Appendix G

OU1 Cap Monitoring and Maintenance Plan

Final

Lower Fox River Operable Unit 1 – Cap Monitoring and Maintenance Plan

Prepared for

WTM I Company
GW Partners, LLC

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Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirements
CCU	cap certification unit
CERCLA	Comprehensive Environmental Response, Compensation, Liability Act
cfs	cubic feet per second
CH2M HILL	CH2M HILL, Inc.
cm	centimeter
CMMP	Cap Monitoring and Maintenance Plan
Foth	Foth Infrastructure & Environment, LLC
GW Partners	GW Partners, LLC
J.F. Brennan	J.F. Brennan Company, Inc.
LFR	Lower Fox River
LLBdM	Little Lake Butte des Morts
OU1	Operable Unit 1
PCB	polychlorinated biphenyl
ppm	parts per million
QA	quality assurance
QAPP	Quality Assurance Project Plan
RA	remedial action
ROD	Record of Decision
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

SECTION 1

1.0 Introduction

This *Lower Fox River Operable Unit 1 – Cap Monitoring and Maintenance Plan* (Foth and CH2M HILL, 2011) (*CMMP*) is included as an appendix to the *Integrated Design and Remedial Action and Work Plan for the Post-2009 Response Work*. This plan describes post-placement cap monitoring activities that will be performed to ensure the cap retains its physical integrity and protectiveness over time. This *CMMP* also outlines contingency response actions that will be implemented if the engineered cap is eroded or otherwise significantly damaged.

Engineered caps were placed over approximately 110 acres of un-dredged river with sediment polychlorinated biphenyls (PCB) concentrations between 2.0 parts per million (ppm) and 10 ppm in the top 8 inches of sediment and a post-cap water depth greater than 6 feet. Areas with PCBs less than 2.0 ppm in the top 8 inches of sediment, and no other 8-inch interval with average PCB concentration greater than 1.0 ppm, were remediated with sand covers. The Operable Unit 1 (OU1) engineered cap placement areas are shown on Figure 1-1.

As described in the *Record of Decision Amendment* (USEPA, 2008) (*ROD Amendment*), long-term monitoring will be performed on the engineered caps to ensure their long-term integrity and protectiveness. However, consistent with the ROD Amendment, sand covers, which were placed as the primary remedy or for post-dredge residuals management, will not require long-term monitoring or maintenance.

This *CMMP* addresses the following:

- Data quality objectives for post-construction monitoring of capped areas, including rationale for the type, location, and frequency of monitoring
- Monitoring techniques/methods to be used
- Response actions
- Reporting requirements

The main body of this *CMMP* has been divided into the following sections:

- Introduction
- Cap Design Summary
- Cap Monitoring
- Cap Maintenance
- Continuing Access Requirements

Section 2 of this *CMMP* presents a summary of the cap designs. Section 3 presents plans for long-term monitoring. Section 4 presents cap maintenance plans for damaged caps.

Aspects of this *CMMP* may be adaptively managed by the Respondents, Response Agencies, and their respective technical consultants. Using an adaptive management approach, information collected during the early stages of the monitoring program may be used to guide or improve the performance of later field or analytical tasks.

SECTION 2

2.0 Cap Design Summary

The sediment capped in OU1 contains less than 10 ppm in any top 8-inch interval and, in most areas, less than 5 ppm PCBs in the top 8-inch interval. In addition to chemically isolating these levels of PCBs, the cap was designed with an armor layer to physically protect the chemical isolation layer from the effects of bioturbation and erosion. The cap design (*Lower Fox River Operable Unit 1 – Final OU1 Cap Design* [Foth 2008a]) considered the stability of the cap's armor stone with regards to stresses generated by prop wash, wind-wave action, and flow. The potential impacts of ice scour and sediment consolidation, shear strength, and liquefaction on the cap were also evaluated. A single engineered cap designed for OU1's physical environment was used to effectively contain these levels of PCBs. The OU1 engineered cap design required a minimum sand and armor stone thickness of 3 inches and 4 inches, respectively. With the inclusion of overplacement allowances, the average sand and armor stone thicknesses were anticipated to be 6 inches and 7 inches, respectively, totaling 13 inches. Verification sampling showed that the placed-thicknesses for both the sand and armor stone layers met the minimum design standards.

SECTION 3

3.0 Cap Monitoring

The *ROD Amendment* requires long-term monitoring and maintenance of the engineered cap to ensure its long-term integrity and, thus, its protectiveness. The long-term cap monitoring will include:

- Routine monitoring of all capped areas using bathymetric surveys and other techniques such as poling and probing; and
- Additional event-based cap monitoring of all capped areas when needed using bathymetric surveys and other techniques such as poling and probing.

The need for, and scope of, continued cap monitoring will be evaluated as part of the 5-year review process.

3.1. Routine Monitoring of Sediment Caps

OU1 cap placement was completed in 2009. As part of construction quality assurance (QA), QA bathymetric surveys were performed on all the OU1 caps following their placement. The results of these surveys were documented in the *Lower Fox River Operable Unit 1 – 2007 Cap Placement Test Summary* (Foth 2008b) and the *Lower Fox River Operable Unit 1 – 2008 Remedial Action Summary Report* (Foth and J.F. Brennan, 2009), and the *Lower Fox River Operable Unit 1 – 2009 Remedial Action Summary Report* (Foth and J.F. Brennan, 2010).

Long-term monitoring bathymetric surveys will be performed using either single beam or multi-beam acoustical systems that conform to guidelines set forth by the U.S. Army Corps of Engineers (USACE) guidance (EM 1110-2-1003, Engineering and Design - Bathymetric Surveying dated April, 2004 [USEPA, 2004]). Details of the survey position and control equipment are presented in Appendix A. Additional procedural requirements are included in Section 11 of the *Lower Fox River Operable Unit 1 and Lake Winnebago Long-term Monitoring – Quality Assurance Project Plan* (Foth and CH2M HILL, 2011) *(QAPP*). To the extent possible, survey data will be collected along the same transects for each survey to aid in data comparisons.

The interpretation of changes in bathymetric surveys should also consider the consolidation of soft sediments beneath the armored cap. Consolidation of soft sediments is a long-term process, and the extent of consolidation depends on the thickness of cap placement, the elapsed time since placement, the thickness of soft sediment beneath the cap, initial conditions of the sediment, and consolidation properties of the sediment. For most cap areas in OU1, where the soft sediment thickness was 6 feet or greater, consolidation was expected to be in the range of 12 inches or greater. Most of the consolidation was expected to occur within the first year after placement, but detailed monitoring and analysis of the OU1 cap areas by poling and bathymetric surveys has indicated that consolidation was not necessarily complete for periods greater than 1 year after placement (Foth, 2010). Further details of trends in consolidation will likely become apparent when reviewing the records

and newly collected data for changes in top-of-cap elevation for OU1 cap areas placed in 2007, 2008, and 2009.

Routine cap monitoring will be performed in 2010, 2012, and every 5 years thereafter or until otherwise determined as part of the 5-year review process. Termination of routine cap monitoring may be appropriate after a certain time period (e.g., 25 years) has passed without significant cap erosion. Discussion of the end-point for cap monitoring will be a routine element of each 5-year review.

3.1.1. Event-Based Cap Monitoring

In addition to routine monitoring, supplemental bathymetric surveys will be performed following major river flow events or construction activities that may have a significant impact on the engineered cap.

Flows for OU1 are approximated using measurements from the Appleton gauging station, which is downstream of OU1 near Appleton. Table 3-1 presents the flow rates in the Lower Fox River (LFR) taken at the Appleton gauging station (U.S. Geological Survey [USGS] Station No. 04084445 http://waterdata.usgs.gov/nwis/) for various return-interval flow events. These flows are taken from *Flood Frequency Characteristics of Wisconsin Streams* (Walker and Krug, 2003). These values may be updated as new information becomes available.

Table 3-1
Summary of Lower Fox River Flow Rates

Recurrence Interval	Flows at Appleton (cfs)
5 years	15,100
10 years	16,500
25 years	18,000
50 years	19,000
100 years	19,900

1. cfs = cubic feet per second

Event-based monitoring will be performed within one year following a designated river flow event. Hourly average flows exceeding the 5-year recurrence-interval flow rate listed in Table 3-1 (i.e., cfs) will be used to trigger the initial event-based bathymetric survey. If cap integrity is verified following a 5-year flow event, the next event-based cap monitoring will occur following a 50-year flow event. No additional event-based cap monitoring is recommended if cap integrity is verified following a 50-year flow event because the 50-year flow event is 95% of the 100-year flow event.

3.2. Cap Monitoring Responses

As discussed in the sections above, monitoring the cap will involve routine periodic evaluation of the cap's physical integrity as well as event-based monitoring triggered by high flows or in-river construction activities that could affect the cap's integrity.

One cap monitoring "trigger" is cap erosion, which is defined as a significant (i.e., detectable within the sensitivity of the hydrographic survey) differential between the previous hydrographic surveys of cap elevation and the most recent hydrographic survey of cap elevation. In other words, erosion is a significant decrease in the cap surface elevation over time. Note, it is important to differentiate between cap erosion and cap consolidation (see Section 3.1 for discussion on cap consolidation).

If a bathymetric survey indicates erosion of the armor layer over more than 5% of a cap certification unit (CCU), the affected cap areas will be assessed by poling and/or diver inspection. The main objective of the poling and diver inspection is to determine if the armor stone layer is intact and, if practical, whether the armor stone layer meets the minimum design thickness. If physical poling and/or diver inspection confirms the armor stone remains intact, it will be determined that the sediment substrate has settled rather than the cap has eroded. Poling will be completed with a standard poling rod (3/4 inch diameter) with gradations of 0.1 feet, used previously on the OU1 project to estimate sediment thickness. Through experience, it has been noted that the poling operator is able to distinguish sediment from gravel/stone by the feel of refusal. It is intended that poling will be completed in suspect areas to determine if gravel/stone is still present, based on pole refusal and measurements to the top of armor layer.

As stated in Section 5.1.1.3 of *Lower Fox River Operable Unit 1, 2007 Cap Placement Test Summary* (Foth, 2008), the accuracy of each hydrographic survey (based on product literature and field testing) is typically within 5 centimeter (cm) (2 inches). Errors are less for quiescent water and hard bottom conditions. For instance, OU1 hydrographic surveys are conducted with a minimum of three poling readings per survey, typically confirming that the spot readings are within 0.1 foot (3 cm or 1.2 inches). Assuming equal errors for each event (UA = UB = 5 cm), the propagation of errors formula (UD = sqrt(UA^2 + UB^2)) would predict that the differential survey accuracy for a point would be within 7.1 cm (3 inches).

The cap monitoring results will be summarized in technical memoranda to be submitted to the Response Agencies following each monitoring event.

SECTION 4

4.0 Cap Maintenance

Maintenance of the engineered cap includes the following:

- Repair
- Enhancement
- Other contingency actions as necessary

4.1. Cap Maintenance Trigger

A cap maintenance response action will be triggered if the monitoring data indicate that a portion of the cap (defined as at least 5% of a CCU) no longer meets its minimum design armor stone layer thickness.

4.2. Possible Response Actions

If a cap maintenance response action is triggered, the possible response actions include:

- Repair the identified area.
- Enhance the area's armor layer.
- Enact institutional or other controls to help minimize further cap erosion.
- Remove the affected portion of the cap and the underlying contaminated sediment if an engineering evaluation determines that cap repair and/or other controls are unlikely to be effective in preventing recurrent future erosion.
- Increase the frequency of cap monitoring in the eroded area.

Additional supplemental evaluations may be performed to identify which additional response activities may be appropriate for consideration. If monitoring or other information shows a pattern of cap degradation in multiple areas, then additional response activities may be considered, including cap enhancement (e.g., application of a thicker armor stone layer or use of larger armor stone) or cap and underlying contaminated sediment removal.

SECTION 5

5.0 Continuing Access and Permit Requirements

5.1. Real Estate Requirements

The post-2009 response work has limited real estate, easement, and access requirements. Long-term monitoring activities will be undertaken through the use of public access points.

The potential need for engineered cap maintenance will require a dedicated location for equipment launch and support, sand/armor stone storage, and related land-based placement operations.

GW Partners, LLC (GW Partners) currently owns a significant parcel (00802910303) in the town of Menasha on Little Lake Butte des Mort's (LLBdM) western shore, south of the Highway 441 bridge (sometimes referred to as the former Huber property), which was utilized as the main staging area for the OU1 remedial action (RA). Any transfer in ownership of this parcel will retain a permanent easement in the former marine access area to the benefit of the U.S., the state of Wisconsin, WTM I Company, P.H. Glatfelter, GW Partners, and their respective successors and assigns.

5.2. Permit Requirements

RAs performed under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) must meet the substantive provisions of the applicable permitting regulations; however, federal, state, and local permits are not required (see 42 U.S.C. §9621(e)).

The 2002 ROD provides a list of applicable or relevant and appropriate requirements (ARAR). The ARARs were analyzed during the 2004 RA and were initially presented in Appendix F of the *Lower Fox River Operable Unit 1 - 2005 Remedial Action Work Plan* (CH2M HILL, 2005). The post-2009 RA Engineer is responsible for reviewing and updating the ARARs and obtaining approval from regulatory agencies of any identified ARARs.

SECTION 6

6.0 References

CH2M HILL, Inc., 2005. *Lower Fox River Operable Unit 1 - 2005 Remedial Action Work Plan.* August 2005.

Foth Infrastructure & Environment, LLC, 2008b. *Lower Fox River Operable Unit 1 - 2007 Cap Placement Test Summary*. March 2008.

Foth Infrastructure & Environment, LLC, 2008. *Lower Fox River Operable Unit 1 - Final OU1 Cap Design*. October 2008.

Foth Infrastructure & Environment, LLC, 2010. "Updated Consolidation Estimates for 2007 Armored Cap Placement Test Areas and 2008 OU1 Cap Areas," Memorandum to Bill Hartman, GW Partners, April 12, 2010. (Also posted as Appendix F in *Lower Fox River Operable Unit 1 - 2009 Remedial Action Summary Report.*) 2010.

Foth Infrastructure & Environment, LLC and JF Brennan Company, 2009. *Lower Fox River Operable Unit 1 - 2008 Remedial Action Summary Report*. September 2009.

Foth Infrastructure & Environment, LLC and JF Brennan Company, 2010. *Lower Fox River Operable Unit 1 - 2009 Remedial Action Summary Report*. April 2010.

Foth Infrastructure & Environment, LLC and CH2M HILL, Inc., 2011. *Lower Fox River Operable Unit 1 – Integrated Final Design and Remedial Action Work Plan for Post-2009 Response Work,* Appendix B, *Quality Assurance Protection Plan.* April 2011.

U.S. Army Corps of Engineers, 2004. Engineering and Design - Bathymetric Surveying Manual, Number EM 1110-2-1003. Revised April 2004.

U.S. Environmental Protection Agency, 2008. *Record of Decision Amendment, Operable Unit 1, Lower Fox River and Green Bay Superfund Site.* June 2008.

Walker, J.F. and Krug, W.R., 2003. *Flood-Frequency Characteristics of Wisconsin Streams.*

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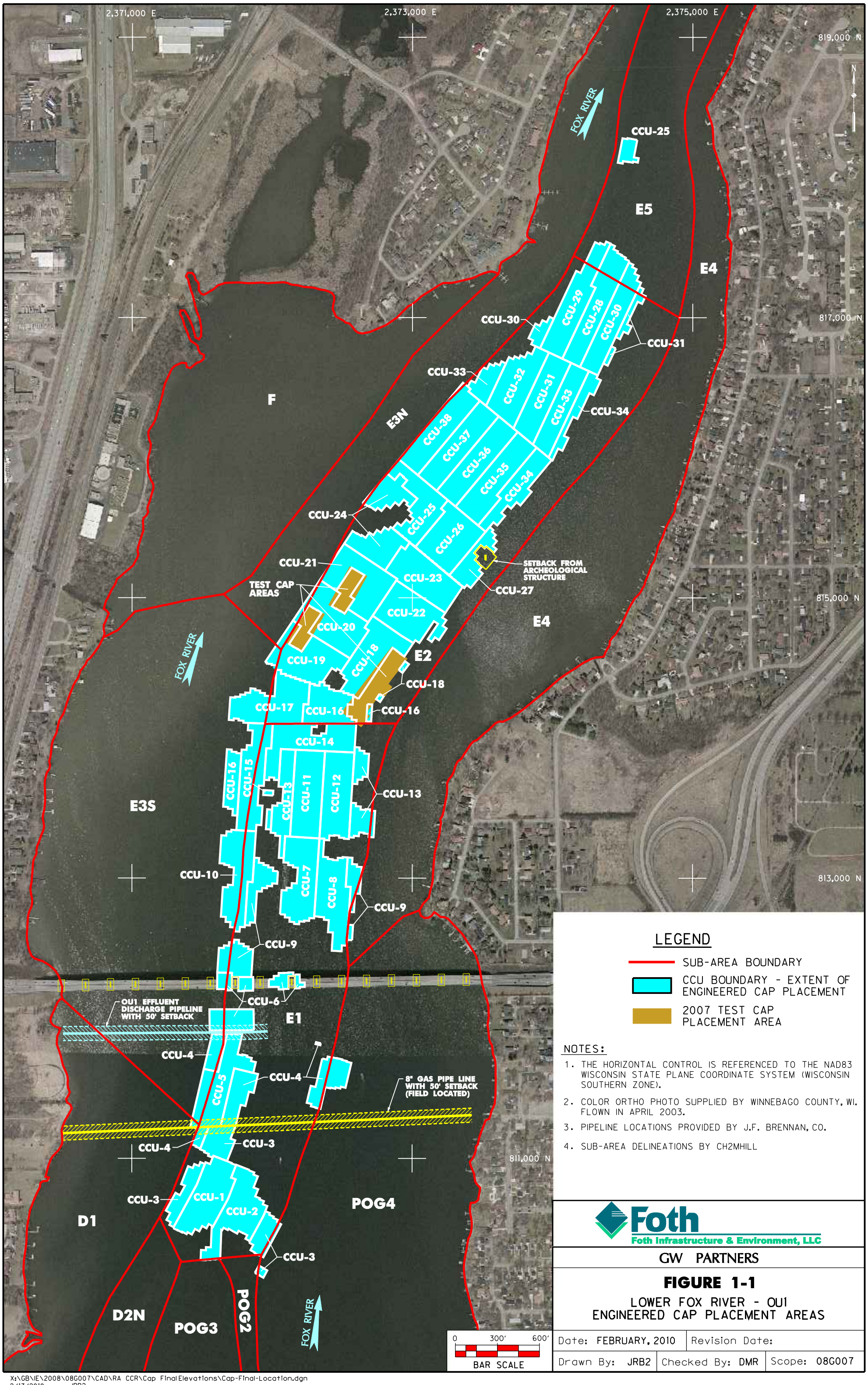
Figures



LEGEND

- SUB-AREA BOUNDARY
- CCU BOUNDARY - EXTENT OF ENGINEERED CAP PLACEMENT
- 2007 TEST CAP PLACEMENT AREA

NOTES:

1. THE HORIZONTAL CONTROL IS REFERENCED TO THE NAD83 WISCONSIN STATE PLANE COORDINATE SYSTEM (WISCONSIN SOUTHERN ZONE).
2. COLOR ORTHO PHOTO SUPPLIED BY WINNEBAGO COUNTY, WI. FLOWN IN APRIL 2003.
3. PIPELINE LOCATIONS PROVIDED BY J.F. BRENNAN, CO.
4. SUB-AREA DELINEATIONS BY CH2MHILL

Foth
Foth Infrastructure & Environment, LLC

GW PARTNERS

FIGURE 1-1

LOWER FOX RIVER - OU1
ENGINEERED CAP PLACEMENT AREAS

Date: FEBRUARY, 2010	Revision Date:	
Drawn By: JRB2	Checked By: DMR	Scope: 08G007

X:\GB\IE\2008\08G007\CAD\RA CCR\Cap FinalElevations\Cap-Final-Location.dgn
2/17/2010 JRB2

Appendix A
Bathymetric Survey Requirements

Table 1

Bathymetric Survey Requirements

Survey Classification	Special Order
Survey Equipment	♦ Real-Time Kinematic Global Positioning System (RTK-GPS). ♦ Single beam 200 kHZ or 455kHz multi-beam transducer (unless otherwise approved by GW Partners). ♦ For multi-beam, motion control unit to compensate for heave, pitch and roll. Heave 5cm or 5%, Roll & pitch 0.2 degrees. ♦ Laptop computer with sounding and navigation software. ♦ Survey boat with maximum 24-inch draft.
Survey Coverage	♦ Full coverage, entire length and width of each cap area. ♦ 25-ft. line spacing, perpendicular to flow for single beam. For multi-beam, minimum overlap at least 95% of cap areas ♦ Cross lines at frequency of 5% of survey lines for single beam. Minimum two cross lines per day of survey generating a minimum of 100 cross check points per each 10 acres surveyed for single beam.
Equivalent Target Map Scale	1 in. = 50 ft. (Note: The mapping may also be used at various smaller scales for different purposes on the project, but the accuracy of the bathymetric survey shall be based on the map scale no smaller than 1 in. = 50 ft.)
Resultant Horizontal Accuracy	+/- 10% of water column depth.
Resultant Elevation/Depth Accuracy	0.25 ft.
Map Contour Interval	0.5 ft.
Coordinate System	Wisconsin State Plane South NAD 83
Vertical Datum	NAVD 88
Unit of Measure	U.S. survey ft.
Output Electronic Format	Compatible with ArcGIS and Microstation
Output Hard Copy Format	ANSI D-size sheets (22 x 34 in.; to allow half-scale plotting directly to 11 x 17 in. when needed).

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Checked by: DMR