Volumes

Sub-area	2007 RAWP Planned Surface Area of 1.0 ppm PCB Target (ac)	2007 RAWP Planned Volume to 1.0 ppm PCB Target (cy)	Revised Final Design Surface Area to 1.0 ppm PCB Target (ac)	Revised Final Design Volume to 1.0ppm Target (cy)	Revised Final Design Planned 4 inch Overcut Volume (cy)	Revised Final Design Planned Total Volume[3] (cy)	2007 Actual Surface Area Dredged[4] (ac)	2007 Actual Dredged Volume to 1.0 ppm PCB Target (cy)	Actual Dredged Volume including Overcut[3] (cy)
A	10.4	4,815	10.4	4,815	5,594	10,409	10.0	2,994	7,446
C	4	2,658	4	2,658	2,128	4,786	3.8	2,827	5,534
D1	22.5	24,344	28.6	31,047	15,357	46,404	28.3	15,869	23,521
D1 Re-dredge	--	--	--	--	--	--	0.2	0.24	152
E1	2.6	4,920	2.6	4,920	1,401	6,321	2.6	4,943	6,463
E2[1]	2.0	7,036	2.6	8,263	1,389	9,652	2.7	5,352	6,924
E2 Re-dredge	--	--	--	--	--	--	0.5	0.48	764
E3S	4.2	5,263	46.3	57,445	24,931	82,376	27.1	28,476	36,192
E3S Re-dredge	--	--	--	--	--	--	0.1	0.08	133
E3N	--	--	1.0	1,288	545	1,833	0	0	0
E5[2]	0.8	392	0.8	392	423	815	0.8	46	580
E6	5.9	10,811	5.9	10,811	3,163	13,974	5.9	9,143	11,606
F	--	--	0.1	44	22	66	0.1	35	57
POG1	3.3	399	3.3	399	1,751	2,150	3.0	1,238	3,042
POG2	3.7	6,881	3.7	6,881	1,983	8,864	0	0	0
POG3 South	0.3	203	0.3	203	169	372	0.3	149	210
POG3 North	8.8	9,949	8.8	9,949	4,723	14,672	8.8	13,827	19,186
POG4 South	0.2	410	0.2	410	122	532	0	0	0
Totals	**68.7**	**78,081**	**118.3**	**139,525**	**63,701**	**203,226**	**93.4**	**84,899**	**121,810**

[1] – Includes 0.04 acres in Sub-area E3N
[2] – Includes 0.01 acres in Sub-area E4
[3] – Includes allowances for 4 inch overcut
[4] – Total excludes re-dredge areas acreage
ac = acres
cy = cubic yards

Prepared by: SVF
Checked by: DMR

Note that with the 2007 RA mid-season addition of Dredge Management Units (DMU) in Sub-areas D1, E3S, and E3N not all of the areas listed in Table 4-2 were dredged in 2007, as described in Appendix G of the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a). Specifically, no dredging occurred in Sub-areas E3N, POG2, or POG4 South and approximately one third of the DMUs in Sub-area E3S. These areas will be dredged during 2008.

However, it should be noted that the *Draft 2007 Pre-Final Design Report and Remedial Action Work Plan* (March 2007) planned dredge volume and area to 1.0 ppm PCB target elevation was 78,081 cy and 68.7 acres, respectively (Table 4-2). The 2007 actual dredged volume to target elevation (84,899 cy) exceeded the original plan by 6,818 cy. The actual area dredged (93.4 acres) exceeded the original plan by 24.7 acres.

Within some DMUs dredged in 2007 (Table 4-3), the actual dredge volume (including overcut) is less than the planned value. This difference can be attributed to the following factors:

- Native red clay or other dense native material was encountered at depths shallower than the 1.0 ppm modeled dredge cut. This high subgrade was not dredged after it was confirmed as native material. Areas of high subgrade did not contribute to overcut volumes.

- In some areas where high subgrade was not present, the dredge operators were able to make a cut to the 1.0 ppm PCB target elevation with less than the anticipated 4 inch overcut.

The following sub-sections provide the location of figures documenting 2007 dredging operations. Tables 4-2 and 4-3 summarize the dredge areas and volumes by sub-area and DMU, respectively.

Table 4-3
OU1 2007 Remedial Action Dredging Summary by DMU

Sub-area Location	Last QA Survey Date	DMU Status (Complete/ In-Progress	DMU Volume (cy) from `07 RAWP)[1]	DMU Area (sq ft)[1]	Area Dredged At or Below Target Elevation (sq ft)[2]	Confirmed High Sub-Grade Area (sq ft)[2]	Actual 2007 Area Dredged (sq ft)[2]	Percent of DMU At or Below Target Elevation[3]	DMU Volume of Planned Overcut (cy)[4]	Volume of Planned Overcut Dredged (cy)	Volume of Sediment Removed Below Planned 4" Overcut (cy)	Average Dredge Overcut (in)[5]	Volume Between 2007 Existing Conditions Survey and GMS 1 ppm Model (cy)[6]	Amount of Sediment Dredged to Target Elevation (cy)	Amount of Material Remaining above Target Elevation (cy)	Total Amount of Sediment Removed (cy)[7]
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
								(F+G)/H	[H*(4"/12")] /27			{[(K+L)*27]/F}*12			(N-O)	(K+L+O]
Sub-area A																
RDMU-1A	4/18/2007	Complete	618	45,453	33,172	8,737	41,909	100.0%	517	327	100	4.2	450	287	163	714
RDMU-2A	4/18/2007	Complete	590	43,997	33,748	7,101	40,849	100.0%	504	308	95	3.9	480	406	74	809
RDMU-3A	4/27/2007	Complete	432	48,147	39,621	6,295	46,373	99.0%	573	407	171	4.7	341	304	37	882
RDMU-4A	4/27/2007	Complete	509	57,821	47,399	5,860	53,453	99.6%	660	531	481	6.9	353	315	38	1,327
RDMU-5A	5/3/2007	Complete	438	26,263	12,396	11,524	24,842	96.3%	307	117	47	4.3	338	163	175	327
RDMU-6A	5/3/2007	Complete	648	54,184	29,698	22,724	52,812	99.3%	652	272	213	5.3	596	277	319	762
RDMU-7A	5/7/2007	Complete	310	47,572	36,921	10,227	47,572	99.1%	587	306	84	3.4	393	318	75	708
RDMU-8A	5/7/2007	Complete	376	44,181	37,125	5,847	44,181	97.3%	545	334	90	3.7	420	364	56	788
RDMU-9A	5/9/2007	Complete	638	54,086	32,609	19,242	54,086	95.9%	668	266	62	3.3	596	414	182	742
RDMU-10A	5/15/2007	Complete	256	31,414	14,653	15,882	31,414	97.2%	388	156	85	5.3	256	146	110	387
Sub-area Total			4,815	453,118	317,342	113,439	437,491	98.5%	5,401	3,024	1,428	4.5	4,223	2,994	1,229	7,446
Sub-area C																
RDMU-1C	5/21/2007	Complete	325	21,664	8,373	7,366	15,739	100.0%	194	90	119	8.1	233	148	85	357
RDMU-2C	5/24/2007	Complete	310	20,573	19,151	1,422	20,573	100.0%	254	209	110	5.4	289	277	12	596
RDMU-3C	5/23/2007	Complete	597	49,032	47,823	0	49,032	97.5%	605	551	580	7.7	674	663	11	1,794
RDMU-4C	5/21/2007	Complete	235	11,645	8,571	2,052	10,623	100.0%	131	92	124	8.2	199	188	11	404
RDMU-5C-A	5/25/2007	Complete	273	12,810	8,537	2,942	11,479	100.0%	142	83	177	9.9	257	239	18	499
RDMU-5C-B	5/25/2007	Complete	420	23,570	18,226	5,344	23,570	100.0%	291	153	45	3.5	644	597	47	795
RDMU-6C	5/17/2007	Complete	498	33,082	27,947	5,135	33,082	100.0%	408	270	104	4.3	755	715	40	1,089

Sub-area Location	Last QA Survey Date	DMU Status (Complete/ In-Progress	DMU Volume (cy) from `07 RAWP)[1]	DMU Area (sq ft)[1]	Area Dredged At or Below Target Elevation (sq ft)[2]	Confirmed High Sub-Grade Area (sq ft)[2]	Actual 2007 Area Dredged (sq ft)[2]	Percent of DMU At or Below Target Elevation[3]	DMU Volume of Planned Overcut (cy)[4]	Volume of Planned Overcut Dredged (cy)	Volume of Sediment Removed Below Planned 4" Overcut (cy)	Average Dredge Overcut (in)[5]	Volume Between 2007 Existing Conditions Survey and GMS 1 ppm Model (cy)[6]	Amount of Sediment Dredged to Target Elevation (cy)	Amount of Material Remaining above Target Elevation (cy)	Total Amount of Sediment Removed (cy)[7]
Sub-area Total			2,658	172,376	138,628	24,261	164,098	99.3%	2,026	1,448	1,259	6.3	3,051	2,827	224	5,534
Sub-area D1																
DMU-1D1	4/19/2007	Complete	508	6,922	6,869	0	6,922	99.2%	85	55	102	7.4	72	67	5	224
DMU-2D1	5/10/2007	Complete	1,713	43,351	17,576	18,456	37,540	96.0%	463	155	78	4.3	626	340	286	573
DMU-3D1	4/27/2007	Complete	527	46,632	42,162	2,343	46,632	95.4%	576	331	158	3.8	80	25	55	514
DMU-6D1	5/10/2007	Complete	834	42,498	14,119	21,759	37,702	95.2%	465	74	2	1.7	407	180	227	256
DMU-14D1-A	8/24/2007	Complete	413	13,500	6,565	6,935	13,500	100.0%	167	65	93	7.8	298	140	158	298
Shoreline DMUs Sub-Total			3,995	152,903	87,291	49,493	142,296	96.1%	1,757	680	433	4.1	1,483	752	731	1,865
DMU-4D1	6/29/2007	Complete	979	35,582	9,970	25,309	35,582	99.1%	439	60	6	2.1	547	299	248	365
DMU-5D1	6/29/2007	Complete	1,105	37,899	10,320	26,229	37,899	96.4%	468	84	21	3.3	665	343	322	448
DMU-7D1	6/29/2007	Complete	1,102	46,480	8,199	37,082	46,480	97.4%	574	47	10	2.3	552	209	343	266
DMU-8D1	7/19/2007	Complete	1,106	43,933	38,900	4,024	43,933	97.7%	542	309	48	3.0	650	636	14	993
DMU-9D1	7/19/2007	Complete	1,512	43,855	43,209	0	43,855	98.5%	541	451	135	4.4	1,332	1,329	3	1,915
DMU-10D1	7/19/2007	Complete	1,224	45,573	45,015	0	45,573	98.8%	563	408	60	3.4	1,009	1,002	7	1,470
DMU-11D1	8/7/2007	Complete	1,048	44,657	13,225	31,432	44,657	100.0%	551	53	2	1.3	715	479	236	534
DMU-12D1	8/2/2007	Complete	1,099	50,183	25,032	23,035	50,064	96.0%	618	138	15	2.0	792	633	159	786
DMU-13D1	8/7/2007	Complete	1,278	49,682	10,824	38,858	49,682	100.0%	613	35	1	1.1	986	714	272	750
DMU-14D1-B	8/15/2007	Complete	1,277	34,479	1,989	32,490	34,479	100.0%	426	5	0	0.8	1,069	675	394	680
DMU-15D1	8/15/2007	Complete	1,167	45,213	9,430	35,783	45,213	100.0%	558	31	0	1.1	932	674	258	705
DMU-16D1	8/15/2007	Complete	1,438	39,323	2,535	36,788	39,323	100.0%	485	16	0	2.0	1,246	795	451	811
DMU-17D1	7/30/2007	Complete	911	38,766	2,094	36,672	38,766	100.0%	479	11	2	2.0	758	326	432	339
DMU-18D1	6/21/2007	Complete	402	18,266	5,586	12,388	18,266	98.4%	226	59	8	3.9	263	188	75	255
DMU-19D1	6/13/2007	Complete	1,054	45,038	9,123	33,848	45,038	95.4%	556	53	18	2.5	854	519	335	590
DMU-20D1	6/13/2007	Complete	963	46,144	5,626	38,494	46,144	95.6%	570	18	0	1.0	924	516	408	534
DMU-21D1	6/13/2007	Complete	1,032	48,510	2,886	43,328	48,510	95.3%	599	11	0	1.2	932	469	463	480

Sub-area Location	Last QA Survey Date	DMU Status (Complete/ In-Progress	DMU Volume (cy) from `07 RAWP)[1]	DMU Area (sq ft)[1]	Area Dredged At or Below Target Elevation (sq ft)[2]	Confirmed High Sub-Grade Area (sq ft)[2]	Actual 2007 Area Dredged (sq ft)[2]	Percent of DMU At or Below Target Elevation[3]	DMU Volume of Planned Overcut (cy)[4]	Volume of Planned Overcut Dredged (cy)	Volume of Sediment Removed Below Planned 4" Overcut (cy)	Average Dredge Overcut (in)[5]	Volume Between 2007 Existing Conditions Survey and GMS 1 ppm Model (cy)[6]	Amount of Sediment Dredged to Target Elevation (cy)	Amount of Material Remaining above Target Elevation (cy)	Total Amount of Sediment Removed (cy)[7]
DMU-22D1	7/3/2007	Complete	209	14,147	12,696	1,451	14,147	100.0%	175	123	22	3.7	28	23	5	168
DMU-23D1	7/25/2007	Complete	283	24,080	23,338	0	24,080	96.9%	297	232	126	5.0	189	187	2	545
DMU-24D1	7/30/2007	Complete	477	36,291	27,331	7,514	36,291	96.0%	448	183	6	2.2	309	262	47	451
DMU-25D1	6/21/2007	Complete	683	38,580	26,933	11,647	38,580	100.0%	476	198	91	3.5	523	407	116	696
DMU-26D1	8/21/2007	Complete	875	38,519	37,234	0	38,519	96.7%	476	360	139	4.3	578	574	4	1,073
DMU-27D1	8/31/2007	Complete	974	32,387	30,941	0	32,387	95.5%	400	279	103	4.0	746	741	5	1,123
DMU-28D1	9/12/2007	Complete	598	34,439	32,307	1,717	34,439	98.8%	425	323	98	4.2	494	478	16	899
DMU-29D1	9/7/2007	Complete	776	38,875	36,647	707	38,875	96.1%	480	384	194	5.1	510	496	14	1,074
DMU-30D1	9/7/2007	Complete	1,137	39,596	38,811	0	39,596	98.0%	489	413	196	5.1	715	710	5	1,319
DMU-31D1	8/31/2007	Complete	1,363	38,111	37,708	0	38,111	98.9%	471	424	255	5.8	978	976	2	1,655
DMU-32D1	9/7/2007	Complete	980	42,390	24,615	16,972	42,390	98.1%	523	188	87	3.6	547	457	90	732
Non-Shoreline DMUs Sub-Total			27,052	1,090,998	572,524	495,768	1,090,879	97.9%	13,468	4,896	1,643	3.7	19,843	15,117	4,726	21,656
Sub-area Total			31,047	1,243,901	659,815	545,261	1,233,175	97.7%	15,224	5,576	2,076	3.8	21,326	15,869	5,457	23,521
Sub-area E1																
DMU-1E1	7/23/2007	Complete	1,395	35,261	33,941	0	35,261	96.3%	435	355	176	5.1	1,637	1,627	10	2,158
DMU-2E1	7/25/2007	Complete	2,782	39,414	17,456	21,061	39,414	97.7%	487	154	58	3.9	2,859	2,475	384	2,687
DMU-3E1	7/23/2007	Complete	743	38,775	37,622	0	38,775	97.0%	479	441	336	6.7	857	841	16	1,618
Sub-area Total			4,920	113,450	89,019	21,061	113,450	97.0%	1,401	950	570	5.5	5,353	4,943	410	6,463
Sub-area E2																
DMU-1E2	8/2/2007	Complete	2,913	44,848	21,928	22,920	44,848	100.0%	554	241	208	6.6	3,349	2,233	1,116	2,682
DMU-2E2	8/15/2007	Complete	1,165	46,755	45,266	0	46,755	96.8%	577	424	131	4.0	1,645	1,639	6	2,194
DMU-3E2	10/29/2007	Complete	1,227	25,432	25,082	0	25,432	98.6%	314	295	273	7.3	1,483	1,480	3	2,048
Sub-area Total			5,305	117,035	92,276	22,920	117,035	98.4%	1,445	960	612	5.5	6,477	5,352	1,125	6,924

Sub-area Location	Last QA Survey Date	DMU Status (Complete/ In-Progress	DMU Volume (cy) from `07 RAWP)[1]	DMU Area (sq ft)[1]	Area Dredged At or Below Target Elevation (sq ft)[2]	Confirmed High Sub-Grade Area (sq ft)[2]	Actual 2007 Area Dredged (sq ft)[2]	Percent of DMU At or Below Target Elevation[3]	DMU Volume of Planned Overcut (cy)[4]	Volume of Planned Overcut Dredged (cy)	Volume of Sediment Removed Below Planned 4" Overcut (cy)	Average Dredge Overcut (in)[5]	Volume Between 2007 Existing Conditions Survey and GMS 1 ppm Model (cy)[6]	Amount of Sediment Dredged to Target Elevation (cy)	Amount of Material Remaining above Target Elevation (cy)	Total Amount of Sediment Removed (cy)[7]
Sub-area E3S																
DMU-1E3S	6/19/2007	Complete	667	33,798	15,418	18,380	33,798	100.0%	417	99	15	2.4	784	652	132	766
DMU-2E3S	6/26/2007	Complete	900	28,691	2,232	26,459	28,691	100.0%	354	11	1	1.7	978	574	404	586
DMU-3E3S	6/26/2007	Complete	1,241	51,338	22,382	28,956	51,338	100.0%	634	120	2	1.8	1,504	1,152	352	1,274
DMU-4E3S	7/23/2007	Complete	2,313	54,838	48,139	5,634	54,838	98.1%	677	488	214	4.7	2,502	2,445	57	3,147
DMU-5E3S	8/7/2007	Complete	142	14,953	2,647	12,306	14,953	100.0%	185	15	2	2.1	208	75	133	92
DMU-6E3S	9/20/2007	Complete	753	32,473	27,692	4,781	32,473	100.0%	401	237	45	3.3	681	645	36	927
DMU-7E3S	9/20/2007	Complete	1,726	57,078	46,976	9,240	57,078	98.5%	705	333	67	2.8	1,658	1,577	81	1,977
DMU-8E3S	9/12/2007	Complete	1,008	39,067	35,281	3,368	39,067	98.9%	482	342	122	4.3	849	818	31	1,282
DMU-9E3S			1,049	39,618												
DMU-10E3S	10/22/2007	Complete	985	36,030	13,160	22,506	36,030	99.0%	445	47	2	1.2	935	760	175	809
DMU-11E3S	10/10/2007	Complete	789	33,766	24,788	7,309	33,766	95.1%	417	232	73	4.0	762	683	79	988
DMU-12E3S	10/23/2007	Complete	913	34,685	27,103	5,837	34,685	95.0%	428	151	10	1.9	883	843	40	1,004
DMU-13E3S	10/29/2007	Complete	1,437	42,931	19,071	22,906	42,931	97.8%	530	110	11	2.1	1,424	1,250	174	1,371
DMU-14E3S	10/24/2007	Complete	1,270	43,209	12,400	28,715	43,209	95.2%	533	50	2	1.4	1,207	1,124	83	1,176
DMU-15E3S	10/23/2007	Complete	1,142	42,687	24,615	16,972	42,687	97.4%	527	188	87	3.6	547	457	90	732
DMU-16E3S	10/22/2007	Complete	1,429	51,222	33,414	16,242	51,222	96.9%	632	235	21	2.5	1,307	1,212	95	1,468
DMU-17E3S			1,692	52,543												
DMU-18E3S	10/26/2007	Complete	1,340	51,869	32,658	18,051	51,869	97.8%	640	193	26	2.2	1,292	1,164	128	1,383
DMU-19E3S			1,350	51,145												
DMU-20E3S			1,162	47,774												
DMU-21E3S			1,438	49,448												
DMU-22E3S			1,135	48,974												
DMU-23E3S			1,483	46,008												
DMU-24E3S			1,354	46,532												

Sub-area Location	Last QA Survey Date	DMU Status (Complete/ In-Progress	DMU Volume (cy) from `07 RAWP)[1]	DMU Area (sq ft)[1]	Area Dredged At or Below Target Elevation (sq ft)[2]	Confirmed High Sub-Grade Area (sq ft)[2]	Actual 2007 Area Dredged (sq ft)[2]	Percent of DMU At or Below Target Elevation[3]	DMU Volume of Planned Overcut (cy)[4]	Volume of Planned Overcut Dredged (cy)	Volume of Sediment Removed Below Planned 4" Overcut (cy)	Average Dredge Overcut (in)[5]	Volume Between 2007 Existing Conditions Survey and GMS 1 ppm Model (cy)[6]	Amount of Sediment Dredged to Target Elevation (cy)	Amount of Material Remaining above Target Elevation (cy)	Total Amount of Sediment Removed (cy)[7]
DMU-25E3S			1,286	45,218												
DMU-26E3S			1,280	47,279												
DMU-27E3S	11/7/2007	Complete	1,238	46,201	45,095	0	46,201	97.6%	570	446	157	4.3	1,150	1,142	8	1,745
DMU-28E3S	11/7/2007	Complete	1,325	46,782	45,223	0	46,782	96.7%	578	426	172	4.3	1,139	1,130	9	1,728
DMU-29E3S	10/31/2007	Complete	1,390	48,329	40,694	6,998	48,329	98.7%	597	341	103	3.5	1,363	1,313	50	1,757
DMU-30E3S	10/30/2007	Complete	1,498	47,089	37,130	9,571	47,089	99.2%	581	277	50	2.9	1,386	1,332	54	1,659
DMU-31E3S	10/24/2007	Complete	1,340	49,858	37,355	12,503	49,858	100.0%	616	221	24	2.1	1,329	1,278	51	1,523
DMU-32E3S	10/24/2007	Complete	1,296	47,997	32,626	15,371	47,997	100.0%	593	184	7	1.9	1,205	1,144	61	1,335
DMU-33E3S	10/24/2007	Complete	1,468	50,706	37,677	12,959	50,706	99.9%	626	270	39	2.7	1,382	1,304	78	1,613
DMU-34E3S	10/1/2007	Complete	1,243	46,568	36,948	7,830	46,568	96.2%	575	299	42	3.0	1,188	1,106	82	1,447
DMU-35E3S	10/22/2007	Complete	1,448	48,974	28,384	20,314	48,974	99.4%	605	212	26	2.7	1,389	1,236	153	1,474
DMU-36E3S	9/24/2007	Complete	1,231	46,254	28,905	15,058	46,254	95.0%	571	183	12	2.2	1,141	1,032	109	1,227
DMU-37E3S	10/24/2007	Complete	1,390	54,026	44,216	9,810	54,026	100.0%	667	490	184	4.9	1,048	1,028	20	1,702
DMU-38E3S			1,373	40,391												
DMU-39E3S			1,094	39,860												
DMU-40E3S			1,285	33,858												
DMU-41E3S			1,075	33,769												
DMU-42E3S			1,094	41,032												
DMU-43E3S			1,207	45,190												
DMU-44E3S			1,343	45,193												
DMU-45E3S			1,464	43,065												
DMU-46E3S			1,359	41,145												
Sub-area Total			57,445	2,019,461	802,229	358,076	1,181,419	98.2%	14,585	6,200	1,516	3.1	31,241	28,476	2,765	36,192

Sub-area Location	Last QA Survey Date	DMU Status (Complete/ In-Progress	DMU Volume (cy) from `07 RAWP)[1]	DMU Area (sq ft)[1]	Area Dredged At or Below Target Elevation (sq ft)[2]	Confirmed High Sub-Grade Area (sq ft)[2]	Actual 2007 Area Dredged (sq ft)[2]	Percent of DMU At or Below Target Elevation[3]	DMU Volume of Planned Overcut (cy)[4]	Volume of Planned Overcut Dredged (cy)	Volume of Sediment Removed Below Planned 4" Overcut (cy)	Average Dredge Overcut (in)[5]	Volume Between 2007 Existing Conditions Survey and GMS 1 ppm Model (cy)[6]	Amount of Sediment Dredged to Target Elevation (cy)	Amount of Material Remaining above Target Elevation (cy)	Total Amount of Sediment Removed (cy)[7]
Sub-area E3N																
DMU-1E3N			1288	44,114												
Sub-area Total			1,288	44,114												
Sub-area E5																
DMU-1E5	9/13/2007	Complete	392	34,272	28,370	3,518	34,272	93.0%	423	290	244	6.1	411	46	365	580
Sub-area Total			392	34,272	28,370	3,518	34,272	93.0%	423	290	244	6.1	411	46	365	580
Sub-area E6																
DMU-1E6	8/29/2007	Complete	1,367	50,284	2,656	45,293	50,284	95.4%	621	20	16	4.4	1,628	415	1,213	451
DMU-2E6	8/30/2007	Complete	1,680	52,896	33,086	18,509	52,896	97.5%	653	305	122	4.2	1,574	1,342	232	1,769
DMU-3E6	8/30/2007	Complete	2,825	46,968	35,268	10,145	46,968	96.7%	580	363	166	4.9	2,792	2,461	331	2,990
DMU-4E6	9/11/2007	Complete	3,836	56,100	53,267	0	56,100	95.0%	693	542	272	5.0	3,882	3,867	15	4,681
DMU-5E6	9/14/2007	Complete	1,103	49,961	38,031	11,059	49,961	98.3%	617	391	266	5.6	1,272	1,058	214	1,715
Sub-area Total			10,811	256,209	162,308	85,006	256,209	96.5%	3,163	1,621	842	4.9	11,148	9,143	2,005	11,606
Sub-area F																
DMU-1F	10/22/2007	Complete	44	1,784	1,700	84	1,784	100.0%	22	14	8	4.2	36	35	1	57
Sub-area Total			44	1,784	1,700	84	1,784	100.0%	22	14	8	4.2	36	35	1	57
Sub-area POG1																
RDMU-1 POG1	5/16/2007	Complete	173	32,262	20,557	9,178	29,735	100.0%	367	242	88	5.2	386	360	26	690
RDMU-2 POG1	5/16/2007	Complete	68	30,627	25,353	1,987	27,340	100.0%	338	182	124	3.9	274	248	26	554
RDMU-3 POG1	5/17/2007	Complete	78	42,069	40,064	0	42,069	95.2%	519	437	306	6.0	252	234	18	977
RDMU-4 POG1	5/29/2007	Complete	80	36,913	26,010	6,602	34,336	95.0%	424	259	166	5.3	514	396	118	821
Sub-area Total			399	141,871	111,984	17,767	133,480	97.2%	1,648	1,120	684	5.2	1,426	1,238	188	3,042

Sub-area Location	Last QA Survey Date	DMU Status (Complete/ In-Progress	DMU Volume (cy) from `07 RAWP)[1]	DMU Area (sq ft)[1]	Area Dredged At or Below Target Elevation (sq ft)[2]	Confirmed High Sub-Grade Area (sq ft)[2]	Actual 2007 Area Dredged (sq ft)[2]	Percent of DMU At or Below Target Elevation[3]	DMU Volume of Planned Overcut (cy)[4]	Volume of Planned Overcut Dredged (cy)	Volume of Sediment Removed Below Planned 4" Overcut (cy)	Average Dredge Overcut (in)[5]	Volume Between 2007 Existing Conditions Survey and GMS 1 ppm Model (cy)[6]	Amount of Sediment Dredged to Target Elevation (cy)	Amount of Material Remaining above Target Elevation (cy)	Total Amount of Sediment Removed (cy)[7]
Sub-area POG2																
RDMU-1POG2			259	5,250												
RDMU-2POG2			123	2,491												
RDMU-3POG2			184	4,975												
RDMU-4POG2			1,901	38,506												
RDMU-5POG2			1,688	34,156												
RDMU-6POG2			1,284	34,716												
RDMU-7POG2			1,323	35,729												
RDMU-8POG2			119	4,801												
Sub-area Total			6,881	160,624												
Sub-area POG3 South																
RDMU-1 POG3S	5/25/2007	Complete	64	7,926	3,907	4,019	7,926	100.0%	98	20	1	1.7	58	36	22	57
RDMU-2 POG3S	6/6/2007	Complete	139	5,791	4,158	1,347	5,791	95.1%	71	34	6	3.1	131	113	18	153
Sub-area Total			203	13,717	8,065	5,366	13,717	97.9%	169	54	7	2.5	189	149	40	210
Sub-area POG3 North																
RDMU-1 POG3N	5/25/2007	Complete	471	25,969	15,241	10,728	25,969	100.0%	321	160	168	7.0	902	751	151	1,079
RDMU-2 POG3N	6/13/2007	Complete	1,072	48,982	27,028	20,188	48,982	96.4%	605	208	281	5.9	1,846	1,454	392	1,943
RDMU Sub-Total			1,543	74,951	42,269	30,916	74,951	97.6%	925	368	449	6.3	2,748	2,205	543	3,022
DMU-35 POG3N	6/14/2007	Complete	1339	43,526	41,232	2,272	43,526	99.9%	537	456	242	5.5	1,833	1,808	25	2,506
DMU-36 POG3N	6/21/2007	Complete	1,165	46,755	45,266	0	46,755	96.8%	577	424	131	4.0	1,645	1,639	6	2,194
DMU-37 POG3N	6/21/2007	Complete	1,370	44,215	43,766	0	44,215	99.0%	546	482	310	5.9	1,818	1,816	2	2,608
DMU-38 POG3N	6/22/2007	Complete	1,317	41,753	41,433	0	41,753	99.2%	515	480	328	6.3	1,761	1,759	2	2,567
DMU-39 POG3N	6/22/2007	Complete	1,222	45,062	44,457	0	45,062	98.7%	556	473	244	5.2	1,717	1,715	2	2,432

Sub-area Location	Last QA Survey Date	DMU Status (Complete/ In-Progress	DMU Volume (cy) from `07 RAWP)[1]	DMU Area (sq ft)[1]	Area Dredged At or Below Target Elevation (sq ft)[2]	Confirmed High Sub-Grade Area (sq ft)[2]	Actual 2007 Area Dredged (sq ft)[2]	Percent of DMU At or Below Target Elevation[3]	DMU Volume of Planned Overcut (cy)[4]	Volume of Planned Overcut Dredged (cy)	Volume of Sediment Removed Below Planned 4" Overcut (cy)	Average Dredge Overcut (in)[5]	Volume Between 2007 Existing Conditions Survey and GMS 1 ppm Model (cy)[6]	Amount of Sediment Dredged to Target Elevation (cy)	Amount of Material Remaining above Target Elevation (cy)	Total Amount of Sediment Removed (cy)[7]
DMU-40 POG3N	6/29/2007	Complete	1,050	45,414	44,585	0	45,414	98.2%	561	434	143	4.2	1,519	1,516	3	2,093
DMU-41 POG3N	6/29/2007	Complete	943	40,920	39,903	0	40,920	97.5%	505	339	56	3.2	1,372	1,369	3	1,764
DMU Sub-Total			8,406	307,645	300,642	2,272	307,645	98.5%	3,798	3,088	1,454	4.9	11,665	11,622	43	16,164
Sub-area Total			9,949	382,596	342,911	33,188	382,596	98.3%	4,723	3,456	1,903	5.1	14,413	13,827	586	19,186
Sub-area POG4 South																
RDMU-1 POG4			410	9,842												
Sub-area Total			410	9,842												
Total			**136,567**	**5,164,370**	**2,754,647**	**1,229,947**	**4,068,726**	**97.9%**	**50,231**	**24,713**	**11,149**	**4.2**	**99,294**	**84,899**	**14,395**	**120,761**

Notes:

RDMU = Residual Dredge Management Unit
DMU = Dredge Management Unit

[1] From 2007 RA Work Plan (to 1.0 ppm RAL)
[2] DMU volumes and areas exclude areas not dredged due to shoreline limitation, set back from structures, etc
[3] Includes areas dredged to target elevation and confirmed high subgrade areas
[4] Planned overcut is the volume of sediment 4 inch directly below the 1.0 ppm neat line (directly below the target elevation for POG2) over the entire area dredged.
[5] Average dredge overcut is calculated by dividing the total overcut volume by the area dredged at or below target elevation.
[6] Used 2005 post-dredge survey as the existing conditions survey due to data gaps in 2007 pre-dredge survey in Sub-areas A RDMUs 1A, 2A and 10A, and Sub-areas C RDMUs 1C, 4C and 5C-A.
[7] Volume between 2007 existing conditions survey and post-dredge QA survey. Used 2005 post-dredge survey as the existing conditions survey due to data gaps in 2007 pre-dredge survey in Sub-area A RDMUs 1A, 2A, and 10A, and Sub-areas C RDMUs 1C, 4C and 5C-A

Re-dredge Areas		
Sub-area Location	2007 Area Dredged	Total Amount of Sediment Removed (cy)
DMU-1D1	6,923	47
DMU-5D1	3,409	105
DMU-2E2	21,115	764
Sub-Total	34,797	1049
2007 Grand Total	**4,103,523**	**121,810**

Prepared by: DAT
Checked by: DMR

4.1.1 Sub-area A

The location of Sub-area A is shown on Figure 4-1.

- A Residual DMU (RDMU) completion summary figure is presented as Figure 4-3.
- An isopach map (post-dredge elevation relative to target elevation) is presented as Figure 4-4.
- The thickness of sediment removed within Sub-area A is presented as Figure 4-5.
- Post-dredge elevations are presented as Figure 4-6.
- Estimated areas of remaining soft sediment are presented as Figure 4-7.
- Post-dredge sample locations are presented as Figure 4-8.
- Post-dredge surface sediment PCB concentrations are presented as Figure 4-9.

4.1.2 Sub-area C

The location of Sub-area C is shown on Figure 4-1.

- A RDMU completion summary figure is presented as Figure 4-10.
- An isopach map (post-dredge elevation relative to target elevation) is presented as Figure 4-11.
- The thickness of sediment removed within Sub-area C is presented as Figure 4-12.
- Post-dredge elevations are presented as Figure 4-13.
- Estimated areas of remaining soft sediment are presented as Figure 4-14.
- Post-dredge sample locations are presented as Figure 4-15.
- Post-dredge surface sediment PCB concentrations are presented as Figure 4-16.

4.1.3 Sub-area D1

The location of Sub-area D1 is shown on Figure 4-2.

- A DMU completion summary figure is presented as Figure 4-17.
- An isopach map (post-dredge elevation relative to target elevation) is presented as Figure 4-18.
- The thickness of sediment removed within Sub-area D1 is presented as Figure 4-19.
- Post-dredge elevations are presented as Figure 4-20.
- Estimated areas of remaining soft sediment are presented as Figure 4-21.
- Post-Dredge Sampling Plan is presented as Figure 4-22.
- Post-dredge surface sediment PCB concentrations are shown as Figure 4-23.

4.1.4 Sub-areas E1 and E2

The locations of Sub-areas E1 and E2 are shown on Figure 4-2.

- A DMU completion summary figure is presented as Figure 4-24.
- An isopach map (post-dredge elevation relative to target elevation) is presented as Figure 4-25.
- The thickness of sediment removed within Sub-areas E1 and E2 are presented as Figure 4-26.
- Post-dredge elevations are presented as Figure 4-27.

- Estimated areas of remaining soft sediment are presented as Figure 4-28.
- Post-Dredge Sampling Plan is presented as Figure 4-29.
- Post-dredge surface sediment PCB concentrations for Sub-area E1 are shown as Figure 4-30.
- Post-dredge surface sediment PCB concentrations for Sub-area E2 are shown as Figure 4-30.

4.1.5 Sub-areas E3S and F

The locations of Sub-areas E3 and F are shown on Figure 4-2.

- A DMU completion summary figure is presented as Figure 4-31.
- An isopach map (post-dredge elevation relative to target elevation) is presented as Figure 4-32.
- The thickness of sediment removed within Sub-areas E3S and F are presented as Figure 4-33.
- Post-dredge elevations are presented as Figure 4-34.
- Estimated areas of remaining soft sediment are presented as Figure 4-35.
- Post-Dredge Sampling Plan is presented as Figure 4-36.
- Post-dredge surface sediment PCB concentrations are shown as Figure 4-37.

4.1.6 Sub-areas E5 and E6

The locations of Sub-areas E5 and E6 are shown on Figure 4-2.

- A DMU completion summary figure is presented as Figure 4-38.
- An isopach map (post-dredge elevation relative to target elevation) is presented as Figure 4-39.
- The thickness of sediment removed within Sub-areas E5 and E6 are presented as Figure 4-40.
- Post-dredge elevations are presented as Figure 4-41.
- Estimated areas of remaining soft sediment are presented as Figure 4-42.
- Post-Dredge Sampling Plan is presented as Figure 4-43.
- Post-dredge surface sediment PCB concentrations are shown as Figure 4-44.

4.1.7 Sub-areas POG1 and POG3

The locations of Sub-areas POG1, POG3 South, and POG3 North are shown on Figure 4-2.

- A DMU/RDMU completion summary figure is presented as Figure 4-45.
- An isopach map (post-dredge elevation relative to target elevation) is presented as Figure 4-46.
- The thickness of sediment removed within Sub-areas POG1, POG3 South, and POG3 North are presented as Figure 4-47.
- Post-dredge elevations are presented as Figure 4-48.
- Estimated areas of remaining soft sediment are presented as Figure 4-49.
- Post-Dredge Sampling Plan is presented as Figure 4-50.
- POG1 post-dredge surface sediment PCB concentrations are shown as Figure 4-51.
- POG3 post-dredge surface sediment PCB concentrations are shown as Figure 4-52.

4.1.8 2007 Dredge Prism Refinements

Dredge prism refinements made in 2007 were reported in two Foth memorandums: *Proposed OU1 Dredge Prism Model Recharacterization for 2007 RA*, submitted on June 13, 2007; and *Proposed 2007 RA for OU1 Sub-Area POG2*, submitted on June 25, 2007. These memorandums are presented in Appendix L of the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a).

4.1.9 TSCA Sediment Characterization

No TSCA sediment was identified or removed in 2007. TSCA core averaging correspondence is provided in Appendix B.

4.2 Dredge Systems

The dredge system used during the 2007 RA included the following components:

- Two 8-inch swinging ladder dredges (Dredging Supply Company) (Appendix A, Photographs 1, 2, and 3);
- One 8-inch diesel engine driven booster (Appendix A, Photograph 4);
- Five miles of 8-inch SDR 17 HDPE pipeline (Appendix A, Photographs 5 and 6); and
- Various shallow draft barges and boats

Both dredges utilized articulating ladders with different attachments to remove the PCB-impacted sediment. A standard non-aggressive cutterhead (Appendix A, Photograph 7), was used primarily in areas that contained over 12 inches of soft sediment. The other attachment used by the dredges was the shrouded open-suction Vic Vac (Appendix A, Photograph 8) which targeted the thin layer of sediments above a firm substrate. Both of these attachments were also used during the 2006 RA work.

Movement through the dredge cuts was achieved by way of a pivoting spud system at the stern of each dredge (Appendix A, Photograph 2). The pivoting spud system allows dredge mobility without the need to move other anchor or cable systems. Each dredge used a real-time kinematic (RTK) global positioning system (GPS) in conjunction with DREDGEPACK®, integrated with Wonderware, for positioning purposes.

4.3 Dredge Elevation Results

The following sections detail the process by which documentation of sediment removal occurred in LLBdM in 2007. Processes addressed include pre- and post-dredge bathymetry and high subgrade documentation.

4.3.1 QA Bathymetric Surveys

Post-dredge QA bathymetric surveys were conducted by Brennan with oversight provided by Foth, who was on board the survey vessel for all pre- and post-dredge QA surveys. A photograph of the bathymetric survey boat is provided in Appendix A, Photograph 9. As with the QA pre-dredge surveys, equipment calibration, survey check to benchmarks, and hydrographic surveying procedures were observed and documented by Foth for all QA post-

dredge surveys. At the completion of each QA survey, Brennan provided Foth with the complete unedited data files. Pre-dredge sub-area QA surveys were completed on the following dates:

- A – September 2005; March & April 2007
- C – November 2005; April 2007
- D1 – March, April, & August 2007
- E1 – May 2007
- E2 – May 2007
- E3N – October 2007
- E3S – May & August 2007
- E5 – May 2007
- E6 – May 2007
- F – August 2007
- POG1 – April 2007
- POG3 – April & May 2007

The dates of the final QA survey for each DMU are provided in Table 4-3.

During project operations, post-dredge QA bathymetric surveys were completed in DMUs that Brennan 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. Post-dredge QA bathymetric surveys were completed as requested by Brennan or, at a minimum, at the end of every two-week period of dredging.

An RTK GPS was utilized by Brennan. The RTK GPS made highly accurate positional measurements and was used on every QA survey that was performed. All measurements were controlled by WDNR established survey monuments. The positional data was recorded in NAD 83, U.S. State Plane, Wisconsin Central for horizontal measurements and NAVD 88 for vertical measurements. The measurement units for both coordinate systems are the U.S. Survey Foot. During the post-dredge surveys, poling was completed by Foth to verify the accuracy of the hydrographic survey procedure. The poling was completed 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 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® system and recorded by Foth for future use.

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* (USACE, 2004).

An initial calibration check included verifying the GPS 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 benchmarks acquired in the field 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 periodically (no less than once per month) to align sonar depth soundings with the horizontal GPS coordinates. This calibration technique verifies that sonar depth soundings being recorded are at the same horizontal location being tracked by the GPS.

Finally, bar checks were performed at the start and at the end of each QA survey (pre-dredge and post-dredge surveys). A bar is lowered beneath the transducer to a measured depth from the water surface. At the 2 foot depth, soundings were used to adjust the draft value of the transducer. This value was entered into the fathometer settings when polings were taken. Past 2 feet, at regular intervals, the bar was lowered to measured depths and the sound velocity adjusted at each depth. The final depth for sound velocity adjustment was made at 1' from the top of sediment or the first one foot increment from top of sediment. For example, if the bar hit bottom at 10.5 feet, then the bar would be raised to 10 feet and that would be the greatest depth that sound velocity would be adjusted to. Then the bar would be raised at the same increments as it was deployed to verify that the values entered into the fathometer for sound velocity and draft was satisfactory. The resulting sound velocity value and draft value were entered into a standard field notebook for record.

Following the field survey, Foth processed the unedited survey data and determined whether the required dredge prism elevations had been attained by Brennan. The following processing procedures were implemented by Foth:

- 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 modeled surface elevations (as the lower surface).
- Using the isopach drawing, 95% or more of each DMU area must be at or below the targeted 1.0 ppm PCB 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 by Foth to calculate the volume of sediment removed in a DMU and to compare actual dredge overcuts to planned overcuts.

4.3.2 Dredge Overcut Results

The target elevations provided to Brennan were the modeled elevation of the 1.0 ppm PCB surface for the 2007 sub-areas. An overcut allowance of 4 inches was planned for all 2007 sub-areas. The actual overcut achieved was calculated by dividing the volume dredged below the 1.0 ppm target elevation by the total area dredged below target elevation.

On a consolidated basis, the average dredge overcut achieved for 2007 dredge areas was 4.2 inches, closely approximating the 4 inch target (Table 4-3).

Table 4-4 summarizes the 2007 overcut achieved by sub-area and RDMU/DMU. The overcut presented excludes all documented high subgrade areas. The average dredge overcut per RDMU/DMU was calculated by adding the volume of overcut actually dredged below the 1.0 ppm PCB target elevation and dividing by the area dredged at or below target elevation. The sub-area average was calculated by summing the total overcut volumes of all RDMU/DMUs in the sub-area and dividing by the summation of the area of each RDMU/DMU that was at or below target elevation.

It is important to note that in the RDMUs and the shoreline DMUs, Brennan was directed to dredge to hard bottom to avoid the need to return to these areas for future residual dredging. Therefore, the average overcut in sub-areas where this occurred (A, C, D1, POG1, POG3 North, and POG3 South) is inflated. The highest average overcut occurred in Sub-area C.

Table 4-4
Summary of 2007 Dredge Overcut

Dredge Management Unit	Average Dredge Overcut[1] (inches)	Dredge Management Unit	Average Dredge Overcut[1] (inches)
Sub-area A		DMU-11D1	1.3
RDMU-1A	4.2	DMU-12D1	2.0
RDMU-2A	3.9	DMU-13D1	1.1
RDMU-3A	4.7	DMU-14D1-B	0.8
RDMU-4A	6.9	DMU-15D1	1.1
RDMU-5A	4.3	DMU-16D1	2.0
RDMU-6A	5.3	DMU-17D1	2.0
RDMU-7A	3.4	DMU-18D1	3.9
RDMU-8A	3.7	DMU-19D1	2.5
RDMU-9A	3.3	DMU-20D1	1.0
RDMU-10A	5.3	DMU-21D1	1.2
Sub-area A Average	**4.5**	DMU-22D1	3.7
Sub-area C		DMU-23D1	5.0
RDMU-1C	8.1	DMU-24D1	2.2
RDMU-2C	5.4	DMU-25D1	3.5
RDMU-3C	7.7	DMU-26D1	4.3
RDMU-4C	8.2	DMU-27D1	4.0
RDMU-5C-A	9.9	DMU-28D1	4.2
RDMU-5C-B	3.5	DMU-29D1	5.1
RDMU-6C	4.3	DMU-30D1	5.1
Sub-area C Average	**6.3**	DMU-31D1	5.8
Sub-area D1		DMU-32D1	3.6
DMU-1D1	7.4	**Sub-area D1 Average**	**3.8**
DMU-2D1	4.3	**Sub-area E1**	
DMU-3D1	3.8	DMU-1E1	5.1
DMU-6D1	1.7	DMU-2E1	3.9
DMU-14D1-A	7.8	DMU-3E1	6.7
DMU-4D1	2.1	**Sub-area E1 Average**	**5.5**
DMU-5D1	3.3	**Sub-area E2**	
DMU-7D1	2.3	DMU-1E2	6.6
DMU-8D1	3.0	DMU-2E2	4.0
DMU-9D1	4.4	DMU-3E2	7.3
DMU-10D1	3.4	**Sub-area E2 Average**	**5.5**

Dredge Management Unit	Average Dredge Overcut[1] (inches)	Dredge Management Unit	Average Dredge Overcut[1] (inches)
Sub-area E3S		**Sub-area E6**	
DMU-1E3S	2.4	DMU-1E6	4.4
DMU-2E3S	1.7	DMU-2E6	4.2
DMU-3E3S	1.8	DMU-3E6	4.9
DMU-4E3S	4.7	DMU-4E6	5.0
DMU-5E3S	2.1	DMU-5E6	5.6
DMU-6E3S	3.3	**Sub-area E6 Average**	**4.9**
DMU-7E3S	2.8	**Sub-area F**	
DMU-8E3S	4.3	DMU-1F	4.2
DMU-10E3S	1.2	**Sub-area F Average**	**4.2**
DMU-11E3S	4.0	**Sub-area POG1**	
DMU-12E3S	1.9	RDMU-1 POG1	5.2
DMU-13E3S	2.1	RDMU-2 POG1	3.9
DMU-14E3S	1.4	RDMU-3 POG1	6.0
DMU-15E3S	3.6	RDMU-4 POG1	5.3
DMU-16E3S	2.5	**Sub-area POG1 Average**	**5.2**
DMU-18E3S	2.2	**Sub-area POG3 North**	
DMU-27E3S	4.3	RDMU-1 POG3 North	7.0
DMU-28E3S	4.3	RDMU-2 POG3 North	5.9
DMU-29E3S	3.5	DMU-35 POG3 North	5.5
DMU-30E3S	2.9	DMU-36 POG3 North	4.0
DMU-31E3S	2.1	DMU-37 POG3 North	5.9
DMU-32E3S	1.9	DMU-38 POG3 North	6.3
DMU-33E3S	2.7	DMU-39 POG3 North	5.2
DMU-34E3S	3.0	DMU-40 POG3 North	4.2
DMU-35E3S	2.7	DMU-41 POG3 North	3.2
DMU-36E3S	2.2	**Sub-area POG3 North Average**	**5.1**
DMU-37E3S	4.9	**Sub-area POG3 South**	
Sub-area E3S Average	**3.1**	RDMU-1 POG3 South	1.7
Sub-area E5		RDMU-2 POG3 South	3.1
DMU-1E5	6.1	**Sub-area POG3 South Average**	**2.5**
Sub-area E5 Average	**6.1**		

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

Prepared by: GJP
Checked by: MCC2

Figures 4-6, 4-13, 4-20, 4-27, 4-35, 4-42, and 4-49 illustrate the specific locations in OU1 where overcuts occurred in 2007.

4.3.3 High Subgrade Areas

Starting in September 2005, a high subgrade policy was implemented that allowed an area to be excluded from attaining the 1.0 ppm PCB target elevation if a high subgrade area had been identified and verified. The high subgrade policy established in September 2005 was also implemented during the 2007 RA, as described below.

When areas suspected to contain high subgrade were encountered (e.g. presence of clay plume or dense subgrade encountered by dredge operator), Brennan provided GPS coordinates of the areas to Foth. Foth placed the areas on DMU project drawings that depicted post-dredge sediment thickness above the target elevation. Proposed poling and core sample collection locations were then identified by Foth for high subgrade verification testing. A photograph of typical high subgrade cores is presented in Appendix A, Photograph 10. 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, with assistance from Brennan, completed 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. The probed depth was also taken to refusal to determine the consistency of the underlying material. Water depth was also obtained at the given location using a survey rod with a 6 inch diameter plate attached to the end.

If the soft sediment thickness was 4 inches or greater at the probing locations, a core sample was obtained using 0.75 inch diameter core tubes for visual confirmation of the probing results. Where thickness 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 Brennan to perform clean-up passes in the specified areas.

After completion of clean-up passes, post-dredge high subgrade verification procedures were again completed to determine whether areas were either dredged to target elevations or could be designated as high subgrade areas. If the first clean-up pass was not sufficient, the process was repeated until the 1.0 ppm PCB target elevation was obtained or confirmed high subgrade was encountered.

As required by the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a), at least 95% of the area in a DMU had to be dredged to target elevation (or confirmed high subgrade area) 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 PCB target elevation surface remained at the completion of dredging. Figures 4-9, 4-16, 4-23, 4-30, 4-38, 4-45, and 4-52 indicate estimated areas with 4 inches or more of soft sediment remaining above the 1.0 ppm PCB target elevation in Sub-areas A, C, D1, E1/E2, E3S/F, E5/E6, and POG1/POG3, respectively.

Appendix C contains high subgrade poling and core sample collection information for 2007. Documentation includes sample point locations, soft sediment thicknesses based on probing, and soft sediment thicknesses based on core sample measurements.

4.4 Post-Dredge Sampling Procedures

Post-dredge sampling procedures regarding the collection, processing, and documentation of post-dredge sediment samples were provided in Appendices D and E of the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a). Post-dredge samples were collected in accordance with the work plan procedures.

4.4.1 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 completed in each DMU by Foth. Photographs of post-dredge sampling and post-dredge sample documentation are provided in Appendix A, Photographs 11, 12, 13, 14, 15, 16, and 17. In accordance with the *2007 Pre-Final Design Report and Remedial Action Work Plan*, sediment sample collection was based on a 230 foot (Sub-areas A, C, D1, E1, E2, E3, E5, POG1, and POG3) or 345 foot (Sub-areas E6 and F) grid. Primary and secondary samples were collected within the grid limits.

The post-dredge primary PCB sampling locations were located at a pre-design sample location nearest the center of each grid unit. If a pre-design sample did not exist within a grid unit, then the primary 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 PCB dredge cut limit of the sub-area, then the primary sample location was selected randomly inside of the 1.0 ppm PCB limit within that grid unit.

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 4-8, 4-15, 4-22, 4-29, 4-36, 4-43, 4-50, and 4-55 show the proposed primary and secondary post-dredge sample locations for Sub-areas A, C, D1, E1/E2, E3S/F, E5/E6, and POG1/POG3, respectively. Actual sample locations are included in Table D-1 of Appendix D and shown (for primary samples) on Figures 4-9, 4-16, 4-23, 4-30, 4-37, 4-44, 4-56, and 4-57.

4.4.2 Sediment Collection Procedures

Sediment sampling stations were located by Foth using RTK GPS capable of locating stations with an absolute and repeatable horizontal accuracy of ± 1 meter and a vertical accuracy of ± 5 cm. 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). A photograph of the RTK GPS and HYPACK® Navigation System is provided in Appendix A, Photographs 14 and 15.

Once a sampling station was located, the sampling platform (boat) was anchored or spudded 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 (field log). The actual sampling location for first attempt samples was typically within 3 feet of the proposed location for primary samples and 10 feet for secondary samples. 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 coring device was pushed to refusal, the depth of core penetration was noted and documented on the field log.

The thickness of the sediment recovered in the core tube was measured and recorded in the field and the contents of the core tube were described and documented on the field log. Since it was not considered in the post-dredge elevation confirmation measurements, the majority of the light, suspended solids on top of the 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 to minimize disturbance until it was processed.

If sampling activities did not yield at least 3 inches of recovery inside the core on the first attempt, a second attempt was made to obtain a sediment core by relocating the vessel between 5 feet and 10 feet from the location of the first attempt. At times, the collection vessel was moved as far as 17.5 feet from the proposed location in an attempt to obtain a sample with the intent to keep the second sampling effort within the same grid unit as the first attempt. If the second attempt failed to yield at least 3 inches of recovery, this information was recorded on the field log and no additional attempts were made to sample this location.

The PCB concentration value assigned to locations where no recovery or less than 3 inches of sample recovery occurred after two attempts was 0.0168 mg/kg. This value is the average PCB concentration of 12 native clay samples from different sub-areas within OU1 collected during the 2003-2004 pre-design sampling season. The locations of these 12 samples are shown on Figure 4-39, and the analytical results are summarized in Table 4-5.

Table 4-5
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. Prepared by: SVF
Checked by: DMR

4.4.3 Sample Processing

Sediment core samples were processed as soon as possible in the Foth lab after the sampling event. All primary and secondary samples were kept on ice during shipment to the laboratory. If cores could not be processed immediately after sampling, they were kept at 4 degrees Celcius. 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 with a pipette. The sediment thickness was measured, while the sample tube was vertical, and recorded on the field log.

The sample tube was then laid horizontal and cut in half lengthwise. 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. A photograph of a core being processed is presented in Appendix A, Photograph 16.

For primary sediment core samples, the top 6 inches were removed from the core, homogenized, and placed in a sample container for delivery to the lab for PCB analysis. The minimum sample weight required was 100 grams wet. The remainder of the soft sediment within the core was divided into 6-inch intervals (minimum 3 inches) until the end of the core was reached or a 6-inch interval consisting entirely of native clay was encountered. These deeper intervals were then frozen for potential future analysis. If the bottom interval was less than 3 inches, the interval was composited with the interval above.

For secondary composite samples, the top 6 inches of each sample were removed and 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 no sediment could be collected from a location after two attempts, no sample was collected, and the location was identified as having no soft sediment; in which case, the remainder of the secondary samples were composited as described above. If all secondary samples were not yet available to generate the composite sample, each discrete secondary sample was placed into a double zip lock plastic bag, labeled, and frozen until the remaining secondary samples were available. The remainder of the soft sediment within each core was divided into 6 -inch intervals (minimum 3 inches) until the end of the core was reached. If the bottom interval was less than 3 inches, the interval was composited with the interval above. These deeper intervals were then frozen for potential future analysis. Sample intervals below the top 6-inch interval that consisted completely of native clay material was not analyzed.

If the PCB concentration of any primary or secondary composite surficial sample exceeded 1.0 ppm, the directly underlying sample interval was sent in for analysis. This process occurred until the PCB concentration was less than 1.0 ppm or until no more sample intervals were available.

Sediments were analyzed for PCBs by Pace Analytical Services, Inc. (Pace) 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% moisture prior to extraction. The sediment samples were then extracted by USEPA SW 846 Method 3541C, automated Soxlet (Soxtherm), and followed by gas chromatography analysis using an electron capture detector (GC/ECD). The initial calibration includes an analysis of a 5-point calibration curve of Aroclors 1242 and 1254, both prominent PCBs found in the LFR. A duplicate sample for every 10 primary samples and for every 10 secondary samples was processed and delivered to Pace for PCB analysis. All post-dredge PCB results, including duplicate values, are presented in Table D-1 and located in Appendix D.

4.4.4 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 field log processing were completed for each core location.

4.4.5 Identification of Re-dredge Areas

As a general rule, areas with residual PCB concentrations of greater than or equal to 5 ppm were considered for redredging. Re-dredge areas are shown on Figure 4-40. Evaluation of potential re-dredge areas was ongoing from May 2007 until the end of the 2007 dredging operations. Only four small areas required redredging in 2007. The aerial extent and volume of re-dredge was very limited as summarized in the bottom right corner of Table 4-3.

4.5 Post-Dredge PCB Results

Post-dredge PCB sediment results for the 2007 project are discussed and summarized in this section of the report.

The data presented summarize PCB mass and SWAC prior to, and following, the 2007 RA. PCB mass and SWAC estimates, and their corresponding reduction percentages, refer only to the areas bounded horizontally by the 2007 dredge prism and vertically by the 1.0 ppm PCB iso-surface.

PCB mass and surface concentrations prior to the 2007 RA are determined by a combination of the pre-design data, post-dredge data collected following the 2005 and 2006 dredge seasons, and recharacterization data collected during January and February 2007. SWAC estimates represent average PCB concentrations in the top 6 inches of sediment. Since sample intervals smaller than 6 inches were collected prior to 2007, depth-weighted averaging was applied to these data to provide a comparable 6 inch surface average.

4.5.1 Summary of PCB Data

A total of 218 primary and 790 secondary post-dredge coring locations were sampled in 2007. All post-dredge sediment PCB results are presented in Appendix D, Table D-1. Re-dredge results are presented in Appendix E, Table E-1.

Table 4-6 presents the pre- and post-2007 RA PCB mass and SWAC results by sub-area in order to evaluate the PCB removal efficiency of dredging. Also presented are the pre-2007 and post-2007 PCB concentration ranges for samples collected from the top core interval.

Table 4-6

2007 Pre- and Post RA PCB Results Summary
(1.0 ppm dredge prism only)

Sub-area	Metric	Pre-2007	Post-2007	PCB Mass Removed	Percent Reduction	Pre-2007 Surface Sample PCB Range	Post-2007 Surface Sample PCB Range
A	PCB mass (kg)	16	9.5	6.5	41%		
	PCB SWAC (ppm)	7.3	1.7		77%	0.0168-33	<0.013-9.2
C	PCB mass (kg)	5.5	3.8	1.7	31%		
	PCB SWAC (ppm)	2.8	0.6		79%	0.0168-6.6	<0.013-5.9
D1	PCB mass (kg)	29	0.6	28.4	98%		
	PCB SWAC (ppm)	2.5	0.4		84%	0.0168-6.1	<0.013-2.2
E1	PCB mass (kg)	1.4	0.1	1.3	93%		
	PCB SWAC (ppm)	1.7	0.6		65%	0.78-4.4	0.0168-2.6
E2	PCB mass (kg)	18	0.6	17.4	97%		
	PCB SWAC (ppm)	4.8	1.8		63%	1.7-2.8	0.0168-4.8
E3S	PCB mass (kg)	22	0.5	21.5	98%		
	PCB SWAC (ppm)	2.9	0.3		90%	0.0168-14	<0.013-3.5
E5	PCB mass (kg)	0.2	0	0.2	100%		
	PCB SWAC (ppm)	1.7	0.3		82%	0.47-2.9	0.1-0.49
E6	PCB mass (kg)	8.4	0	8.4	100		
	PCB SWAC (ppm)	0.4	0.3		25%	<0.027-0.81	<0.013-0.54
F	PCB mass (kg)	0.02	0	0.02	100%		
	PCB SWAC (ppm)	2.1	0.08		96%	2.1	0.041-0.11
POG1	PCB mass (kg)	0.8	0.2	0.6	75%		
	PCB SWAC (ppm)	7.5	0.7		91%	0.0168-41	0.0168-8.3
POG3	PCB mass (kg)	16	3	13	81%		
	PCB SWAC (ppm)	5.8	0.9		84%	<0.027-40	<0.013-3.8

The PCB concentrations and mass are for the area in the 2007 dredge prisms only, not for the entire sub-area.
SWAC = surface weighted average concentration

Prepared by: SGL
Checked by: SVF

Overall, in the sub-areas targeted for dredging in 2007, the PCB mass reduction in the dredged areas ranged from 31% to 100%. Within the sub-areas which contained only new dredging (D1 E1, E2, E3S, E5, E6, and F), the mass reduction rate was considerably higher, ranging from 93% to 100%. Overall, the average surface concentration reduction ranged from 63% to 90%, with the exception of Sub-area E6.

Surface concentrations in Sub-area E6 were generally low (either below or slightly above the 1.0 pm RAL) before the 2007 RA, so percent reduction in SWAC following the 2007 RA likewise is small (25%). In contrast to most sub-areas in OU1, PCB concentrations in E6 generally were higher at depth than at the surface. Since there were no post-dredge samples in E6 with PCBs above 1.0 ppm, the mass removal is calculated at 100%.

The target RAL (1.0 ppm PCB) was achieved in all samples in Sub-areas E5, E6, and F but not in Sub-areas A, C, D1, E1, E2, E3S, POG1, POG3 South, and POG3 North.

SWAC calculations were performed by weighting sample core surface concentrations with their representative areas. The SWAC for each sub-area (dredged areas only) was calculated as:

$$\bar{x}_h = \frac{\sum_i w_i x_{h,i}}{\sum_i w_i}$$

where $x_{h,i}$ are the surface sample concentrations from the sediment core samples and w_i are the representative area weights. The weights are taken to be associated Thiessen polygon weights surrounding each core sample, and are calculated as follows:

1) Identify sediment cores within sub-area dredge boundaries.
2) Develop a Thiessen polygon shapefile for this data subset.
3) Clip Thiessen polygon shapefile to the sub-area dredge boundaries.

As previously stated, SWAC estimates prior to the 2007 RA are based on the combined pre-design data, post-dredge data collected following the 2005 and 2006 dredge seasons, and recharacterization data collected during January and February 2007. SWAC estimates of post-2007 RA are based on the 2007 post-dredge data set. Sample intervals of 6 inches were used during the 2007 RA, while intervals of 4 inches were used prior to this. Therefore, surface samples collected at 4-inch interval depths were converted to represent a 6-inch surface by simple depth-weighted averaging. This was done as follows:

1) If only a single 4-inch interval exists (total soft sediment thickness is less than 6 inches) the surface concentration was the resulting 4 inch sample concentration.

2) If two 4-inch intervals exist, a depth weighted 6 inch average was calculated as [(4 x Top Interval ppm) + (2 x Second Interval ppm)] / 6.

PCB mass estimates were made based on the sediment bed model (GMS-SED) updated with post-dredge and recharacterization results. Modeling parameter selection details were documented in the white paper, *Development of Sediment Prisms in Lower Fox River OU1* (Foth and Van Dyke, 2005). The pre-2007 mass estimates are based on the combined pre-design data, post-dredge data collected following the 2005 and 2006 dredge seasons, and recharacterization data collected during January and February 2007. Post-2007 RA mass estimates are based on the sediment bed model using the 2007 post-dredge results.

In constructing the post-dredge sediment bed model, post-dredge data was interpolated using the same interpolation settings as those chosen for the pre-dredge (BODR) model. 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 result.

To calculate PCB mass remaining, the post-dredge sediment bed model was used with a representative volume at each three dimensional mesh node. The mesh node volumes were 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 multiplication of the representative volume, the interpolated PCB concentration, the sediment dry density and appropriate conversion factors.

The dry density used in PCB mass calculations was derived uniquely at each post-dredge interpolation model node. The post-dredge percent solids data was interpolated to the three-dimensional post-dredge sediment bed model under the BODR parameterization. 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.

Undisturbed residuals were interpreted as the sediment in dredged areas with PCB concentrations greater than 1.0 ppm that are beneath the top 6 inches of sediment. The sediment in the top 6 inches of dredged areas is referred to as "disturbed residuals." An accounting of the sediment volume and PCB mass in the top 6 inches, as analyzed from the current post-dredge model, is presented in Table 4-7. The accounting is based on actual post-dredge core results collected in only those regions dredged during 2007. Of all post-dredge samples collected, only a relatively small portion (14%) of the core locations exceeded 1.0 ppm PCBs. Of these locations, only Sub-areas A, C, and E2 contained sample concentrations exceeding 1.0 ppm PCB that extended to the second 6-inch interval. In total, only 1% of all 2007 post-dredge core locations exceeded 1.0 ppm PCB below the top 6 inches.

Table 4-7
Summary of 2007 Dredge Residuals

OU1 Sub-area	Total 2007 Post-Dredge Core Locations	Total Exceeding 1.0 ppm PCB	Percent	Total Exceeding 1.0 ppm PCB in Second Interval	Percent
A	102	34	33%	7	7%
C	39	4	10%	4	10%
D1	282	23	8%	0	0%
E1	27	5	19%	0	0%
E2	25	18	72%	1	4%
E3S	257	12	5%	0	0%
E5	8	0	0%	0	0%
E6	25	0	0%	0	0%
F	2	0	0%	0	0%
POG1	34	4	12%	0	0%
POG3	90	24	27%	0	0%
Total	**891**	**124**	**14%**	**12**	**1%**

Prepared by: SGL
Checked by: SVF

5 Dewatering

5.1 Description & Process Flow

As in 2006, two sediment screening and thickening units located prior to the geotextile tubes (Appendix A, Photograph 18) were used for sediment dewatering in 2007. The screening and thickening provided the following benefits:

- Screening of debris larger than 1/8 inch resulted in improved sediment dewatering and decreased the potential for geotextile tube tears.

- Thickening of the sediment slurry prior to introducing into the geotextile tubes reduced the hydraulic loading on the geotextile tubes, reduced the number of tubes online at one time, provided a uniform slurry for dewatering, and reduced the amount of time required for the tubes to dewater to a desired consistency.

- Decreased the dredge pump discharge pressure as a result of pumping material discharging to the screens, rather than pumping directly into the geotextile tube header system. This resulted in the overall effect of improving dredge efficiency while minimizing the amount of carriage water that is delivered to the dewatering pad with the dredge slurry.

- Reducing the dewatering time and allowed stacking of the geotextile tubes sooner.

The dewatering system was made up of a manifold system, thickener system, geotextile tubes, dewatering pad, and carriage water sump. Photographs of the geotextile tubes are presented in Appendix A, Photographs 19, 20, 21, and 22, and a view of the dewatering pad is shown in Photograph 23. The process flow diagram for the sediment dewatering system is shown on Figure 5-1. A conditioning chemical (polymer) was added to the sediment slurry prior to discharge into the trammel screens. The dosing rate was based on the dredge slurry flow rate, the slurry solids content, and resulting visual floc characteristics. The material was then screened and allowed to settle before being pumped to the geotextile tubes. Carriage water from the geotextile tubes wept through the geotextile fabric, percolated through the dewatering pad gravel, and flowed to the carriage water sump before being pumped to the water treatment system.

5.2 Chemical Addition

During the 2007 RA, a cationic polymer was fed to the dredge slurry to flocculate the sediment particles, thus aiding the geotextile tube dewatering process. The dewatering system was designed to deliver both a cationic polymer (Appendix A, Photograph 24), as well as ferric sulfate (Appendix A, Photograph 25) and/or aluminum chlorohydrate (ACH) to the slurry. There were three injection points which were used for polymer addition at different times during the dredge season, in addition to one point used for the addition of the ACH. The first polymer injection was approximately 200 feet upstream of the thickeners and consisted of an injection ring in the pipeline (Appendix A, Photograph 26). The second point was after the trammel screens but before the thickener tank. The second point was seldom used. The third was at the discharge of the thickeners to the geotextile tubes. It consisted of an injection ring in the pipeline and a static mixer

immediately following it. The addition of the ACH also consisted of an injection ring in the pipeline and was located approximately 200 feet upstream of the first polymer addition point.

Samples were taken at various locations periodically throughout the day to monitor particle charge of the water. The samples were taken from the geotextile weep, thickener effluent, dewatering pad sump, and a background from the river. These were used to monitor the dosage of polymer used. Visual observations also were used to adjust the polymer dosage.

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 (Appendix A, Photograph 27), fed signals to a programmable logic controller, which in turn adjusted the feed rates. A total of approximately 141,950 pounds of polymer were used for the geotextile tube dewatering system. In addition, 125,517 pounds of ACH were used in 2007.

5.3 Sediment Screening and Thickening

From the dredge pipeline the dredge slurry was discharged into rotating trammel screens from the inclined end of the screens. The screens removed 1/8-inch and larger material from the slurry. These screenings were then discharged down chutes and onto the dewatering pad and stored for load out. The remaining slurry entered the thickeners where the flocculated sediment was allowed to settle to the bottom. The supernatant overflowed the weirs from the thickeners and flowed into two 8,000 gallon tanks. These two open top tanks, placed in series, provided additional retention time. This additional time aided in total suspended solids (TSS) removal and provided contact time for the sodium hypochlorite, which was injected into the thickener overflow. The discharge from the first tank flowed into the second tank, which discharged onto filter fabric that contained weirs to retain the water briefly before allowing it to enter the pad. The tanks were connected with a series of 8-inch pipes and a second set of pipes discharged the water to the decant water discharge basin (commonly referred to as the “hot tub”) before percolating through the dewatering pad gravel (Appendix A, Photograph 28). Sodium hypochlorite (bleach) was added to the effluent from the thickeners to destroy any residual polymer and to minimize or eliminate any biological growth that had occurred.

The thickened sediment was pumped periodically to the geotextile tubes. The frequency of this pumping was dependent on the level of material in the thickeners. As described below, a contingency bag was located on an area opposite of where the thickened sediment was being sent to the tubes. The filling of the contingency bag was accomplished through the use of a bypass valve located immediately upstream of the discharge into the screens. Flexible piping, similar to that used to deliver thickened sediment to the geotextile tubes, connected this valve to the contingency tube, which was used in the rare event of a mechanical malfunction of the thickeners.

The maximum design capacity of each of the two thickeners is 2,400 gpm, which is sufficient to handle flow from two 8-inch dredges. The normal operating design capacity for each of the two thickeners is between 1,100 and 1,900 gpm. During normal operating conditions in 2007, both thickeners units were employed, treating an average actual influent flow total of approximately

1,200 gpm. The units were designed so that in the event of mechanical problems with one of the units, the remaining unit could treat the material from both dredges for a period of up to 8 hours without negatively impacting operations.

5.4 Dewatering Pad Management

The dewatering pad area is approximately 510 feet by 410 feet surrounded by containment berms. Dewatering pad modifications are provided in Appendix F. The pad and berms are lined with a composite barrier layer consisting of compacted clay subgrade, a geosynthetic clay liner, 30 mil PVC geomembrane, and 20 ounce per square yard non-woven geotextile. A minimum 2-foot thickness of 2.5-inch crushed limestone drainage layer covers the liner to protect it from vehicle traffic and provides storage volume for flow equalization into the WTP, stormwater retention, and spill containment. A 6-inch-thick layer of 0.75-inch gravel overlays the stone drainage layer—providing a base suitable for supporting the geotextile tubes and acting as a filter for sediment solids. As designed, sediment solids associated with geotextile tube filtrate, spills, and load-out operations accumulate in the surface of the dewatering pad gravel and stone layers. An excessive accumulation of solids in the gravel and stone can inhibit the free passage of water through either or both layers.

Prior to the start of the 2007 dredge season, Brennan conducted an investigation to visually observe and assess the dewatering pad and drain pipe. The objective of the investigation was to assess whether clogging/blinding of the gravel pore space and drain pipe had occurred due to migration of dewatered river sediments and/or biological growth. Blinding of the surface gravel was first observed in the dewatering pad at locations that received the majority of the geotextile tube filtrate.

The investigation consisted of excavating four test pits into the stone drainage layer at various locations across the pad. Two pits were excavated in the northwest corner, one in the southwest, and one on the east side of the pad.

Based on field observations on January 9, 2007, Brennan concluded that the southwest and east side of the dewatering pad appeared to be relatively clean. A portion of the gravel layer in the northwest corner contained a significant fraction of sediment and was recommended to be replaced. This material was replaced the week of March 19, 2007, and the entire dewatering pad was graded with a small dozer.

In an effort to remove suspended solids that had accumulated over the previous dredge seasons from bag ruptures, load out, and upset conditions, the dewatering pad drain water was pumped directly into the thickeners the week of March 26, 2007.

The previous week the WTP pumped, filtered, and discharged the dewatering pad water to the lake. This left a pad water level of approximately 5.5 feet with a water pH of 9 and a turbidity of 25 nephelometric turbidity units (NTU).

The northern 8-inch Godwin pump was flanged to allow its discharge to be pumped into a lay flat hose which was then hooked up to the vertical pipe that transports the water into the trammel screens. The polymer was mixed and pumped with the existing polymer make down system and

injected on the chute underneath the trammel screens. Ferric sulfate was added into the discharge line immediately after the Godwin pump. A tote of muriatic acid was placed at the dewatering pad carriage water sump with a gravity feed to balance the pH of the pad water.

An "A" level geotextile tube was placed in the closest location to the thickeners possible, which was NWA-6. Semi-rigid hose connected the discharge of both thickeners to the geotextile tube. The thickener effluent entered the blue retention tanks and was then piped to the northwest and southwest corners of the pad. This was done to help the circulation of the dewatering pad water.

The initial approach was to treat the pad water with ferric sulfate and Ciba FC2204 flocculant as was used the previous year. A make down concentration of 0.14% was used with an injection rate of 0.5 lbs/tds which was the lowest polymer pump setting. The influent flow averaged 1,100 gpm which was split between the two thickeners. As treatment started, it was noted that the solids were flocculating but remained near the specific gravity of water and the clarity of the water (NTUs) decreased due to the addition of the ferric sulfate. The ferric sulfate was added at a rate of 2.6 gph. Ferric sulfate addition has a tendency to raise the NTU value of treated water because it adds color to the water. Also, ferric sulfate starts becoming insoluble at a pH of 6.5 to 7, and is completely insoluble at a pH of 8.5 to 9. Due to this fact, the pH was adjusted to try and improve the clarity. This had some effect but the NTU and TSS levels remained higher than desired.

At this point, a change in chemistry was tried. ACH was chosen for its past ability to lower TSS while not staining or raising the NTU value of the water. The ferric sulfate injection point was removed and the ACH was injected in its location. The ACH was also added at a lower concentration (25 ppm) than the ferric sulfate. The result of this addition was the particles flocculated and the NTU values improved to the desired levels. The turbidity was lowered to as low as 6 NTUs. The treatment was continued until the incoming water NTU values remained unchanged.

The clarifier tanks were emptied periodically throughout the day and there was no noticeable accumulation of sediment in the geotextile tube.

In total, this operation took five days, of approximately 10 hours each, to complete. This included a total of one day for set up and tear down activities and four days of circulation.

5.5 Geotextile Tube Operations

Geotextile tubes were constructed of Geolon GT500, or an equivalent material, and were manufactured by Miratech. The majority of tubes ranged in circumference from 60 feet to 65 feet and in length between 203 feet to 158 feet. Smaller geotextile tubes were also used as filler tubes between the gaps of the geotextile tube as they were being stacked. These smaller tubes ranged in size from 30 feet to 40 feet in circumference and 100 feet to 172 feet in length.

Figure 5-2 shows the final geotextile tube layout. Geotextile tube operation began on April 2, 2007, in conjunction with hydraulic dredging of sediment in Sub-area A and continued until November 2, 2007. The first geotextile tube filled was on the northwest side of the dewatering pad. The geotextile tubes were stacked simultaneously on the northwest and southwest sides

until this area was almost filled. The operations then moved to the east side of the pad. When the filling of bags on the east side was nearly complete, geotextile tube filling operations were switched back to the northwest side of the dewatering pad, and then on the southwest. Finally filling operations moved back to the east side of the pad. Due to low temperatures at the start of the dredging season three geotextile tubes were used as contingency geotextile tubes when temperatures prevented the use of the thickeners.

An aggressive stacking plan was used to accommodate the anticipated volume to be dredged in 2007. Geotextile tubes were placed up to four-high in a pyramid fashion lying side by side. Geotextile tubes were stacked as soon as safety would allow. Level "A" was considered the first layer and consisted of tubes 203 feet in length. The second layer was level "B", with tubes 15 feet shorter in length. This pattern continued to level "D" or the fourth layer. The goal of the aggressive stacking was to minimize the time that occurred between when the "A" level and the "D" level geotextile tubes were filled and taken off-line so that load out of the dewatered material could proceed as planned.

The labeling of the tubes remained constant with the 2006 labeling scheme. The geotubes were labeled with letters and numbers to designate their location on the pad. For example, the first tube (1) located on the first, or bottom, layer (A) on the eastern (E) half of the pad was labeled E-A-1. The second tube on the first layer, on the eastern side of the pad, was labeled E-A-2, with the first tube on the second layer labeled E-B-1. This labeling scheme was followed until the entire eastern half of the pad was filled. However, because the pad management in 2007 dictated the need to place tubes on all sections of the pad a second time, after all material from the tubes initially filled had dewatered and been removed, these bags were labeled with an N preceding the original label during the second filling on the west side, the NW was changed to N for the northwest corner; and the southwest was changed from SW to S. The second filling of the geotextile tubes on the eastside had the letter E added to its prefix. Thus, the first tube situated on the first layer on the east side, the second time, was labeled as NE-A-1, the next tube NE-A-2, and so forth.

Each of the geotextile tubes was initially filled to a height of 6 feet. When the geotextile tube reached 6 feet, the flow of dredge slurry to the tube was stopped to allow water in the tube time to decant. After this, the tube was filled again, but never to a height greater than 6 feet. As the geotextile tubes gradually accumulated more solids, they filled to 6 feet more quickly and dewatered more slowly. While geotextile tubes were being filled, they were carefully observed for signs of rips, separations, or places where the geotextile fabric had been weakened.

Trammel screenings were loaded out periodically during the project, as needed, beginning the end of April. Full scale load-out began on July 9, 2007. See Section 6.3 for a detailed description of the loading sequence.

5.6 Dewatered Sediment Sampling

Dewatered sediment was sampled from the geotextile tubes to determine free liquids (paint filter), percent solids (moisture content), and the required geotechnical data for disposal purposes. This section summarizes the geotextile tube sampling procedures and dewatering results.

5.6.1 Dewatered Sediment Sampling Overview

The dewatering process created three media requiring QA sampling: thickener slurry, trammel screenings (material >1/8 inch), and dewatered sediment. These media were sampled in accordance with the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a). The sampling procedures are provided in Section 5.6.3.

5.6.2 Sampling Procedures

The following section provides the procedures for sampling geotextile tubes, slurry, and the stockpile.

5.6.2.1 Geotextile Tube Sampling

Dewatered sediment was sampled at a minimum 30 days after the last discharge to the tube in accordance with Appendix E of the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a). For the geotextile tubes on the A, B, or C levels (excluding perimeter tubes) of the stacking pyramid only two sample augers were advanced, one on each exposed end. Perimeter and D level geotextile tubes required three hand auger advancements because the entire tube surface was exposed. These upper, exposed geotextile tubes 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 was cut in the top of the geotextile tube at each sample location. First, an in-situ vane shear test was performed in the sample hole, typically at the approximate midpoint of the geotextile tube thickness. The in-situ vane shear result and depth was recorded on the field form. In the small hole, a stainless steel hand auger was used to obtain a sample for the entire dewatered sediment thickness in the geotextile tube at each location. At no time was auger refusal observed. Finally, once the sample hole was completed the sediment probing rod was inserted to determine the total thickness of dewatered sediment in the geotextile tube. Photographs of dewatered sediment sampling are provided in Appendix A, Photographs 29, 30, and 31.

Grab samples from each borehole were placed into a separate durable plastic bag and homogenized within the bag. The hand auger was field cleaned between sample holes; however, it was not decontaminated as no PCB sampling was completed by this method. Each grab sample from the geotextile tubes that had two grab samples collected, were placed into separate durable plastic bags, homogenized within the bag, and then analyzed for QC percent solids and free liquids. For geotextile tubes that had three grab samples collected, equal volumes of sample from each of the three sample locations were placed into a stainless steel bowl for homogenization to produce a single representative sample. This composite sample was then placed in a jar, cooled to 4 C, and sent to the laboratory for QA percent solids analyses. Results of the percent solids and free liquids tests are presented in Table 5-1.

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. A QC percent solids analysis was completed for each sediment sample. Foth personnel completed these tests on site.

A composite sample for geotechnical strength analyses was completed once for approximately every 30,000 cy dredged. The composite sample was placed in a durable plastic bag within a 5 gallon bucket for delivery to the geotechnical lab.

Undrained shear strength testing was originally required by the Veolia 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.

5.6.2.2 Slurry Sampling

During the 2007 season, composite samples of thickener slurry were collected prior to discharging to the geotextile tubes and analyzed for PCBs. A composite sample of the thickener slurry was collected over the course of one week during the 2007 RA activities. This was completed by thickener operators, every two hours during thickener operation, collecting an approximate 200 milliliter (mL) sample. Thickener operators recorded time of sample removal, geotextile tubes being filled at the time of the sample, and the samplers' initials. Each two-hour sample, over the course of an operational week, was placed in a covered, plastic bag-lined, 5 gallon pail and stored in a cooler containing ice. At the end of each week, Foth removed the plastic bag from the pail and homogenized the week's samples. Upon completing homogenization, three equal aliquots of slurry were removed from the bag and placed in 4 ounce glass jars supplied by the laboratory. The samples were delivered to Pace for PCB analysis (Fox River Method) within the maximum 14-day holding time. The PCB result for each week was recorded as the arithmetic average of the results of the three aliquots.

Over the course of the 2007 RA activities, a total of 88 aliquots of thickener slurry were sampled and analyzed for PCBs. The weekly average PCB values were all below 50 ppm for 2007. The weekly average PCB values ranged from a low of 0.20 ppm to a high of 16.73 ppm, with the average for the entire season being 2.80 ppm.

5.6.2.3 Stockpile Sampling

Two new trammel screen units were operated to screen the sediment slurry prior to entering the thickener units, removing materials 1/8 inch or larger. The screened materials generally included gravel, larger wood chunks/chips, and foreign debris (golf balls, shotgun shells, fishing lures, etc.). Materials caught in the trammel screen were directed towards a conveyor belt which placed the materials in a stockpile on the dewatering pad. A photograph of a typical stockpile is presented in Appendix A, Photograph 32. Periodically, as the pile grew in size, Foth sampled the pile as required by the landfill for disposal purposes.

Foth followed the American Society of Testing Materials (ASTM) D75-87 – Standard Practice for Sampling Aggregates to collect a representative sample for PCB analysis. The sampling procedure included using a 3-inch diameter hand auger to retrieve discrete samples from beneath the surface of the pile. A field technician used the hand auger in three locations from the lower, middle, and upper 1/3 of the stockpile. A spade shovel was pushed vertically into the pile just above the sampling point to help prevent further sample segregation. Each of the nine samples were placed into a plastic bag-lined 5 gallon bucket and homogenized into one composite

sample. One aliquot was removed from the composite sample and placed into a 4 ounce amber glass jar for laboratory analysis of PCBs and percent solids.

Eleven stockpile composite samples were collected over the course of the 2007 RA. PCB analytical results ranged from 0.58 ppm to 38.0 ppm with an average of 4.77 ppm.

5.6.3 Dewatered Sediment Results

A summary of the geotextile tube sampling results for the 2007 RA for percent solids and free liquids is provided below in Table 5-1. Table 5-2 summarizes the data by sub-area. It should be noted that Table 5-1 shows that many of the geotextile tubes contained sediments from multiple sub-areas. The following method was used to obtain overall percent solid values for the individual sub-areas.

For average percent solids per sub-area, it was assumed that the result from the composite sample (Table 5-1) represented, equally, all sub-areas contained within that geotextile tube. For example, the composite sample result for geotextile tube EA-1 is 38.3%. This result represents the percent solids from a composite of sediments from Sub-areas E3S, D1, POG3 North, and E1. In calculating the average it was assumed that Sub-areas E3S, D1, POG3 North, and E1 all had a percent solid result of 38.3%. This method was carried through all geotextile tubes providing an average percent solid result by sub-area (Table 5-2). Average values, per sub-area, were calculated in the same manner for the geotechnical data with the results presented on Tables 5-3, 5-4, and 5-5.

Table 5-1

Dewatered Sediment Free Liquids, Percent Solids, and Vane Shear Results

Geotextile Tube Number	Circumference Feet x Length (ft)	Contained Sub-Area(s)	Date Taken Out of Service	Percent Solids Sample Date	Paint Filter Test Free Liquids	Vane Shear Results[1] (kPa)	QA Percent Solids	QC Percent Solids Average
EA1	200 X 60	E3S, D1, POG3N, E1	7/17/07	8/27/07	Pass	13/16/13	38.3	38.6
EA2	200 X 60	D1, POG3N, E3S	7/11/07	8/09/07	Pass	27/11		42.2
EA3	200 X 60	D1, POG3N, E3S	6/29/07	8/09/07	Pass	30/20		39.5
EA4	200 X 60	D1, POG3N, E3S	7/11/07	8/09/07	Pass	27/15		38.5
EA5	200 X 60	E3S, D1, POG3N, E1	7/18/07	8/28/07	Pass	14/15		36.0
EA6	200 X 60	E3S, E1, D1	7/18/07	8/28/07	Pass	17/16		36.3
EA7	200 X 60	D1, A, POG1, C	5/15/07	6/19/07	Pass	12/25/19	45.3	44.2
EA8	200 X 60	E3S, E1, D1	7/24/07	8/28/07	Pass	11/16		38.7
EA9	200 X 60	A, D1, POG1, C	5/17/07	6/19/07	Pass	7/19/18	39.2	39.5
EA10	200 X 60	D1, E3S, E1, E2	8/07/07	9/11/07	Pass	19/20		32.9
EA11N	200 X 60	D1, POG1, C, POG3N, POG3S, E3S, E1, E2	8/02/07	9/21/07	Pass	7/16		34.1
EA11S	200 X 60	D1, E3S, E1, E2, E6	8/17/07	9/11/07	Pass	12/15		31.3
EA13	200 X 60	D1, E3S, E2, E6	8/28/07	9/28/07	Pass	17/13		37.6
EA14	200 X 60	D1, E3S, E2, E6	8/29/07	9/28/07	Pass	14/17		37.1
EA15	200 X 60	D1, E6	9/06/07	10/18/07	Pass	25/20		38.9

Geotextile Tube Number	Circumference Feet x Length (ft)	Contained Sub-Area(s)	Date Taken Out of Service	Percent Solids Sample Date	Paint Filter Test Free Liquids	Vane Shear Results[1] (kPa)	QA Percent Solids	QC Percent Solids Average
EA16	200 X 60	D1, E6	9/06/07	10/18/07	Pass	22/25		38.4
EA17	200 X 60	D1, E3S, E6	9/12/07	10/18/07	Pass	22/25		40.0
EA18[2]	200 X 60	D1, E3S, E6	9/12/07	10/18/07	Pass	17/21/24	37.6	40.4
EB1[2]	186 X 65	D1, E1, E2	7/31/07	9/07/07	Pass	8/9/9	39.0	38.0
EB2	186 X 65	D1, E3S, E1, E2	7/31/07	9/07/07	Pass	13/12		42.8
EB3	186 X 65	D1, E1, E2	7/31/07	9/07/07	Pass	15/15		40.9
EB4	186 X 65	D1, E3S, E1, E2	8/07/07	9/07/07	Pass	13/12		35.2
EB5	186 X 65	D1, E3S, E1, E2	8/07/07	9/07/07	Pass	12/10		31.6
EB6	186 X 65	D1, E3S, E1, E2	8/08/07	9/11/07	Pass	11/11		35.6
EB7	186 X 65	D1, E3S, E1, E2	8/07/07	9/07/07	Pass	10/9		35.7
EB8	186 X 65	D1, E2, E6	8/15/07	9/21/07	Pass	10/11		31.7
EB9	186 X 65	D1, E3S, E2, E6	8/27/07	9/28/07	Pass	9/10		33.5
EB10	186 X 65	D1, E3S, E6	9/11/07	10/18/07	Pass	21/24		39.0
EB11	186 X 65	D1, E3S, E6	9/11/07	10/18/07	Pass	25/22		39.4
EB12	186 X 65	D1, E3S, E6	9/12/07	10/18/07	Pass	23/23		39.1
EB13	186 X 65	D1, E3S, E6	9/12/07	10/18/07	Pass	28/17		39.9
EB14	186 X 65	D1, E3S, E5, E6	9/19/07	10/23/07	Pass	22/20		34.5
EB15	186 X 65	D1, E3S, E5, E6	9/18/07	10/23/07	Pass	22/21		37.7
EB16	186 X 65	E6, E3S	9/20/07	10/23/07	Pass	18/15		36.3
EB17	186 X 65	E6, E3S	9/20/07	10/23/07	Pass	14/11/10	34.9	34.4
EC1	172 X 70	D1, E3S, E2, E6	8/21/07	9/21/07	Pass	4/3/3	30.8	30.1
EC2	172 X 70	D1, E3S, E2, E6	8/23/07	9/28/07	Pass	2.5/3/3	30.7	32.5
EC3	172 X 70	D1, E3S, E2, E6	8/23/07	9/28/07	Pass	6/6/5	33.0	33.1
EC3.5	100 X 40	D1, E6	8/23/07	9/28/07	Pass	11		40.2
EC4	172 X 70	D1, E3S, E2, E6	8/21/07	9/21/07	Pass	10/9		39.7
EC4.5	100 X 40	D1, E6	8/24/07	9/28/07	Pass	8.5/12		41.1
EC5	172 X 70	D1, E3S, E2, E6	8/21/07	9/21/07	Pass	10/11		38.9
EC6	172 X 70	D1, E2, E6	8/27/07	9/28/07	Pass	7/7.5		32.2
EC7	172 X 70	D1, E3S, E6	9/11/07	10/18/07	Pass	8/10/9	32.7	31.5
EC8	172 X 70	E6, E3S	9/20/07	10/23/07	Pass	9/10		35.0
EC9	172 X 70	D1, E3S, E5, E6	9/20/07	10/23/07	Pass	6/5/6	30.0	31.1
EC10	172 X 70	D1, E3S, E5, E6	9/20/07	10/23/07	Pass	5.5/6/6	33.3	31.6
EC11[2]	172 X 70	E3S	9/24/07	11/13/07	Pass	4.5/6/7.5	31.7	32.0
EC12	172 X 70	E3S, E5, E6	9/25/07	11/13/07	Pass	12/15		31.9
EC13	172 X 70	E3S	10/03/07	11/13/07	Pass	7/13		32.3
EC14	172 X 70	E3S	10/02/07	11/13/07	Pass	9/10.5		35.0
EC15	172 X 70	E3S	10/02/07	11/13/07	Pass	11/20		30.6
EC16	172 X 70	E3S	10/03/07	11/13/07	Pass	5/4/6	32.1	31.5
ED3	157 X 70	D1, E6	9/06/07	10/9/07	Pass	8/7/6	32.8	32.1
ED4	157 X 70	D1, E6	9/06/07	10/9/07	Pass	9/10/12	36.7	35.8
ED5	157 X 70	D1, E6	9/06/07	10/9/07	Pass	8/8/6	33.8	34.1
ED7	157 X 70	E3S	9/25/07	11/2/07	Pass	5/4/4	29.8	30.4
ED9	157 X 70	E3S	9/25/07	11/2/07	Pass	2/1.5/5	30.0	29.8
ED11	157 X 70	E3S	10/04/07	11/13/07	Pass	4/7/5	31.1	31.9
ED12	157 X 70	E3S	10/11/07	11/19/07	Pass	4/4/4	27.1	27.1

Geotextile Tube Number	Circumference Feet x Length (ft)	Contained Sub-Area(s)	Date Taken Out of Service	Percent Solids Sample Date	Paint Filter Test Free Liquids	Vane Shear Results[1] (kPa)	QA Percent Solids	QC Percent Solids Average
ED13	157 X 70	E3S	10/16/07	11/19/07	Pass	15/15/15	25.6	26.8
ED14	157 X 70	E3S	10/16/07	11/19/07	Pass	3/4/3	29.0	29.3
ED15	157 X 70	E3S	10/16/07	11/19/07	Pass	4/3/3	26.8	26.6
NWA1[2]	200 X 60	D1, A	4/26/07	6/7/07	Pass	15/10/14	42.3	43.8
NWA2	200 X 60	D1, A	4/26/07	6/7/07	Pass	29/25		47.8
NWA3	200 X 60	D1, A, POG1	5/07/07	6/7/07	Pass	14/9		46.5
NWA3.5-W	100 X 40	A, POG1, C	5/12/07	6/14/07	Pass	24		38.5
NWA3.5-E	100 X 40	A, POG1, C	5/12/07	6/14/07	Pass	15		41.1
NWA4	200 X 60	D1, A, POG1	5/07/07	6/7/07	Pass	11/12		47.6
NWA4.5-W	100 X 40	A, POG1, C	5/12/07	6/14/07	Pass	16		46.2
NWA4.5-E	100 X 40	A, POG1, C	5/12/07	6/14/07	Pass	24		47.7
NWA5	200 X 60	A, D1	5/02/07	6/7/07	Pass	13/15		46.0
NWA6	200 X 60	A, D1	5/02/07	6/7/07	Pass	15/17/19	44.0	47.8
NWB1	186 X 65	A, D1, POG1, C, POG3S, POG3N	5/02/07	6/29/07	Pass	11/8/8	35.3	34.6
NWB2	186 X 65	C, POG1, POG3S, POG3N	5/02/07	6/29/07	Pass	16.5/10		37.8
NWB3	186 X 65	C, POG1, POG3S, POG3N, D1	5/30/07	6/29/07	Pass	12/14.5		33.2
NWB4	186 X 65	C, POG1, POG3S, POG3N	5/30/07	6/29/07	Pass	16/18		34.6
NWB5	186 X 65	C, POG1, POG3S, POG3N	6/01/07	6/29/07	Pass	9/14/16	33.2	32.7
NWC1	172 X 70	POG3N, D1, POG3S	5/29/07	6/29/07	Pass	5/8/8	36.2	34.6
NWC2	172 X 70	D1, POG3N, POG3S	6/12/07	6/29/07	Pass	6/4.5/5	37.3	34.4
NWC3	172 X 70	D1, POG3N, POG3S	6/11/07	6/29/07	Pass	5/4.5/5	35.2	37.8
NWC4	172 X 70	POG3N, D1, POG3S	6/11/07	6/29/07	Pass	6/6/6	37.6	36.7
SWA1[2]	200 X 60	C, POG1, POG3S, POG3N, D1	6/05/07	7/19/07	Pass	16/18/18	36.6	35.2
SWA2	200 X 60	A, D1, POG1, C	5/18/07	6/19/07	Pass	14/15		42.8
SWA3	200 X 60	A, D1, POG1, C	5/18/07	6/19/07	Pass	18/17		44.5
SWA4	200 X 60	A, D1, POG1	5/07/07	6/14/07	Pass	12/14.5		41.7
SWA5	200 X 60	A, D1, POG1, C	5/18/07	6/19/07	Pass	10/14.5		42.9
SWA6	200 X 60	C, POG1, POG3S, POG3N	5/25/07	8/27/07	Pass	21/30/25	41.4	39.5
SWB1	186 X 65	D1, POG3N, E3S	6/18/07	7/19/07	Pass	15/11/12	40.4	37.4
SWB2	186 X 65	D1, POG3N, E3S	6/16/07	7/19/07	Pass	18/15		35.7
SWB3	186 X 65	POG3S, C, POG1, D1, POG3N, E3S	6/16/07	7/19/07	Pass	11/15		38.7
SWB4	186 X 65	D1, POG3N, E3S	6/18/07	7/19/07	Pass	14/24		35.0
SWB5	186 X 65	D1, POG3N, E3S	6/19/07	7/19/07	Pass	15/13/13	38.0	36.6
SWC1	172 X 70	D1, POG3N, E3S	7/10/07	8/9/07	Pass	8/10/11	35.8	36.2
SWC2	172 X 70	D1, POG3N, E3S	7/10/07	8/9/07	Pass	8/11/9	37.4	36.6
SWC3	172 X 70	D1, POG3N, E3S	7/10/07	8/9/07	Pass	12/12/11	38.7	38.5
SWC4	172 X 70	D1, POG3N, E3S	7/10/07	8/9/07	Pass	11/14/12	39.4	37.6

Geotextile Tube Number	Circumference Feet x Length (ft)	Contained Sub-Area(s)	Date Taken Out of Service	Percent Solids Sample Date	Paint Filter Test Free Liquids	Vane Shear Results[1] (kPa)	QA Percent Solids	QC Percent Solids Average
SWD3	172 X 70	E3S, E1, D1	7/24/07	8/28/07	Pass	5/5.5/5	32.8	33.8
NEA1	200 X 60	E3S	11/02/07	12/6/07	Pass	10/9/9	29.7	31.2
NEA2	157 X 70	E3S	11/02/07	12/6/07	Pass	7/9/10	30.6	30.1
NEA3	200 X 60	E3S	11/02/07	12/6/07	Pass	8/7/7	31.0	31.2
NEA4	157 X 70	E3S	11/02/07	12/6/07	Pass	7/7/10	32.3	29.7
NEA7	200 X 60	E3S, E1, D1	7/24/07	8/28/07	Pass	13/16		39.9
NEA9	200 X 60	D1S, E1, E2	8/02/07	9/11/07	Pass	20/22		34.1
NA1	200 X 60	D1, E3S, E5, E6	10/01/07	11/19/07	Pass	10/10/10	35.3	36.6
NA2	200 X 60	D1, E3S, E5, E6	10/02/07	11/19/07	Pass	17/15		36.2
NA3	200 X 60	E3S, E5, E6	10/10/07	11/20/07	Pass	11/12		34.4
NA4	200 X 60	E3S	10/10/07	11/20/07	Pass	10/11		36.0
NA5	200 X 60	E3S	10/15/07	11/20/07	Pass	10/9		35.7
NA6	200 X 60	E3S	10/15/07	11/19/07	Pass	7/7/7	40.5	39.0
NB1	186 X 65	E3S, F	10/24/07	11/28/07	Pass	7/8/6	35.1	33.0
NB2	186 X 65	E3S, F	10/22/07	11/28/07	Pass	5.5/8		30.8
NB3	186 X 65	E3S, F	10/22/07	11/28/07	Pass	5/5		29.8
NB4	186 X 65	E3S, F	10/23/07	11/28/07	Pass	6/5.5		31.9
NB5	186 X 65	E3S, F	10/24/07	11/28/07	Pass	6/5/5	30.8	30.0
NC1[2]	172 X 70	E3S, E2	10/31/07	12/4/07	Pass	5/5/5	25.4	26.0
NC2	172 X 70	E3S, E2	10/31/07	12/4/07	Pass	5/5/5	25.8	25.3
NC3	172 X 70	E3S, E2	10/31/07	12/4/07	Pass	4/4/5	25.3	25.8
NC4	172 X 70	E3S, E2	10/31/07	12/4/07	Pass	3/4/5	25.1	25.7
SA1	200 X 60	E3S, E2, F	11/1/07	12/4/07	Pass	4/5/6	25.8	26.9
SA2	200 X 60	E3S, E2, F	11/1/07	12/4/07	Pass	5/5/5	31.2	30.8
SA3	200 X 60	E3S	10/11/07	11/20/07	Pass	5/5.5/5	30.4	30.2
SA4	200 X 60	E3S	10/11/07	11/20/07	Pass	10/7.5		32.1
SA5	200 X 60	E3S	10/11/07	11/20/07	Pass	9/7		34.3
SA6	200 X 60	E3S	10/11/07	11/20/07	Pass	5/8/8	32.4	31.2
SB3	186 X 65	E3S, E2, F	10/29/07	12/5/07	Pass	8/7/9	29.8	29.0
SB4	186 X 65	E3S, E2, F	10/29/07	12/5/07	Pass	4/5		28.1
SB5	186 X 65	E3S, E2, F	10/29/07	12/5/07	Pass	4/4/4	23.2	23.4
SC3	172 X 70	E3S, E2	11/01/07	12/6/07	Pass	5/5.5/5.5	25.5	26.5
SC4	172 X 70	E3S, E2	11/01/07	12/6/07	Pass	5/5/5.5	27.7	27.3

Notes:

[1] 13/16/13 = The individual result from each tube test hole.

[2] A geotechnical sample was collected from the tube. Geotech results for the sample summarized in Tables 5-3 and 5-4 apply to all sub-areas' sediment contained within the geotextile tube.

Prepared by: NRA
Checked by: MCC2

Table 5-2

Dewatered Sediment Free Liquids Percent Solids Data Summary

Sub Area	Paint Filter Test (Free Liquids)	Percent Solids Average (QA)	Percent Solids Range (QA)	Percent Solids Average (QC)	Percent Solids Range (QC)
A	Pass	41.2	35.3 – 45.3	43.7	34.6 – 47.8
C	Pass	38.5	33.2 – 45.3	39.3	32.7 – 47.7
D1	Pass	36.5	30.0 – 45.3	37.6	30.1 – 47.8
E1	Pass	36.7	32.8 – 39.0	36.2	31.1 – 42.8
E2	Pass	28.5	23.2 – 39.0	32.4	23.4 – 42.8
E3	Pass	31.6	23.2 – 40.5	33.6	23.4 – 42.8
E5	Pass	32.8	30.0 – 35.3	34.2	31.1 – 37.7
E6	Pass	33.5	30.0 – 37.6	35.8	30.1 – 41.1
F	Pass	29.02	23.2 – 35.1	29.37	23.4 – 31.9
POG1	Pass	38.5	33.2 – 45.3	39.6	32.7 – 47.7
POG3	Pass	37.1	33.2 – 41.4	36.2	32.7 – 42.2

Prepared by: NRA
Checked by: MCC2

5.6.4 Dewatered Sediment Geotechnical Characteristics

In accordance with WDNR's *Conditional Plan of Operations Approval Modification – Special Waste Acceptance Plan for Dredged Material Disposal at the Veolia Environmental Services Hickory Meadows Landfill,* dated September 29, 2005, dewatered sediment from OU1 should 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). Dewatered sediment from OU1 was tested for percent solids / moisture content and UCS was calculated using vane shear results. In addition, Appendix J of the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007), required dewatered sediment to be tested for Grain Size Distribution (ASTM D422); Triaxial Shear (ASTM D4767); Consolidation (ASTM D2435); Hydraulic Conductivity (ASTM 5084), and Atterberg Limits (ASTM 4318). Six geotechnical samples were collected from six geotextile tubes. Sediment from multiple sub-areas is contained within each tube. The geotechnical results from a sample were applied to each sub-area represented in that tube. These results are summarized in Tables 5-3 and 5-4.

Gradation analysis was performed for dewatered sediments from Sub-areas A, C, D1, E1, E2, E3, E6, POG1, and POG3. Referring to Table 5-3 below, the sediment in Sub-areas A, C, D1, E3, E6, POG1, and POG3 can be generally described as fine grained (i.e. $P_{200} > 50\%$). Sub-areas D1, E1, and E2 are generally described as coarse grained (i.e. $P_{200} < 50\%$). The absence of a gravel-sized fraction is likely due to the 1/8-inch trammel screen removing the gravel (and probably some coarse sand) from the dredge slurry before it was consolidated in the thickeners and pumped to the geotextile tubes.

Table 5-3
Dewatered Sediment Gradation

Sub-area	Clay (%) D422	Silt (%) D422	Sand (%) D6913	Gravel (%) D6913
A	22.8	41.1	36.1	0.0
C	4.9	45.4	49.7	0.0
D1	22.8/4.9/12.4/21.6	41.1/45.4/34.1/42.1	36.1/49.7/53.5/36.3	0.0/0.0/0.0/0.0
E1	12.4	34.1	53.5	0.0
E2	12.4/20.7	34.1/41.3	53.5/38.0	0.0/0.0
E3S	21.6/24.7/20.7	42.1/36.0/41.3	36.3/39.3/38.0	0.0/0.0/0.0
E6	21.6	42.1	36.3	0.0
POG1	4.9	45.4	49.7	0.0
POG3	4.9	45.4	49.7	0.0

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

Prepared by: NRA
Checked by: GJP

Testing for Atterberg limits were also performed on dewatered sediment samples to determine plasticity. The sediments are classified as either fat clay (CH), organic silt (OH), or elastic silt (MH). Atterberg limits values of the sediments within each sub-area are summarized in Table 5-4.

Table 5-4
Dewatered Sediment Atterberg Limits

Sub-area	Liquid Limit (LL) D4318	Plastic Limit (PL) D4318	Plasticity Index (PI) D4318	USCS Classification
A	117	46	71	CH
C	169	78	91	MH
D1	117	46	71	CH
D1	152	54	98	OH
D1	169	78	91	MH
D1	110	75	35	OH
E1	152	54	98	OH
E2	152	54	98	OH
E2	155	86	69	OH
E3S	110	75	35	OH
E3S	86	59	27	OH
E3S	155	86	69	OH
E6	110	75	35	OH
E2	155	86	69	OH
POG1	169	78	91	MH
POG3	169	78	91	MH

Prepared by: NRA
Checked by: GJP

Following a period of dewatering within a geotextile tube, sediment was sampled from predetermined locations within each geotextile tube and field tested for strength using in-situ field vane shear ASTM 2573. Sample location, and frequency within each geotextile tube was based upon geotextile tube size and associated sediment volume (refer to Section 5.6.5 Dewatered Sediment Sampling). The test was conducted using a calibrated GEONOR H-60 Field Vane device. Average results of the Field Vane Shear test are provided in Table 5-5.

Dewatered sediment collected during 2007 ranged from 23.4% to 47.8% solids. UCS was estimated by doubling the result of the field vane shear tests. These results ranged from 0.02 tons per square foot (tsf) to 0.62 tsf. The Veolia Hickory Meadows Landfill is permitted to accept normal and low strength dewatered sediment for disposal. Normal strength dewatered sediment should be 50% solids or greater, with a UCS > 0.4 tsf, and have an undrained shear strength > 400 pounds per square foot (psf). Low strength dewatered sediment should be 20% to 50% solids, with a UCS > 0.1 tsf. In addition, because of the uncertainty regarding the physical properties of the dewatered river sediment from the LFR, Veolia, 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 ("Baseline Workability/Strength Requirements") to be considered workable.

While there were samples tested that achieved the required percent solids and met the estimated UCS for normal strength testing, none of the sediment passed the "Baseline Workability/Strength Requirements". As a result, almost all of the dewatered river sediment was required to be handled and disposed of as low strength material.

Table 5-5
Dewatered Sediment Field Vane Shear Tests

Sub-area	Vane Shear ASTM D2573 (tsf) MIN/MAX/AVE	Estimated UCS ASTM D2166 (tsf) MIN/MAX/AVE
A	0.07/0.30/0.16	0.14/0.60/0.32
C	0.07/0.31/0.16	0.14/0.62/0.32
D1	0.02/0.31/0.13	0.04/0.62/0.26
E1	0.05/0.23/0.13	0.10/0.46/0.26
E2	0.02/0.23/0.09	0.04/0.46/0.18
E3	0.01/0.31/0.10	0.02/0.62/0.20
E5	0.04/0.26/0.12	0.08/0.52/0.24
E6	0.02/0.30/0.13	0.04/0.60/0.26
POG1	0.07/0.31/0.15	0.14/0.62/0.30
POG3	0.04/0.31/0.13	0.08/0.62/0.26

Note: Refer to Appendix G for a complete listing of Field Vane Shear test results.
UCS = Vane Shear * 2

Prepared by: NRA
Checked by: GJP

6 Dewatered Sediment Load-out, Transport, and Disposal

6.1 Dewatered Sediment Load-out, Transportation, and Disposal

Load-out, transportation and disposal (LTD) of the dewatered sediment removed during the 2007 dredging season began on July 9, 2007. As in previous years, load-out which involved only the removal of non-TSCA sediments was contracted to Brennan. Transportation of this dewatered non-TSCA sediment was contracted with Gene Frederickson Trucking. Disposal of the non-TSCA dewatered sediment was contracted with Veolia at their Veolia Hickory Meadows Landfill.

During 2007, Brennan had three pieces of equipment onsite for the load-out activities. The main piece of equipment used for load-out was a 950 Case excavator outfitted with a clamshell. The clamshell bucket had a capacity of approximately 2.5 cy and was capable of removing the sediment from the geotextile tubes, and loading the material into dump trucks, in an effective and efficient manner. Brennan also had onsite one 360 Hyundai excavator with a standard bucket. This piece of equipment was used as a backup, should mechanical issues develop with the Case excavator. The third piece of equipment that was used was a 950 Caterpillar loader. The loader was used primarily to maintain the haul road located within the dewatering pad.

In 2007, the sediment handling process was similar to 2006 with the use of two thickeners, each outfitted with a trammel screen. With implementation of the thickeners, stacking of the geotextile tubes occurred much more rapidly after the retirement of a tube, than in 2004 and 2005. Because of this, material from several bags was removed at the same time during the loading process (Figure 6-1). Typically, there was dewatered sediment from geotextile tubes on four different layers being loaded simultaneously.

As in 2006, the pad management dictated the need to place geotextile tubes on the dewatering pad a second time, after all material from the tubes initially filled had dewatered and been removed. The labeling of the geotextile tubes was similar to that used in 2006 and is described in detail in Section 5.5. In addition, due to the presence of the thickeners and the decant water discharge basin, the western half of the dewatering pad was divided into two distinct sections, the northwest section and the southwest section.

The trammel screens removed material greater than 1/8-inch in diameter from the dredge slurry prior to its introduction to the thickeners. This material, commonly referred to as “screenings” was allowed to accumulate in a pile located adjacent to the screens. A photograph of sediment screening load out is presented in Appendix A, Photograph 33. The first LTD activities of 2007 occurred on April 23, 2007 approximately two weeks after the initiation of dredging activities with removal of trammel screenings. This material was loaded, transported, and disposed at Veolia Hickory Meadows Landfill as workable material, meaning that it was not placed into a monofill, where the majority of dewatered sediment from the 2007 RA was placed.

The LTD activities associated with the dewatered sediments in the geotextile tubes initially began on July 9, 2007, with the removal of material from tubes EA-7 and EA-9, which were located on the eastern side of the pad. LTD operations then moved to the northwest quadrant of the pad. The removal rate was initially targeted at 2,500 tons/week. This was typically achieved

with 5 trucks hauling 4 days/week. The LTD rate was increased on August 20, 2007 to approximately 3,000 to 3,500 tons/week. This was typically accomplished employing 8 trucks hauling 4 days/week. Finally, in October 2007, the target was increased to a minimum of 4,000 tons/week, with up to 10 trucks hauling on a daily basis, 4 days/week. The LTD activities followed the filling sequence of the geotextile tubes, as detailed in Section 5, to allow maximum drying time of the sediment.

There were no LTD activities from November 16, 2007 to November 25, 2007 due to the Thanksgiving holiday or from December 22, 2007 through January 6, 2007 due to the Christmas/New Year's holiday. LTD activities associated with dewatered sediment from the western half of the pad was completed on October 1, 2007. Removal of the remaining dewatered sediment was completed on March 31, 2008. A photograph of dewatered sediment load out is presented in Appendix A, Photograph 34.

6.1.1 Sampling Plan

The 2007 pad management plan determined that the dewatering pad would not be large enough to handle all of the sediment projected to be removed in 2007, thus requiring that geotextile tubes would need to be placed in the same location more than once. As in 2006, a decision was made to have sediment in the geotextile tubes, once filled, remain on the pad for a minimum of 30 calendar days. This plan also assumed that the geotextile tubes would be stacked four high. Because the stacking of the geotextile tubes pose problems for sampling, specifically the tubes on the bottom rows, the stacking plan was discussed with the Foth QA team. Following that discussion, a load-out and sampling plan was developed.

A detailed description of the sampling procedures can be found in Section 5.6 and in Appendix E of the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et al., 2007a).

6.1.2 Loading and Transport of Non-TSCA Sediment

As in previous years, Gene Frederickson Trucking was contracted by GW Partners to perform the non-TSCA transportation phase of the 2007 RA activities. Trucks that were used for the transportation activities had been previously outfitted with permanent liners. In addition, tarps were employed to cover the sediment during transport, and tailgates with rubber seals and turnbuckles were used to ensure that there was no leakage of material during transport to the landfill. During the majority of the period when the temperatures were at or below freezing, plastic liners were used to prevent the sediment from sticking to the sides of the trucks.

The LTD activities associated with the sediment contained in the geotextile tubes began daily between 6:00 a.m. and 6:30 a.m. and continued until approximately 3:30 p.m. at the staging area. The hours of operation at the landfill were 6:30 a.m. to 4:00 p.m. The schedule relating to the LTD was re-evaluated on a weekly basis to ensure that all of the sediment was removed from the dewatering pad in time to allow preparations of the pad for the 2008 RA work.

At the staging area, trucks entered through the south entrance and proceeded along the marine access road, turned north toward the dewatering pad and then east where they proceeded along the berm until they again turned north and entered the pad along the haul road in the center of the dewatering pad. The trucks then continued to the area where they were loaded. Temporary

mats, which had been used in the past, were not required in 2007. 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 spray washed the trucks as they entered the decontamination building. This was done to remove any sediment left on the trucks during the loading process. Once the trucks were sprayed clean, they entered the decontamination building, where scaffolding was positioned on each side of the building. This allowed decontamination personnel to clean the top rails of each truck before a tarp was positioned over the sediment in the box of the truck. Once the tarp was fastened into place, the decontamination process was complete and the trucks proceeded to the landfill.

Disposal of the OU1 non-TSCA sediment was contracted to Veolia. Once arriving at the landfill, trucks were weighed. They then proceeded into the landfill. After disposing of the materials, the trucks proceeded to the landfill decontamination area. A photograph of the decontamination process is presented in Appendix A, Photograph 35. The trucks were again spray washed to remove any sediment that may have been placed on the truck or tires during the disposal process. After decontamination, the trucks left the landfill and returned to the OU1 site. The trucks, typically, made five round trips on a daily basis.

During 2007, unworkable materials were disposed of in specified monofills. In 2005, two monofills (MF1 and MF2) were constructed; and in 2006, a third monofill (MF3) was constructed and began receiving sediment. MF1 reached its capacity as of December 12, 2005. In 2006, the filling of MF2 was completed. MF2 had a certified capacity of 73,110 cy and was deemed full on November 7, 2006, after receiving a total of 105,288 tons. On November 8, 2006, the first sediment was placed into MF3, which has a capacity of 109,300 cy. Through December 31, 2007, MF3 had received approximately 129,500 tons. During 2007 remedial activities, it was determined that another monofill would need to be constructed in order to have enough space available to dispose of all remaining OU1 dredged sediment. The construction of MF5 began in September 2007, was completed in March 2008, and began receiving sediments in late March 2008. (MF4 is dedicated to the sediments from Phase 1 remedial activities in OU4.)

All workable material was disposed of in specific areas on the landfill's working face and co-mingled with municipal waste as directed by Veolia personnel. During 2007, the majority of the sediment was deemed unworkable at the landfill, and therefore, placed into the monofills. A total of 120,614 tons of non-TSCA material was disposed at Veolia Hickory Meadow Landfill, from April 2007 through March 2008. This material was from the 2007 RA operations and was made up of 115,956 tons of unworkable sediment, 4,381 tons of workable trammel screenings, and approximately 277 tons of miscellaneous materials.

6.1.3 Loading and Transport of TSCA Sediment

There were no TSCA sediments removed from OU1 in 2007.

6.1.4 LTD Schedule

As mentioned above, the LTD activities began on April 23, 2007. The goal was to remove enough sediment, on a weekly basis, to have the dewatering pad cleared of all sediment by the end of the second week in March 2008. This would allow one month to prepare the pad for 2008 operations, as the plan was to have the 2008 in-water remedial activities begin in mid-April. The last material was removed from the pad on March 31, 2008

7 Water Treatment Plant

7.1 Process Description

At the beginning of the 2007 RA activities the WTP consisted of:

- A chemical conditioning system
- A Krofta Sandfloat SAF-BP unit (combined dissolved air flotation [DAF] clarifier and sand media bed filter) (Appendix A, Photographs 36 and 37.)
- Bag filters
- Granular activated carbon (GAC) vessels (Appendix A, Photograph 38)
- A sludge tank
- A non-potable water tank

A city water line to the WTP, to aid in the treatment process, was installed in 2006 and is in place.

The plant influent was pumped from the dewatering pad into the Sandfloat unit by Godwin pumps (Appendix A, Photograph 39), where suspended solids were removed with dissolved air flotation and sand filtration. Effluent from the Sandfloat was pumped to the bag filters for additional solids removal and then through the GAC vessels for final treatment before discharge into the river. A portion of the effluent from the GAC vessels, or city water, was stored in the non-potable water tank for use in dry polymer makeup water, and backwash cycles. Sodium hypochlorite (bleach) was added at various locations to minimize or eliminate biological growth. A WTP process flow diagram is presented as Figure 7-1.

Sludge from the DAF portion of the Sandfloat was sent to the sludge tank before being pumped to the WTP decant water discharge basin, which was located in the northeast corner of the dewatering pad. DAF and GAC backwash water was discharged directly to the WTP decant water discharge basin, as well.

Throughout the majority of the 2007 RA, the WTP was operated on a 24 hour/day, 5 day a week (24/5) schedule, with scheduled maintenance performed, as needed, during the weekends.

7.2 Water Treatment Plant Improvements

During the 2007 remedial activities, the WTP was operated by Earth Tech personnel, a subcontractor to Brennan. At the beginning of the 2007 operations, Earth Tech personnel were asked to identify any concerns that, if addressed, could potentially improve operations. A summary of these issues follows:

- Ferric Sulfate: a concern with the use of the chemical, specifically its negative impact on filter media was identified. The fact that it appeared to be blinding the media was confirmed and discussed with the project team. At that time, a decision was made to replace the ferric sulfate with ACH.

- Effluent Meter: At times, the meter was inaccurate. After a brief investigation, the meter was found to lose set points and return to default settings that allowed erroneous empty pipe readings after power spikes. To address this issue, the meter was programmed to the correct set points and recalibrated.

- Influent Piping: The inlet meter to the Krofta had an accuracy problem. It was identified that this was caused by air buildup in the influent pipe. To address this issue, an air valve was installed. The meter was also found to lose set points and return to default settings that allowed erroneous empty pipe readings after power spikes. The meter was programmed to the correct set points and recalibrated.

7.2.1 Sandfloat Upgrades and Operation

During the majority of the 2007 RA, two 8 inch hydraulic dredges operated on a 24/hour day, 5 day per week (24/5) schedule. As a result, the Sandfloat needed to operate continuously (as per its design). Prior to the start of 2007 operations, a sample of the media was collected and sent Krofta for analysis.

When 2007 operations began, it was immediately evident that the design flow of 4,000 gpm was not achievable. As such, after an examination of the condition of the media and discussions with Krofta personnel, the hood and travel was adjusted to eliminate air leakage during backwash and drain down steps. In addition, several other upgrades to the Sandfloat unit were performed, as identified by Earth Tech. These included modifying the speed of the backwash valve, unplugging the drain lines and adjusting the backwash flow rates and frequency to minimize the loss of media.

As in the previous years, the Sandfloat experienced solids loading during the 2007 RA activities, which resulted in gradually decreasing performance. As part of the on-going improvement in WTP operations, a modified backwash was implemented that improved cleaning of the media. In addition, a different chemical boil-out, using sodium hypochlorite, was identified and implemented on a regular basis. The first boil-out with the sodium hypochlorite returned the unit to optimum performance. However, as the operations progressed more frequent boil-outs were required over weekends and the results of the latter treatments did show improved flow.

Near the completion of the 2007 remedial operations it became apparent that with each successive chemical boil-out the performance of the Krofta did recover well as it had following the previous one that had been implemented. It is currently not planned to replace the media prior to commencing 2008 RA activities because of the maintenance changes made during the 2007 operating season.

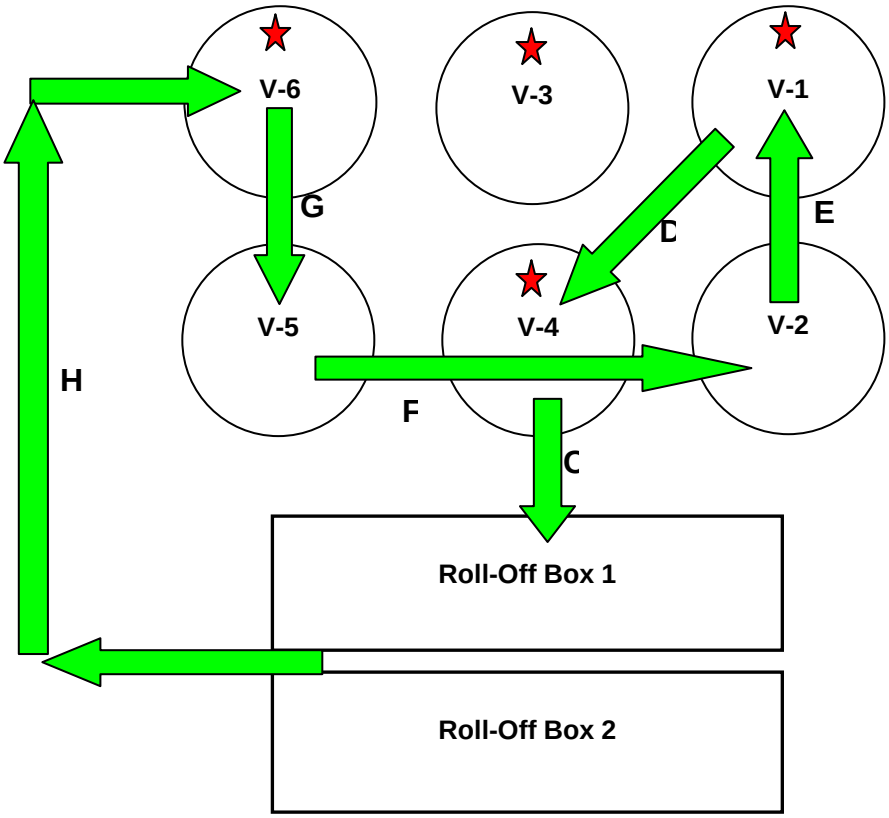
7.2.2 Granular Activated Carbon Upgrades and Operation

The WTP GAC units have a design capacity of 3,000 gpm. The anticipated flow to the WTP during 2007 was approximately 2,300 gpm, which was based on the operation of two 8-inch hydraulic dredges.

During the 2006 RA period, the GACs operated as designed. However, as the season progressed, the flow through the units decreased. Prior to the start of 2007 operations a decision was made to remove the media from one GAC vessel so that an inspection could be performed. Upon examination of the media from this vessel it was determined that the media from all GAC units would be removed, one unit at a time. Following is the description of this work:

Carbon Transfers Prior to 2007 Season:

A. On January 23, 2007, GAC carbon from V-3 was transferred into 2 roll-off boxes.
B. On January 24, 2007, the GAC carbon was returned to the V-3 from the roll-offs.
C. On March 7, 2007, V-4 was transferred into 2 roll off boxes.
D. On March 8, 2007, V-1 was transferred into V-4.
E. On March 12, 2007, V-2 was transferred into V-1.
F. On March 13, 2007, V-5 was transferred into V-2.
G. On March 13, 2007, V-6 was transferred into V-5.
H. On March 15, 2007, the roll offs (old V-4) was transferred into V-6 by H20UnderPressure.
I. All vessels were boiled out with 50% caustic soda and returned to service.

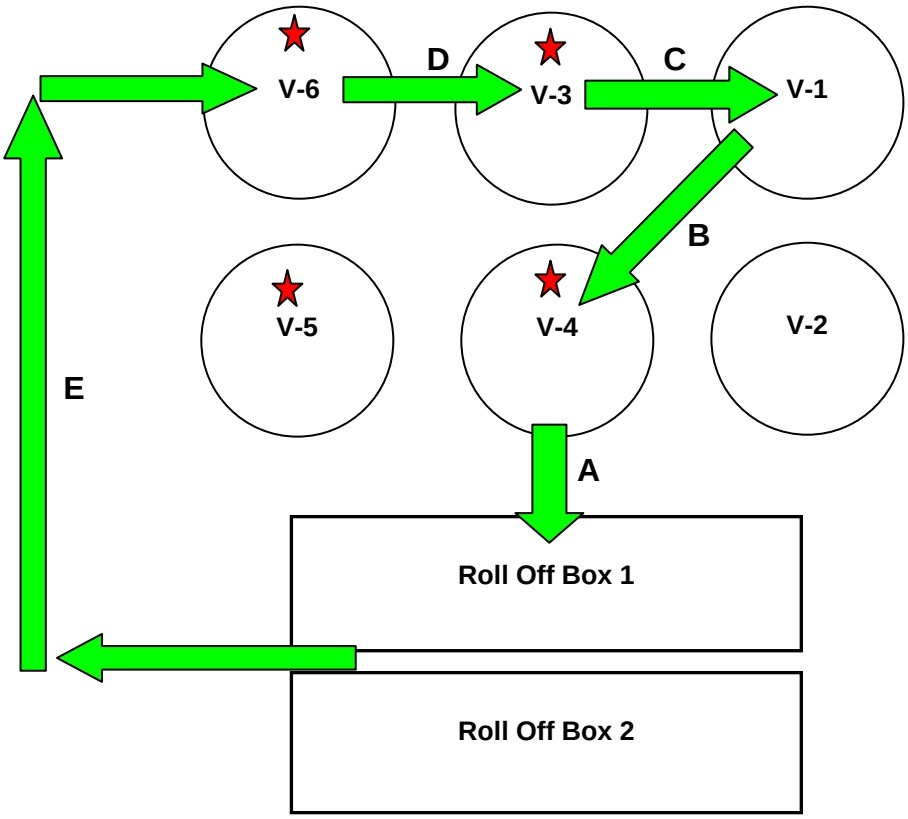


★ Indicates vessels that had new carbon in July of 2006, prior to the carbon transfers at the beginning of the 2007 season.

The GAC units operated at the beginning of 2007 dredging operations with minimum pressure loss through the units. However, as 2007 operations progressed, high pressure loss in several vessels occurred on a more frequent basis. 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. A chemical boil out, similar to that being employed with the Krofta, was implemented using sodium hypochlorite. This initially improved operations. However, during the course of the 2007 project, the flow capable of being sent through the units continued to decrease. During the production shutdown that coincided with the July 4th holiday, the carbon from each vessel was transferred, similar to the work performed prior to the start-up of the 2007 operations, and is detailed below:

Carbon Transfers During Week of July 4, 2007:

A. On June 30, 2007, V-4 was transferred into 2 roll off boxes.
B. On June 30, 2007, V-1 was transferred into V-4.
C. On June 30, 2007, V-3 was transferred into V-1.
D. On July 1, 2007, V-6 was transferred into V-3.
E. On July 2, 2007, the roll off boxes (old V-4) was transferred into V-6.
F. All vessels were then boiled out with 50% caustic soda and returned to service.

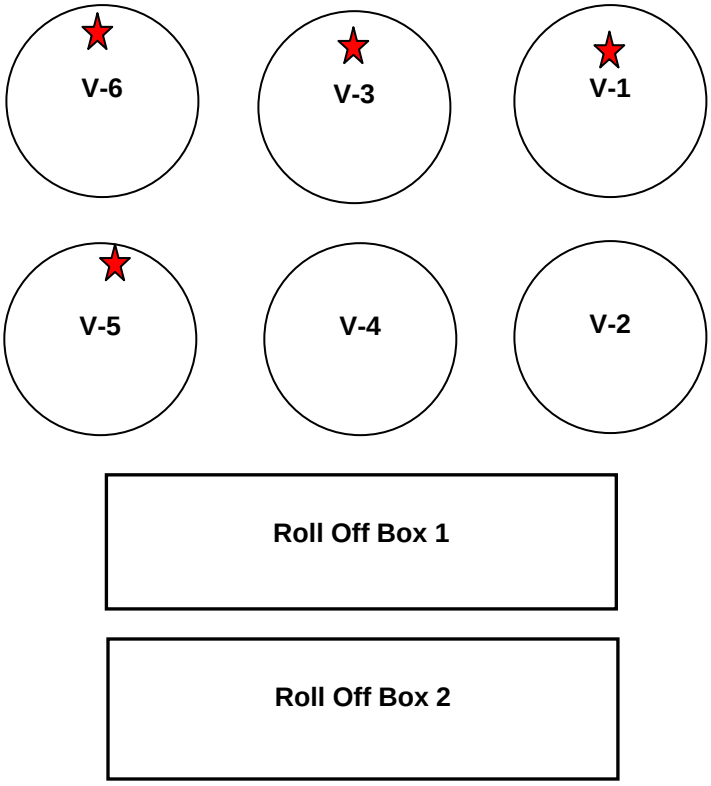


Indicates the location of the newest carbon from July of 2006, prior to the carbon transfers during the week of July 4, 2007.

This improved operations and allowed the units to perform well throughout the remainder of the 2007 project. At the end of the 2007 dredging season, it was decided to remove the GAC media from all of the units again. An inspection was performed to see if there was plugging of the Septas, or the under-drain system of the units. Upon viewing the inside of the vessels it was evident that there was no media plugging the Septa's. Following is a summary of these events:

Carbon Transfers Post 2007 Season:

A. On November 12, 2007, V-4 media was transferred into 2 roll off boxes.
B. On November 13, 2007, V-4 media was transferred back into V-4, V-2 was transferred into 2 roll off boxes, V-4 backwashed.
C. On November 14, 2007, V-2 media was transferred back into V-2, V-1 was transferred into 2 roll off boxes, V-2 backwashed.
D. On November 15, 2007, V-1 media was transferred back into V-1, V-1 backwashed.
E. On November 16, 2007, V-3 was transferred into 2 roll off boxes.
F. On November 26, 2007, V-3 media was transferred back into V-3, V-6 was transferred into 2 roll off boxes.
G. On November 27, 2007, V-6 media was transferred back into V-6, V-5 was transferred into 2 roll off boxes.
H. On November 28, 2007, V-6 media was transferred back into V-5, V-3, V-5, V-6 backwashed.



★ Indicates the location of the newest carbon as of November 30, 2007.

While it was unclear whether the Septa had blinded over during 2007 operations, it is clear that the removal and cleaning of the media had a significant positive impact on the capacity of these units, as flows through the units increase substantially. Upon verifying that all units could now perform as designed, they were filled with water containing a slight residual chlorine concentration in preparation for 2008 operations.

7.3 Performance

The WTP was designed to remove suspended solids and dissolved organics such as PCBs. For the majority of the 2007 operations, all WDNR performance expectations were met, except mercury. Effluent sampling results are presented in Section 10.2.

8 Productivity

8.1 Percent Uptime

Percent uptime is a key measure of productivity for the project as a whole and for the 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 weekends). Table 8-1 (refer to Tables tab in the back of this report) uses information from the Brennan daily reports to calculate percent uptime for the project and the individual operations. The LTD 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 efficiency) was 88%. The 88% uptime calculation includes 791 hours for delays. The remaining 12% was spent on a variety of delays that were encountered throughout the dredging process. The delays of most significance included moving the dredge, engine room and spuds, and the dredge GPS sensors'computers. The dredging operations percent uptime was achieved without the need for a standby dredge. A marked improvement in percent uptime has occurred since 2004. In 2004, percent uptime was 78%, in 2005 percent uptime was 85%, and in 2006 percent uptime was 84%.

8.2 Sediment Removal Efficiency

The 2007 dredging season for OU1 began on April 2, 2007 and concluded on November 2, 2007. During this time, Brennan compiled 6,795 gross operational hours (GOH) on the project. Of those gross operational hours, 6,003.5 hours were net operational dredging hours (NOH) for the three 8-inch hydraulic articulating ladder dredges: the *Fox River*, the *Grand Calumet* and the *Palm Beach*. The dredges listed did not dredge simultaneously. The dredge, *Fox River,* was replaced at the end of the project by the dredge, *Palm Beach.*

Operational reporting was separated into five production categories for activity codes as listed in daily production reports. These activity codes are as follows: Standard Configuration First Pass (Cutter head), Standard Configuration Second Pass (Cutter head), Vic Vac, Second Pass Vic Vac, and Day Rate. Second pass was reported as any time a dredge covered an area more than once. These efficiency rates were evaluated on the individual dredges and combined. Table 8-2 shows the operational hours of the individual dredges and combined per dredging activity.

Table 8-2

Operational Hours/Production Categories

Standard Configuration First Pass				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	—	1,134.50	—	1,134.50
NOH	—	1,013.75	—	1,013.75
SF	—	883,021	—	883,021
Efficiency	—	89%	—	89%

Standard Configuration Second Pass				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	—	394.50	—	394.50
NOH	—	290.50	—	290.50
SF	—	305,995	—	305,995
Efficiency	—	74%	—	74%

Vic Vac First Pass				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	2,924.00	1,523.75	58.00	4,505.75
NOH	2,634.75	1,326.00	52.25	4,013.00
SF	2,038,205	1,137,713	58,023	3,233,941
Efficiency	90%	87%	90%	89%

Vic Vac Second Pass				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	267.25	265.25	175.00	707.50
NOH	241.00	240.75	157.75	639.50
SF	294,864	312,330	274,307	881,501
Efficiency	90%	91%	90%	90%

Day Rate				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	29.75	23.00	—	52.75
NOH	26.50	20.25	—	46.75
SF	20,619	24,027	—	44,646
Efficiency	89%	88%	—	89%

Prepared by: TRL
Checked by: GMS

The production of dredges was also separated by the areas they worked in. Table 8-3 shows the operational hours of the individual dredges and combined per dredge sub-area.

Table 8-3

Operational Hours/Sub-area

A				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	—	607.00	—	607.00
NOH	—	481.50	—	481.50
SF	—	433,093	—	433,093
Efficiency	—	79%	—	79%

C				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	—	213.00	—	213.00
NOH	—	190.25	—	190.25
SF	—	157,800	—	157,800
Efficiency	—	89%	—	89%

D1				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	1,637.00	330.00	—	1,967.00
NOH	1,473.00	309.75	—	1,782.75
SF	1,255,123	229,887	—	1,485,010
Efficiency	90%	94%	—	91%

E1				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	—	281.00	—	281.00
NOH	—	212.25	—	212.25
SF	—	222,005	—	222,005
Efficiency	—	76%	—	76%

E2				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	—	295.00	79.00	374.00
NOH	—	240.75	72.50	313.25
SF	—	192,407	103,393	295,800
Efficiency	—	82%	92%	84%

E3S				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	727.00	1,063.00	154.00	1,944.00
NOH	676.75	962.00	137.50	1,776.25
SF	491,968	948,483	228,937	1,669,388
Efficiency	93%	90%	89%	91%

E5				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	—	48.00	—	48.00
NOH	—	44.00	—	44.00
SF	—	53,786	—	53,786
Efficiency	—	92%	—	92%

E6				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	—	487.00	—	487.00
NOH	—	435.50	—	435.50
SF	—	393,967	—	393,967
Efficiency	—	89%	—	89%

POG 1				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	257.00	—	—	257.00
NOH	222.50	—	—	222.50
SF	126,818	—	—	126,818
Efficiency	87%	—	—	87%

POG3 South				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	24.00	—	—	24.00
NOH	20.75	—	—	20.75
SF	10,030	—	—	10,030
Efficiency	86%	—	—	86%

POG3 North				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	432.00	—	—	432.00
NOH	375.00	—	—	375.00
SF	361,896	—	—	361,896
Efficiency	87%	—	—	87%

F				
	Fox River	**Grand Calumet**	**Palm Beach**	**Total**
GOH	—	—	17.00	17.00
NOH	—	—	15.25	15.25
SF	—	—	14,701	14,701
Efficiency	—	—	90%	90%

Prepared by: TRL
Checked by: GMS

Dredge delays were divided in 19 delay categories for evaluation. As each delay occurred, the dredge operator logged its time. Table 8-4 shows the total time per delay for each dredge and the combined delay time.

Table 8-4

Dredge Delay Summary

Time Consumption / Delays (hours)		Fox River	Grand Calumet	Palm Beach	Total
OPERATIONAL	Obstructions	0.00	0.25	0.00	0.25
		0.00	0.00	0.00	0.00
(Sediment)	Clean Pipeline	11.50	12.25	0.00	23.75
	Clean Cutter head	3.75	8.75	0.00	12.50
	Clean Main Pump	1.00	4.25	0.00	5.25
	Change Cutter head	20.75	17.75	0.00	38.50
(Execution)	Move Dredge	71.00	105.25	8.75	185.00
	Move and Repair Pipeline	13.00	7.00	0.75	20.75
	Anchors	3.25	1.00	0.00	4.25
	Mob Dredge to New Area	9.00	5.75	0.00	14.75
	Sensors, DREDGEPACK®				
(Mechanical)	GPS	13.00	68.50	1.25	82.75
	Engine Room & Spuds	80.25	76.00	2.75	159.00
	Startup - Shutdown	22.00	30.50	2.50	55.00
	Dredge Pumps	2.00	30.25	0.00	32.25
	Booster	0.00	2.50	0.00	2.50
PROJECT	Water treatment plant	0.00	0.25	0.00	0.25
	Clarifier	11.75	22.25	3.75	37.75
	Geotextile Tube	23.00	27.25	3.25	53.50
OUTSIDE	Water Quality & Weather	28.00	22.50	0.00	50.50
	Misc	5.50	7.50	0.00	13.00
	Total Delays	318.75	449.75	23.00	791.50
	Net Operational	2902.25	2891.25	210.00	6003.50
	Gross Services	3221.00	3341.00	233.00	6795.00
	Efficiency	90%	87%	90%	88%

Prepared by: TRL
Checked by: GMS

8.3 Sediment Load-Out Rates

LTD activities began on April 23, 2007, with the removal of accumulated trammel screenings. Load out of the dewatered sediment from the geotextile tubes began on July 9, 2007, from the east side of the pad. LTD activities associated with the geotextile tubes are anticipated to be completed in early March 2008. The amounts of sediment loaded on a daily basis averaged 683 tons per day through December 2007 and 998 tons per day during peak loading September through December 2007.

Table 8-5 shows the 2007 RA daily and monthly load-out rates.

Table 8-5

Load-Out Rates for Sediments Remediated in 2007

Date	Maximum Daily Tonnage	Average Daily Tonnage	Total Tons Removed
April-07	216	129	275
May-07	357	345	692
June-07	378	332	668
July-07	596	575	8,044
August-07	1,232	776	13,972
September-07	1,089	919	14,708
October-07	1,157	1,042	20,840
November-07	1,222	964	8,677
December-07	1,208	1,068	12,811
January-08	1,214	1,002	11,017
February-08	1,075	896	10,747
March-08	1,339	1,068	18,163
Total			**120,614**

Prepared by: TRL
Checked by: GMS

9 POG1 Phase II Work

9.1 POG1 B Phase 2 Post Construction Observations

Deposit POG1 B remedial activities were completed in November 2006. The WDNR conditional work plan approval for remediation of Deposit POG1 B, dated September 11, 2006, (Appendix H) required monthly reports following construction activities. The monthly reports were required to document the condition of the erosion control measures and any required maintenance activities. The monthly reports were required the first week of each month until the area was re-vegetated and stable.

A summary of construction activities was submitted to Kristy Rogers, of the WDNR, on November 29, 2006. From November 2006 through August 2007, the monthly post-construction reports were submitted to the WDNR. A copy of the 2007 post-construction reports is included in Appendix H.

The area of Deposit POG1 B was last observed by STS Consultants (STS), on August 31, 2007. The shore zone and slope were stable. Poor winter carryover of seed and extremely dry conditions in 2007 resulted in poor germination of the native prairie seeding. The site was dominated by common ragweed; however, there was an under-story of desired species such as black-eyed Susan, goldenrod, vervain, lobelia, cinquefoil and coneflowers. The shore area had a significant smartweed cover. The shallow water area west of the site was filling in naturally.

GW Partners requested suspension of monthly post-construction status reports until April 2008. Four post-construction reports were proposed for 2008, including April, May, June, and August/September. The revised schedule was approved by Kristy Rogers on September 10, 2007.

10 Environmental Monitoring During Dredging

10.1 Surface Water Quality

During dredging operations, surface water quality monitoring was performed by Foth to identify the occurrence and duration of dredge-induced sediment resuspension.

10.1.1 Turbidity

During dredging operations, surface water turbidity, reported as 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 feet 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. Foth representatives verified the monitoring locations.

Turbidity was measured using three in-stream, real-time turbidity meters (YSI Model 600), which took four successive readings per hour at 0, 15, 30, and 45 minutes. Turbidity data was collected by the base station every 15 minutes from each meter. The data was digitally recorded and stored with time and date for downloading via radio modem to an onsite PC located in the Foth OU1 office.

The performance expectation for dredging-induced increases in surface TSS was no more than 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 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, the performance expectation for turbidity was set at <78 NTUs (comparable to 80 ppm TSS) above background. An action level of 38 NTUs (comparable to 40 ppm TSS) above background was also established to evaluate TSS increases prior to reaching the 78 NTU level.

The three real-time, in-river turbidity meter rafts were used to detect exceedances of the 38 NTU action level and exceedances of the potential shut-down level of a difference of greater than 78 NTU between upstream and downstream turbidity. A photograph of turbidity raft 902 is presented in Appendix A, Photograph 40. Foth 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. All hand-held readings were documented in a field book. Turbidity meters were calibrated according to manufacturer specifications. Photographs of surface water sampling are provided in Appendix A, Photographs 41 and 42.

If turbidity readings exceeding the action level were noted over an extended duration from the real-time turbidity data, hand-held turbidity data, or by visual inspections, the Brennan Site Manager would be notified. Once Brennan's Site Manager was notified, he would contact the

leverman on the dredge. The leverman would then implement procedures to minimize the turbidity. All steps taken by the leverman to control the turbidity would be recorded and summarized in the daily production report. The same procedure was to be used if high turbidity was detected by other members of the project team. Any observations or turbidity readings collected by Foth during turbidity events were documented and summarized in the daily production reports.

No visual plumes were observed during 2007 dredging activities that required more intensive plume monitoring. There was one exceedance of the performance expectation on August 22, 2007 during hand-held turbidity monitoring. However, no visual plume resulting from dredging could be observed. This difference was likely due to algal blooms or wind blown sediment suspension.

10.1.2 Total Suspended Solids

Surface water grab samples were obtained 2-3 times weekly at the same location and time as the turbidity field measurements and real time turbidity meters to validate turbidity results. The grab samples were collected from a boat next to the turbidity rafts utilizing a discrete grab sampler (Kemmerer Water Sampler) and analyzed for TSS. During each sampling event, one water sample was collected at the approximate elevation of the real time turbidity meter at each sampling location. Relevant information collected during sampling was documented in the field notebook and on field forms including weather conditions (including wind direction and speed), raft ID, location and distance from dredge, water depth, sample time, turbidity reading, and water temperature. Field duplicates and rinseate blanks were collected for every 10 water samples collected. Table 10-1 summarizes the range of turbidity and TSS data obtained at the turbidity raft locations.

Table 10-1

Summary of Turbidity Readings and TSS Results Obtained at Raft Locations

	Minimum	Maximum	Average	Standard Deviation
Hand-Held Turbidity (NTU)	0.4	120.5	18.7	17.4
Telemetric Turbidity[1] (NTU)	0.2	114.6	16.6	17.9
TSS (mg/l)	0.3	110.0	20.6	17.4

Prepared by: ECB
Checked by: SVF

Table I-1, in Appendix I, contains laboratory TSS results with corresponding hand-held and telemetric turbidity readings. Monitoring of visible turbidity plumes was not necessary during the 2007 RA as no plumes were identified.

10.2 Water Treatment Plant Effluent Quality

Treated effluent water was sampled prior to discharge to the LFR using a 24-hour, flow-proportional, composite sampler. Photographs of the composite sampler and effluent sample collection are presented in Appendix A, Photographs 43 and 44. 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.

During WTP operation, effluent water was also collected for low-level mercury (LLHg) analysis once per week from a spigot in the discharge pipe just outside of the WTP. A photograph of the LLHg sample location is presented in Appendix A, Photograph 45. Continuous weekly operation of the WTP was halted on November 29, 2007.

LLHg sampling procedures were utilized during sampling events. A field blank was collected with each LLHg sample. In addition, field duplicates were collected for every 10 LLHg samples collected. Beginning on April 5, 2007, at each sample collection point for LLHg, water was also collected for QC TSS analysis.

Water samples were sent to Pace for PCB, ammonia, TSS, BOD, and LLHg analyses. Tables I-2 and I-3 in Appendix I contain a complete data set for these parameters. WTP performance expectations are provided in Table 10-2.

Table 10-2
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

Prepared by: TRL
Checked by: GMS

PCB and ammonia effluent concentrations consistently met the WDNR's performance expectations of less than 0.1 to 0.5 µg/L and 67 mg/l, respectively. The WDNR's daily TSS performance expectation (less than 10 mg/l) was exceeded 2 out of 159 operation days and the monthly TSS expectation (less than 5 mg/l) was exceeded one time during the nine months of WTP operation. The WDNR's BOD performance expectation (less than 10 mg/l) was exceeded 8 out of 159 operation days. The daily and monthly TSS exceedances were in November 2007. Five of the eight BOD exceedances were also in November.

Table 10-3 summarizes the QA daily analytical results for WTP effluent. Table 10-4 summarizes the monthly averages of laboratory analytical results for WTP effluent. Table 10-5 summarized the WTP QC average TSS.

Table 10-3

Summary of Laboratory Analytical Results for Water Treatment Plant Effluent

	Minimum	Maximum	Average	Standard Deviation
TSS (mg/l)	0.2	14.0	1.7	1.7
BOD (mg/l)	1.0	46.0	3.0	4.8
Ammonia Nitrogen (mg/l)	0.3	11.0	1.6	1.9
Total PCBs (µg/L)	0.12	0.13	0.12	0.004

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: ECB
Checked by: SVF

Table 10-4

Monthly Averages of Laboratory Analytical Results for Water Treatment Plant Effluent

Month	TSS (mg/l)	BOD (mg/l)[1,2]	Ammonia Nitrogen (mg/l)	Total PCBs (µg/L)[1,2]
April	1.8	1.4	1.4	0.12
May	1.2	1.3	0.8	0.12
June	1.2	1.9	1.2	0.12
July	2.0	2.9	1.5	0.12
August	1.5	2.4	3.1	0.12
September	1.3	3.3	1.4	0.12
October	1.5	2.3	1.3	0.12
November	5.3	15.2	2.5	0.12
December	3.1	6.4	2.6	0.13

Notes:
[1] Limit of Detection (LOD) vary for BOD and total PCBs. The highest LOD reported in Table I-2 for each was as follows:
BOD – 2 mg/l
Total PCBs – 0.26 µg/L
[2] For values less than the LOD, half the LOD value was used to calculate the average.

Prepared by: ECB
Checked by: SVF

Table 10-5
QC Water Treatment System
Average Total Suspended Solids

Krofta Influent Composite (mg/l)	Krofta Effluent Composite (mg/l)	WTP Effluent Composite (mg/l)
8.57	3.00	2.21

mg/l = milligrams per liter

Prepared by: TRL
Checked by: GMS

As in 2006, the LLHg concentrations in the effluent generally exceeded the WDNR's performance expectation of <0.2 to 0.5 ng/L. Table 10-6 summarizes the LLHg results.

Table 10-6
Summary of WTP Final Effluent Low-Level Mercury and QC TSS Results

Minimum		Maximum		Average		Standard Deviation	
LLHg (ng/L)	QC TSS (mg/l)	LLHg (ng/L)	QC TSS (mg/l)	LLHg (ng/L)	QC TSS (mg/l)	LLHg (ng/L)	QC TSS (mg/l)
0.28	0.16	5.07	3.70	2.6	1.1	1.2	0.82

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

Prepared by: ECB
Checked by: SVF

While this remediation project's primary function was the removal of significant PCB contaminated sediment, a secondary benefit was the removal of mercury. Laboratory analysis shows that the average ambient mercury concentration found within LFR OU1's near surface water is 42.69 ng/L (Table 8-3, *LFR OU1 2005 RA Summary Report* [Foth & Van Dyke and Associates, Inc., CH2M HILL, 2007]), while the average mercury levels in the treated effluent water in 2007 was 2.6 ng/L. Effluent water returned to the Fox River was 16 times cleaner than near ambient surface water, when comparing LLHg averages.

During the 2007 LFR OU1 remediation project, from April 2, 2007 through November 8, 2007, there were 31 field blanks decanted while sampling treated effluent. LLHg laboratory analysis of the field blanks revealed that only 5 of the 31 field blanks had non-detectable levels of mercury.

LLHg 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 approved prior to beginning 2007 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.

10.3 Air Quality

To establish a 2007 air quality baseline prior to beginning removal of dewatered sediment, air samples were collected and analyzed for PCBs. Further, air sampling was then limited to the beginning of dewatered sediment load-out because PCBs had not been detected at any of the four air samplers during the 2004-2006 remedial activities.

Four high-volume samplers were used to measure possible PCB emissions leaving the site. A photograph of one of the air sampling locations is presented in Appendix A, Photograph 46. Locations, on and adjacent to the site, were selected based on potential residential receptors, site topography, site operations, and prevailing wind directions. 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 10-1 shows the locations of the air monitors.

Baseline monitoring commenced on March 29, 2007 and was completed on April 16, 2007. PCB ambient air was continuously sampled during baseline sampling. Three rounds of air monitoring were completed at the beginning of dewatered sediment load-out during July 9 to 18, 2007.

All PCB samples were collected using a high volume sampler (Tisch Environmental model number TE-PUF) loaded with a combination quartz filter and polyurethane foam (PUF) cartridge, following USEPA TO-4A protocols. Air was drawn through the sampler at about 8 cubic feet (226 liters) 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 each sample, the filter and PUF cartridge was packed in hexane-rinsed aluminum foil and shipped to Pace for analysis. In the laboratory, PUF cartridges and filters were extracted with 5% 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, Wisconsin, 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.

Six rounds of air sampling were completed at four locations and consisted of 24 samples. Three of the rounds occurred during a baseline period in Spring 2007, before dredging activities commenced. The laboratory reported that all samples for the baseline sampling period were below the Limit of Detection (LOD) for PCBs, which is 0.5 micrograms (ug) per sample cartridge. For purposes of developing airborne concentration values, it was assumed that all non-detect concentrations were at the LOD. Although air volumes vary slightly from sample to sample, this cartridge concentration translates into a calculated PCB concentration that is approximately < 0.0005 $\mu g/m^3$ at each sampler for each sampling event

During load out in July 2007, an additional three rounds of sampling were completed. The laboratory detected PCBs at locations 1, 3, and 4 during Rounds 97 and 99, while all other samples results were below the LOD. The highest concentration was 0.001 ug/m^3 at location GWP-1 over a 72-hour period. The 24-hour standard for PCB air quality as set forth in NR 445 by the state of Wisconsin is 12 $\mu g/m^3$. Given the sampling period was set at 72 hours to increase the PCB detection level, all samples obtained during baseline and load-out periods are well below this standard. Results are summarized in Table 10-7.

Due to the design of the OU1 air samplers, field duplicates can not be collected as specified in Table E-4 of the*2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth et. al, 2007a). In place of field duplicates, field blanks are collected in accordance with USEPA Compendium Method TO-4A.

Table 10-7
Air Monitoring Results Summary

		Minimum	Maximum	Average	Standard Deviation
Total Air Volume Sampled (Total m^3)	Baseline	1053.6	1155.1	1118.2	27.0
	Load-out	1069.7	1130.65	1094.6	15.0
Calculated PCB Conc'n ($\mu g/m^3$)	Baseline	$\leq$ 0.00043	$\leq$ 0.00047	$\leq$ 0.00045	1.1×10^{-5}
	Load-out	$\leq$ 0.00045	0.001	0.00068	2.6×10^{-4}

Prepared by: ECB
Checked by: SVF

Table I-4, in Appendix I, contains the laboratory PCB air sampling results, the total air volumes sampled, and calculated PCB concentrations for each air sample (calculated at the LOD).

10.4 Data QA/QC

10.4.1 Data Reduction, Validation and Reporting

Foth 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, the package was logged into a data tracking table. The final analytical data package was then sent to MAKuehl Company (MAKuehl) for third party validation and verification.

A minimum of ten percent of the analytical data was verified and validated by MAKuehl 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. The following steps were used:

- The completeness, correctness, and contractual compliance of the data were evaluated against the USEPA or other reference method, laboratory, field, or specific Standard Operating Procedure (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 performed a forms review on 100% of the analytical data.

10.4.2 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 (USEPA 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 LFR OU1.

Data validation technical memoranda received to date from MAKuehl for the 2007 RA is contained in Appendix J.

11 Residual Sand Cover

11.1 Residual Sand Cover Placement Overview

During the 2007 RA, residual sand cover was placed over 5.4 acres of previously dredged area in Sub-area POG3. The sand covers were placed as a means to assist in achieving an overall OU1 SWAC of 0.25 ppm. Sand placement in 2007 served as a basis for gaining valuable information about estimating production rates, thickness control, and sand cover placement costs. Photographs from the 2007 residual sand cover activities are provided in Appendix A, Photographs 47 to 56. The goals for the 2007 sand cover placement work were:

1. To reduce the post-dredging residual concentration of surface sediments to assist with achievement of the SWAC

2. To provide information and placement refinement related to:
   - Accuracy of placement
   - Rate of placement
   - Overplacement required to ensure design thickness has been achieved
   - Cost

3. To refine methods for verification to achieve statistical goals

4. To verify use of sediment traps as the "gold standard" for measuring proper placement of sand covers

11.1.1 2007 Residual Sand Cover Areas

Sand cover placement occurred from July 10, 2007 to August 31, 2007 in selected dredged and re-dredged areas in Sub-area POG3 that had post-dredge average residual PCB concentrations ranging from 1.5 ppm to 2.5 ppm. Sand cover placement areas were broken into four Sand Certification Units (SCUs), which were further broken into 16 individual Sand Management Units (SMU) (Figure 11-1). The SMUs ranged in size from 0.05 acres to 1.42 acres. In total, approximately 5.4 acres of sand cover was placed in Sub-area POG3 in 2007. A breakdown of the 16 individual SMUs and their grouping into SCUs is provided in Table 11-1.

Table 11-1

Design Area for 2007 Residual Sand Cover Placement

Sand Certification Unit	Sand Management Unit	Square Feet	Acres	Total Acres	Average PCB Concentration (ppm)
SCU-01:	POG – SMU3	20,416	0.47	0.47	2.2
SCU-02:	POG – SMU1	12,453	0.29		2.1
	POG – SMU2	7,340	0.17		2.2
	POG – SMU4	2,309	0.05	0.51	2.3
SCU-03:	POG – SMU5	61,920	1.42		2.3
	POG – SMU6	18,383	0.42	1.84	1.8
	Subtotal:			2.82	
SCU-04:	POG – SMU7	6,655	0.15		1.9
	POG – SMU8	6,959	0.16		1.6
	POG – SMU9	21,613	0.5		1.9
	POG – SMU10	5,449	0.13		1.9
	POG – SMU11	6,293	0.14		1.7
	POG – SMU12	6,962	0.16		1.6
	POG – SMU13	18,898	0.43		1.5
	POG – SMU14	8,004	0.18		2.5
	POG – SMU15	8,863	0.2		2.3
	POG – SMU16	24,673	0.57		1.8
	Subtotal:			2.58	
	Total:	**237,190**	**5.4**	**5.4**	**1.9**

SCU = Sand Certification Unit
SMU = Sand Management Unit
PCB = Polychlorinated biphenyls
ppm = parts per million

Prepared by: JRB2/SGL
Checked by: DMR

11.1.2 Residual Sand Cover Placement Design

The OU1 *2007 Pre-Final Design Report* and *Remedial Action Work Plan* (Foth, et. al, 2007a) proposed placing a 6-inch-thick residual sand cover over select dredged and re-dredged areas in Sub-area POG3. The design thickness specification was 6 inches of applied sand with less than 5% of the material passing the number 200 sieve (P_{200}). GW Partners selected a sand material which generally met the ASTM C33 gradation for fine aggregates. The reason for this material selection was that it was readily available (concrete sand), its coarse nature lended it to be readily cast by the Brennan spreading equipment, and it appeared not to cause significant turbidity plumes when placed into water.

11.1.3 Sand Source Information and Quality Control

For the 2007 sand cover placement, materials were provided by two separate suppliers, Michels Materials, of Neenah, Wisconsin, and Faulks Bros. Construction, Inc. of Waupaca, Wisconsin. On August 9, 2007, a switch was made from the Michels Materials' sand to the Faulks Bros.' sand to see if different sand sources would impact spreading production and surface water

quality. Both materials generally met the ASTM C33 specification; however, the Michels Materials' sand appeared to have slightly more fines.

Sand cover materials were delivered by the material supplier to the designated stockpiling area(s). Upon arrival at the stockpile site, the trucks were unloaded on clean areas of the asphalt pad to prevent material contamination from other products or materials. Photographs of the asphalt pad and sand stockpile are provided in Appendix A, Photographs 48 and 49. An excavator working with a rubber tire front-end loader then moved the materials into a stockpile. Materials from the stockpile were then hauled via front-end loaders to the cover transport slurry system.

The sand cover materials used in the sand cover placement consisted of 6 inches of sand meeting the specified gradation criteria. Further, the sand used was required to be free of organic material and debris which could contribute to degradation of water quality.

The sand cover material suppliers were required to provide source QC sampling to ensure the product specifications were being met during delivery. This included analyses conducted by an independent laboratory. Once the materials were delivered to site, the source sand material was sampled for PCBs and total organic carbon (TOC) at a frequency of one sample per 5,000 cy in accordance with ASTM D75-87 "Sampling Stockpiled Aggregates." Sampling on site, rather than at the source (sand pit), insured that the materials being tested were the materials applied to the sand cover areas. Table 11-2 shows the PCB and TOC results for all stockpile samples taken. All PCB results were below detection limits (<0.013 ppm). TOC results ranged from 1000 mg/kg to 2700 mg/kg with an average of 1700 mg/kg.

Table 11-2

Quality Assurance Sand Stockpile PCB and TOC Results

Date	Sample ID	PCB Results (ppm)	TOC Results (mg/kg)
7/2/2007	1-RA-07-DEWT-SANDSTOCKPILE-01	< 0.013	2300
7/2/2007	1-RA-07-DEWT-SANDSTOCKPILE-02	< 0.013	1000
7/2/2007	1-RA-07-DEWT-SANDSTOCKPILE-03	< 0.013	2700
8/29/2007	1-RA-07-DEWT-SANDSTOCKPILE-04	< 0.013	1500
8/29/2007	1-RA-07-DEWT-SANDSTOCKPILE-05	< 0.013	1000
	Average	**< 0.013**	**1700**

PCB = Polychlorinated biphenyls
TOC = Total Organic Carbon
ppm = parts per million
mg/kg = milligram per kilogram

Prepared by: MCC2
Checked by: NRA

Sand cover material was supplied from Michels Material's Meyers Pit and Faulk's Highway Q Pit. Both locations are located in Waupaca County, Wisconsin. In addition, the suppliers provided gross weight tickets of the materials delivered to the site and provided information on source locations as well as certification that PCB concentrations were below the LOD. The sand as tested generally met ASTM C33 fine aggregate criteria. The percent of fines (those passing P_{200}) was less than 1%.

11.2 Residual Sand Cover Placement Operations

11.2.1 Pre-Placement Activities

Prior to the initiation of the sand cover operations, multiple pre-placement activities took place. Significant efforts were required to prepare the site and equipment for sand cover placement operations.

As stated previously, GW Partners contracted with two outside materials suppliers to supply the sand cover materials. Prior to materials being hauled and stockpiled, an asphalt pad was constructed at the onshore staging area. This pad was constructed to segregate materials from foreign materials on site. This also decreased the possibility of cross contamination from top soil and gravel materials found on site.

Sand material began to be delivered on June 4, 2007 for covering operations. Sand continued to be delivered throughout the duration of the project. A switch in sand suppliers occurred on August 9, 2007.

Prior to completing any placement of cover materials, Brennan completed pre-placement surveys, under supervision of Foth, in each of the SMUs. Surveys were collected along transects, 25 feet apart, per the OU1 bathymetry procedures described in the *2007 Pre-Final Design Report and Remedial Action Work Plan* (Foth, et. al, 2007a).

11.2.2 Sand Delivery and Placement Equipment

The delivery and placement of the sand cover can be broken into three major categories: land plant and transport, spreader barge dewatering, and spreader broadcast delivery.

The system began with the land plant which transferred the material from shore to the spreader barge. A front-end wheel loader was used to load a conveyor which transported the material to a hopper. This 24-inch belt feed metering hopper conveyed the material at a set rate into an adjacent slurry hopper. The material was metered by the feed opening and/or the variable speed of the belt. Lake water was injected into the hopper creating slurry. An overflow weir allowed excess water to be discharged back into the lake. The hopper then fed the slurry pump, which pumped the material through an 8-inch SDR 17 HDPE pipeline to a booster pump and finally to the sand spreader. Photographs of the sand delivery and placement equipment are provided in Appendix A, Photographs 50 to 53.

The material arrived at the spreader barge and was dewatered before it was placed. The material pipeline discharged into a velocity box on the spreader barge which was located above the dewatering screen. The velocity box dissipated the slurry's energy before it arrived at the dewatering screen. A 6-foot by 16-foot vibrating screen was used to dewater the sand. The carriage water was then discharged to a weired holding container to create a quiescent zone that allowed the remaining fines to drop out prior to the carriage water being discharged back into the contained discharge area, which was located at the stern of the spreader barge. The contained discharge area was surrounded by a silt curtain. As fine sand built up in the weired holding container, an excavator was used to remove the fines from the container and transport them to the spreader hopper for placement.

The shaker screen discharged the dewatered sand into the 6.5 cy spreader hopper. The material hopper metered the material used and placed the sand onto a conveyor belt located under the hopper. This conveyor delivered the material into two chutes that channeled the sand onto two spreader discs. This twin disc spreader, located on the bow of the barge, broadcasted the sand material in a uniform overlapping pattern. The granular material hit the water and fell at a reduced velocity covering the soft sediment.

The sand placement area or spreader bay was constructed to be approximately 36 feet by 30 feet. Once material was placed in this set placement area, the barges stepped back to allow material to be placed in an adjacent window. The realized spread material area, one step, was approximately 35 feet by 4 feet. This step dimension varied with the materials used.

The sand spreader consisted of two barges. One served as the working barge (the spreader barge), while the other served as the guide barge. The two barges worked in unison walking back and forth parallel to one another. The spreader barge was 40 feet by 80 feet, and the guide barge was 20 feet by 120 feet. Both barges were equipped with hydraulic power packs, winches, and spuds. When the spreader barge stepped back, the guide barge would have both of its spuds down on the lake bed. The spreader barge moved along the guide barge until reaching its stopping point. At this time, the spreader barge spudded down. During these steps, the material was continually spread. The guide barge would remain in one location until the spreader barge had moved to the end of the guide barge. At this time, the spreader barge would remain spudded down and the guide barge would slide along the spreader barge resetting itself. The spuds for both barges were located outside of the effective spread area. This allowed the material spread to always cover the previous spud locations.

The spreader barge was outfitted with RTK-GPS. Similar to the dredges, the onboard computer utilized DREDGEPACK® and Wonderware for the operator interface software. DREDGEPACK® displayed and tracked the barge's position while Wonderware was used to track and record the amount of material spread.

11.2.3 Quality Control Residual Sand Cover Measurements

The volume of the placed sand material was measured in several ways by Brennan to enable accurate placement. The primary volume measurement was the rotary feeder spreader that is an integral part of the barge spreader equipment. The rotary feeder measures the volume of sand placed. The rotary feeder measures materials placed by recording the speed of the delivery drive shaft. The delivery drive shaft has several cams of known size. Each of these cams, when turned, delivers a known volume of sand from the hopper onto the delivery conveyor. A pulse generator then records the number of revolutions of the drive shaft per minute. This data is then sent to the computer system and is multiplied by the input sand density to achieve the tons placed per minute. For example, in a 420 square foot placement window with 0.5 foot material applied, a targeted measured volume of 7.8 cy per set-up location would be needed to achieve a 0.5 foot specification, assuming the material is uniformly applied.

Material volume was also metered onshore by a similar rotary feeder as the material was fed into the slurry pipeline. Materials were metered on shore using the conveyor from the feed metering hopper to the adjacent slurry hopper. The material was metered by the feed opening and/or the

variable speed of the belt. Brennan completed QC checks to check the mass balance calculations from the metering hopper. The QC checks counted the number of struck front end loader buckets (of a known volume) placed into the system, computer outputs from the Epoke spreader system, and finally bathymetric surveys. All of these QC checks were compared to the metering hopper values to determine if the QC checks balanced with the material placed. The onshore metering was used to determine volume measurements over longer periods of time, such as per day.

Both pre-and post-placement bathymetric surveys were completed in the placement test areas. These surveys were completed at all test locations following placement of the sand lift. The bathymetric vessel was the same as used during the OU1 2007 RA and specifically designed for operations in shallow water. The vessel was equipped with a single frequency fathometer, two RTK global positioning units, and one laptop computer unit. Post-placement QC bathymetric surveys were conducted within 24 to 48 hours after the barge placed material over an area.

QC data was tracked by Brennan and provided on their daily reports. Accounting of the cover material mass was completed for each window step, which required recordkeeping of application rates, locations, and the application time.

Brennan informed GW Partners when the material was placed to the required application thickness in each designated SMU. Brennan relied on the several QC measurements, including bathymetry, push cores, sediment traps, and Epoke output data to evaluate whether the specification had been met.

The material spreader also had DREDGEPACK® and Wonderware software onboard. Wonderware integrates the use of four sounding sensors located in each corner of the application area with RTK GPS for the real time measurement of the material elevation and location. DREDGEPACK® illustrates the cover-placement elevation and the targeted elevation in two profile views, along with a top view. As the material is added to the lake floor, the sensors measure and record the elevation of the placed material. The operator sees this elevation change in both a profile view and the top view. Results of the QC/QA measurements are provided in Section 11.3 of this report.

11.2.4 Sand Cover Progress Tracking

On a daily basis, Brennan identified to GW Partners the areas where the sand cover was placed in the previous 24-hour period. The data provided allowed GW Partners and Brennan to better manage and schedule cover placement activities and ensure the availability of adequate sand cover material.

The entire 2007 sand cover work was completed using an adaptive management process whereby changes to the plan were requested and documented as experience was gained.

A summary of sand spreader production rates by day is provided in Table 11-3.

Table 11-3
2007 Sand Spreader Production Rates

Date	NOH	GOH	cy/NOH	Material Spreader Efficiency	SF Covered	cy by Bucket	Area	SCU	SMU
11-Jul-07	3	10	42	30%	3,066	125	POG3	1	3
12-Jul-07	5.75	10	43	58%	6,132	250	POG3	1	3
16-Jul-07	6	10	25	60%	6,132	150	POG3	1	3
17-Jul-07	5.25	10	32	53%	2,847	170	POG3	1	3
18-Jul-07	0	0	0	0%	0	0	POG3	NA	NA
19-Jul-07	0.25	10	80	3%	146	20	POG3	1	3
23-Jul-07	3.75	10	33	38%	2,628	125	POG3	1,2	3,2
24-Jul-07	5	10	43	50%	6,278	215	POG3	2	2
25-Jul-07	3.25	10	15	33%	2,774	50	POG3	2	1
26-Jul-07	1.75	10	29	18%	1,460	50	POG3	2	1
30-Jul-07	1.5	10.75	70	14%	1,022	105	POG3	2	1
31-Jul-07	2	11	40	18%	2,482	80	POG3	2	1
1-Aug-07	8.75	10.75	52	81%	9,052	455	POG3	2	1
2-Aug-07	5.5	11	83	50%	3,942	455	POG3	2,3	4,5
3-Aug-07	6.75	9	36	75%	5,840	240	POG3	3	5
6-Aug-07	10	11	31	91%	8,505	310	POG3	3	5
7-Aug-07	8.25	11	33	75%	5,913	275	POG3	3	5
8-Aug-07	7.5	11	44	68%	9,198	330	POG3	3	5
9-Aug-07	8	11	44	73%	9,308	355	POG3	3	5
10-Aug-07	6.25	10	53	63%	7,337	330	POG3	3	5
13-Aug-07	3.25	11	58	30%	2,628	190	POG3	3	5
14-Aug-07	7.75	11	46	70%	9,527	355	POG3	3	5
15-Aug-07	7	11	46	64%	8,531	320	POG3	3	5
16-Aug-07	6	11	52	55%	8,760	310	POG3	3,4	6,8
17-Aug-07	7.25	10	44	73%	8,468	320	POG3	3,4	6,8
20-Aug-07	7.75	11	42	70%	11,096	325	POG3	3,4	6,7
21-Aug-07	8.75	11	43	80%	12,848	375	POG3	4	7,9
22-Aug-07	8.5	11	48	77%	12,848	404	POG3	4	9
23-Aug-07	6.75	11	58	61%	10,366	392	POG3	4	9,10
24-Aug-07	8.25	10	55	83%	11,680	452	POG3	4	13
27-Aug-07	8.25	11	50	75%	11,826	413	POG3	4	12,13
28-Aug-07	8.75	11	54	80%	13,578	472	POG3	4	11,12,14
29-Aug-07	8.5	11	51	77%	13,286	432	POG3	4	14,15,16
30-Aug-07	8.5	11	56	77%	12,702	472	POG3	4	16
31-Aug-07	7.25	10	50	73%	10,804	360	POG3	4	16
Totals and Averages	**211**	**359**	**45**	**57%**	**253,009**	**9,682**	**--**	**--**	**--**

NOH = Net Operational Hours
GOH = Gross Operational Hours
cy = cubic yards
SF = Square Feet
SCU = Sand Certification Unit
SMU = Sand Management Unit

Prepared by: TRL
Checked by: GMS

11.3 Residual Sand Cover Verification and Environmental Monitoring

This section presents the verification procedures and environmental monitoring activities during the 2007 sand cover placement work.

11.3.1 Quality Assurance Residual Sand Cover Measurements

For the 2007 sand cover placement work, a variety of methods were used to measure placed thickness of sand. At the start of the work, the primary thickness measurement tool intended to be used was a sediment trap to document the application of the specified sand thickness ("gold standard"). The sediment traps did not work effectively because of the shallow water (typically less than 4 feet deep) in the sand cover placement areas. As a result, sediment cores (Russian Peat Borer) became the primary thickness measurement tool.

The sand placement was deemed completed to the satisfaction of the specification when sufficient material was applied. Sufficient material application was satisfied by meeting approved statistical criteria based on measurements taken by sediment cores and/or sediment traps. The verification process of the applied material in the placement areas was designed to provide a statistically valid number of samples in order to confirm the applied thickness. Several examples of statistical verification methods for cap thickness are provided in Section 11.3.2 of this report. These methods vary in the type of required supporting sample data, and, hence, sufficient data of each type was collected during the placement. To this end, collected data included:

- Sediment cores (Russian Peat Borer, primary QA measurement tool)
- Sediment traps
- Bathymetry surveys

The following sub sections of Section 11.3.1 present the results of the QA verification monitoring for sand. Statistical verification of thickness measurements is presented in Section 11.3.2 of this report.

11.3.1.1 SCU-01 Sand Cover Results

Four SCUs were developed for the OU1 2007 residual sand covering project. Each of the SCUs was made up of one or more SMUs. SCU-01 was made up of one SMU, namely SMU3 (Figure 11-1). SMU3 was approximately 0.47 acres in size, with rough dimensions of 100 feet by 200 feet. Following the proposed statistical models, it was determined that a sample density of 11 thickness verification samples for this SCU would be sufficient. The sample locations were strategically placed at bathymetric transect intersections to the extent practicable, to allow for comparison of the measured thicknesses with the bathymetric survey results. Sand cover placement for SCU-01 began on July 10, 2007 and was completed on July 23, 2007.

11.3.1.1.1 Sediment Traps

Based on the 2007 RA Sand Cover Placement Plan (Appendix K of the *2007 Pre-Final Design Report and Remedial Action Work Plan* [Foth, et. al, 2007a]), the use of sediment traps was to be the "gold standard" for verifying sand cover placement thicknesses. At the start of the sand cover placement work, Foth's field technicians deployed sediment traps both from the working surface of the spreader barge and from Foth's sampling vessel. The sand cover placement work occurred in relatively shallow areas throughout the 2007 project. Because of the shallow water (typically less than 4-feet deep), the following difficulties were encountered while using the sediment traps:

- Sediment traps were knocked over as the walkway on the spreader bay moved over the traps.
- The bouy and rope system fastened to the sediment trap became entangled with the placement equipment (slurry pipeline, silt curtain, etc.).
- At times, the barges were very near or dragging on the bottom of the lake bed, not allowing sufficient space for the sediment trap to pass by.
- When the sand, traveling at a high velocity, hit the water it did not instantly begin falling to the bottom vertical. Therefore, in shallow water the side of the sediment traps facing the spreader heads shielded the traps from receiving the full amount of sand being placed, causing a "false low" sediment thickness value.

Throughout the sand cover placement work, seven sediment traps were deployed. Results from the sediment traps ranged from no recovery to 1 foot (Tables 11-4 and 11-5).

Table 11-4
SCU-01 Thickness Verification Results

OU1 2007 Residual Sand Cover QA Measurements

Sand Certification Unit (SCU)	Sample	Actual Sample Location Russian Peat Borer		Offset from Proposed Location Russian Peat Borer	Sand Thickness (ft) Field Measurement Sediment Trap	Sand Thickness (ft) Field Measurement Russian Peat Borer	Mixing Layer Thickness (ft) Field Measurement Russian Peat Borer	Total Core Length (ft) Field Measurement Russian Peat Borer	Sand Thickness (ft) Survey Measurement Bathymetry
		Northing	Easting	(ft)					
SCU-01	SMU3-1	806627.80	2371308.10	35.40	0.38	1.57	0.00	1.57	1.18
SCU-01	SU3-2	806670.14	2371257.83	0.22	1.00	0.80	0.00	0.92	0.44
SCU-01	SMU3-3	806693.30	2371284.65	4.71	0.38	0.71	0.00	0.71	0.70
SCU-01	SMU3-4	806751.20	2371361.00	2.20	No Recovery	0.67	0.00	0.95	0.55
SCU-01	SMU3-4A	806639.07	2371306.90	NA	0.29	0.82	0.00	1.47	0.86
SCU-01	SMU3-5	806721.30	2371314.80	3.81	NA	0.95	0.00	1.12	0.64
SCU-01	SMU3-6	806669.50	2371336.00	0.50	NA	1.05	0.00	1.05	0.62
SCU-01	SMU3-7	806624.00	2371265.90	2.76	NA	0.84	0.00	1.00	0.79
SCU-01	SMU3-8	806593.00	2371312.31	5.17	NA	0.80	0.00	0.80	0.79
SCU-01	SMU3-9	806749.83	2371337.82	1.83	NA	0.52	0.06	1.30	0.41
SCU-01	SMU3-10	806772.39	2371306.55	1.46	NA	1.15	0.00	2.00	0.62
					Minimum	**0.52**	**0.00**	**0.71**	**0.41**
					Maximum	**1.57**	**0.06**	**2.00**	**1.18**
					SCU Average	**0.90**	**0.01**	**1.17**	**0.69**
					Standard Deviation	**0.28**	**0.02**	**0.38**	**0.21**

SCU = Sand Certification Unit
SMU = Sand Management Unit
ft = feet
NA = Not Applicable

Prepared by: TAG/MCC2
Checked by: NRA

Table 11-5
SCU-02 Thickness Verification Results

OU1 2007 Residual Sand Cover QA Measurements

Sand Certification Unit (SCU)	Sample	Actual Sample Location Russian Peat Borer		Offset from Proposed Location Russian Peat Borer	Sand Thickness (ft) Field Measurement Sediment Trap	Sand Thickness (ft) Field Measurement Russian Peat Borer	Mixing Layer Thickness (ft) Field Measurement Russian Peat Borer	Total Core Length (ft) Field Measurement Russian Peat Borer	Sand Thickness (ft) Survey Measurement Bathymetry
		Northing	Easting	(ft)					
SCU-02	SMU1-1	806675.31	2371039.42	2.71	NA	1.22	0.00	1.50	0.95
SCU-02	SMU1-2	806717.28	2371034.01	2.12	NA	1.04	0.00	1.04	0.83
SCU-02	SMU1-3	806751.70	2371036.11	3.70	NA	0.74	0.15	1.45	0.84
SCU-02	SMU1-4	806699.70	2371011.70	0.76	NA	0.83	0.00	1.45	0.93
SCU-02	SMU1-5	806670.80	2371085.70	0.36	NA	0.94	0.00	1.40	1.15
SCU-02	SMU1-6	806720.80	2371110.80	1.13	NA	0.83	0.00	0.83	0.71
SCU-02	SMU2-1	806721.70	2371192.70	3.19	0.73	0.84	0.00	1.06	0.36
SCU-02	SMU2-2	806775.10	2371211.10	2.37	0.87	0.57	0.00	0.75	0.28
SCU-02	SMU2-3	806719.10	2371210.80	0.81	NA	1.42	0.00	1.42	0.64
SCU-02	SMU2-4	806746.00	2371236.30	2.02	NA	0.62	0.28	0.90	0.25
SCU-02	SMU4-1	806897.80	2371135.40	0.45	NA	0.58	0.15	0.95	0.25
					Minimum	**0.57**	**0.00**	**0.75**	**0.25**
					Maximum	**1.42**	**0.28**	**1.50**	**1.15**
					SCU Average	**0.88**	**0.05**	**1.16**	**0.65**
					Standard Deviation	**0.27**	**0.10**	**0.29**	**0.32**

SCU = Sand Certification Unit
SMU = Sand Management Unit
ft = feet
NA = Not Applicable

Prepared by: TAG/MCC2
Checked by: NRA

11.3.1.1.2 Sediment Cores

Upon completion of sand cover placement in SCU-01, QA cores were collected to verify the sand cover thickness using a Russian Peat Borer. A photograph of the Russian Peat Borer is provided in Appendix A, Photograph 54. Foth's field team navigated their sampling vessel to the proposed sampling locations, using GPS with HYPACK® navigation system (Figures 11-2 and 11-3). Once spudded on location, a field technician advanced the Russian Peat Borer through the sand layer into the underlying sediment. The sampler was then rotated to collect the core. The sample was brought to the surface where it was opened for logging by the field team. Cores were segregated by lithology, measured, logged, and photographed (Appendix A, Photograph 55 and 56).

Eleven Russian Peat Borer sand thickness cores were recorded for areas in SCU-01 and are presented in Table 11-4. Results indicate a sand thickness range of 0.52 to 1.57 feet (6.2 to 18.8 inches), with the average being 0.90 feet (10.8 inches) and a standard deviation of 0.28 feet. Sand thickness core results indicate a variable thickness distribution across the SCU with all samples meeting the 6 inch applied thickness target.

The variable distribution of the sand cover was mainly attributed to the volume of fine sand that was falling through the shaker screens and being deposited to the river through the diffuser pipe. The diffuser pipe was a perforated 18 inch diameter Schedule 40 PVC pipe that drained the carriage water from the sand slurry.

Another variable which affected the spread pattern was the sand spinners and the speed at which they rotated. Brennan varied the speed at which the sand spinners turned to determine the optimum spread pattern. Each speed setting resulted in a different spread pattern, resulting in varying thickness results.

11.3.1.1.3 Bathymetry

Due to consolidation, differential bathymetric survey results would generally be expected to show a thinner average sand thickness when compared to sand core data. However, when sediment consolidation is minimal, for example in areas of higher sediment percent solids, sampling variation and accuracy limitations of bathymetric survey may result in bathymetric-determined sand thickness exceeding sand core measured thickness.

It should also be noted that the measurement error (accuracy) of the Russian Peat Borer measurements is less than 1 inch, whereas the accuracy of each of the bathymetric surveys (based on product literature and field testing) is typically within 5 centimeters (2 inches). Assuming propagation of errors from a simple difference equation (D = A - B) and equal errors for each event (UA = UB = 5 cm), it follows then that the differential survey error would be the square root of the sum of squared errors (UD = sqrt(UA^2 + UB^2) = 7.1cm), or roughly 3 inches. When comparing thickness results at discrete locations using sand core measurements and differential bathymetry-derived thickness data, observed scatter on the order of 3 inches or greater should be expected. (Note: the statistical verification methodologies described in Section 10.4 account for the accuracy differences in measurement methods.)

When looking at large data sets (such as complete SCUs), the accuracy differences between bathymetry and sand core measurements becomes less significant as the sample number tends to dampen the effects of accuracy variability. The standard deviation of sand core and bathymetry-derived thickness data sets provides a quick assessment of the sample variability and accuracy variability between the methods. Since the accuracy of the sand core measurements is very tight, it can be assumed that the standard deviation of the sand core results is due solely to sample variation.

Bathymetry was utilized as another QA thickness verification method for residual sand cover placement. Pre-placement bathymetric surveys were performed on all SCUs, by Brennan, under the supervision of Foth, prior to sand cover placement on April 30, 2007 and May 2, 3, and 4, 2007. Post-sand cover placement bathymetric surveys were performed on all SCUs. The post-placement bathymetric surveys were compared to the top of sediment surveys (pre-sand cover placement) to evaluate overall sand cover thickness.

Brennan, under the supervision of Foth, completed the post-placement surveys for all of the SCUs on September 12, 2007. The unedited files were processed by Foth and then compared to the pre-placement surveys. An isopach map was developed for the differences in the pre and post placement survey (Figure 11-4). The isopach map indicates that the average sand thickness for SCU-01 is 7.4 inches. In summary, the average sand thickness for the sand cover in SCU-01, as measured by the Russian Peat Borer and bathymetry is 10.8 inches and 7.4 inches, respectively (Table 11-4). The likely cause for the thinner average thickness by bathymetry can be attributed to consolidation of the underlying sediment. Sand placement was completed in SCU-01 over the period July 10, 2007 through July 23, 2007. The Foth field team completed sand core thickness measurements over the period July 16, 2007 through August 3, 2007. The post-placement bathymetric survey was completed on September 12, 2007, 39 days after the final sand core was collected. The time lag in between measurements may have resulted in noticeable consolidation. Another variable which was somewhat problematic was shallow water conditions. This poses a problem for completing bathymetric surveys. When Brennan operates their survey vessel in very shallow water, the river bed can become disturbed due to the boat dragging on bottom as well as propeller wash from the boat. Once the water becomes turbid, the fathometer may have difficulty sensing the “true” river bed. This, in turn, can produce error (false high readings) in the bathymetric survey.

11.3.1.2 SCU-02 Sand Cover Results

SCU-02 was made up of three SMUs, namely SMU1, SMU2, and SMU4 (Figure 11-1). SMU1 was approximately 0.29 acres in size, SMU2 was approximately 0.17 acres, and SMU4 was approximately 0.05 acres, respectively. The total acreage in SCU-02 was approximately 0.51 acres. Following the proposed statistical models, it was determined that a sample density of 11 thickness verification samples for this SCU would be sufficient. The sample locations were strategically placed at bathymetric transect intersections to the extent practicable, to allow for comparison of the measured thicknesses with the bathymetric survey results. Sand cover placement in SCU-02 began on July 23, 2007 and was completed on August 2, 2007.

11.3.1.2.1 Sand Thickness Cores

Foth performed QA sand cover thickness coring upon completion of sand cover placement in SCU-02 (Figure 11-4). Cores were again segregated by lithologies, measured, logged, and photographed. Eleven Russian Peat Borer sand thickness cores were recorded for areas in SCU-02 and are presented in Table 11-5. Results indicated a range of 0.57 to 1.42 feet (6.8 to 17.0 inches), with the average being 0.88 feet (10.6 inches) and a standard deviation of 0.27 feet. Again, sand thickness core results indicate a variable thickness distribution across SCU-02 similar to SCU-01, with all samples meeting the 6 inch applied thickness target.

11.3.1.2.2 Bathymetry

Brennan, under the supervision of Foth, completed the post-placement surveys for all of the SCUs on September 12, 2007. The unedited survey files were processed by Foth and then compared to the pre-placement surveys completed April 30, 2007 through May 4, 2007. An isopach map was developed for the differences in the pre and post placement survey (Figure 11-5). The isopach map indicates that the average sand thickness for SCU-02 is 8.5 inches. In summary, the average sand thickness for the sand cover in SCU-02, as measured by the Russian Peat Borer and bathymetry is 10.6 inches and 8.5 inches, respectively. As with results from SCU-01, average thickness results indicate a lower average thickness for bathymetry when compared to results from the Russian Peat Borer.

11.3.1.3 SCU-03 Sand Cover Results

SCU-03 was made up of two SMUs, namely SMU5 and SMU6 (Figure 11-1). SMU5 was approximately 1.42 acres in size and SMU6 was approximately 0.42 acres. The total acreage covered by sand in SCU-03 was approximately 1.84 acres. Following the proposed statistical models, it was determined that a sample density of 18 thickness verification samples per this SCU would be sufficient. The sample locations were strategically placed at bathymetric transect intersections to the extent practicable, to allow for comparison of the measured thicknesses with the bathymetric survey results. Sand cover placement in SCU-03 began on August 2, 2007 and was completed on August 16, 2007.

11.3.1.3.1 Sand Thickness Cores

Foth performed QA sand cover thickness coring upon completion of sand cover placement in SCU-03 (Figure 11-2). Cores were again segregated by lithologies, measured, logged, and photographed. Eighteen Russian Peat Borer sand thickness cores were recorded for areas in SCU-03 and are presented in Table 11-6. Results indicated a range of 0.54 to 1.43 feet (6.5 to 17.2 inches), with the average being 0.81 feet (9.7 inches) and a standard deviation of 0.24 feet. Again, sand thickness core results indicate a variable thickness distribution across the SCU, with a slightly lower standard deviation than SCU-01 and SCU-02. In all cases, however, the 6 inch applied sand thickness target was met.

Table 11-6
SCU-03 Thickness Verification Results

OU1 2007 Residual Sand Cover QA Measurements

Sand Certification Unit (SCU)	Sample	Actual Sample Location Russian Peat Borer		Offset from Proposed Location Russian Peat Borer	Sand Thickness (ft) Field Measurement Sediment Trap	Sand Thickness (ft) Field Measurement Russian Peat Borer	Mixing Layer Thickness (ft) Field Measurement Russian Peat Borer	Total Core Length (ft) Field Measurement Russian Peat Borer	Sand Thickness (ft) Survey Measurement Bathymetry
		Northing	Easting	(ft)					
SCU-03	SMU5-1	807122.35	2371159.77	1.37	NA	0.98	0.00	1.18	0.67
SCU-03	SMU5-2	806998.69	2371013.86	1.98	NA	0.54	0.00	1.32	0.70
SCU-03	SMU5-3	807070.21	2371064.74	2.85	NA	0.58	0.00	1.02	0.78
SCU-03	SMU5-4	807021.69	2370988.58	1.72	NA	1.07	0.00	1.40	0.52
SCU-03	SMU5-5	807119.53	2371063.42	2.56	NA	1.43	0.00	1.43	1.05
SCU-03	SMU5-6	807019.91	2370938.54	0.47	NA	0.75	0.00	1.56	0.45
SCU-03	SMU5-7	807171.92	2371063.38	1.96	NA	0.92	0.37	1.30	0.69
SCU-03	SMU5-8	807021.52	2370910.57	3.55	NA	0.60	0.00	1.10	0.45
SCU-03	SMU5-9	807203.55	2371062.84	1.76	NA	0.60	0.00	1.27	0.11
SCU-03	SMU5-10	807171.10	2371012.47	1.84	NA	0.60	0.00	1.46	0.55
SCU-03	SMU5-11	807248.43	2371037.10	1.18	NA	1.02	0.00	1.42	0.70
SCU-03	SMU5-12	807204.17	2370985.32	1.21	NA	0.80	0.00	1.50	0.55
SCU-03	SMU5-13	807103.94	2370887.31	1.96	NA	0.67	0.00	1.60	0.73
SCU-03	SMU5-14	807055.48	2370854.70	0.57	NA	0.70	0.00	1.37	0.36
SCU-03	SMU6-1	807376.66	2371213.27	2.95	NA	0.71	0.00	1.55	0.77
SCU-03	SMU6-2	807427.08	2371260.40	2.62	NA	0.68	0.07	0.75	0.27
SCU-03	SMU6-3	807371.19	2371113.53	2.66	NA	0.77	0.00	1.00	0.67
SCU-03	SMU6-4	807424.82	2371135.01	2.07	NA	1.15	0.00	1.15	0.32
					Minimum	**0.54**	**0.00**	**0.75**	**0.11**
					Maximum	**1.43**	**0.37**	**1.60**	**1.05**
					SCU Average	**0.81**	**0.02**	**1.30**	**0.57**
					Standard Deviation	**0.24**	**0.09**	**0.23**	**0.22**

SCU = Sand Certification Unit
SMU = Sand Management Unit
ft = feet
NA = Not Applicable

Prepared by: TAG/MCC2
Checked by: NRA

11.3.1.3.2 Bathymetry

Brennan, under the supervision of Foth, completed the post-placement surveys for all of the SCUs on September 12, 2007. The unedited survey files were processed by Foth and then compared to the pre-placement surveys completed April 30, 2007 through May 4, 2007. An isopach map was developed for the differences in the pre and post placement survey (Figure 11-6). The isopach map indicates that the average sand thickness for SCU-03 is 6.7 inches, respectively. In summary, the average sand thickness for the sand cover in SCU-03, as measured by the Russian Peat Borer and bathymetry is 9.7 inches and 6.7 inches. Again, average thickness results indicate a lower average thickness for bathymetry when compared to results from the Russian Peat Borer.

11.3.1.4 SCU-04 Sand Cover Results

SCU-04 was made up of 10 SMUs, namely SMU7 through SMU16 (Figure 11-1). The approximate acreage covered by each SMU is 0.15, 0.16, 0.50, 0.13, 0.14, 0.16, 0.43, 0.18, 0.20, and 0.57, respectively. The total acreage in SCU-04 was approximately 2.58 acres. Following the proposed statistical models, it was determined that a sample density of 18 thickness verification samples for this SCU would be sufficient. The sample locations were strategically placed at bathymetric transect intersections to the extent practicable, to allow for comparison of the measured thicknesses with the measured bathymetric survey results. Sand cover placement in SCU-04 began on August 16, 2007 and was completed on August 31, 2007.

11.3.1.4.1 Sand Thickness Cores

Foth performed QA sand cover thickness coring upon completion of sand cover placement in SCU-04 (Figure 11-3). Cores were again segregated by lithologies, measured, logged, and photographed. Eighteen Russian Peat Borer sand thickness cores were recorded for areas in SCU-04 and are presented in Table 11-7. Results indicated a range of 0.45 to 1.27 feet (5.4 to 15.2 inches), with the average being 0.77 feet (9.2 inches) and a standard deviation of 0.20 feet. Sand thickness core results indicate a more even distribution of sand in SCU-04 than in the first three SCUs due to Brennan “dialing in” their equipment settings. In 17 of the 18 sample locations, the 6 inch applied sand thickness target was met.

Table 11-7
SCU-04 Thickness Verification Results

OU1 207 Residual Sand Cover QA Measurements									
Sand Certification Unit (SCU)	**Sample**	**Actual Sample Location Russian Peat Borer**		**Offset from Proposed Location Russian Peat Borer**	**Sand Thickness (ft) Field Measurement Sediment Trap**	**Sand Thickness (ft) Field Measurement Russian Peat Borer**	**Mixing Layer Thickness (ft) Field Measurement Russian Peat Borer**	**Total Core Length (ft) Field Measurement Russian Peat Borer**	**Sand Thickness (ft) Survey Measurement Bathymetry**
		Northing	**Easting**	**(ft)**					
SCU-04	SMU7-1	807505.11	2371736.67	2.89	NA	0.45	0.00	0.93	0.07
SCU-04	SMU8-1	807528.48	2371186.69	0.86	NA	0.61	0.06	1.60	0.20
SCU-04	SMU9-1	807848.96	2371463.91	1.32	NA	0.71	0.00	1.06	0.35
SCU-04	SMU9-2	807848.52	2371455.85	2.63	NA	0.63	0.00	0.87	0.28
SCU-04	SMU9-3	807900.55	2371460.91	1.89	NA	0.84	0.11	0.95	0.32
SCU-04	SMU9-4	807977.50	2371457.61	2.53	NA	0.75	0.00	0.85	0.16
SCU-04	SMU10-1	807972.27	2371536.00	1.04	NA	0.90	0.00	1.05	0.46
SCU-04	SMU11-1	808221.73	2371412.78	0.83	NA	0.60	0.00	0.98	0.29
SCU-04	SMU12-1	808171.43	2371684.55	2.52	NA	0.71	0.43	1.14	0.09
SCU-04	SMU12-2	808199.68	2371685.84	0.70	NA	1.00	0.00	1.00	0.69
SCU-04	SMU13-1	808272.99	2371633.53	0.47	NA	0.64	0.00	1.01	0.31
SCU-04	SMU13-2	808298.80	2371562.50	0.94	NA	0.61	0.00	1.02	0.21
SCU-04	SMU13-3	808370.17	2371534.04	1.05	NA	0.77	0.00	1.00	0.84
SCU-04	SMU14-1	808498.79	2371518.53	1.72	NA	0.99	0.00	0.99	0.00
SCU-04	SMU15-1	808648.49	2371687.51	1.59	NA	0.63	0.00	0.90	0.00
SCU-04	SMU16-1	809021.14	2371588.10	1.11	NA	0.98	0.00	1.48	0.24
SCU-04	SMU16-2	808973.47	2371511.94	0.47	NA	0.80	0.08	1.17	0.35
SCU-04	SMU16-3	808995.40	2371488.24	0.47	NA	1.27	0.00	1.40	0.33
					Minimum	**0.45**	**0.00**	**0.85**	**0.00**
					Maximum	**1.27**	**0.43**	**1.60**	**0.84**
					SCU Average	**0.77**	**0.04**	**1.08**	**0.29**
					Standard Deviation	**0.20**	**0.10**	**0.21**	**0.22**

SCU = Sand Certification Unit
SMU = Sand Management Unit
ft = feet
NA = Not Applicable

Prepared by: TAG/MCC2
Checked by: NRA

11.3.1.4.2 Bathymetry

Brennan, under the supervision of Foth, completed the post-placement surveys for all of the SCUs on September 12, 2007. The unedited survey files were processed by Foth and then compared to the pre-placement surveys completed April 30, 2007 through May 4, 2007. An isopach map was developed for the differences in the pre- and post-placement survey (Figures 11-7 and 11-8). The isopach maps indicate that the average sand thickness for SCU-04 is 3.4 inches. In summary, the average sand thickness for the sand cover in SCU-04, as measured by the Russian Peat Borer and bathymetry is 9.2 inches and 3.4 inches, respectively. Average thickness results indicate a significantly lower average thickness for bathymetry when compared to results from the Russian Peat Borer.

11.3.2 Post Placement PCB Results

Following sand cover placement, surficial PCB concentrations in the residual sand cover were analyzed. The Russian Peat Borer was used as the primary tool for collecting sand cover samples for PCB analysis. Sample locations were randomly picked in each SMU but located at bathymetric survey cross lines. Each sample collected consisted of taking the top 4 inches of sand recovered using the Russian Peat Borer. This material was placed in a clean container and was later composited with four other adjacent samples. PCB analyses were only completed on composited samples. Fifty individual samples were collected in SCU-01 thru SCU-04, which resulted in 10 composite samples (Table 11-8). Results indicate that all samples were below the LOD for PCBs (<13 ug/kg). Composite samples were also analyzed for percent solids. Percent solids results ranged from 82% to 86% with an average of 83.9%. The collected samples were all characterized as clean sands.

Table 11-8
OU1 2007 Residual Sand Cover Post-Placement PCB Results

Sand Certification Unit	SMU	Sample	Actual Sample Location		Percent Solids	PCB Results (ppm)
			Northing	Easting		
SCU-01	SMU-3	1A	806622.10	2371318.70		
SCU-01	SMU-3	1B	806637.20	2371268.70		
SCU-01	SMU-3	1C	806670.30	2371313.50		
SCU-01	SMU-3	1D	806726.40	2371348.90		
SCU-01	SMU-3	1E	806748.30	2371319.90		
		Composite			83.2	<0.013
SCU-02	SMU-2	2A	806726.40	2371217.10		
SCU-02	SMU-2	2B	806757.60	2371196.80		
SCU-02	SMU-1	2C	806692.10	2371056.50		
SCU-02	SMU-1	2D	806733.82	2371055.36		
SCU-02	SMU-4	2E	806893.34	2371162.02		
		Composite			84.2	<0.013
SCU-03	SMU-5	3A	806968.02	2370859.32		
SCU-03	SMU-5	3B	807016.18	2370850.16		
SCU-03	SMU-5	3C	807017.10	2370901.95		
SCU-03	SMU-5	3D	807006.36	2371010.50		
SCU-03	SMU-5	3E	807043.56	2370980.95		
		Composite			83.2	<0.013
SCU-03	SMU-5	4A	807028.13	2371069.84		
SCU-03	SMU-5	4B	807058.70	2371033.90		
SCU-03	SMU-5	4C	807073.04	2371098.84		
SCU-03	SMU-5	4D	807095.39	2371143.32		
SCU-03	SMU-5	4E	807117.71	2371112.36		
		Composite			84.5	<0.013
SCU-03	SMU-5	5A	807096.72	2370941.77		
SCU-03	SMU-5	5B	807095.51	2370997.30		
SCU-03	SMU-5	5C	807157.75	2370948.41		
SCU-03	SMU-5	5D	807138.05	2371007.99		
SCU-03	SMU-5	5E	807170.19	2371045.93		
		Composite			86.0	<0.013
SCU-03	SMU-6	6A	807384.47	2371133.57		
SCU-03	SMU-6	6B	807394.92	2371191.87		
SCU-03	SMU-6	6C	807406.65	2371247.89		
SCU-04	SMU-8	6D	807502.89	2371157.60		
SCU-04	SMU-8	6E	807530.24	2371173.95		
		Composite			85.0	<0.013

Sand Certification Unit	SMU	Sample	Actual Sample Location		Percent Solids	PCB Results (ppm)
			Northing	Easting		
SCU-04	SMU-7	7A	807517.20	2371728.54		
SCU-04	SMU-9	7B	807838.62	2371494.65		
SCU-04	SMU-9	7C	807882.75	2371449.39		
SCU-04	SMU-9	7D	807931.75	2371462.70		
SCU-04	SMU-9	7E	807963.65	2371413.91		
		Composite			84.0	<0.013
SCU-04	SMU-10	8A	807959.62	2371567.03		
SCU-04	SMU-11	8B	808245.95	2371406.79		
SCU-04	SMU-12	8C	808171.12	2371646.30		
SCU-04	SMU-12	8D	808195.57	2371682.76		
SCU-04	SMU-13	8E	808264.25	2371589.93		
		Composite			83.3	<0.013
SCU-04	SMU-13	9A	808298.39	2371564.20		
SCU-04	SUM-13	9B	808371.80	2371534.20		
SCU-04	SMU-14	9C	808482.12	2371528.88		
SCU-04	SMU-14	9D	808564.84	2371523.60		
SCU-04	SMU-15	9E	808611.41	2371692.51		
		Composite			83.3	<0.013
SCU-04	SMU-15	10A	808656.99	2371697.17		
SCU-04	SMU-16	10B	808981.20	2371630.57		
SCU-04	SMU-16	10C	809028.78	2371618.14		
SCU-04	SMU-16	10D	808928.65	2371569.56		
SCU-04	SMU-16	10E	808977.18	2371494.79		
		Composite			82.0	<0.013
					83.9	**<0.013**

SCU = Sand Certification Unit
SMU = Sand Management Unit
ft = feet
ppm = parts per million

Prepared by: MCC2
Checked by: NRA

11.3.3 Quality Control Residual Sand Cover Measurements

Brennan was required to complete QC monitoring during the placement operations. Brennan completed QC sand thickness measurements using a 2-inch push coring device, using information gathered from their metering equipment, and mass balance calculations. QC measurements were used as a tool by Brennan to determine if their placement activities were meeting specifications and also to guide them in making necessary adjustments to operations.

11.3.3.1 Thickness Verification

During placement of the sand cover, Brennan needed a way to collect numerous sand thickness samples quickly to evaluate the placement efficiency and precision. To meet this sampling need, Brennan utilized a reusable 2-inch push core device that quickly sampled the sand thickness. Brennan assembled a 2-inch push core device incorporating a ball valve as the chief retrieval method for the sand samples. The sampler consisted of a 10-foot long piece of 2-inch

Schedule 40 PVC pipe (used as the sampler handle) inserted into a 2 inch PVC ball valve, with compression fittings on either side. To finish the sampler, a 3-foot long piece of 2-inch, clear, Schedule 40 PVC was inserted into the other end of the valve. The Schedule 40 PVC had an I.D. of approximately 2 inches.

As the placement operations moved, Brennan QC personnel would walk out on the walkway around the spreader bay and take a series of samples to determine sand thickness prior to moving. In analyzing the QC results, Brennan was able to adjust settings on the spread pattern and materials delivery to get a more uniform spread thickness.

11.3.3.2 Metering Equipment and Mass Balance Calculation

Brennan measured the volume of placed sand in several ways to check and adjust placement operations. The primary volume measurement was the rotary feeder spreader that is an integral part of the barge spreader equipment. The rotary feeder measures materials placed by recording the speed of the delivery drive shaft. The delivery drive shaft has several cams of known size. Each of these cams, when turned, delivers a known volume of sand from the hopper onto the delivery conveyor. A pulse generator then records the number of revolutions of the drive shaft per minute. This data is then sent to the computer system and is multiplied by the input sand density to achieve the tons placed per minute. For example, in a 420 square foot placement window, with 0.5 feet material applied, targeted measured volume of 7.8 cy per set-up location would be needed to achieve a uniform half-foot specification.

Material volume was also metered onshore by a similar rotary feeder as the material was fed into the slurry pipeline. Materials were metered on shore using the conveyor from the feed metering hopper to the adjacent slurry hopper. The material was metered by the feed opening and/or the variable speed of the belt. Brennan completed QC checks of the mass balance calculations from the metering hopper. The QC checks counted the number of struck front-end loader buckets (of a known volume) placed into the system, computer outputs from the Epoke spreader system, and finally bathymetric surveys. All of these QC checks were compared to the metering hopper values to determine if the material placed balanced with the feed. Compared to the rotary feed spreader, the onshore metering was used to determine volume measurements over longer periods of time, such as per day.

The spreader barge had DREDGEPACK® and Wonderware software onboard, which is the same software used by the OU1 dredges. Wonderware integrates the use of four sounding sensors located in each corner of the application area with RTK GPS for real time measurement of the material elevation and location. DREDGEPACK® illustrates the pre-cover placement elevation and the targeted elevation in two profile views, along with a top view. As the material was placed onto the sediment, the sensors measured and recorded the elevation of the placed material. The operator was able to view this elevation change in both profile views and the top view displayed the changes in elevation as an isopach.

During placement operations, Brennan completed QC checks to calculate mass balance of materials entering and leaving the spreader system. In order to keep track of the amount of materials entering the system, Brennan completed surveys of the material stockpiles and counted the number of struck front-end loader buckets dumped throughout the day.

Another way that material volume placed into the placement system was measured was by counting the number of front-end loader buckets delivered. The loader buckets were of known volumes, ranging from 3 to 5 cy. Each day, the loader operator verified the size of the bucket that was being used. The operator loaded the bucket so that the material was mounded. The bucket. The bucket was raised and quickly rocked back and forth to level out the material. Once the material was level (struck bucket) the material was dumped into a conveyor / hopper system, where it was conveyed to the on-shore metering hopper. The number of buckets added to the spreader system were recorded throughout the day and added up at the end of the week to be compared against the survey and the output measurements. Volumes for the survey and the bucket counts are found in Table 11-9.

Table 11-9
OU1 2007 QC and QA Sand Thickness Volume Comparisons

Area	Design[1] Square Footage	Placed[2] Square Footage	QA Average[3] Thickness Russian Peat Borer (ft)	QA Average[4] Thickness Bathymetry (ft)	QC Average[5] Thickness Loader Buckets (ft)	Calculated Volume Based on QA Core Average Thickness (cy)[6]		Calculated Volume Based on Bathymetry (cy)[7]		Calculated Volume Based on Loader Buckets QC Average Thickness (cy)[8]		Calculated Volume Based on QC Recorded Epoke Data (cy)[9]	
						Design	Placed	Design	Placed	Design	Placed	Design	Placed
SMU-1	12,453	19,741	0.93	0.87	1.01	428.94	679.97	401.26	636.10	465.83	738.46	NA	710.00
SMU-2	7,340	9,813	0.86	0.45	0.77	233.79	312.56	122.33	163.55	209.33	279.85	NA	317.00
SMU-3	20,416	24,301	0.90	0.62	0.86	680.53	810.03	468.81	558.02	650.29	774.03	NA	546.00
SMU-4	2,309	3,725	0.58	0.69	2.47	49.60	80.02	59.01	95.19	211.23	340.77	NA	134.00
SMU-5	61,920	74,414	0.80	0.61	1.02	1,834.67	2,204.86	1,398.93	1,681.21	2,339.20	2,811.20	NA	3,080.00
SMU-6	18,383	22,317	0.83	0.40	0.38	565.11	686.04	272.34	330.62	258.72	314.09	NA	743.00
SMU-7	6,655	8,884	0.45	0.38	1.56	110.92	148.07	93.66	125.03	384.51	513.30	NA	287.00
SMU-8	6,959	8,911	0.61	0.39	0.96	157.22	201.32	100.52	128.71	247.43	316.84	NA	299.00
SMU-9	21,613	25,349	0.73	0.32	0.77	584.35	685.36	256.15	300.43	616.37	722.92	NA	746.00
SMU-10	5,449	7,270	0.90	0.34	0.97	181.63	242.33	68.62	91.55	195.76	261.18	NA	221.00
SMU-11	5,838	6,821	0.60	0.18	0.93	129.73	151.58	38.92	45.47	201.09	234.95	NA	224.00
SMU-12	7,335	9,090	0.86	0.27	0.81	233.63	289.53	73.35	90.90	220.05	272.70	NA	257.00
SMU-13	17,266	19,395	0.67	0.39	0.99	428.45	481.28	249.40	280.15	633.09	711.15	NA	707.00
SMU-14	7,278	8,582	0.99	0.27	0.87	266.86	314.67	72.78	85.82	234.51	276.53	NA	243.00
SMU-15	6,482	7,889	0.63	0.08	0.80	151.25	184.08	19.21	23.37	192.06	233.75	NA	210.00
SMU-16	22,045	26,964	1.02	0.18	0.86	832.81	1,018.64	146.97	179.76	702.17	858.85	NA	818.00
					Totals	**6,869.50**	**8,490.35**	**3,842.26**	4,815.90	**7,761.65**	**9,660.56**	**NA**	**9,542.00**

Notes listed on next page

Notes:

[1] Design square footage values calculated from shape files provided by Foth.

[2] Placed square footage values provided by Brennan. Calculated by multiplying the number of steps taken by the area of the spreader bay.

[3] Average thickness for QA Russian Peat Borer. Values are from Tables 11-4, 11-5, 11-6, and 11-7 in this report.

[4] Average thickness from QA bathymetric surveys within the design square footage. See Figures 11-4, 11-5, 11-6, 11-7, and 11-8.

[5] Average thickness for QC loader buckets. Calculated by using the estimated cubic yards delivered (struck buckets) spread over the design square footage. Provided by Brennan.

[6] Design volume is the design square footage multiplied by average Russian Peat Borer thickness. Placed volume is the placed square footage multiplied by the average Russian Peat Borer thickness.

[7] Volume from QA bathymetry surveys within the design square footage. See Figures 11-4, 11-5, 11-6, 11-7, and 11-8.

[8] Design volume is the design square footage multiplied by average QC loader bucket thickness. Placed volume is the placed square footage multiplied by the average QC loader bucket thickness.

[9] Total volume placed as recorded by the pulse generator on the Epoke system located on the spreader barge.

SMU = Sand Management Unit
ft = feet
cy = cubic yards

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Checked by: TAG

Once the materials were fed into the on-shore delivery system, the placement outputs were measured by the Epoke metering system and finally by QA measurements, including sediment cores, sediment traps, and bathymetry. The Epoke output was the primary tool used by Brennan to QC the volume being placed at each placement step. The Epoke spreader system was linked to an onboard computer system supported by DREDGEPACK® and Wonderware software. These software programs were linked directly to the Epoke in order to keep track of the revolutions of the belt on the spreader system. A known volume of material was placed on the belt. The software kept track of each revolution of the belt and added up the quantity of materials placed throughout the placement step. Once the appropriate amount of material was spread, the software set off an alarm alerting Brennan to move the spreading barge to the next step, while continuing placement. At the end of each day's placement operations, the data (i.e., time and volume placed) was downloaded and saved as a spreadsheet. Upon completion of placement in each Cap Certification Unit (CCU), the Epoke totals were added up and compared to the totals of materials placed into the system. The final QC volumes are presented in Table 11-9.

Table 11-9 presents both QA and QC volume values for each of the SMUs. Volumes were also calculated for each QA and QC measurement method. One volume is associated with the designed square footage, whereas the other volume is for the actual placed square footage as measured by Brennan.

In comparing the design versus placed volumes, Brennan determined that 10% to 38% horizontal over-placement was observed. The horizontal over-placement is largely due to the need to overlap between placement lanes and to place additional material around the SMU perimeter to meet the required thickness at the SMU design boundary. Comparing QA volumes with QC volumes, Brennan found differences. Brennan believes that there is an overall loss of 20% (by volume) from QC measurements (struck front-end loader buckets and RTK surveys of the stockpile) to the final QA measurements (sediment cores and bathymetry). Foth, through general geotechnical calculations, believes the loss is more on the order of 7% to 10%, resulting from consolidation that takes place when sand is added to the water (e.g. 10 inches of dry sand equates to 9.0 inches to 9.3 inches when submerged).

11.4 Statistical Analysis of Sand Thickness Data

As discussed previously, lack of adequate water depth limited the number and accuracy of sediment trap samples that could be collected to evaluate the OU1 2007 residual sand cover placement. Therefore, for this analysis, Russian Peat Borer data is considered the primary QA measurement. Based on Russian Peat Borer data, all sand placement measurements in SCU-01, SCU-02 and SCU-03, were at least 6 inches in thickness, and 17 of the 18 measurements in SCU-04 were at least 6 inches in thickness.

Thickness measurement distributions for each certification unit are presented in Figures 11-2 and 11-3. Box plots were used to evaluate the placement thickness distributions. The box plots (shown in Figure 11-9) were used to summarize the data minimum and maximum, the data quartiles, the mean, and any outliers. In addition to the Russian Peat Borer results, box plots are also presented for thickness-derived estimates based on pre- and post-placement bathymetric surveys. As can be seen, bathymetric survey-derived thickness results, on average, are lower

than the Russian Peat Borer results, illustrating varying levels of apparent consolidation of the underlying sediments. The most significant deviation occurred in SCU-04 data and the apparent consolidation was approximately 0.5 feet on average.

In the *2007 Cap Placement Test Plan* (Foth, 2007), statistical methods were developed to verify that minimum thickness placement requirements are reliably achieved. When only Russian Peat Borer data is utilized (or sediment trap data when available), a minimum of 11 out of 11 or 17 out of 18 measurements must be greater or equal to minimum targeted thickness in order to demonstrate that the targeted placement thickness has been obtained for a particular certification unit. The minimum thickness (target) was achieved for all four SCUs in Sub-area POG3, as shown in Table 11-10.

Table 11-10
Sediment Thickness Data Summary

Certification Unit	Target Applied Thickness (ft)	Sample Size	Minimum Observed Thickness[1] (ft)	Number of Samples Exceeding Target Thickness	Average Observed Thickness (ft)
SCU-01	0.5	11	0.52	11	0.90
SCU-02	0.5	11	0.57	11	0.88
SCU-03	0.5	18	0.54	18	0.81
SCU-04	0.5	18	0.45	17	0.77

1. Observed thicknesses based on Russian Peat Borer results.

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While exclusive use of Russian Peat Borer data (or sediment trap data when available) is an effective way to demonstrate attainment of the minimum-thickness target, there are advantages in using other measurements such as bathymetry readings, particularly when there is a significant correlation with peat borer results. When placement thickness can be accurately estimated from other measurements such as bathymetry results, these estimates not only result in higher density sets, but also provide a more cost-effective means of verifying placement thickness.

To this end, it was also proposed in the *2007 Cap Placement Test Plan* (Foth, 2007) to apply a multiple regression model for predicting the primary QA measurement (i.e., sediment trap or Russian Peat Borer thickness) from other measurement types such as bathymetry data. The model approach is summarized by the following steps:

- Develop a multiple regression model predicting the primary QA measured placement thickness from a combination of secondary QA measurements and in-situ sediment characteristics.

- As a conservative estimate of placed thickness, calculate a lower 95% prediction limit on the estimate.

A regression model for placement thickness was developed based on the Russian Peat Borer data collected in the four SCUs. In addition to bathymetry derived thicknesses, other independent (predictor) variables were chosen from in-situ sediment characteristics such as:

- water depth;
- sediment thickness;
- percent solids; and
- time lag between Russian Peat Borer data and bathymetric survey

An analysis of variance approach was used with a linear regression model to select those data that minimized additional variation in the regression model.

The regression model, calculated for the combined data of the four SCUs, is:

$$\textit{Russian Peat Borer Thickness}_i = 0.669 + 0.395 \times \textit{BathymetryThickness}_i + 0.168 \times \textit{Sediment Thickness}_i - 0.002 \times \textit{Percent Solids}_i + e_i$$

where thickness data are presented in units of feet and percent solids are presented in units of percent (%).

The regression ANOVA results, and also model results at each sample location are tabulated and presented in Table 11-11. The observed and predicted thicknesses, as well as lower 95% prediction limits (PLs) are included. The lower 95% PLs are limits on $Y_{h(new)}$, or a new observation at X_h.

The multiple regression analysis lower 95% PLs is calculated as:

$$\hat{Y}_h - t_{0.95,n-3}\, s\left(Y_{h(new)}\right)$$

where $\hat{Y}_h$ is the predicted sediment trap thickness from the linear regression equation, $t_{0.95,n-2}$ is the upper 95th percentile of the *t*-distribution with *n*-3 degrees of freedom, and

$$s^2\left(Y_{h(new)}\right) = MSE\left[1 + X'_h\left(X'X\right)^{-1} X_h\right].$$

The goal is to use the lower 95% PL as a conservative estimate for a primary QA measurement. If the placement process variation is sufficiently small, this would be useful in developing a highly dense and cost-effective data set for placement thickness evaluation.

As supported from a review of the results illustrated in Table 11-11, the regression model explains a significant portion of the variation in the Russian Peat Borer data. Further, the lower 95% PL can be used as a conservative estimate in lieu of an observed peat borer measurement. However, for the regression model to be used in practice, the correlation between the primary QA measurement and predictor variables would need to improve, since the lower 95% PLs based on the data collected from the four SCUs too frequently fall below the minimum thickness requirement of 0.5 feet.

If the placement process and associated measurements continued to be refined such that correlation improves, the PL method of estimating thickness could successfully be utilized for placement verification. Increased correlation between the primary and secondary measurements could occur, as regression models performed individually on the four SCUs illustrates increased explainable variation, particularly with SCU-01 and SCU-02.

Table 11-11
Sand Placement Regression Model Results

Sand Certification Unit	Sample	Russian Peat Borer Thickness (ft)	Bathymetry Thickness (ft)	In-Situ Sediment Thickness (ft)	In-Situ Percent Solids	Y_{pred} (ft)	Lower Prediction Limit [1]
SCU-01	SMU3-1	1.57	1.18	0.44	29.2	1.15	0.77
SCU-01	SMU3-2	0.8	0.44	0.02	37.5	0.77	0.40
SCU-01	SMU3-3	0.71	0.7	0.13	30.2	0.91	0.54
SCU-01	SMU3-4	0.67	0.55	0.23	42.1	0.84	0.48
SCU-01	SMU3-4A	0.82	0.86	0.44	29.2	1.02	0.66
SCU-01	SMU3-5	0.95	0.64	0.37	30.7	0.92	0.56
SCU-01	SMU3-6	1.05	0.62	0.34	27.3	0.92	0.55
SCU-01	SMU3-7	0.84	0.79	0.44	33.6	0.99	0.62
SCU-01	SMU3-8	0.8	0.79	0.65	27.6	1.03	0.66
SCU-01	SMU3-9	0.52	0.41	0.35	36.7	0.82	0.45
SCU-01	SMU3-10	1.15	0.62	0.21	47.4	0.85	0.49
SCU-02	SMU1-1	1.22	0.95	0.27	69.5	0.95	0.58
SCU-02	SMU1-2	1.04	0.83	0.31	57.7	0.93	0.57
SCU-02	SMU1-3	0.74	0.84	0.15	62.2	0.90	0.53
SCU-02	SMU1-4	0.83	0.93	0.16	70.6	0.92	0.55
SCU-02	SMU1-5	0.94	1.15	0.06	66.1	1.00	0.62
SCU-02	SMU1-6	0.83	0.71	0.25	68.3	0.85	0.49
SCU-02	SMU2-1	0.84	0.36	0.31	31.7	0.80	0.43
SCU-02	SMU2-2	0.57	0.28	0.12	47.4	0.70	0.34
SCU-02	SMU2-3	1.42	0.64	0.31	31.7	0.91	0.55
SCU-02	SMU2-4	0.62	0.25	0.01	34.9	0.70	0.32
SCU-02	SMU4-1	0.58	0.25	0.00	72.5	0.62	0.25
SCU-03	SMU5-1	0.98	0.67	0.25	53.7	0.87	0.51
SCU-03	SMU5-2	0.54	0.7	0.34	44.3	0.91	0.55
SCU-03	SMU5-3	0.58	0.78	0.27	49.1	0.92	0.56
SCU-03	SMU5-4	1.07	0.52	0.36	45.4	0.84	0.48
SCU-03	SMU5-5	1.43	1.05	0.11	49.2	1.00	0.63
SCU-03	SMU5-6	0.75	0.45	0.35	30.7	0.84	0.48
SCU-03	SMU5-7	0.92	0.69	0.18	52.1	0.87	0.51
SCU-03	SMU5-8	0.6	0.45	0.40	34.2	0.85	0.48
SCU-03	SMU5-9	0.6	0.11	0.35	55.3	0.66	0.29
SCU-03	SMU5-10	0.6	0.55	0.17	53.3	0.81	0.45
SCU-03	SMU5-11	1.02	0.7	0.35	55.0	0.89	0.53
SCU-03	SMU5-12	0.8	0.55	0.11	60.0	0.78	0.42
SCU-03	SMU5-13	0.67	0.73	0.15	67.4	0.85	0.48
SCU-03	SMU5-14	0.7	0.36	0.15	68.6	0.70	0.33
SCU-03	SMU6-1	0.71	0.77	0.36	55.8	0.92	0.56
SCU-03	SMU6-2	0.68	0.27	0.21	65.7	0.68	0.31
SCU-03	SMU6-3	0.77	0.67	0.41	56.5	0.89	0.53
SCU-03	SMU6-4	1.15	0.32	0.41	55.7	0.75	0.39
SCU-04	SMU7-1	0.45	0.07	0.28	70.2	0.60	0.23
SCU-04	SMU8-1	0.61	0.2	0.23	56.8	0.67	0.31
SCU-04	SMU9-1	0.71	0.35	0.38	72.3	0.72	0.36

Sand Certification Unit	Sample	Russian Peat Borer Thickness (ft)	Bathymetry Thickness (ft)	In-Situ Sediment Thickness (ft)	In-Situ Percent Solids	Y_{pred} (ft)	Lower Prediction Limit [1]
SCU-04	SMU9-2	0.63	0.28	0.38	70.1	0.70	0.34
SCU-04	SMU9-3	0.84	0.32	0.36	72.5	0.71	0.34
SCU-04	SMU9-4	0.75	0.16	0.46	73.3	0.66	0.29
SCU-04	SMU10-1	0.9	0.46	0.39	72.0	0.77	0.41
SCU-04	SMU11-1	0.6	0.29	0.79	60.7	0.79	0.42
SCU-04	SMU12-1	0.71	0.09	0.64	67.9	0.67	0.30
SCU-04	SMU12-2	1	0.69	0.64	67.9	0.91	0.54
SCU-04	SMU13-1	0.64	0.31	0.74	50.1	0.81	0.44
SCU-04	SMU13-2	0.61	0.21	0.67	46.3	0.77	0.40
SCU-04	SMU13-3	0.77	0.84	0.54	51.0	0.99	0.62
SCU-04	SMU14-1	0.99	0	0.21	61.2	0.58	0.21
SCU-04	SMU15-1	0.63	0	0.01	40.0	0.59	0.20
SCU-04	SMU16-1	0.98	0.24	0.98	43.3	0.84	0.45
SCU-04	SMU16-2	0.8	0.35	0.40	40.4	0.79	0.43
SCU-04	SMU16-3	1.27	0.33	0.71	25.4	0.87	0.49

Notes:
1 Assumes 5% Type 1 error rate (ά)

Summary Output

Regression Statistics	
Multiple R	0.513
R Square	0.263
Adjusted R Square	0.222
Standard Error	0.212
Observations	58

ANOVA

	df	SS	MS	F	Significance F
Regression	3	0.866	0.289	6.416	0.001
Residual	54	2.431	0.045		
Total	57	3.297			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.669	0.139	4.822	0.000	0.391	0.948
Bathymetry Thickness (ft)	0.395	0.100	3.940	0.000	0.194	0.596
In-Situ Sediment Thickness (ft)	0.168	0.140	1.205	0.233	-0.112	0.448
In-Situ Percent Solids	-0.002	0.002	-1.062	0.293	-0.006	0.002

DF = Degrees of Freedom
SS = Sum of Squares
MS = Mean Square
t Stat = t Statistic
F = F Statistic
P-value = Probability of Coefficient Equaling Zero

Prepared by: SGL
Checked by: GRE

11.5 Surface Water Quality Monitoring

During sand cover placement operations, surface water turbidity, reported in NTUs, was monitored 2 to 3 times per week. Monitoring included taking field readings both upstream and downstream of the operation to determine the impacts of sand cover placement on surface water turbidity. Brennan implemented Best Management Practices to minimize the amount of turbidity and TSS downstream of placement operations. After initial startup of the sand spreader, Brennan implemented silt curtains, used to contain suspended solids, which were placed at both the spreader bay and discharge line.

11.5.1 Turbidity

During sand cover placement, surface water turbidity (reported as NTUs) was measured in the river at two locations: one upstream and one downstream of the sand spreader. The upstream sampling location was between 100 feet and 500 feet from the sand spreader. The downstream locations were 500 feet or less from the sand/stone spreader. Turbidity measurements were collected 2 to 3 times per week during operation, unless a visible plume was observed. When a plume was visually observed, Foth documented the plume.

During sand cover placement operations, turbidity increases resulting from placement operations were present; however, they were relatively low as compared to background readings. On average, values greater than the WDNR performance expectation of no more than 80 NTUs above background readings were only encountered within 150 feet of the discharge pipe of the sand spreader. For all plumes monitored, turbidity readings of less than 38 NTUs above background were reached within 250 feet of the discharge pipe of the sand spreader. The turbidity results are provided in Tables I-5 and I-6.

11.5.2 Total Suspended Solids

During the weeks of August 13, 2007 and August 27, 2007, surface water samples were collected for TSS analysis of the turbidity plumes coming from sand cover placement activities. Along with these samples, a turbidity reading was also taken. This turbidity reading was performed at the request of GW Partners and WDNR as a way to correlate turbidity readings with TSS values. The results from these samples are presented in Appendix I, Table I-5, and a comparison of sand spreading turbidity and TSS is provided in Appendix I, Table I-6. Results indicated that turbidity readings can serve to reasonably approximate TSS values for sand spreading operations.

12 2007 Project Performance Versus Objectives

Objective No. 1: Re-dredge areas with post-dredge PCB concentrations greater than or equal to 5.0 ppm to reduce the SWAC.

- Areas with post-dredge PCB residual concentrations greater than or equal to 5.0 ppm were re-dredged in Sub-areas A, C, D1,E2, E3S, POG1 and POG3.

- In Sub-areas A and C some of the residual PCB concentrations following the re-dredge activities were still greater than 5.0 ppm. These areas were originally dredged in 2005 or 2006, then again in 2007. Since these areas are not amenable to dredging to effectively reach the 1.0 ppm RAL, they will be covered with a residual sand cover in 2008. An exception to this is a small portion of Sub-area C, where the post-dredge residual PCB concentration was 48.1 ppm. This area, with modeled lateral extent of 0.14 acres and sediment volume of 90 cy, is planned for dredging in 2008.

- The residual PCB concentrations in the re-dredge areas in D1, E2, and E3S were all less than 2.0 ppm.

- Small areas with residual PCB concentrations exceeding 5.0 ppm remain in POG1 and POG3 North and will be re-dredged in 2008.

- POG2 was not re-dredged in 2007, but will be re-dredged and receive a 9-inch thick sand cover in 2008.

Objective No. 2: Re-dredge residential dock areas with PCBs greater than 1.0 ppm and less than 5.0 ppm that are too shallow to place a 6-inch-thick sand cover (i.e., pre-cover water depth less than 3.5 feet) to reduce the SWAC.

- Shoreline areas meeting this criterion were re-dredged in Sub-areas A and C.

Objective No. 3: Dredge residential dock areas with PCBs greater than 1.0 ppm with pre-cap water depth les than 3.5 feet.

- Shoreline areas meeting this criterion were dredged in Sub-areas D1 and E3S.

Objective No. 4: Dredge undredged shallow areas with PCB's greater than 1.0 ppm.

- Shoreline areas meeting this criterion were dredged in Sub-areas A and C.

- Shoreline areas meeting this criterion in POG4 were not dredged in 2007, but will be completed during a high water level event in 2008.

Objective No. 5: Dredge areas with PCBs greater than 2.0 ppm with pre-cap water depth less than 7.08 feet.

- Dredging to meet this criterion occurred in Sub-areas D1, E3S, E6, and F.
- Dredging to meet this criterion will be completed in 2008 in Sub-areas E3S and E3N.
- Dredging beneath the Highway 441 bridge in E3S was not completed in 2007 due to poor GPS reception. Plans to address this area will be included in the 2008 OU1 RA Work Plan.

Objective No. 6: Dredge areas with PCB concentrations greater than 10 ppm (2-four inch intervals) in areas otherwise deep enough to receive an engineered cap.

- Three DMUs meeting this criterion, DMUs 1E2, 2E2, and 3E2, were dredged in 2007.

Objective No. 7: Dredge select small or isolated areas with PCBs greater than 2.0 ppm and water depth greater than 7.08 feet.

- Dredging to meet this criterion occurred in Sub-areas E5 and E6 (north of Northing 820100).

Objective No. 8: Dredge areas with PCBs greater than 1.0 ppm that would be in the path of future Highway 441 expansion.

- Dredging to meet this criterion occurred in Sub-areas E3S and E1.

Objective No. 9: Optimize dredging and re-dredging operations to minimize turbidity, over dredging, and residual PCB concentrations.

- During 2007 dredging and sand cover operations, there were no sustained exceedances of the 78 NTU differential (WDNR performance expectation) between turbidity readings upstream and downstream of dredging or sand covering operations.
- The actual area dredged and the sediment volume removed to target elevation in 2007 exceeded the original plan by 24.7 acres and 6,818 cy, respectively.
- The average overdredge for the 2007 dredge season was 4.2 inches below the 1.0 ppm PCB target elevation, which essentially met the expectation of 4 inches set at the 2007 project start.
- PCB post-dredge residuals for 2007 were lower than anticipated. Eighty seven percent of the post-dredge residual surficial PCB concentrations were less than the 1.0 ppm RAL.

Only 1% of the samples below the top 6-inch surficial interval exceeded the 1.0 ppm PCB RAL. The resulting PCB SWAC within each of the 2007 dredge areas (not the entire sub-area), ranged from 0.3 to 1.8 ppm, with only two of the sub-areas (Sub-areas A and E2S) being above 1.0 ppm.

Objective No. 10: Sand cover select dredged and re-dredged areas with PCBs less than 5.0 ppm to reduce the SWAC and to test sand placement operation.

- 5.4 acres of residual sand cover were placed in 2007.
- The placement production rate averaged approximately 45 cubic yards per NOH, with higher production rates up to 83 cubic yards per NOH being achieved in the later stages of the placement operations.
- Sand placement thickness control improved over the course of the placement activities. The average thickness varied by SCU from 9.2 to 10.8 inches, with SCU 04, the final SCU having the lowest average as well as a relatively low standard deviation (2.4 inches).
- The minimum required sand thickness was placed in all SCUs.
- Fifty as-placed residual sand cover samples were collected, composited and tested for PCB content. All results (ten composite samples) were below the LOD.

Objective No. 11: Optimize dewatering and water treatment operations to maximize dewatered percent solids, while minimizing operations costs and meeting environmental standards.

- The trammel screens and thickeners operated efficiently and effectively, while removing approximately 75% of the water from the sediment slurry prior to its introduction to the geotextile tubes.
- The two retention tanks, added to the system immediately downstream of the thickeners in 2007, increased TSS removal in the water stream to the Krofta.
- The addition of bleach to the thickener effluent aided in reducing or eliminating the formation of undesirable biological growth downstream of the thickeners.
- A switch from ferric sulfate to ACH improved flocculation of the sediment in the thickeners.
- Weekend WTP maintenance allowed the media to efficiently filter the dewatering pad effluent.

- Periodic treatment of the media in the Krofta unit prevented the need for replacement of this media in 2007.

- Periodic treatment of the GAC in the GAC units prevented the need for replacement of this media in 2007.

Objective No. 12: Dispose of non-Toxic Substance Control Act (non-TSCA) dewatered sediment at the Veolia Environmental Services Hickory Meadows Landfill facility (Veolia Hickory Meadows Landfill), in the town of Chilton, Wisconsin.

- Approximately 120,614 tons of dewatered sediment were transported and disposed of at the Hickory Meadows Landfill.

- Sediment hauling commenced on April 23, 2007 and was completed on March 31, 2008.

- There were no TSCA sediments encountered during the 2007 RA.

Objective No. 13: Monitor RA activities and their impacts (sediment removal verification, sand placement verification, water treatment effluent, surface water quality, and air quality).

- Dewatered sediment paint filter and percent solids tests were performed on materials from each geotextile tube.

- Additional analysis of dewatered sediment for PCB concentration and strength parameters was completed to meet specific landfill requirements.

- Air quality was sampled and analyzed for PCBs. PCBs were detected at very low levels below WDNR air quality emission standard.

- WTP effluent was sampled and analyzed for PCBs, TSS, BOD, ammonia, and mercury.

- Surface water quality real-time turbidity testing was performed upstream and downstream of dredges.

- PCB and ammonia effluent concentrations consistently met the WDNR's performance expectations.

- WDNR's daily TSS performance expectation was met 157 out of 159 operation days.

- WDNR's monthly TSS performance expectation was exceeded only 1 time during the 9 months of WTP operation.

- WDNR's daily BOD performance expectation was met 151 out of 159 operation days.

- Effluent water quality for mercury did not consistently meet WDNR performance expectations; however, 2007 RA effluent low-level mercury concentrations were on average an order of magnitude less than background river water concentrations.

- Sediment removal verification.
  - Bathymetric surveys were performed and confirmed that the 1-ppm PCB target dredge elevation (or documented high subgrade areas) had been attained in over 95% of each dredge management unit.

- Dredged areas were sampled and analyzed for residual PCB concentrations.

- Sand thickness verification sampling was completed during residual sand cover placement over 5.4 acres in POG3. The minimum required sand thickness was documented in all four SCUs.

- A secure website was utilized to communicate environmental and production data requested by Agency/Oversight Team and GW Partners.

13 References

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