Monitoring to Address 7 of 11 BUI's – Milwaukee River Estuary AOC
Task 3: Sediment Contamination Sampling
Final Project Report

Final Report for the Great Lakes Restoration Initiative Grant #GL-00E00607-0

Funded by the Great Lakes Restoration Initiative and the United States Environmental Protection Agency

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Introduction

The Ozaukee County (County) Planning and Parks Department (Department) Fish Passage Program (Program), a component of the Department's Ecological Division, and its project partners began monitoring activities during 2011 (Project) to address seven of the Milwaukee Estuary Area of Concern (AOC) Beneficial Use Impairments (BUI's) and move toward proposed BUI removal targets. These activities were federally funded through the Great Lakes Restoration Initiative (GLRI) and administered by the United States Environmental Protection Agency (USEPA) under grant #GL-00E00607-0, entitled "Monitoring to Address 7 of 11 BUI's – Milwaukee River Estuary AOC." The Project included water quality monitoring, sediment contamination sampling, and fish community surveys with analyses in portions of the AOC within Ozaukee County and other relevant reaches of the Milwaukee River Watershed in Ozaukee County. Significant benefits for portions of the AOC far beyond Ozaukee County are anticipated. **This final report documents the progress and results for Task 3, Sediment Contamination Sampling, under the aforementioned grant.**

Task 3 of the Project directly pertains to three BUIs for the Milwaukee Estuary AOC:

- Restrictions on Fish and Wildlife Consumption
- Degradation of Benthos
- Restrictions on Dredging Activities

Information pertinent to specific BUI delisting targets and actions was garnered through analysis of historic orthophotographs, sediment poling, and extensive sediment sampling and laboratory analysis in six specific reaches of the Milwaukee River to "implement sediment monitoring…to locate historic sites of PCB…contamination impacting the AOC," identify "contaminated sediment hot spots within and upstream of the AOC," and potentially identify "known contaminant sources contributing to sediment contamination and degraded benthos" (SEH and ECT 2008).

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Project Implementation Personnel

Personnel involved in Project implementation are listed in Table 1.

Table 1: Project Implementation Personnel

Individual	Role in Project	Organizational Affiliation
Rajen Patel	Project Officer	U.S. Environmental Protection Agency
Louis Blume	QA Manager	U.S. Environmental Protection Agency
Andrew Struck	Project Coordinator (Department Director)	Ozaukee County Planning and Parks Department
Thomas Dueppen	Planning & Parks Specialist	Ozaukee County Planning and Parks Department
Matt Aho	Program Manager and QA/QC Manager/Officer	Ozaukee County Planning and Parks Department
Luke Roffler	Program Assistant	Ozaukee County Planning and Parks Department
Ryan McCone	Program Assistant	Ozaukee County Planning and Parks Department
Beth Stuhr	Program Assistant	Ozaukee County Planning and Parks Department
Kristina Kroening	Program Assistant	Ozaukee County Planning and Parks Department
Cynthia DeGroot	Office Assistant	Ozaukee County Planning and Parks Department
Multiple	Fish Passage Program and Planning and Parks Intern(s)	Ozaukee County Planning and Parks Department
Primary Consultant	Project Management	AECOM
Sub Consultant	Sediment Sampling	Himalayan Consultants, LLC
Certified Laboratory	Sample Analysis	Pace Analytical, Northern Lake Service

Project Timeline

On 1/20/10, the Ozaukee County Environment and Land Use Committee authorized the Ozaukee County Planning and Parks Department (Department) to submit a grant application to USEPA for water quality monitoring, sediment contamination sampling, and fish community surveys in Milwaukee River Watershed in Ozaukee County. On 8/30/10, the Department, with the support of several Program partners, submitted a grant application to the United States Environmental Protection Agency (USEPA) Region V Offices entitled "Monitoring to Address 7 of 11 BUI's – Milwaukee Estuary AOC" under the 2010 Great Lakes Restoration Initiative (GLRI) Request For Proposals (RFP). On 9/30/10, USEPA announced that Ozaukee County was awarded $491,000 in GLRI funding for its "Monitoring to Address 7 of 11 BUI's – Milwaukee Estuary AOC" project (Project). The Ozaukee County Board of Supervisors formally accepted this award at its 10/6/10 meeting and the contract was executed by the Ozaukee County Administrator on 10/10/10.

2012 No Cost Time Extension

The original project end date listed in the initial award document was 12/31/12. After discussions with USEPA staff, Ozaukee County submitted a formal no-cost one year time extension request to USEPA

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staff on 9/14/12. The request extended the project period from 1/1/13 through 12/31/13, outlined remaining work to be completed and addressed scheduling deficiencies caused by:

- Equipment and consultant procurement delays as a result of the QAPP approval process.
- 2012 drought conditions and abnormally low water levels throughout the entire year, which likely resulted in non-baseline fisheries and continuous water quality data, did not produce necessary "high flow" conditions and rain events to complete discrete water sampling activities, and delayed access to sediment sampling sites and activities.

The no-cost time extension was formally approved by USEPA on 10/25/12.

2013 No Cost Time Extension

After additional discussions with USEPA staff, Ozaukee County submitted a formal no-cost one year time extension request to USEPA staff on 11/13/13. The request extended the project period from 1/1/14 through 12/31/14, outlined remaining work to be completed and addressed scheduling deficiencies caused by:

- 2013 abnormal high spring precipitation and summer drought conditions not producing field conditions safe or adequate to preform Task 2 discrete water sampling activities per the standard operating procedures outlined in the QAPP.

The no-cost time extension was formally approved by USEPA on 11/14/13. Both time extensions and approval letters and included as Appendix J.

Problem Definition/Background:

Milwaukee Estuary Area of Concern (AOC) Beneficial Use Impairments (BUI's)

The Milwaukee Estuary was designated an Area of Concern (AOC) during the 1980s due to historical modifications and pollutant loads. The Milwaukee Estuary Remedial Action Plan and Delisting Targets Report have been subsequently released and updated. They document 11 beneficial use impairments (BUIs) effecting the AOC as well as proposed removal targets and actions for each BUI. The original boundaries of the AOC included the lower 5 km of the Milwaukee River downstream of 35th Street; the lower 4 km of the Kinnickinnic River downstream of Chase Avenue; the inner and outer harbors; and the nearshore waters of Lake Michigan, bounded by a line extending north from Sheridan Park to the city of Milwaukee's Linnwood water intake (WDNR 2014). In 2008, the boundaries were expanded to address sites that contributed significant loads of contaminated sediments to the estuary, including Cedar Creek downstream of Bridge Road to the confluence with the Milwaukee River, in Ozaukee County (WDNR 2014). Figure 1 shows the original and expanded boundaries of the Milwaukee Estuary Area of Concern.

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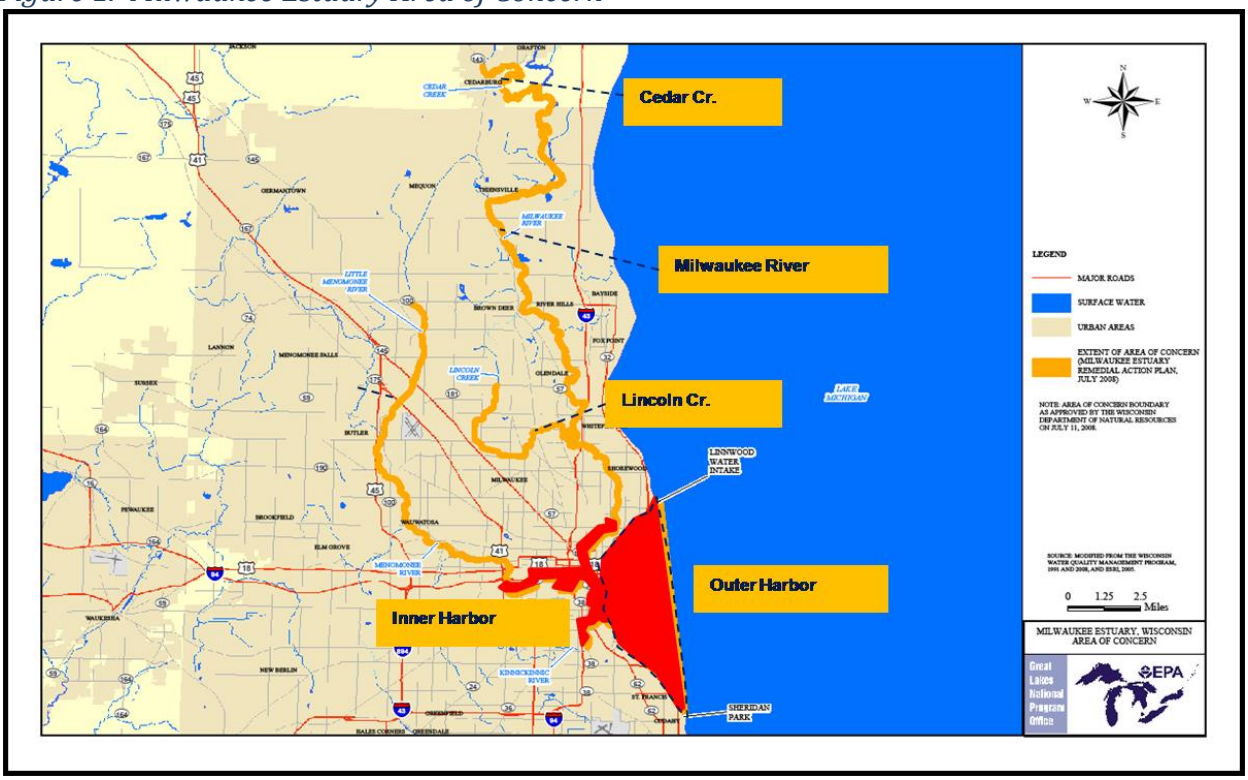
Figure 1. Milwaukee Estuary Area of Concern



Most Milwaukee Estuary AOC BUI's are closely tied to sediment contamination from compounds including polychlorinated biphenyl (PCB), polycyclic aromatic hydrocarbon (PAH), and various heavy metals (SEH and ECT 2008; WDNR 2011). While sediment contamination is known as a problem of great significance within the AOC, the extent of the contamination at specific locations is largely unknown (WDNR 1994). Without initial characterization of the location and extent of those deposits that continue to operate as a source of contaminants to the AOC, successful and cost-effective remediation of the AOC in the future may not be possible (WDNR 1994).

Initial PCB sampling and analysis was performed at various sites throughout the AOC from October 1993 through December 1995 (Westenbroek 1997). However, the large majority of the sampling during this study occurred outside the area proposed for this Project. Also, in 1996, the Hamilton Dam in Cedarburg collapsed and was removed. Given that Cedar Creek and the Hamilton Pond were identified by Westenbroek (1997) as a source of PCBs to the Milwaukee River, assessing sediment contamination at locations downstream of the Cedar Creek terminus in Ozaukee County fills a critical knowledge gap regarding the current characterization of contaminated sediments within the Milwaukee Estuary AOC.

Project Objectives

The Project, through a measured and science-based approach, began locating and evaluating sediment contamination in Ozaukee County portions of the Milwaukee River Watershed. The Project provided initial characterization of the current location and extent of sediment contamination within certain portions of the AOC in Ozaukee County. Specifically, the Project aimed to address the following objectives:

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- Delineating approximate areas of sediment accretion in specific sampling reaches through historic orthophotography analysis.
- Determining the thickness and general composition (e.g., sand, silt, etc.) of targeted sediment accretions through poling surveys.
- Determining general locations and extent of contaminated sediment deposits through core sampling and laboratory analysis.

Monitoring Design

The Project was constituted of a monitoring design, not an experimental design, for providing initial characterization of the location and extent of contaminated sediment deposits in Ozaukee County portions of the mainstem Milwaukee River. As such, the measurement and data quality objectives were largely based on the precision and accuracy limits specified in the Standard Operating Procedures (SOPs) of the Certified Laboratories chosen for this project (Appendix I). Generated data was shared with local WDNR AOC staff for consideration while developing BUI removal criteria. Applying robust statistical inferences to the entire Project Area or AOC is not a Project objective. Thus, the data quality objectives were that data collected in the field, generated in the field, or generated in a laboratory conforms to the items below to ensure it provided accurate representation of sediment quality at the time of sampling/measurement.

Results from discrete sediment quality samples were considered data of acceptable quality if the samples were:

- Collected in accordance with Consultant and Sub-Consultant SOPs
- Preserved (if required) in accordance with certified laboratory SOPs
- Documented in accordance with certified laboratory SOPs
- Analyzed in accordance with certified laboratory SOPs

Consultant Procurement

The Department issued a request for proposals for water quality and sediment sampling and analysis - professional services support on 6/3/11. Seven proposals were received, and the Ozaukee County Natural Resources Committee awarded AECOM the contract at their 7/7/11 meeting after a review of cost and qualifications. The Department and AECOM entered into a formal professional services agreement on 7/29/11. AECOM subsequently provided a requisite work plan and standard operating procedures for all subconsulants (Himalayan Consultants, LLC, Northern Lake Service, Inc., and Pace Analytical Services, Inc.) associated with Project activities.

Quality Assurance Project Plan Approvals

A Quality Assurance Project Plan (QAPP) was required for all project tasks per the USEPA contract award document. Department staff met with numerous Program partners and preformed significant research to determine specific data collection metrics and procedures to provide the most benefit to AOC BUI removal criteria. Staff initiated a conference call with the local WDNR AOC coordinator on 12/17/10. WDNR did not provide specific comments or recommendations on the fish survey component during workplan development. A draft QAPP was submitted to WDNR on 2/15/11. General WDNR comments were received on 3/9/11, and a meeting was held on 3/15/11. Elements of WDNR's recommendations were included in the final draft QAPP. The QAPP was divided into three individual QAPP's per WDNR's recommendation on 3/15/11 (Revision 1) and the final draft QAPP was submitted for USEPA approval on 4/1/11 (Revision 2) and approved by USEPA on 5/24/11. QAPP Revision 3 was submitted to USEPA on 10/14/11, which included minor modifications in the QA/QC manager role,

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scheduling, and references to the final consultant workplans and SOP's, and was approved by USEPA on 10/17/11. QAPP Revision 4 (Appendix F) was submitted to USEPA on 1/4/13, which included timeline modifications and other changes as part of the approved 2012 no-cost one year time extension request, and was approved by USEPA on 1/17/13. All workplan activities followed procedures as outlined in the QAPP's and no data-gathering activities occurred until the initial QAPP was approved.

Project Locations

Fine-grained or 'muddy' sediments with high organic carbon content may accumulate PCBs to considerably higher levels than those of the surround waters (WDNR 2001). Therefore, identification of the thickest, soft sediment deposits should correspond to potential PCB "hotspot" locations along the targeted river sections. Sampling river sections upstream of the Cedar Creek confluence also indicate how much impact the PCB release(s) from Cedar Creek has affected sediment quality of the Milwaukee River in this area. Sediment composition, thickness, and distribution also dictates the most effective sampling methods to achieve one of the Project objectives (PCB sediment contamination within the Milwaukee Estuary AOC) within the allotted budget for this task.

To provide a more general assessment of the degree/extent of sediment quality (e.g., PCB contamination) within the main stem Milwaukee River, several sections upstream and downstream of the confluence with Cedar Creek were chosen (Appendix A). Sediment quality monitoring activities along six sections of the Milwaukee River included:

1. Site 1 – River Barn Park: The reach extending from the Milwaukee-Ozaukee county line, approximately River Mile (RM) 17, to the base of the Mequon-Thiensville (M-T) Dam (RM 20)
2. Site 2 – MT Impoundment: The reach from MT Dam impoundment to a point approximately 1,200 yards downstream of CTY C bridge (extending approximately from RM 20 to RM 26)
3. Site 3 – Downstream of Cedar Creek: The reach extending from RM 26 to a point approximately 100 to 200 yards upstream of the confluence with Cedar Creek (RM 28)
4. Site 4 – Newburg Dam Impoundment: The Newburg Dam impoundment (approximately RM 57)
5. Site 5 – BSD Impoundment: The Bridge Street Dam impoundment (extending approximately from RM 32 to RM 33)
6. Site 6 – Upstream of BSD Impoundment: The reach extending from the Ozaukee Interurban Trail bike bridge to STH 33 (extending approximately from RM 33 to RM 37)

Methods

Orthophoto Review Process

Per procedures outlined in the Quality Assurance Project Plan (QAPP), a review of historical aerial photographs was conducted to assist locating potential areas of sediment accretion within the targeted river sections specified above. A series of orthophotographs from each stream section dated 1941, 1950, 1963, 1970, 1980, 1990, 2000, and 2010, were inspected and compared to previous / proceeding years. This coincides with the period dating from the estimated earliest date for release of PCBs (approximately 1950) to present. Multiple images were compared for conspicuous and common landmarks (e.g., large manmade structures, bridges, dams, etc.). An example series for reach "4" is included as Appendix B. Any changes in the position of the river channel were documented, including areas subject to sediment deposition / accretion, including slack water areas during flood events where deposits of PCB contaminated sediment may be present outside of the main-stem river channel. Standing bodies of water (e.g. lakes & ponds) outside the floodway were excluded from poling and sampling, since they have less potential for sediment to be scoured, re-suspended, and transported back into the main-stem river. Fifty-eight suspected areas of sediment accretion were identified. Project staff produced maps depicting the

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geographic extent of each suspected sediment deposition area and uploaded centroid coordinates to the GPS unit to assist staff in locating these potential sediment accretion areas in the field (Appendix C).

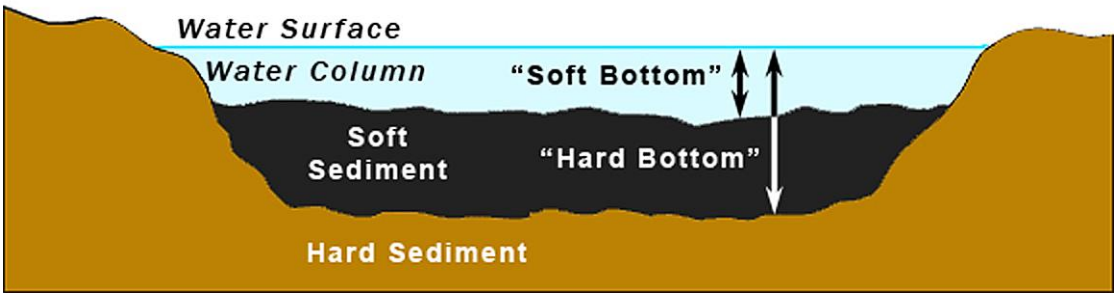
Preliminary Sediment Poling Activities

The primary objectives of the preliminary poling activities were to establish the logistics of the formal sediment poling surveys (e.g., mobilization/demobilization, river access points, data acquisition methods, equipment limitations, weather conditions, water levels, etc.) for each targeted river section, and confirm the presence / absence of sediment accretion in suspect areas. Staff conducted preliminary sediment poling activities for each potential sediment accretion area by initially visiting public access points for these six sections of the Milwaukee River. Land elevation benchmarks and water level staff gauges were established at the Newburg Dam, near County Highway C, and at the Mequon Thiensville Dam along the Milwaukee River. Periodic poling at each potential sediment accretion area was performed, including visual inspection of numerous other sediment deposition areas along the Milwaukee River. The thickness and general composition (e.g., sand, silt, etc.) of sediment in these areas was determined and the areas with the thickest, fine-grained sediments were scheduled for formal sediment poling activities.

Sediment Poling Surveys

Sediment poling surveys occurred in 2011, 2012 and 2013 (see Figure 3 below) in the sediment deposition areas that were identified in the orthophoto review process and confirmed during the preliminary sediment poling activities. The logistics of sediment poling surveys (mobilization/demobilization, river access points, data acquisition methods, equipment limitations, weather conditions, water levels, etc.) varied for each targeted river section. All sediment poling procedures followed protocols as indicated in the QAPP. The sediment poling surveys conformed to a gridded sampling pattern consisting of transects arranged perpendicular to the main channel flow direction. Poling locations typically originated at the shoreline and traversed perpendicular across the channel and toward the opposite shoreline. The spacing between each poling location along a given transect was approximately 10 feet. Transects of the grid upstream or downstream from the origin were 50 to 100 feet apart, depending on the overall size of the survey area. Each poling location included a GPS location and water depth measurements to soft bottom and total depth to hard bottom (see Figure 2).

Figure 2.



Sediment Poling Sampling Method Requirements

Project staff used the following procedure to estimate and record sediment thickness at each individual poling location following the methods established by WDNR (2001):

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1. Initialize GPS position tracking
    a. Ensure GPS unit is as close as possible to the actual point of poling
    b. Begin logging points when in position for poling (multiple points will cancel out any error associated with a single position point)
2. Determine water depth and record in GPS and/or field log book
    a. Insert tile probe vertically into the water column
    b. Note tile probe depth mark at the water surface when the probe contacts the sediment-water interface
    c. Note any observations regarding suspected sediment composition based on sound (no sound suggests silt)
3. Determine depth of refusal and record in GPS and/or field log book
    a. Insert tile probe past the sediment-water interface using "reasonable human force" until refusal
    b. Note tile probe depth mark at the water surface
4. Stop GPS position tracking after collection of at least 10 points and record all latitude/longitude coordinates in GPS and/or field log book prior to moving to the next poling location

The daily survey activities also included referencing the GPS locations of known bench marks and the water elevations from staff gauges located near the Newburg Dam, near County Highway C, and at the Mequon-Thiensville Dam. All GPS locations and sediment measurements were recorded in the field on a TOPCON GRS-1, which was later downloaded at the office as a point shapefile that could be imported the Department's GIS databases.

Summary of Sediment Poling Events

Staff collected 2,997 survey points along approximately 16.5 miles of the main-stem Milwaukee River between 8/1/11 and 11/14/13.

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Figure 3: Summary of Sediment Poling Activities

DATE	SITE I.D.	POLING POINTS	STAFF	FIELD NOTES
8/1/2011	SITE #4	46	TD, SK	Overcast, mid-80s, humid, 3 hours
8/4/2011	SITE #4	192	TD, SK	Partly cloudy, low-80s, 6 hours
8/5/2011	SITE #4	146	TD, SK	Partly sunny, 70's, 6 hours
8/11/2011	SITE #4	87	TD, SK	Sunny, 70's, 5 hours
8/18/2011	SITE #3	19	TD, SK	Sunny, low-80s, 2 hours
9/1/2011	SITE #2	99	TD, SK	Sunny, 80s, 8 hours
9/12/2011	SITE #1	52	TD, SK	Sunny, 80s, 7 hours
9/23/2011	SITE #1	35	TD, SK	Partly cloudy, 60s, 6 hours
10/10/2011	SITE #3	71	TD, SK	Clear, 70s, 6 hours
10/24/2011	SITE #3	65	TD, SK	Sunny, windy, mid-50s, 6 hours
3/22/2012	SITE #2	135	TD, SK	Sunny, low-50s, 6 hours
4/2/2012	SITE #2	164	TD, SK	Sunny, high-50s, 8 hours
4/6/2012	SITE #2	153	TD, SK	Sunny, 60s, 8 hours
4/9/2012	SITE #2	76	TD, SK	Partly sunny, mid-60s, 6 hours
4/23/2012	SITE #2	107	TD, SK	Sunny, windy, mid-60s, 7 hours
4/27/2012	SITE #2	31	TD, SK	Partly sunny, mid-60s, 5 hours
12/17/2012	SITE #5	135	TD, LR	Overcast, mid-30s, 7 hours
12/18/2012	SITE #5	41	TD, LR	Overcast, mid-30s, 4 hours
6/3/2013	SITE #6	83	TD, RM	Sunny, low-60s, 5 hours
6/4/2013	SITE #6	83	TD, RM	Sunny, low-70s, 5 hours
6/5/2013	SITE #6	113	TD, RM	Overcast, rainy, mid-50s, 6 hours
11/4/2013	SITE #2	259	TD, RM, KW	Cloudy, gusty winds, mid-40s, 7 hours
11/5/2013	SITE #2	268	TD, RM, MD	Overcast, calm, mid-50s, 8 hours
11/7/2013	SITE #2	204	TD, KW, TK	Sunny, gusty winds, mid-40s, 7 hours
11/8/2013	SITE #2	130	TD, RM, TK	Sunny, calm, mid-40s, 5 hours
11/13/2013	SITE #3	121	TD, RM, TK	Sunny, gusty winds, low-30s, 6 hours
11/14/2013	SITE #2	82	TD, RM, TK	Sunny, gusty winds, low-40s, 6 hours
TOTAL		2,997		

TD = Thomas Dueppen
TK = Tina Kroening
LR = Luke Roffler
KW = Katie Werner

RM = Ryan Miller
MD = Michael Denis
SK = Steve Kunst

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The combined survey point locations and associated attributes were utilized to generate maps depicting sediment types along each targeted river section. This GIS data was also utilized to generate localized bathymetry and isopach maps of soft sediment thicknesses along each sampling reach (see Appendix D).

Sediment Coring Maps

Sediment core sampling undertaken by this project was specifically targeted for those areas most likely to contain contaminated sediment, and to confirm or refute their contamination status. Given that PCB accumulation is most likely in areas of soft sediment deposition (WDNR 2001), the soft sediment isopach maps were used to prioritize sediment core sampling locations. No additional statistical extrapolation or estimation of total contaminated sediment volume was intended, therefore, no random sampling design was utilized. Areas with the thickest soft sediment were prioritized for core sampling activities, including a range of soft sediment depths to be sampled at each targeted river section (e.g., less than 1 foot, 1-2 feet, 2-3 feet, 3-4 feet, over 4 feet). Core sample locations for each river section were also distributed according to sample size (minimum of 100 – 6 inch core samples, including replicates) and spacing determined by the extent of the depositional areas. A GPS coordinate was generated for each proposed core sample site, and maps depicting the geographical extent of prioritized core sample locations and estimated core depths were provided to the Primary Consultant and Sub-Consultant (see Appendix E).

Sediment Coring Sampling Method Requirements

Specific sediment coring procedures are fully described in the Primary Consultant workplan (Appendix I). In general, the methods followed sampling guidelines from WDNR:

1. Gently lower core sampler to the sediment-water interface and push into the sediment to the point of refusal
2. Extract the sampler from the sediment, taking care to preserve the sample in its entirety
3. Remove and cap the core liner and minimize handling to prevent sediment mixing
4. Label the core with the name of the sampling reach and unique core number
    a. Record GPS coordinates, water depth, depth of refusal, unique core number, and other relevant field observations in field book
5. Extrude six inch segments of each core sample into clean sample bottles
6. Label each sample bottle with the name of the sampling reach, unique core number, and depth of segment below the sediment-water interface (e.g., 0-6 inches, 6-12 inches, etc.)

It is worth noting is that the analysis of core samples occurred at six inch intervals, as opposed to the 10 cm (~four inch) intervals used by WDNR (2001). Segmenting core samples every six inches not only allows for general characterization of the location and extent of sediment contamination in specified sampling reaches, but also addresses issues related to total sample size and allocated budget for laboratory analyses. Future sediment sampling efforts in these reaches (e.g., pre-remediation studies) may wish to further refine specific depths of contamination, though six inches is expected to be at the lower limit of dredging precision.

The Sub-Consultant performing sediment core sampling in the depositional areas identified by Project staff did so with the intent of retrieving a fully intact vertical core of sediment at each site (sample thickness dependent on depth of refusal). Each six-inch increment of collected core samples was analyzed. The purpose of all analyses was the gathering of initial information at the sites specified, not direct guidance for a future reclamation project. The assessed parameters were based on WDNR (2001) and conversations with WDNR Water Resources and Office of the Great Lakes (OGL) staff (D. Dinsmore, M. Burzynski, and M. O'Shea, personal communication, March 15, 2011). Initially (per QAPP Revisions #1, #2 and #3), sediments were tested for Total PCB's, Total Organic Carbon, and Grain Size Analysis. After subsequent discussions with WDNR and OGL staff it was determined that RCRA metals and PAH's should also be tested at select sites (Site 2, Site 5, and Site 6), which was formalized in QAPP

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Revision #4. Sediment samples were tested for the following parameters (Figure 4) by the specified methods (Figure 5):

Figure 4: Sediment Sample Parameters

Sediment Contamination Parameters and Laboratory Limits

Test	Detection Limit	Reporting Limit	Total Samples[1]
Total PCBs	4.33 ppb	14.43 ppb	700
Total Organic Carbon	95 ppm	1,000 ppm	264
Sediment Particle Grain Size Analysis	N/A	N/A	264
PAH[2]	8.33 ppb[3]	16.67 ppb	175
Metals (Hg, Pb, Cd, As, Cu, Zn)[2]	0.96 ppm[3]	4.00 ppm[3]	175

1 – Sample size includes field replicates and background samples and was largely dependent on the extent of soft sediment deposition delineated during poling surveys and the final price quote for each analysis
2 – Analyses added as part of no-cost time extension for 2013 sediment sampling at Sites 2, 5, and 6.
3 – Test includes a suite of analytes for which the limits vary (least sensitive listed).

Figure 5: Sediment Contamination Parameters and Methods

Sediment Contamination Parameters and Methods

Test	Method
Total PCBs (PCB's)	EPA SW-846 8082
Total Organic Carbon (TOC)	Walkley Black
Grain Size Analysis (GSA)	Hydrometer plus percent retained on 200 sieve
PAH (PAH's)	8270 SIM
Metals (Hg, Pb, Cd, As, Cu, Zn (RCRA Metals)	ICP

Quality Assurance/Quality Control

Per the QAPP and SOP's, all sediment samples were sealed, labeled, and transported to the laboratory in a prompt timeframe to ensure analysis occurs within necessary hold times per the Certified Laboratory SOPs. The Primary Consultant, Sub-Consultant and Certified Laboratory staff were required to adhere to current industry-accepted practices for safe handling, testing of samples, QA/QC, and chain-of-custody

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methods. Specific details are included in the attached work plan and SOPs (Appendix I) and field forms, release records, and data quality review forms (Appendix K). Field precision was confirmed by the use of one field duplicate sample (taken as close as possible to another sample) each sampling day. The laboratory was required to confirm precision by analyzing both samples for the full suite of parameters. Westenbroek (2001) also employed background samples to provide the laboratory with "clean" samples and a determination of natural soil composition and/or bias in the sampling or analysis process. As such, "clean" samples from sites 5 and 6 can be considered as background data for comparison to samples containing higher levels of contaminants. Criterion for acceptance for each type of quality control sample was based on the SOPs provided by the Certified Laboratory chosen to perform the sampling and analysis. The creation of duplicate samples for analysis of sediment contamination is known to be a highly variable process, often with precision limits up to 50% (WDNR 2001; S. Westenbroek, personal communication). Accuracy was maintained by strict adherence to sampling protocol and handling time for the tests listed in Figure 4. The laboratory assumed custody of each sample it received and was responsible for forwarding all sample analysis results to the Project Coordinator (or designee) following the completion of analysis (Appendix K). All Project sediment analysis parameters were assessed by Pace Analytical and Northern Lake Service, both WDNR Certified Laboratories.

Sediment Coring Data: Results

Sediment coring and laboratory analysis occurred between November 2011 and November 2013. All raw data was received from the laboratory, analyzed by Department staff, and forwarded to local WDNR staff. To aid in the analysis, Department staff also created site specific, color coded maps indicating the levels of PCB contamination at each sample site using the WDNR's Consensus-Based Sediment Quality Guidelines (Appendix G). These guidelines establish "concern level" schemes (e.g., Threshhold Effect Concentration (TEC), Midpoint Effect Concentration (MEC), Probable Effect Concentration (PEC)) for various contaminants including PCB's, PAH's, RCRA metals, and other assorted contaminants. These mapped results are included as Appendix H and notable results are described further below. All raw data is saved in electronic spreadsheets on the Ozaukee County servers and is available upon request.

Site 1 (River Barn)

Fifty-six samples from 33 locations were collected in May 2012 tested for PCB's and TOC, with GSA (a total of 822 tests, inclusive of all tests). PCB's were found in 14 samples from nine locations, including seven samples exceeding the TEC and one sample exceeding the MEC. These results indicate the general level of contamination levels as the Milwaukee River leaves the County.

Site 2 (MT Impoundment)

The MT Impoundment is the first major depositional area downstream of the Cedar Creek confluence. Eighty eight samples from 35 locations were collected in November 2011, May 2012, May 2013, and November 2013 and tested for PCB's and TOC with GSA, PAH's, and RCRA metals (a total of 5,304 tests, inclusive of all tests). PCB's were found in 48 samples from 22 locations, including 33 samples exceeding the TEC, 11 samples exceeding the MEC, and four samples exceeding the PEC.

Site 3 (Downstream of Cedar Creek)

Fifty nine samples from 36 locations downstream (26 locations) and immediately upstream (10 locations) of the Cedar Creek confluence were collected in August 2012 and tested for PCB's and TOC, with GSA (a total of 790 tests, inclusive of all tests). PCB's were found in 15 samples from 14 locations, including 13 samples exceeding the TEC. Three of these locations containing PCB's were immediately upstream of the confluence.

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Site 4 (Newburg Dam Impoundment)

USEPA/GLRI project sampling occurred in conjunction with additional sampling required by the WDNR for permitting requirements as part of the 2012 Newburg Dam removal and restoration project funded by the National Oceanic and Atmospheric Administration (NOAA) under the American Recovery and Reinvestment Act (ARRA). WDNR staff recommended laboratory analysis of three cores taken from the thalweg at various distances upstream of the dam. Sediment coring and laboratory analysis completed in late November 2011 under the USEPA/GLRI project protocols indicated elevated levels of cadmium. In February 2012, WDNR staff subsequently requested that ten additional sediment cores be collected and analyzed for Total Cadmium and Sediment Size from the impoundment and surrounding reaches (two locations upstream of the impoundment, two locations downstream of the dam). This additional analysis was completed in late February 2012 and provided to WDNR immediately upon receipt. WDNR subsequently provided sediment management recommendations and requested the recommendations be incorporated into a formal sediment management plan to be implemented during the dam removal process. In total, 48 samples from 42 locations were tested for PCB's and TOC with GSA, PAH's, and RCRA metals (a total of 728 tests, inclusive of all tests). PCB's were found in 22 samples from 12 locations, including 18 samples exceeding the TEC. Cadmium was found in each of the 10 additional samples required by WDNR, including 4 samples exceeding the TEC and one sample exceeding the PEC. These samples provided a known contaminant level as the Milwaukee River enters the County, as well as the extent of sediment contamination in an impoundment uninfluenced by the known PCB contamination of Cedar Creek.

Site 5 (Bridge Street Dam Impoundment)

Ninety three samples from 33 locations were collected in April 2013 and tested for (a total of 2,224 tests, inclusive of all tests) PCB's and TOC with GSA, PAH's, and RCRA metals. PCB's were found in one sample at a single location, which exceeded the TEC. PAH's were found in 18 samples from 13 locations, including 10 PAH's exceeding the TEC, six PAH's exceeding the MEC, and 13 PAH's exceeding the TEC. RCRA metals were found in 47 samples from 26 locations. Cadmium was found in 18 samples from 14 locations, including eight samples exceeding the TEC, three samples exceeding the MEC, and one sample exceeding the PEC. Copper was found in 47 samples, including 3 samples exceeding the TEC. Lead was found in 47 samples, including eight samples exceeding the TEC, one sample exceeding the MEC, and one sample exceeding the PEC. Zinc was found in 47 samples, including five samples exceeding the TEC. Mercury was found in 47 samples, including six samples exceeding the TEC. These samples provide the first comprehensive analysis of sediment contamination at the first impoundment downstream of Newburg.

Site 6 (Upstream of Bridge Street Dam Impoundment)

Fifty eight samples from 13 locations were collected in November 2013 and tested for (a total of 1,569 tests, inclusive of all tests) PCB's and TOC with GSA, PAH's, and RCRA metals. PCB's were found in one sample at one location, which exceeded the TEC.

Discussion

Analysis of Project Goals and Objectives

The Project, through a measured and science-based approach, began locating and evaluating sediment contamination in Ozaukee County portions of the Milwaukee River Watershed. The Project provided initial characterization of the current location and extent of sediment contamination within certain portions of the AOC in Ozaukee County. Specifically, the Project fully addressed the following objectives as outlined in the QAPP and original grant proposal:

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- Delineating approximate areas of sediment accretion in specific sampling reaches through historic orthophotography analysis.
- Determining the thickness and general composition (e.g., sand, silt, etc.) of targeted sediment accretions through poling surveys.
- Determining general locations and extent of contaminated sediment deposits through core sampling and laboratory analysis.

Upstream Contamination

After a review of historical records and conversations with WDNR and Wisconsin Department of Health Services staff it was determined that the likely source of sediment containing contaminants including heavy metals (e.g., Cadmium) found at the most upstream site (Site 4) was likely attributed to historical industrial operations (including a metal plating company) located upstream of Site 4 in the City of West Bend. This sediment was likely released during the abandonment of the Woolen Mills Dam and impoundment in 1988. Approximately 2,310 cubic yards of sediment immediately behind the Newburg Dam containing the highest concentrations of cadmium was removed in 2012 (see "Ongoing and Relevant Work" below for additional details) prior to the dam removal, and the remaining exposed sediments in the impoundment were fully restored. As such, sediment from Site 4 is not suspected to be a significant PCB containment source for locations downstream. An analysis of the remaining "baseline" or "control" data from Sites 5 and 6 (both located downstream of Site 4 and upstream of Cedar Creek) indicates that relatively low levels of PCB contamination are found in areas upstream of Cedar Creek.

Cedar Creek and Hamilton Pond

A primary Project objective was to assess sediment contamination at locations downstream of the Cedar Creek terminus in Ozaukee County, given that Cedar Creek and the Hamilton Pond were identified by Westenbroek as a source of PCBs to the Milwaukee River. As noted above, PCB's exceeding the TEC were found at all sample locations (both upstream and downstream of the Cedar Creek confluence).
Sediment from Sites 5 and 6 each yielded a single sample containing PCB's exceeding the TEC. Given the total number of samples exceeding TEC, MEC, and PEC for PCB's at Sites 1 (14), 2 (48) and 3 (15) downstream of the Cedar Creek confluence compared to the two samples exceeding the TEC for PCB's at Sites 5 and 6, ***it can be inferred that Cedar Creek and the Hamilton Pond is a likely source of contaminants (particularly PCB's) to the Milwaukee River downstream of the Cedar Creek confluence.*** These findings also confirmed the suspected locations of contaminants as referenced in the Task 1 (Fisheries Communities Surveys) sampling sites ("uncontaminated" and "contaminated" sites) and associated Task 1 final report.

Ongoing and Relevant Work

Project activities directly supported sediment analysis and management work associated with the 2012 Newburg Dam removal and restoration project funded by NOAA under the ARRA. A sediment management plan was prepared, approved, and implemented to meet WDNR dam removal permit requirements at Site 4, and in August 2012 the primary contractor began excavation of sediment immediately behind the dam (approximately 2,310 cubic yards) extending approximately 150 feet upstream using a long-arm excavator. The sediment was then trucked to the sediment reuse area on the south shore of the former impoundment and spread using a conveyor belt. The sediment reuse area was capped with six inches of clean fill, seeded, mulched, and planted with native live stakes during November 2012.

Since 2011, Department staff has been participating on the Milwaukee Estuary AOC's Fish and Wildlife Technical Advisory Committee, the Stakeholder Delegation, and the recently-formed Citizen Advisory

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Committee Transition Team, and assisting in Remedial Action Plan development and yearly updates. The Lincoln Creek and Milwaukee River Channel Legacy Act cleanup project within the AOC has been ongoing since 2012, which has included the cleanup of approximately 140,000 yards of contaminated sediment (Phase I, completed in 2012) and ongoing Phase II efforts to continue sediment removal activities downstream of the Lincoln Park confluence to the Estabrook Dam.

Ozaukee County staff is also directly involved in ongoing efforts to address the remaining contaminated sediments in Cedar Creek lead by the WDNR, the City of Cedarburg, UW-Extension, the USEPA, and Mercury Marine. The site is designated as a USEPA Region 5 cleanup alternative superfund site and the USEPA is currently evaluating potential clean-up activities in the stretch of the Creek between Ruck Pond Dam and Wire and Nail Factory Dam and the associated spillway downstream of Ruck Pond Dam. USEPA is expected to issue its recommended cleanup plan (Action Memorandum), which will be subject to public review and comment before it is finalized. Once the Action Memorandum is finalized, Mercury Marine will develop a detailed engineering design that will serve as a blueprint for implementing the cleanup activities. Ozaukee County staff is participating in the City of Cedarburg's ad-hoc advisory committee, and in particular, issues associated with improving or restoring in-stream and riparian habitat within and adjacent to the cleanup locations and public education and outreach activities.

All sediment characterization data has been shared with the WDNR AOC staff for reference in guiding future AOC related management plans and sediment cleanup activities, in particular, those related to cleanup of the MT Impoundment, and Department staff will continue to support future cleanup efforts as time and resources allow.

Lessons Learned

Boat access to certain areas of the river during sediment poling activities was severely limited during periods of low water levels. Collection of GPS locations were difficult during certain weather conditions (high winds and below freezing temperatures) and in areas with deep water (greater than six feet deep) with limited soft sediment and high water velocities. Department staff anticipated that sediment accumulations upstream (within 100 – 200 yards) upstream of the Cedar Creek confluence would provide additional background or "control" samples for comparison to downstream locations. A large sediment deposit was identified immediately upstream and adjacent to the confluence, but no deposits were identified farther upstream (within 100-200 yards). The QAPP indicated that additional samples would be collected and analyzed from tributary streams upstream of the Cedar Creek confluence to be used as baseline data. These samples were unnecessary given the relatively low levels of contamination found at upstream sample sites 4 and 5, which can act as baseline data for direct comparison to locations downstream of Cedar Creek.

Education and Outreach

As outlined in the original grant narrative, public outreach and information dissemination efforts regarding Project goals, results, and Program partners, was a joint effort between the County and other major stakeholders. Specific outreach activities used to foster public participation and education as part of this Project included:

- Detailed Program information and the Ozaukee County Planning & Parks Department Ecological Division - Fish Passage Program website (http://www.co.ozaukee.wi.us/540/Planning-Parks), as well as other partner websites.
- Detailed Program information on the Program's Facebook page (www.facebook.com/MRWFishPassage) and routine updates via Twitter (www.twitter.com/OzCoFishPassage).

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- Articles in the Planning & Parks Department's newsletters and articles in partner, advocacy and community action group newsletters (e.g. Milwaukee Audubon Society, Ozaukee Treasures Network).
- Presentations and/or Program information provided to over 10,441 people at 99 international, national, regional, state, and local professional and scientific conferences, technical meetings, workshops, webinars, partner meetings, field trips, tours, and other events.
- Program and Project information to 216 volunteers associated with fisheries community monitoring activities.
- Inclusion of project information in the Department's posters, pamphlets, and factsheets.
- Inclusion of project information in AOC-related meetings and documents, including pamphlets, brochures, and RAP updates.

Recognition and Awards

The County and its partners have received numerous awards and recognition for efforts supported by the GLRI and USEPA. In 2011, the Ozaukee County Planning and Parks Department received a National Association of Counties (NACO) award for its "Fish Passage for the Milwaukee River Watershed" Program, noting promotion of quality, efficient, and responsive management and administration. In 2012, Andrew Struck received the Treasures of Oz "Wizard of Oz" for environmental leadership and organization. Also in 2013, Andrew received the Gathering Waters "Conservationists of the Year" award for aquatic connectivity efforts, and Andrew received the Ozaukee Washington Land Trust "Timothy Kaul Leadership Award" for outstanding leadership in conservation. In addition, the Ozaukee County Fish Passage Program received a 2013 Wisconsin Department of Natural Resources "Wisconsin Citizen Based Monitoring Program of the Year" award, and Rick Frye, a Program volunteer, received the Wisconsin Department of Natural Resources "Wisconsin Citizen Volunteer of the Year" award.

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List of Appendices

Funded by the United States Environmental Protection Agency and the Great Lakes Restoration Initiative, Grant #GL-00E00607.0