Memorandum

Foth Infrastructure & Environment, LLC

2121 Innovation Court, Suite 300
P.O. Box 5126 • De Pere, WI 54115-5126 (920) 497-2500 • Fax: (920) 497-8516 www.foth.com

October 15, 2019

TO:	Pablo Valentin, EPA	George Berken, Boldt
	Beth Olson, WDNR	Rick Fox, OBG
	Gary Kincaid, WDNR	Larry DeBruin, Boldt
CC:	Bill Hartman, P.H. Glatfelter	Michael Davis, Georgia Pacific
	Paul Montney, Georgia Pacific	Roger Kaminski, Georgia Pacific
	Bryan Heath, NCR	Jay Grosskopf, Boldt
	Rebecca Frey, EPA	Phil Brochocki, OBG
	Bill Nelson, WDNR	Jennifer Hagen, OBG
	Jim Killian, WDNR	Ava Grosskopf, Boldt
	Jordan Salley, WDNR	John Kern, Kern Statistical Services
	Denis Roznowski, Foth	Scott Janssen, Foth
	Sharon Kozicki, Foth	Steve Lehrke, Foth
FR:	Tim Wagner, Foth	Tara Van Hoof, Foth

RE: Lower Fox River OU3 – Sentinel Cap Areas Selection

Introduction

P.H. Glatfelter Company (Glatfelter) retained Foth Infrastructure & Environment, LLC (Foth) to evaluate and select sentinel cap areas within the Lower Fox River (LFR) Operable Unit 3 (OU3), as required by the revised *Cap Operations, Maintenance, and Monitoring Plan – Revision 1 (COMMP*) for the LFR OUs 2-5 (Anchor QEA and Tetra Tech EC [TtEC], 2012).

Specifically, the *COMMP* requires the following:

> "In addition to the scheduled monitoring of all capped areas in OU3-5, supplemental bathymetric surveys will be performed only in "sentinel" capping areas following major river-flow events, periods of extended low water, or construction activities that may have a significant impact on river hydrodynamics. Sentinel capping areas are defined herein as those areas most likely to exhibit erosion under extreme flow events or areas with the greatest risk of contaminant exposure. They are located in areas with relatively high peak bottom shear stresses from river flows, seiches, wakes, and/or propeller wash, and also in areas with relatively high near-surface polychlorinated

biphenyls (PCB) concentrations. Such sentinel cap monitoring locations will be located in areas potentially subjected to the upper 10% of predicted peak bottom shear stresses within capping areas (based on project-specific hydrodynamic modeling), and will be generally distributed across OUs 3 to 5, including areas of relatively high near-surface PCB concentrations (e.g., greater than 20 ppm) and high recreational vessel use (e.g., near boat launches)."

This evaluation looked at hydrodynamic modeling predictions, location, near-surface PCB concentrations, cap type, and bathymetry to establish sentinel cap areas for monitoring. Evaluation of cap stability, including the hydrodynamic modeling results, were presented in a 2018 technical memorandum by TtEC (TtEC, 2018). Candidate sentinel caps represent areas of higher shear stress, and other factors as described below.

Evaluation

Sentinel cap areas were selected to focus on areas of higher shear stress, high near- surface PCB concentrations as well as a range of geomorphological conditions and water depths to provide a good representation of the cap areas within OU3. Table 1 (end of memo) lists all caps in OU3, the sheer stress values present as determined by Tetra Tech, and PCB concentrations at sediment cores collected within the cap footprint. All cap locations are shown on Figure 1. Sentinel cap candidates were then chosen to represent areas that vary across depth, location within the river width, predicted flow velocities, near-surface PCB concentrations, and cap grain size, in order to capture responses to varied storm events and potential man-made impacts such as boat traffic. While the caps have been designed to be stable under a 100-year flood event, other forces may pose hazards in lesser events (e.g., propwash), and the varied sentinel cap locations and cap types will help monitor for those impacts.

Table 2 lists the six areas that have been chosen as sentinel cap areas. These areas are also shown on Figure 2.

Table 2

Maximum Predicted Bed Shear Stress for Selected Sentinel Cap Areas

Cap Area	Water Depth Range (ft)	Maximum Predicted Bed Shear Stress (dyn/cm^2)	Maximum Near-Surface PCB Concentration (ppm)
CA3	7.3	7.3	2.3
CA9A	14.6-15.6	15.9	9
CA69	2.9-11.4	11.4	7.1
CB3A	18.8-19.8	21.7	2.88
CA15	9.4-24.9	25	16.2
CB31	13.7-22.7	22.8	53.2

dyn/cm^2 = dyne per square centimeter
ft = feet
ppm = parts per million

Prepared by: TSW1
Checked by: TMK1

CA3

The farthest upstream cap area in OU3, CA3 is located in relatively shallower water than the downstream cap areas. Its location makes it susceptible to rapidly varying flows as well as influences from possible debris and recreational boating. In addition, this cap area could provide a good baseline for cap behavior during low flow events.

CA9A

Cap area CA9A lies at the beginning of a stretch of river where the river width narrows as it approaches the De Pere dam. Located adjacent to CB2 and CA9B, CA9A provides a representative area for monitoring the effectiveness and stability of the caps within that small reach. Located on the west side of the main channel, there is potential for impacts from recreational boating activities.

CA69

CA69 was chosen for its location off the main channel area, in a small cove. It is not anticipated that flow events would have significant impacts on this cap; however, water depths within this area are shallow and increase the potential for impacts from recreational boating activities. Several homes along the shoreline in the vicinity have docks and, therefore, increased boat traffic is anticipated in the cove.

CB3A

CB3A lies at the beginning of high velocity/ higher bed shear stress areas, as the influence from the De Pere dam operations begin to be felt in the river channel. Predicted bed shear stress is approximately 22 dyn/cm^2, which is representative of the neighboring cap areas and indicates that CB3A would be a suitable sentinel cap for that stretch of river.

CA15

CA15 has been identified as having the second highest predicted bed shear stress in OU3 (25 dyn/cm^{2,}), has relatively high near-surface PCB concentrations (maximum of 16.20 ppm), and is located along the edge of the navigation channel where more turbulence would be expected. It is located on the outside of the last bend in the river before it reaches the De Pere dam and will be subjected to turbulent flows and erosional forces under varying river conditions.

CB31

CB31 is the farthest cap area downstream in OU3. It's located just upstream from the De Pere dam. Flow velocities at the bed in CB31 are dependent upon dam operations. When water is released through the bascule gates, flow is focused at top elevation of the gate sills, which results in higher flow velocities across the bed and increasing bed shear stress. It is anticipated that during high events, the flow through the bascule gates would be increased. CB31 also has the highest near-surface PCB concentration of the OU3 caps (53.20 ppm).

Recommendations

Based on the evaluation presented herein, Foth recommends that the above six selected sentinel cap locations (CA3, CA9A, CA69, CB3A, CA15, and CB31) be monitored as part of the event-based monitoring in OU3 as required by the *COMMP*. Foth is requesting approval from the A/OT for this recommendation.

References

Anchor QEA, LLC and Tetra Tech EC, Inc., 2012. *Cap Operations, Maintenance, and Monitoring Plan –Revision 1* (Appendix H in the *Lower Fox River Remedial Design 100 Percent Design Report for 2010 and Beyond Remedial Actions,* Volume 2 of 2). Prepared for Lower Fox River Remediation LLC. October 2012.

Tetra Tech, Inc. 2018. "Hydrodynamic Modeling of Post-Remedy Conditions in OU3 to Evaluate Cap Stability" technical memorandum. Fairfax, VA.

Tables

Table 1

Total PCB Concentrations and Predicted Bed Shear Stress for OU3 Cap Areas

OU3 Cap Areas	Maximum Predicted Bed Shear Stress [dyn/cm^2]	Location ID	Logged Interval Top	Logged Interval Bottom	Total PCB
CA13A	19.8	3048-21	0.00	0.50	3.30 ppm
			0.50	1.00	1.40 ppm
			1.00	1.50	0.41 ppm
			1.50	2.00	0.07 ppm
			2.00	2.50	0.07 ppm
		3049-01.5	0.00	0.50	0.97 ppm
			0.50	1.00	0.73 ppm
			1.00	1.50	0.44 ppm
		3049-21	0.00	0.50	10.00 ppm
			0.50	1.00	1.10 ppm
			1.00	1.50	1.30 ppm
			1.50	2.00	0.51 ppm
			2.00	2.50	0.29 ppm
		3050-02	0.00	0.50	7.50 ppm
			0.50	1.00	0.76 ppm
CA13B	18.7	3050.5-90	0.00	0.50	2.02 ppm
			0.50	1.00	1.60 ppm
			1.00	1.50	0.02 ppm
		3051.5-05	0.00	0.50	6.28 ppm
			0.50	1.00	4.40 ppm
			1.00	1.50	0.95 ppm
		3051-02	0.00	0.50	5.90 ppm
			0.50	1.00	0.90 ppm
			1.00	1.50	1.10 ppm
			1.50	2.00	0.35 ppm
			2.00	2.50	0.06 ppm
			2.50	3.00	0.03 ppm
		3051-02.5	0.00	0.50	3.48 ppm
			0.50	1.00	2.23 ppm
			1.00	1.50	1.83 ppm
			1.50	2.00	0.11 ppm
			2.00	2.50	0.03 ppm
			2.50	3.00	0.02 ppm
		3052.5-91	0.00	0.50	1.70 ppm
			0.50	1.00	1.70 ppm
			1.00	1.50	0.31 ppm
			1.50	2.00	0.07 ppm
		3052-02	0.00	0.50	3.30 ppm
			0.50	1.00	1.02 ppm
			1.00	1.50	0.24 ppm
			1.50	2.00	0.03 ppm
			2.00	2.50	0.03 ppm
		3053-93	0.00	0.50	3.24 ppm
			0.50	1.00	8.98 ppm
			1.00	1.50	0.95 ppm
		3053-95	0.00	0.50	1.14 ppm
			0.50	1.00	0.91 ppm
			1.00	1.50	0.67 ppm
			1.50	2.00	0.19 ppm
		3054.5-90	0.00	0.50	6.31 ppm
			0.50	1.00	6.59 ppm
			1.00	1.50	0.93 ppm
		3054-01	0.00	0.50	1.90 ppm
			0.50	1.00	1.30 ppm
			1.00	1.50	0.73 ppm
			1.50	2.00	0.15 ppm
			2.00	2.50	0.03 ppm
			2.50	3.00	0.03 ppm
			3.00	3.50	0.13 ppm

Table 1
Total PCB Concentrations and Predicted Bed Shear Stress for OU3 Cap Areas

OU3 Cap Areas	Maximum Predicted Bed Shear Stress [dyn/cm^2]	Location ID	Logged Interval Top	Logged Interval Bottom	Total PCB
CA13C (A3)	15.3	3048.5-01	--	--	--
CA13D (A3)	22.5	3056-22	0.00	0.50	3.70 ppm
			0.50	1.00	2.60 ppm
			1.00	1.50	0.86 ppm
			1.50	2.00	0.31 ppm
			2.00	2.50	0.03 ppm
CA13E (A3)	17.1	3056.5-04	0.00	0.50	1.35 ppm
			0.50	1.00	1.16 ppm
			1.00	1.50	0.43 ppm
			1.50	2.00	0.09 ppm
		3056.5-91	0.00	0.50	1.62 ppm
			0.50	1.00	1.00 ppm
		3056-90	0.00	0.50	1.28 ppm
			0.50	1.00	1.28 ppm
			1.00	1.50	0.18 ppm
			1.50	2.00	0.22 ppm
		3056-91	0.00	0.50	1.23 ppm
			0.50	1.00	1.07 ppm
			1.00	1.50	0.34 ppm
CA15 (A2)	25.0	3057.5-90	0.00	0.50	5.44 ppm
			0.50	1.00	1.54 ppm
			0.00	0.50	0.64 ppm
			0.50	1.00	0.25 ppm
		3058-92	0.00	0.50	14.90 ppm
			0.50	1.00	3.88 ppm
			1.00	1.50	0.17 ppm
		3058-94	0.00	0.50	2.36 ppm
			0.50	1.00	16.20 ppm
			1.00	1.50	0.51 ppm
CA16A (A3)	21.2	3059.5-90	0.00	0.50	4.70 ppm
			0.50	1.00	22.90 ppm
			1.00	1.50	11.20 ppm
		3059-93	0.00	0.50	4.04 ppm
			0.50	1.00	5.45 ppm
			1.00	1.50	0.60 ppm
		3060-01	0.00	0.50	2.80 ppm
			0.50	1.00	1.10 ppm
			1.00	1.50	0.24 ppm
			1.50	2.00	0.07 ppm
			2.00	2.50	0.09 ppm
		3060-97	0.00	0.50	1.93 ppm
			0.50	1.00	2.01 ppm
			1.00	1.50	2.09 ppm
			1.50	2.00	0.06 ppm
CA16B (A3)	24.9	3060.5-04	0.00	0.50	0.24 ppm
			0.50	1.00	0.24 ppm
			1.00	1.50	0.24 ppm
			1.50	2.00	0.17 ppm
			2.00	2.50	0.02 ppm
		3060-96	0.00	0.50	9.08 ppm
			0.50	1.00	1.06 ppm
CA17 (A3)	25.4	3063.5-102	0.00	0.50	1.07 ppm
			0.50	1.00	8.84 ppm
		3064-95	0.00	0.50	2.16 ppm
			0.50	1.00	3.81 ppm
CA3	7.3	3007-05	0.00	0.50	0.62 ppm
			0.50	1.00	2.30 ppm
			1.00	1.50	0.83 ppm

Table 1

Total PCB Concentrations and Predicted Bed Shear Stress for OU3 Cap Areas

OU3 Cap Areas	Maximum Predicted Bed Shear Stress [dyn/cm^2]	Location ID	Logged Interval Top	Logged Interval Bottom	Total PCB
CA6 (A3)	14.7	3035-06	0.00	0.50	5.50 ppm
			0.50	1.00	3.10 ppm
			1.00	1.50	1.40 ppm
			1.50	2.00	0.60 ppm
			2.00	2.50	0.86 ppm
			2.50	3.00	0.31 ppm
			3.00	3.50	0.03 ppm
CA69 (A1)	11.4	3051.5-10	0.00	0.50	3.46 ppm
			0.50	1.00	5.54 ppm
		3051-05	0.00	0.50	0.18 ppm
			0.50	1.00	0.33 ppm
			1.00	1.50	0.03 ppm
		3052-04.5	0.00	0.50	7.10 ppm
			0.50	1.00	2.18 ppm
CA9A	15.9	3043-21	0.00	0.50	9.00 ppm
			0.50	1.00	1.40 ppm
			1.00	1.50	0.03 ppm
			1.50	2.00	0.03 ppm
			2.00	2.50	0.03 ppm
		3043-21.5	0.00	0.50	7.08 ppm
			0.50	1.00	0.76 ppm
			1.00	1.50	0.30 ppm
		3044-21	0.00	0.50	3.70 ppm
			0.50	1.00	2.10 ppm
			1.00	1.50	0.03 ppm
			1.50	2.00	0.03 ppm
			2.00	2.50	0.03 ppm
CA9B (A3)	15.4	3043.5-05	0.00	0.50	12.20 ppm
			0.50	1.00	0.79 ppm
			1.00	1.50	0.22 ppm
		3044.5-90	0.00	0.50	0.78 ppm
			0.50	1.00	0.87 ppm
		3044-02	0.00	0.50	6.80 ppm
			0.50	1.00	1.10 ppm
			1.00	1.50	0.40 ppm
			1.50	2.00	0.19 ppm
		3045-02	0.00	0.50	7.00 ppm
			0.50	1.00	4.30 ppm
			1.00	1.50	1.30 ppm
			1.50	2.00	0.03 ppm
CB2 (B3)	16.0	3042-21	0.00	0.50	13.00 ppm
			0.50	1.00	0.53 ppm
			1.00	1.50	2.40 ppm
			1.50	2.00	1.60 ppm
			2.00	2.50	0.03 ppm
		3042-90	0.00	0.50	1.15 ppm
			0.50	1.00	2.51 ppm

Table 1

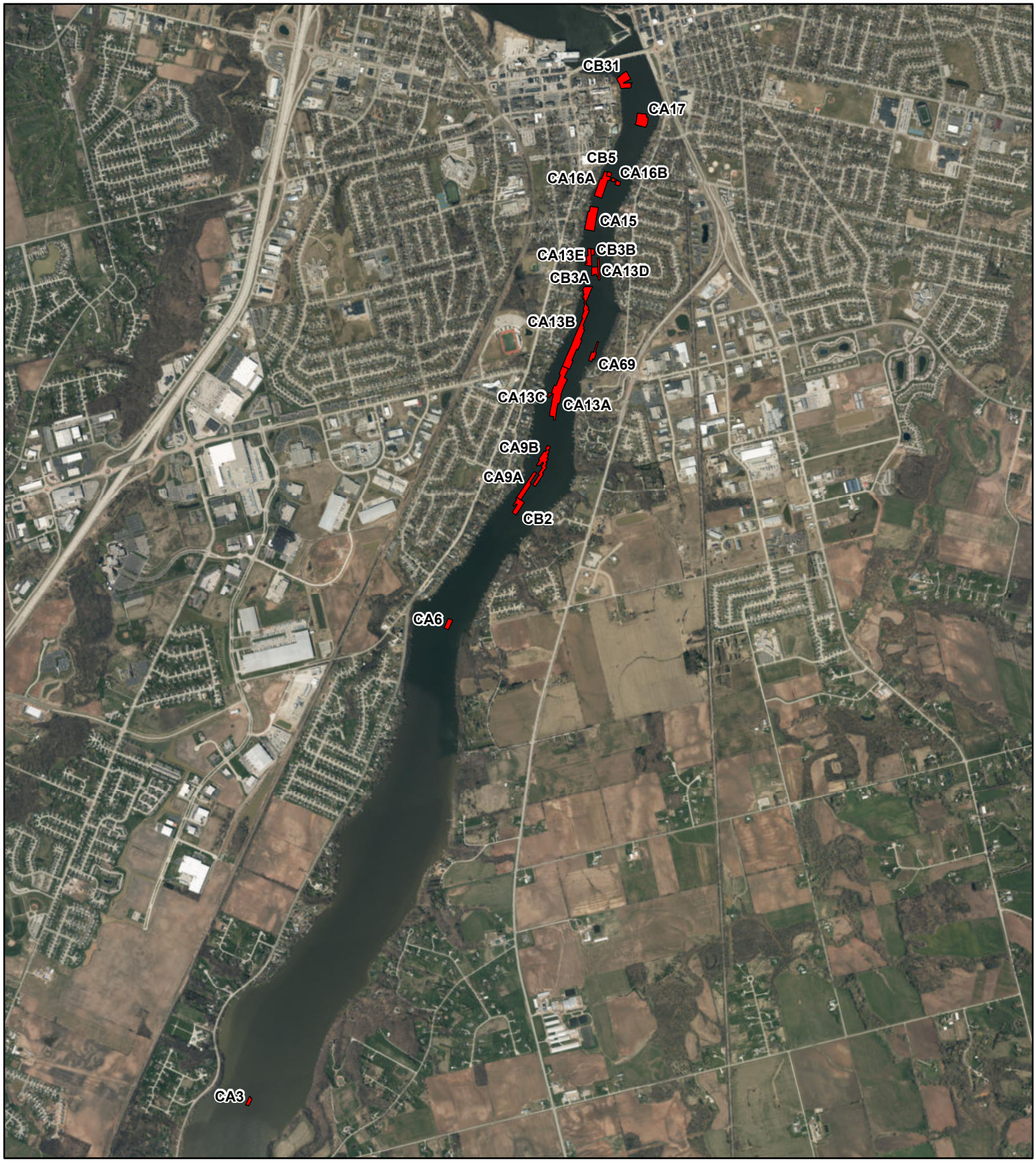
Total PCB Concentrations and Predicted Bed Shear Stress for OU3 Cap Areas

OU3 Cap Areas	Maximum Predicted Bed Shear Stress [dyn/cm^2]	Location ID	Logged Interval Top	Logged Interval Bottom	Total PCB
CB31	22.8	3066.5-02	0.00	0.50	14.50 ppm
			0.50	1.00	53.20 ppm
			1.00	1.50	15.40 ppm
			1.50	2.00	10.10 ppm
			2.00	2.50	0.14 ppm
		3067-01	0.00	0.50	3.30 ppm
			0.50	1.00	36.00 ppm
			1.00	1.50	25.00 ppm
			1.50	2.00	1.20 ppm
			2.00	2.50	0.30 ppm
			2.50	3.20	0.08 ppm
		3067-01.5	--	--	--
		3067-02	0.00	0.50	28.00 ppm
			0.50	1.00	42.00 ppm
			1.00	1.50	21.01 ppm
			1.50	2.00	0.03 ppm
			2.00	2.50	0.03 ppm
			2.50	3.00	0.03 ppm
			3.00	3.40	0.03 ppm
CB3A	21.7	No cores collected within cap footprint - closest core 3055-90	0.00	0.50	2.88 ppm
			0.50	1.00	0.95 ppm
			1.00	1.50	0.22 ppm
CB3B	20.5	No cores collected within cap footprint - closest core 3056.5-05	0.00	0.50	1.92 ppm
			0.50	1.00	1.06 ppm
			1.00	1.50	0.55 ppm
		No cores collected within cap footprint - closest core 3056.5-91	0.00	0.50	1.62 ppm
			0.50	1.00	1.00 ppm
CB5 (B3)	21.2	3060.5-91	0.00	0.50	1.33 ppm
			0.50	1.00	2.98 ppm
			1.00	1.50	1.01 ppm

Proposed sentinel caps dyn/cm^2 = dyne per square centimeter

Prepared by: TRN
Checked by: TMK1

Figures



LEGEND

OU3 Cap Areas

NOTES:

1. Imagery from esri and its data suppliers.

This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

Foth

N

0 1,500 3,000

Feet

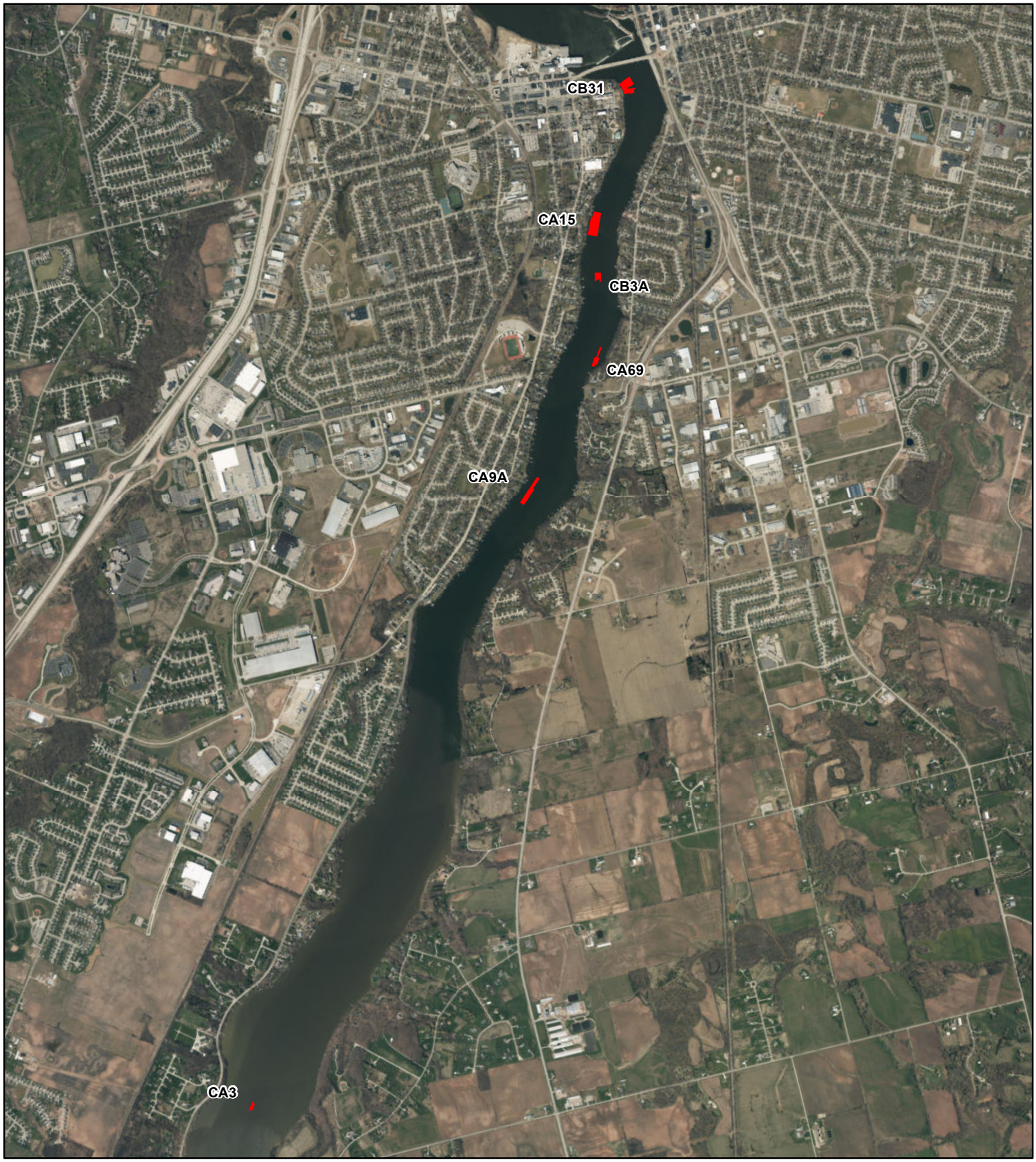
P.H. GLATFELTER COMPANY

FIGURE 1

OU 3 CAP AREAS
FOX RIVER, WISCONSIN

Date: SEPTEMBER 2019	Revision Date:	
Drawn By: JRS6	Checked By: TSW	Project: 19G007

Path: Q:\Glatfelter\19G007\GIS\mxd\Figure 1 - All cap areas.mxd Date: 9/5/2019



LEGEND

Proposed Sentinel Cap Locations

NOTES:

1. Imagery from esri and its data suppliers.

This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

Foth

N

0 1,500 3,000

Feet

P.H. GLATFELTER COMPANY

FIGURE 2

OU 3 PROPOSED SENTINEL CAP AREAS
FOX RIVER, WISCONSIN

Date: SEPTEMBER 2019	Revision Date:	
Drawn By: JRS6	Checked By: TSW	Project: 19G007

Path: Q:\Glatfelter\19G007\GIS\mxd\Figure 2 - Sentinel.mxd Date: 9/5/2019