REGION 5 RAC2

REMEDIAL ACTION CONTRACT FOR

Remedial, Enforcement Oversight, and
Non-Time Critical Removal Activities at Sites of Release
or Threatened Release of Hazardous Substances in Region 5

FEASIBILITY STUDY

Lincoln Park/Milwaukee River Channel Sediments Site
Milwaukee Estuary Area of Concern
Milwaukee, Wisconsin

WA No. 052-RICO-6082/Contract No. EP-S5-06-01

December 2009

PREPARED FOR

U.S. Environmental Protection Agency

PREPARED BY

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FOR OFFICIAL USE ONLY

FEASIBILITY STUDY

LINCOLN PARK/MILWAUKEE RIVER CHANNEL SEDIMENTS SITE

MILWAUKEE ESTUARY AREA OF CONCERN

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Feasibility Study

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Executive Summary

This feasibility study (FS) presents the results of the remedial action objectives (RAOs), technology screening, and alternatives development and evaluation completed for the Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary Area of Concern (AOC), in Milwaukee, Wisconsin. The objective of the FS is to develop a list of remedial alternatives for the Lincoln Park/Milwaukee River site such that the U.S. Environmental Protection Agency (USEPA) and the Wisconsin Department of Natural Resources (WDNR) (in consultation with Milwaukee County) can select a remedial action to eliminate, reduce, or control risks to human health and the environment and move forward delisting of the Milwaukee Estuary AOC beneficial use impairments (BUIs).

Sediment RAOs were developed for the media of concern to protect human health and the environment based on the nature and extent of the contamination, resources that are currently and potentially threatened, potential to move delisting forward, and potential for human and environmental exposure as determined by the human health and ecological exposure and hazard evaluations. Consistent with the RAOs, remedial technologies and process options were identified and screened. Remedial technologies and process options that remained following screening were assembled into a range of alternatives.

Based on the risks present at the site and the remaining remedial technologies and process options available after completion of the screening, seven alternatives were assembled and then evaluated against six criteria:

- Alternative 1—No Action
- Alternative 2—Monitored Natural Recovery
- Alternative 3—Containment
- Alternative 4—In Situ Treatment
- Alternative 5—Partial Excavation and Cap
- Alternative 6—Excavation and Offsite Disposal
- Alternative 7—Excavation, Ex Situ Treatment, and Offsite Disposal

Each alternative, with the exception of Alternative 1 (No Action) which is not applicable, passes threshold criteria evaluation. The summary of balancing criteria ranking indicates that Alternative 6 (Excavation and Offsite Disposal) has the highest average ranking. Alternative 6 ranks high in comparison to other alternatives for long-term benefits. The benefits of excavation and offsite disposal support the overall protection of human health and the environment, faster removal of BUIs within the Milwaukee Estuary AOC and delisting of the AOC, and improvement of the habitat in the area after the remedial action is complete. In addition, excavation and offsite disposal is beneficial in minimizing residual risk and the transport of contaminated sediment downstream. Therefore, the recommended remedial alternative for the Lincoln Park/Milwaukee River Channel Sediments Site is excavation and offsite disposal. The long-term benefits of excavation and offsite disposal, as well as the ability to mitigate the short-term risks, support recommendation of this alternative.

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Acronyms and Abbreviations

3D	three-dimensional
AOC	area of concern
BMP	best management practice
BUI	beneficial use impairment
CBSQG	consensus-based sediment quality guideline
CFR	Code of Federal Regulations
CWA	Clean Water Act
FS	feasibility study
ft^2	square feet
GAC	granular activated carbon
GLNPO	Great Lakes National Program Office
GPS	global positioning system
LDR	land disposal restriction
mg/kg	milligrams per kilogram
MNR	monitored natural recovery
MPRSA	Marine Protection, Research, and Sanctuaries Act of 1972
MVS	Mining Visualization System
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	probable effect concentration
ppb	parts per billion
PPE	personal protective equipment
PRB	permeable reactive barrier
QA	quality assurance
QC	quality control

RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
SOW	statement of work
SQG	sediment quality guideline
TEC	threshold effect concentration
TOC	total organic content
TSCA	Toxic Substances Control Act
U.S.C.	United States Code
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WA	Work Assignment
WDNR	Wisconsin Department of Natural Resources
yd^3	cubic yards

SECTION 1

Introduction

1.1 Purpose

This feasibility study (FS) presents the results of the remedial action objectives (RAOs), technology screening, and alternatives development and evaluation completed for the Lincoln Park/Milwaukee River Channel Sediments Site (hereinafter referred to as the Lincoln Park/Milwaukee River site), Milwaukee Estuary Area of Concern (AOC), in Milwaukee, Wisconsin. It is being submitted pursuant to the U.S. Environmental Protection Agency (USEPA) statement of work (SOW) dated October 8, 2008. The work is being conducted in accordance with Work Assignment (WA) No. 052-RICO-6082 under Contract No. EP-S5-06-01.

The objective of the FS is to develop a list of remedial alternatives for the Lincoln Park/ Milwaukee River site such that USEPA and the Wisconsin Department of Natural Resources (WDNR) (in consultation with Milwaukee County) can select a remedial action to eliminate, reduce, or control risks to human health and the environment and alleviate the Milwaukee Estuary AOC beneficial use impairments (BUIs).

1.2 Report Organization

This document consists of six sections. Section 1 provides an introduction and summarizes background information, such as site physical description and nature and extent of contamination. Section 2 presents the applicable federal, state, and local regulations and the RAOs. Section 3 summarizes the identification and screening of the technology types and process options. Section 4 summarizes the development of the alternatives. Section 5 presents the evaluation of the alternatives individually and to one another with respect to six criteria. Section 6 presents the recommended alternative. Section 7 provides a list of the references cited.

1.3 Site Description

The following sections briefly describe the physical location of the site; the geologic, hydrogeologic, and ecological setting; the nature and extent of contamination; contaminant fate and transport; and summary of human health and ecological risks. Additional information on the site is presented in the *Remedial Investigation Report* (STN, 2009).

1.3.1 Site Location

Figure 1 shows the boundaries of the Lincoln Park/Milwaukee River site, which is located within the Milwaukee Estuary AOC between Lincoln Creek downstream of Green Bay Road, the western oxbow of the Milwaukee River, and the Milwaukee River downstream of the confluence with Lincoln Creek to the Estabrook Park Dam. The Lincoln Park/ Milwaukee River site was divided into five zones during the Estabrook Impoundment sediment remediation pre-design study (WDNR, 2005). The zones (Figure 1) consist of the following:

- Zone 1: Lincoln Creek from Green Bay Road to the confluence with the Milwaukee River
- Zone 2: Entire western oxbow in the Milwaukee River, which contains the main sediment deposit
- Zones 3, 4, and 5: Milwaukee River from the confluence of the western oxbow downstream to Estabrook Park Dam

This FS focuses on Zones 1, 2, and the northwestern part of Zone 3 (Zone 3a). Zones 4, 5, and the remaining portion of Zone 3 will be addressed separately in the future. The Estabrook Park Dam forms the downstream boundary of the Lincoln Park/Milwaukee River site, and backs up water approximately 2.5 miles to a point 0.3 miles upstream of Silver Spring Road on the Milwaukee River, creating a 103-acre impoundment. The dam also has an impact on Lincoln Creek to a point about 0.5 miles upstream from the confluence with the Milwaukee River. The dam was built on a limestone outcrop in the river channel in 1936, and has a hydraulic height of 8 feet and maximum storage of 700 acre-feet. The dam, owned and operated by Milwaukee County, is kept open during the winter months and closed in the summer. The water pool behind the dam also has been lowered in anticipation of high flows. The bottom draw design of the dam and periodic opening and closing of the dam has caused the contaminated sediment to be released downstream and dewatered upstream, resulting in some compaction of the sediment upstream within the impoundment.

Inspections by WDNR have identified the need for significant repair work on the dam. WDNR issued a Repair or Abandon Order to Milwaukee County on July 28, 2009. This order establishes deadlines for Milwaukee County to meet related to outstanding maintenance and repair requirements. The order also gives Milwaukee County the option of deciding whether to abandon the dam. The decision for repair or abandonment is the responsibility of Milwaukee County, the owner of the dam.

1.3.2 Background

Contaminated sediment is a major contributor to use impairments within the Milwaukee Estuary AOC (WDNR, 1994). BUIs within the AOC include the following:

- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Fish tumors or other deformities
- Bird or animal deformities or reproduction problems
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Beach closings/recreational restrictions
- Degraded aesthetics
- Degradation of phytoplankton and zooplankton populations
- Loss of fish and wildlife habitat

Fish consumption advisories are in place, such as those in effect from Grafton to the mouth of the Milwaukee River, because of polychlorinated biphenyl (PCB) contamination.

A PCB mass balance study of the site estimated that the Lincoln Park/Milwaukee River sediments hold over 100,000 cubic yards of sediment contaminated with an estimated 5,200 kilograms (11,500 pounds) of PCBs as Aroclor-1242 (Baird and Associates, 1997). The mass balance study determined the Lincoln Park/Milwaukee River site contributes the greatest mass loading of PCBs to the Milwaukee River and Harbor, and that remediation of contaminated sediment within this area is expected to result in a long-term reduction in PCB mass transport in the Milwaukee River of up to 70 percent. BUIs specifically associated with the Lincoln Park/Milwaukee River site include restrictions on fish and wildlife consumption, degradation of fish and wildlife populations, degradation of benthos, and restrictions on dredging activities.

From March 2008 through August 2008, approximately 4,700 cubic yards of contaminated sediment/soil were removed and the area backfilled at a small area immediately adjacent to the Blatz Pavilion Lagoon (Zone 3) through funding from WDNR. The Blatz Pavilion Lagoon area is isolated from the other contaminated areas in Zones 1 through 5 and has easy public access. WDNR selected the Blatz Pavilion Lagoon site to be the first area remediated.

1.4 Summary of Recent Investigations

The aforementioned WDNR pre-design study of the Lincoln Park/Milwaukee River project area was initiated in 2000 through a grant by USEPA Great Lakes National Program Office (GLNPO). Water and sediment samples were collected on 12 dates between October 2001 and September 2003. Sediment samples were collected using a core sampler and a Ponar dredge sampler. A total of 246 sediment samples were used to map the occurrence and distribution of PCBs, polynuclear aromatic hydrocarbons (PAHs), and metals in the impoundment sediments. Other data collected included water depth, sediment thickness, sediment total organic content (TOC), and geotechnical characteristics.

GLNPO and contractor STN conducted additional sediment sampling activities in February 2008 and March 2009 to support the RI. Additional sediment sampling activities supported assessment of sediment thickness, horizontal and vertical extent of PCB contamination, and the nature of the contaminants. In February 2008, 33 sediment samples were collected from Zone 2 for chemical and physical analysis. In March 2009, 18 sediment samples were collected from Zones 1, 2, and 3 for chemical analysis. In addition, sediment thickness was surveyed at over 250 locations in Zones 1 and 2 using direct-push technology and manual poling techniques. The results of the investigation are summarized in the *Remedial Investigation Report* (STN, 2009).

1.5 Major Findings

1.5.1 Physical Site Characteristics

The regional geology of the site is dominated by the effects of multiple glacial advances and retreats. Coarse-grained (sand and gravel) glacial outwash deposits predominate along the Milwaukee River, which occupies the course of a former glacial outwash channel. Surface and near-surface deposits outside the area immediately along the Milwaukee River tend to be dominantly fine-grained (silt and clay) glacial till deposits (STN, 2009).

Zone 1—Lincoln Creek

Sediment thickness in Lincoln Creek tends to be dominated by coarser grained sediments like sand and gravel overlain by clay and silt. The thickness and characteristics of the sediments in Zone 1 vary depending on their relative location with respect to main channel flow and the morphology of the underlying substrate. Sediment thickness in Zone 1 varies from less than 1 foot to 4 feet (near the mouth of Lincoln Creek); however, most measured sediment thicknesses within Zone 1 ranged from less than 1 foot to approximately 2 feet.

Zone 2—West Oxbow

Sediment thickness in Zone 2 varies from less than 1 foot to 9.5 feet. Sediments tend to be fine grained (silts and clays) in the upper interval, and sandy in the lower interval with thin, interbedded sandy intervals of 1 foot or less. Sediment in the main channels is generally sandy with some silt. Variability in soil profiles between adjacent borings indicates that the interbedded units are likely limited in horizontal extent.

Bulk characteristic profiling of sediments indicates that the fine-grained sample intervals tend to be predominately silts (60 to 70 percent), while the coarse-grained intervals are predominantly fine- to medium-grained sand (greater than 90 percent) (STN, 2009).

1.5.2 Nature and Extent of Contamination

The findings of the field investigation relative to the nature and extent of contamination in the project area are summarized below and described in further detail in the *Remedial Investigation Report* (STN, 2009). Sediment PCB concentrations ranged from below laboratory detection levels to 823 milligrams per kilogram (mg/kg) at location LPMR-S-6, as a mixture of the Aroclors-1242, -1248, and -1254. The highest concentrations were observed in sediment from the western oxbow lagoon (Zone 2) and on the west bank of the Milwaukee River below the oxbow (Zone 3). In Zone 2, PCB concentrations are generally higher at depth when compared to PCB concentrations in the surface sediment. The concentrations at depth do not generally correlate with surface sediment concentrations, consistent with the depositional nature of the area. The average PCB concentration in Zone 1 was 1.52 mg/kg. The average PCB concentration in Zone 2 varied by subsection. The average concentration in Zone 2a was 29.3 mg/kg. The average concentration in Zone 2b was 6.76 mg/kg.

1.5.3 Data Evaluation

The RI data were evaluated by using a three-dimensional (3D) interpolation method to delineate the horizontal and vertical extent of sediment containing total PCB concentrations equal to or greater than 1 mg/kg, and equal to or greater than 50 mg/kg. The computer application Mining Visualization System (MVS) v9.22 by CTECH (www.ctech.com) was used to interpolate PCB concentrations. Horizontal distributions of total PCB concentrations greater than 1 mg/kg and 50 mg/kg are presented on Figures 2 and 3, respectively.

Key attributes of the MVS-based interpolation approach for delineation of the extent of PCB concentrations included the following:

- The dataset included analytical results from sediment core samples collected from 2001 through 2003, as well as 2008 and 2009, resulting in a total of 187 samples from 94 locations (Table C-1, Appendix C). Sediment grab samples collected to represent sediment surface concentrations were not included within the dataset as they are not representative of concentrations within the entire sediment profile and therefore could lead to skewed model results at depths greater than 0.5 foot. This resulted in eliminating two grab sample locations (5x1 and 5x3) within Zone 1 originally collected by WDNR in 2003.
- Total PCB concentrations were represented as point values located at corresponding horizontal coordinates (such as northing and easting) for each sampling station. The vertical position was represented by the sample midpoint depth below the top of the sediment surface. Analytical results from quality assurance (QA)/quality control (QC) samples were excluded.
- Interpolation of PCB data was performed within a 3D mesh representing each individual zone (Zones 1, 2, and 3a). One 3D mesh was used for Zone 1 (Lincoln Creek), two separate 3D meshes for Zone 2 resulting in two subzones (Zones 2a and 2b), and one 3D mesh for Zone 3 (Zone 3a). During interpolation to each of the 3D meshes, the complete PCB dataset was used to prevent potentially different interpolation results at zone and subzone boundaries.
- The 3D meshes of each zone and subzone were constructed with a normalized, flat-top sediment surface. This was necessary because of PCB concentrations being correlated with sediment stratigraphy measured in depth, rather than elevation. The lower boundary of the 3D mesh was defined by the bottom of the sediment surface as determined by probe refusal reported for 267 locations collected in 2008 and 2009 (Table C-2, Appendix C). Therefore, the resultant mesh thickness at each horizontal coordinate approximates the sediment thickness.
- Each zone-specific model was built on convex hull-bounded grids limited to the areal extent of each subzone with Z spacing determined by sediment thickness and using the adaptive gridding option. Adaptive gridding automatically refines gridding in the cells surrounding measured samples to ensure that the interpolated results and isosurfaces accurately honor measured sample data. Adaptive gridding provides an effective resolution that cannot be approximated by any other method, and often more accurate results than increasing the number of elements by 100 to 1,000 times.
- The selected grid density used within each zone and subzone was a compromise between providing the highest detailed resolution while maintaining reasonable model run times. Model grid resolution was also limited by the spatial density of field data and resulted in the following grid resolutions: Zone 1 = 100x200 nodes, Zones 2a and 2b = 100x100 nodes, and Zone 3a = 100x50 nodes.
- The PCB concentration distribution was modeled within the 3D mesh using a geostatistically defensible process called kriging. The models utilize expert systems to analyze the spatial distribution and number of field data points; construct a multidimensional variogram, which is a best fit to the dataset being analyzed; and then

perform kriging in the domain of the model. One of the fundamental design criteria used in developing the variogram and kriging algorithms was to produce modeled distributions that honor the measured distributions as closely as possible. MVS's variogram modules utilize a nugget of zero, which cannot be changed and requires the calculated value to be equal to the known value of data points that fall exactly on a grid point in the modeled domain. Modeled PCB concentration results also were verified qualitatively by verifying that the models' isosurface of 1 mg/kg and 50 mg/kg captured all samples with PCB concentrations equal or greater than 1 mg/kg and 50 mg/kg, while minimizing capture of samples known to have PCB concentrations less than the targeted concentrations.

Once the 3D distribution of PCB was modeled, the volumes of sediment with PCB concentrations equal or greater than 1 and 50 mg/kg, respectfully, were calculated. Table 1 summarizes the area, volume of sediment, and total mass of PCBs equal to or exceeding 1 and 50 mg/kg. Volumes reported include material to be removed associated with 3:1 (horizontal to vertical) side slopes to account for typical construction methods, overburden sediment needed to be removed before removing sediment exceeding the target PCB concentration, and an estimated average 6 inches of over excavation.

TABLE 1
Summary of Estimated Sediment Volume and Mass of PCBs
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Zone	Total Sediment Volume (yd^3)	Volume Exceeding 1 mg/kg (yd^3)	Lateral Area Exceeding 1 mg/kg (square feet [ft^2])	Volume Exceeding 50 mg/kg (yd^3)	Total Mass of PCBs (lbs)
1	9,330	9,270	246,500	0	34
2a	42,000	32,800	274,600	9,100	2,954
2b	56,500	45,500	463,700	4,600	917
3a	10,300	10,300	103,800	100	170
Total	**118,130**	**97,870**	**1,088,600**	**13,800**	**4,075**

Notes:

lbs = pounds
ft^2 = square feet
mg/kg = milligrams per kilogram
yd^3 = cubic yards

1.5.4 PCB Fate and Transport

PCBs strongly adsorb to silt and clay particles, have low water solubility, are persistent in the environment (do not readily break down), and thus, their fate and transport is generally dictated by sediment stability. Adsorbed PCBs will move primarily with the sediments they are sorbed to—the amount of movement will depend on the location within the project area. Sediment movement within the project area is expected to be limited to erosional effects from stormwater runoff and flood events.

1.5.5 Human Health Risk Evaluation

The WDNR and the Wisconsin Department of Health Services have reviewed data and research from the Lincoln Park/Milwaukee River site and elsewhere in Wisconsin. They concluded that inhalation exposure of PCBs from exposed sediment in the Lincoln Park/ Milwaukee River area is not significant compared to exposure from fish consumption or direct contact with exposed sediment (WDNR, 2009). The amount of PCBs that a person might inhale from air near contaminated sediment at the site is small compared to eating fish from the river or from accidentally ingesting small amounts of sediment from dirty hands. Exposure to PCBs from direct contact or from airborne particles at the levels found at the site is not expected to result in illness over the short term; however, PCBs can accumulate in the body over time to the point where they can cause harm. The area is posted with advisory signs to warn the public about contact with the sediments and fish consumption.

1.5.6 Ecological Risk Evaluation

The Wisconsin Water Program staff developed and published a set of consensus-based sediment quality guidelines (CBSQGs) (WDNR, 2003). The CBSQG numbers are the geometric means from several sets of sediment quality guidelines (SQGs) that had been previously developed independently by several states, Canadian provinces, USEPA, the National Oceanic and Atmospheric Administration, and several researchers (Persaud et al. 1993; Long and Morgan, 1991; Ingersoll et al., 1996a, 1996b; MacDonald et al., 2000a, 2000b; Swartz, 1999). The SQGs generally were developed using empirical approaches based on databases that related a range of observed effects (for example, reduced survival, growth, or reproduction of benthic macro invertebrate organisms) to a range of increasing concentration of individual sediment-associated contaminants. The guidelines establish two concentration levels based on effects—a lower threshold effect concentration (TEC) at which no or minimal effects are predicted and a probable effect concentration (PEC) at which adverse effects are highly probable or will frequently be seen. The focus of the CBSQGs was primarily on developing concentrations of chemicals that would be protective of the majority of bottom dwelling species that reside on or in the sediment and sediment pore water.

The effects-based CBSQGs are intended as screening level concentrations for commonly found contaminants that will help identify the need for further actions. They are used to assess the quality of prospectively dredged materials, to screen site concentrations for evaluation of the relative potential risks to sediment dwelling species, to evaluate the need to collect additional sediment chemistry data, as toxicity benchmarks in a screening level ecological risk assessment, and as one line of evidence among multiple lines of evidence used to support decision making. The CBSQG should not be used on a stand-alone basis to establish cleanup levels or for sediment management decision making.

Data from both the 2003 sampling event (WDNR, 2005) and the 2008 investigation show that the total PCB concentrations in the biologically active zone exceeds the PEC in more than 50 percent of the samples analyzed. This suggests probable adverse effects on sediment dwelling organisms because of elevated total PCB concentrations in much of the surface sediment (STN, 2009).

SECTION 2

Development and Identification of Applicable Regulations and RAOs

2.1 Summary of Applicable Federal, State, and Local Regulations

Applicable federal, state, and local regulatory requirements were evaluated with respect to exposure pathways and receptors. The primary pathway of concern is human health with respect to ingestion of fish tissue. Other human receptor exposure pathways include dermal contact and ingestion through incidental contact with PCB-contaminated sediment. Standards also were evaluated with respect to federal and state permitting requirements for implementing remedial operations at the site. Applicable regulatory requirements identified to address these considerations and establish RAOs were grouped into three types: chemical-specific, location-specific, and action-specific and are discussed below.

2.1.1 Chemical-Specific Requirements

Chemical-specific requirements include laws and requirements that establish health- or risk-based numerical values or methodologies for environmental contaminant concentrations or discharge.

Resource Conservation and Recovery Act

Sediment to be excavated and disposed offsite should be classified as to its Resource Conservation and Recovery Act (RCRA) status to determine whether RCRA requirements apply. Under RCRA, there is an exclusion from hazardous waste requirements for dredged materials at 40 Code of Federal Regulations (CFR) 261.4(g). RCRA is not a requirement for contaminated sediments if the sediments are remediated under the Clean Water Act (CWA) Section 404 or the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) Section 103. RCRA specifically excludes sediments managed under a Section 404 permit as follows:

> *40 CFR 261(g). Dredged material that is not a hazardous waste. Dredged material that is subject to the requirements of a permit that has been issued under 404 of the Federal Water Pollution Control Act (33 U.S.C.* [United States Code] *1344) or Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1413) is not a hazardous waste*.

Exclusion from hazardous waste requirements does not exclude the sediment from potentially being regulated as a solid waste by the state.

If the sediments are not remediated under the CWA or MPRSA, Subtitle C requirements may apply.

Land disposal restrictions (LDRs) apply to hazardous wastes that are intended for land disposal. Because the sediments are not hazardous waste, LDRs do not apply and are not a requirement for the sediment.

Clean Water Act

The CWA provides regulations for the discharge of pollutants into the waters of the United States. It required USEPA to set water quality standards for all contaminants in surface waters and that permits are obtained for the discharge of pollutants from a point source into navigable waters.

A federal program called the Great Lakes Water Quality Initiative was begun in 1989 to develop uniform water quality criteria for the Great Lakes Basin and resulted in the publication of criteria and methodologies for developing water quality criteria. These criteria were promulgated in the Great Lakes Critical Programs Act of 1990 and are incorporated in 40 CFR Part 132. Based on these criteria, it is likely that National Pollutant Discharge Elimination System (NPDES) limits for PCBs will be set at nondetectable levels.

2.1.2 Action-Specific Requirements

Action-specific requirements are requirements that define acceptable treatment and disposal procedures for hazardous substances. They generally set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities related to managing hazardous substances or pollutants. These requirements are triggered by the remedial activities selected to accomplish a remedy. Since there are usually several alternative actions for any remedial site, very different requirements may apply. The action-specific requirements do not solely determine the remedial alternative, but indicate how or to what level treatment or cleanup will be achieved.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) regulates the remediation of soil contaminated with PCBs under 40 CFR 761.61(a), *Self-implementing On-site Cleanup and Disposal of PCB Remediation Waste*; however, this section specifically excludes remediation of sediment from the self-implementing rules. As a result, the TSCA self-implementing rules are not requirements for the Lincoln Park/Milwaukee River site.

TSCA also requires soil contaminated with PCBs at concentrations of 50 mg/kg or greater to be disposed of at either a hazardous waste landfill permitted under RCRA or at a chemical waste landfill permitted under TSCA. Currently, it is estimated that approximately 14,000 cubic yards of sediment exceeds 50 mg/kg at the Lincoln Park/Milwaukee River site. Therefore, the chemical waste landfill requirements under 40 CFR 761.75 do have to be met and are a requirement for excavated sediment.

Clean Water Act

Contaminated sediments are addressed under 40 CFR 761.61(b)(3), *Performance-based Cleanup.* This section specifically requires that sediment dredged or excavated from waters of the United States be managed in accordance with a permit issued by the U.S. Army Corps of Engineers (USACE) under Section 404 of the CWA.

WDNR Chapter 30 Permit (Section 401 Water Quality Certification)

The WDNR Chapter 30 permit refers to Section 281.14, 401 CWA, 30.20, 30.12(1), Wisconsin Statutes, a permit to remove materials from the bed of a river and a permit to place structures (such as fill material, steel sheet pilings, coffer dams) on the bed of the river.

WDNR NR 216 Permit

The WDNR NR 216 permit addresses requirements for construction site storm water runoff under the WPDES.

2.1.3 Location-Specific Requirements

Location-specific requirements are requirements that relate to the geographical position of the site. State and federal laws and regulations that apply to the protection of wetlands, construction in floodplains, and protection of endangered species in streams or rivers are examples of location-specific requirements. The most important location-specific requirements for the Lincoln Park/Milwaukee River site are the following:

- Fish and Wildlife Coordination Act—This act was enacted to protect fish and wildlife when actions result in the control or structural modification of a natural stream or body of water. The statute requires that any action taken involves consideration of the effect that water-related projects would have on fish and wildlife, and that preventative actions are made to prevent loss or damage to these resources.
- River and Harbors Act—Section 10, administered by USACE as part of the Section 404 permit, prohibits the creation of obstructions to the capacity of, or excavation or fill within the limits of, the navigable waters of the United States. Typical requirements of dredging permits include measures to minimize resuspension of sediments and erosion of sediments and stream banks during excavation.
- Endangered Species Act of 1973—This act requires that federal agencies ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species and will not destroy or adversely modify critical habitat.
- Milwaukee Metropolitan Sewerage District—A permit is required to discharge treated groundwater and storm water to a sanitary sewer before any action is initiated. The permit outlines the requirements to be adhered to, which typically include limitations on chemical concentrations and total suspended solids; volume of discharge; effluent sampling monitoring requirements; and reporting requirements.

2.2 Remedial Action Objectives

RAOs are requirements that remedial alternatives should achieve to provide adequate protection of human health and the environment while meeting requirements or complying with permits. This section presents RAOs for the contaminated sediment at the Lincoln Park/Milwaukee River site.

General remedial objectives relate to specific contaminated media such as sediment, potential exposure routes, and the identification of target remediation levels. This analysis is focused on the contaminated sediments at the Lincoln Park/Milwaukee River site.

The following RAOs were established for the assessment of remedial alternatives:

- Support removal of BUIs within the Milwaukee Estuary AOC
  - Fish and wildlife consumption advisories
  - Degradation of benthos
  - Restrictions on dredging
  - Degradation of fish and wildlife habitat
- Minimize potential human health and environmental risks associated with remedial activities, to the extent practical
- Upon completion of remedial activities, improve habitat of the site through restoration efforts

A remedial action goal of 1 mg/kg PCB in sediment is recommended for the Lincoln Park/ Milwaukee River site. This goal is consistent with what has been established previously at other reaches within the Milwaukee Estuary AOC (Blatz Pavilion site [NRT, 2007]) and is considered to be protective to human health and the environment.

SECTION 3

Identification and Screening of Technologies and Process Options

This section describes the identification and screening of available remedial technologies and process options based on the remedial objectives applicable to the Lincoln Park/ Milwaukee River site. The first step in the process is to identify general remedial actions that can meet the remedial objectives. Remedial actions are broad categories that can be used alone or in conjunction with other actions to meet the remedial objectives of the site. Within each remedial action, technologies and their associated process options were identified. For each remedial action, several remedial technologies may exist, each of which may be subdivided according to process options for screening purposes.

Those technologies and process options identified for screening are assembled into alternatives described in the next section. Habitat restoration will be included with alternatives as appropriate.

3.1 General Remedial Actions

General remedial actions that may be applicable to the project include the following:

- No action
- Monitored natural recovery (MNR)
- Containment
- In situ treatment
- Ex situ treatment
- Sediment removal
- Offsite disposal
- Habitat restoration

For each remedial action (except no action), remedial technologies and associated process options considered to be potentially appropriate and effective for the contaminated sediment within the various zones of the Lincoln Park/Milwaukee River site were identified based on professional experience, published sources, computer databases, and other documentation and resources.

3.2 Identification and Screening of Technology Types and Process Options

In this section, the available technology types and process options were screened to identify technologies applicable to remediating sediment at the Lincoln Park/Milwaukee River site. This screening step may eliminate a general remedial action from the FS process if no feasible technologies are identified. The objective, however, is to retain the best technology types and process options within each general remedial action and to use them to develop remedial alternatives. Each technology type and process option is either a demonstrated or proven process, or a process that has undergone laboratory trials or bench-scale testing.

The screening process of remedial actions is based on the following criteria:

- Technical and logistical feasibility (implementability)
- Environmental risk (effectiveness)
- Relative cost
- Public acceptance

Effectiveness is the ability of the process option to perform as part of a comprehensive remedial plan to meet RAOs under the conditions and limitations present at the site. The National Oil and Hazardous Substances Pollution Contingency Plan defines effectiveness as the "degree to which an alternative reduces toxicity, mobility, or volume, minimizes residual risk, affords long-term protection, complies with applicable regulations, minimizes short-term impacts, and how quickly it achieves protection." This is a relative measure for comparison of process options that perform the same or similar functions. Implementability refers to the relative degree of difficulty anticipated in implementing a particular process option under regulatory, technical, and schedule constraints posed by circumstances at the Lincoln Park/Milwaukee River site. At this point, the cost criterion is comparative only. Similar to the effectiveness criterion, the cost criterion is used to preclude further evaluation of process options that are costly if other lower cost choices with similar functions and similar effectiveness could be performed. The cost criterion includes costs of construction and any long-term costs to operate and maintain technologies that are part of an alternative.

Available treatment processes are typically divided into three technology types—biological, physical/chemical, and thermal—which are applied in one or more general remedial actions.

Technologies and process options that are screened out based on the defined criteria listed above are highlighted in Table 2.

TABLE 2
Remedial Action Screening Summary
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Remedial Action	Process Options	Descriptions	Screening Criteria: Effectiveness	Implementability	Relative Cost	Public Acceptance	Screening Comment
No Action							
	None	No further actions to address contaminated sediment.	Some natural attenuation will occur as PCBs slowly biodegrade over time and sediments are redistributed and buried.	Not applicable.	None	Unfavorable	Required for comparison.
Natural Recovery							
	Monitored Natural Recovery	Allow naturally occurring physical, chemical, and biological processes to reduce the bioavailability and/or toxicity of PCBs to acceptable levels.	Some natural attenuation will occur as PCBs slowly biodegrade over time and sediments are redistributed and buried or covered by clean sediments.	Easily implementable.	Low	Unfavorable	Retained for further evaluation.
Monitoring							
	Sampling and Analysis	Routine long-term sampling and analysis of sediment at selected locations to record site conditions and contamination levels.	Not effective in reducing concentrations or controlling exposure. Can be used in conjunction with other technologies to allow monitoring of effectiveness.	Easily implementable.	Low	Uncertain	Retained for further evaluation. This technology includes monitoring the natural decline in PCB concentrations or monitoring the effectiveness of remedial technologies.
Containment							
	Isolation Cap	Place one or more layers of clean material over the sediment to isolate sediments and reduce the amount of contaminant flux to environment.	Can be effective if cap remains in place. Regular cap inspection and maintenance is required for eroded or disturbed areas. Unless combined with partial sediment removal, will increase river bottom elevation and increase flooding potential.	Easily implementable.	Low to Moderate	Uncertain	Retained for further evaluation.
In Situ Treatment							
	Fixation / Stabilization	Immobilize contaminants by physically binding or enclosing the sediments within a stabilized mass or chemically treating them to become immobile.	Can be effective in immobilizing contaminants; but not consistently proven.	Requires dewatering of sediments.	High	Uncertain	Not retained because of effectiveness uncertainty, cost, and public acceptance.
	Reactive Cap	Placement of a layer of reactive material on top of contaminated sediment to isolate contaminated sediments, prevent contact with the water column or benthic organisms, and treat contaminant flux.	Effectiveness is uncertain, however reactive caps are gaining acceptance and several pilot- and full-scale applications are being implemented. Same concerns as isolation cap regarding cap maintenance, and river bottom elevation, although reactive cap thickness could be less than isolation cap.	Generally more difficult to implement than isolation cap,	Moderate to High	Uncertain	Retained for further evaluation.
	Activated Carbon Sequestration	Bioavailability of sediment contaminant is reduced by addition of sorbent amendment (activated carbon). Carbon coated with a weighting agent is broadcast over the top of the biologically active sediment layer where coating material breaks down and amendment is slowly mixed in by benthic organisms through bioturbation.	Recent development; pilot test sites currently underway. Targeted for low contaminant concentrations at the surface. Potential toxicity to organisms is still being studied.	Availability of trademarked agglomerate material may be limited. Broadcasting material over sediments should be easy to implement.	Moderate	Uncertain	Not retained because of effectiveness uncertainty.
Sediment Removal							
	Dry Excavation	Install temporary barriers and/or temporarily reroute river, dry out sediment, and excavate sediment using conventional earthmoving equipment.	Very effective. Unsaturated soil within normal range of excavation equipment (0 to 8 feet). Very few obstructions to excavation at the site. PCB-contaminated sediment greater than 1 mg/kg is removed from the waterway eliminating direct contact human exposure and fish/benthic community exposure.	Implementation is possible. Adequate workspace and staging areas available. Need for drying agent to meet paint filter test could be readily conducted as pilot or bench scale testing.	Moderate	Favorable	Retained for further evaluation.

TABLE 2
Remedial Action Screening Summary
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Remedial Action	Process Options	Descriptions	Screening Criteria: Effectiveness	Screening Criteria: Implementability	Screening Criteria: Relative Cost	Screening Criteria: Public Acceptance	Screening Comment
	Mechanical Dredge	Install temporary barriers to contain suspended solids, excavate submerged sediment using mechanical dredge, and dewater sediment.	Effective. Similar to dry excavation, but with less precision. Sediment within normal range of excavation equipment. PCB-contaminated sediment greater than 1 mg/kg is removed from the waterway eliminating direct contact human exposure and fish/benthic community exposure.	Implementation is difficult because of shallow overall depth of water. Inadequate depth for barge and too deep for excavator alone. Limited accessibility from shore.	Moderate to High	Favorable	Not retained because of implementability.
Ex Situ Treatment							
	Particle Size Segregation	Vibrating or fixed screens, hydrocyclones, or gravity separation used to segregate particle sizes in sediment.	Effective. Can be a good source of fill materials for beneficial use and habitat restoration activities if sufficient quantity of sands/gravels exists within sediments to be removed.	Requires sediment excavation. Easily implemented. Pilot or bench scale testing would be required.	Moderate	Favorable	Retained for further evaluation.
	Sediment Washing	PCBs sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system based on particle size. Wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics. It does not destroy or immobilize the contaminants. Consequently, the resulting concentrated sediment must be disposed of carefully.	Considered a transfer technology in that the contaminants are not destroyed, but transferred to another media. Varying concentrations and mix of PCBs at the site creates a complex washing solution. There is a significant volume of sediment greater than 50 mg/kg. Reduction to below 1 mg/kg may require multiple washings.	Requires sediment excavation. Pilot/bench scale testing would be required. Equipment and utility requirements are substantial.	High	Uncertain	Not retained because of implementability and cost.
	Vitrification	Dewatered and dried sediment heated to a glass state resulting in the incineration of PCBs.	Effective. PCBs are vaporized. Post-process soil can be used for beneficial use. However, offgas vapors require collection and treatment, and high moisture content sediments must be dried out before the melting process can begin.	Requires excavation and dewatering of sediments. Drying process requires large amounts of energy. Permits for the acceptance of PCB-contaminated sediments at the fixed vitrification facility in Neenah or Winneconne are not known to be in place.	High	Uncertain	Not retained because of implementability and cost.
Offsite Disposal							
	Subtitle D Solid Waste Landfill	Sediments with PCB concentrations less than 50 mg/kg are permanently disposed in a non-TSCA landfill approved for special waste disposal of non-TSCA PCB sediments.	Very effective.	Local landfills within the Milwaukee area are approved for special waste disposal of the less than 50 mg/kg PCB sediment.	Moderate	Favorable	Retained for further evaluation.
	TSCA Landfill	Sediments with PCB concentrations greater than 50 mg/kg are permanently disposed of in a licensed TSCA-approved facility.	Very effective	Out-of-state landfills are relatively close and approved for disposal of greater than 50 mg/kg PCB sediments.	Moderate to high	Favorable	Retained for further evaluation.
Habitat Restoration							
	Specific to remedial alternative implemented	Implemented objectives would include best management practices (BMPs) to restore the terrestrial and aquatic habitats affected by the remedial action activities to provide improved recreational activities.	Not incorporated to directly impact remediation effectiveness.	Easily implemented.	Low to Moderate	Favorable	Retained for further evaluation.

3.2.1 No Action

Under a no action alternative, no remedial response is performed. This alternative typically is used as a baseline to which other remedial options are compared. A no action alternative may be appropriate where current site conditions present little or no human health or environmental risk. The no action alternative is retained for the purpose of comparison with other remedial options.

3.2.2 Monitored Natural Recovery

MNR involves the reliance upon naturally occurring physical, chemical, and biological processes to reduce the bioavailability and/or toxicity of contaminants to acceptable levels. For example, exposure levels are reduced by a decrease in contaminant concentration levels in the near-surface sediment zone through burial or mixing-in-place with cleaner sediment. Contaminated sediment in depositional areas can be buried gradually by cleaner sediment. This alternative can be implemented only after all significant continuing sources of contaminants to the system have been eliminated.

Typically, MNR is required to occur within a set amount of time and may be used in combination with other approaches. A remedial alternative that involves MNR will require a comprehensive long-term monitoring program to verify that such processes are taking place and that anticipated human health and environmental risk reductions are being achieved. MNR is generally conducive at sediment sites with the following conditions:

- Sources are controlled.
- Short-term human health and environmental risks are low and/or declining.
- Natural recovery processes have a high degree of certainty to continue.
- Institutional controls effectively restrict human exposure.
- The sediment bed is stable and likely to remain stable.
- Sediment excavation could cause significant resuspension and recontamination downstream.
- Space limitations preclude ex situ remedial options and are not considered cost effective relative to the risk reduction achieved.

In general, the site is conducive to the conditions above with the exception of the potential instability of the sediment in some areas of the site. These areas of the site would be evaluated further during a detailed analysis. Therefore, MNR is retained for further evaluation at the site.

3.2.3 Monitoring

Monitoring can be implemented in combination with any remedial technology as an early warning of the need for additional remedial action or to monitor the effectiveness of a completed remedial action. Monitoring may include sampling and analysis of sediment, soil, groundwater, surface water, groundwater/surface water interface, fish tissue, toxicity tests, and/or bioaccumulation tests. A sampling plan is developed in accordance with the final remedial alternative selected to ensure that remedial objectives are met. Regardless of the technologies or combination of technologies selected for implementation at the Lincoln Park/Milwaukee River site, monitoring will likely be required; therefore, it is retained.

3.2.4 Institutional Controls

Institutional controls are administrative and/or legal restrictions placed on uses of a property or waterway (for example, deed restrictions, and access restrictions). Institutional controls also can take the form of issuance of public health advisories (for example, fish consumption advisories).

Deed and access restrictions can be established for a contaminated property to limit its future use. Similarly, public waterways can be regulated by establishing recreational use limitations, such as swimming bans and "no wake" zones to minimize the potential for sediment disturbance. Fences can be built around the perimeter of contaminated properties to prevent entry by unauthorized persons.

Fish consumption advisories are intended to provide guidelines to members of the public who may eat fish with elevated contamination levels. The site is posted with advisory signs to warn the public about contact with the sediments and fish consumption. Although institutional controls currently are in use, the objectives are to remove the institutional controls. Therefore, this option will not be retained for incorporation into alternatives.

3.2.5 Containment

Capping of sediments involves subaqueous placement of a layer of clean material over the contaminated sediment to physically isolate the contaminated sediment, impeding contaminant flux to the environment, and/or stabilization of contaminated sediment to prevent transport and redeposition elsewhere. Capping has been implemented at numerous sites.

Developing a complete in situ capping remedial alternative involves the following steps:

- Defining project objectives and performance standards
- Characterizing the physical, chemical, and biological properties of the sediment, laterally and vertically
- Characterizing hydrodynamic conditions of the Lincoln Park/Milwaukee River site, which includes bathymetry, currents, depths, waterway uses, and geotechnical conditions such as layer stratification and physical properties of foundation layers
- Determining the feasibility of capping, which may apply to some portions of the site and not other areas
- Designing the cap, considering types and thickness of materials
- Determining appropriate equipment and methods for placement of the cap materials
- Determining methods to verify that the final cap design meets the standards and objectives
- Developing a suitable long-term monitoring and management program, allowing for maintenance and repair

Feasibility of capping is dependent upon the characteristics of contaminants, physical and hydrological site conditions, and current and anticipated future uses of the waterway. Contaminant transport through the cap is dictated by contaminant type (for example, organic or inorganic), diffusivity, and adsorption potential on the cap material. Capping is more appropriate for contaminated sediment located in areas with low erosion potential, low surface water velocities, and less groundwater seepage.

Little upward transport of PCBs would be expected through a cap because they are highly adsorptive. Consideration should be given to existing and future uses of the waterway, such as recreation, navigation, or use as a water source that may preclude the implementation of an isolation cap.

Components of caps can include sand, clean sediment, geotextiles, gravel, or a combination of these materials. If the cap is placed in a higher energy environment with exposure to strong currents, waves, ice, or propeller wash, an armoring layer of large armor stone will need to be placed as the top layer of the cap. For low energy areas such as within floodplains outside of the main river channel, the cap could consist of sand overlain by gravel.

Sediment disturbance and resuspension/mixing should be minimized when choosing placement methods and materials for capping. Delivery method selection also incorporates the relative importance of cap thickness consistency and the water depth at the capping site, which could limit delivery options if water depth is shallow.

Because of the overall shallow water depths at the Lincoln Park/Milwaukee River site, installing an isolation cap would only be feasible if the site was dewatered and allowed to dry. Furthermore, in order to maintain the current water elevation, removal of sediment at least equal to the thickness of the capping materials applied would need to take place. Failure to maintain current elevations and grades within the river channel and associated floodplain could result in flooding of properties upstream of the project because of the additional volume of capping materials within the project site.

Capping may be an appropriate technology for one or more areas within each zone at the Lincoln Park/Milwaukee River site and therefore will be evaluated further.

3.2.6 In Situ Treatment

In situ treatment methods are implemented without excavating contaminated sediment. Three specific technologies are considered under this remedial alternative: fixation/stabilization, activated carbon sequestration using SediMite®, and reactive cap.

Fixation/Stabilization

This technology involves immobilizing contaminants by physically binding or enclosing the sediment within a stabilized mass, or chemically treating the contaminants. Portland cement, lime, or some other additive is mixed with the sediment in situ to encapsulate the sediment and/or reduce the solubility, mobility, and toxicity of the contaminants. Potential problems with this technology include the facts that contaminant release because of erosion may still be possible, and post-treatment physical characteristics of the sediment are not very amenable to growth of aquatic organisms. The application of this technology would require dewatering of sediment; otherwise, substantial resuspension of sediment would occur.

Because of the potential difficulties stated above, in situ fixation/stabilization will not be retained for further evaluation at the Lincoln Park/Milwaukee River site.

Activated Carbon Sequestration (SediMite®)

Researchers have demonstrated that the bioavailability of sediment contaminants can be reduced by the addition of sorbent amendments such as activated carbon for PCBs. This method is based on adding carbon to the biologically active sediment layer (typically the top 6 to 12 inches), which is the primary source of exposure to benthic organisms and to the water column leading to bioaccumulation in the food web. The addition of activated carbon reduces PCB flux to the overlying waters compared to an isolation cap that does not have the sorption capacity of carbon.

SediMite® is an agglomerate material for in situ sediment treatment that does not require mechanical mixing as in fixation/stabilization technologies. SediMite® uses the activity of the benthic organisms in a bioturbation process to naturally mix the activated carbon into the top sediment layers over an extended time period.

The principal advantage to this approach is that the biologically active zone is targeted with minimized disruption to the habitat and sediment. In addition, existing application technologies can be used to distribute the material at the water body surface. The SediMite® agglomerate is typically broadcast over the water body surface and is weighted to sink the bottom to resist entrainment or resuspension.

The disadvantages are that the treatment is limited to surface sediment with low-level contamination. High energy environments could disturb the higher concentration sediments at depth and potential toxicity to organisms is still being studied. The anticipated application for this technology is in widespread areas of low-level contamination, chiefly for sensitive ecosystems.

Since this technology relies on bioturbation for mixing and portions of the site are not submerged for several months of the year, the effectiveness is limited. In addition, portions of the surface sediment are not low-level contamination. Therefore, this technology is not retained for further evaluation.

Reactive Cap

This remedial alternative involves placing a layer of reactive material on top of contaminated sediment. The reactive material is intended to isolate contaminated sediment from the water phase while reducing contaminant concentrations where an upward groundwater gradient exists through the sediment column. Examples include engineered clay aggregate materials (for example, AquaBlok®), and reactive/adsorptive materials such as activated carbon, apatite, coke, organoclay, zero-valent iron, and zeolite. These caps will not treat contaminants that are at depth, but will treat or immobilize contaminants that are mobilized up through the cap, preventing contact with the water column or benthic organisms. Innovative in situ treatment in the form of reactive caps or sediment additives is gaining acceptance and several pilot- and full-scale applications of the more promising technologies are underway. Two specific reactive cap technologies (Reactive Core Mat™ and AquaBlok®) were selected based on their more advanced stage of development and commercial availability.

Reactive Core Mat™

This permeable reactive cap can incorporate a variety of reactive core materials (for example, organoclay, activated carbon, apatite, dual media) designed to treat the site contaminants of concern. The core materials are encapsulated between textiles to form a geosynthetic mat, which can be readily deployed in a controlled manner. Multiple reactive materials can be layered in series depending on the site requirements. Once installed, the permeable cap acts like horizontal permeable reactive barrier (PRB), a commonly implemented approach for contaminated groundwater treatment. Multiple reactive materials can be selected for inclusion in the mat. Organoclay works well for the retention of low solubility organic compounds such as PCBs. The primary advantages of the Reactive Core Mat™ approach are a reduction in dissolved contaminant transport into surface water, a reduction in overall cap thickness, verifiable coverage of sediment, and the ability to incorporate a variety of reactive media to target specific pollutants. Furthermore, the geotextile provides tensile strength and a biointrusion barrier. It is possible to retrieve a sample of the mat following site implementation to evaluate system performance.

The disadvantages of this approach are that the cap amendments ultimately become exhausted when all of the adsorption sites are saturated requiring eventual replacement. This duration depends on contaminant concentrations and field conditions. Laboratory testing is recommended to determine the appropriate composition and thickness of the Reactive Core Mat™. The placement of the Reactive Core Mat™ can cause damage to sensitive habitat. This technology is retained for further evaluation because of its effectiveness on PCBs and its implementability at the site.

AquaBlok®

The primary characteristic of the AquaBlok® material is that it swells significantly when hydrated, expanding and contracting to create an impermeable chemically sorptive barrier. The primary goal of this approach is to isolate macroinvertebrates from the contamination. This cap typically is bentonite based for fresh water applications and is good to a salinity of approximately 14,000 parts per billion (ppb). The typical cap thickness is 6 inches. The materials composition can be modified to deliver in situ chemical reagents for treatment.

The principal advantages of this approach include physical isolation and stabilization of contaminated sediment, and contaminant treatment for the reactive gate approach. The composite aggregate also provides a clean habitat for benthic organisms.

With the standard AquaBlok® installation, the primary disadvantage is the alteration of natural groundwater flow potentially diverting contaminants around the side of the cap in an unpredictable manner and potential issues with gas buildup under the cap, which can lead to cap displacement. In comparison to a reactive cap, AquaBlok® is less implementable at the site because of the varying surface water elevations. Therefore, AquaBlok® is not retained for further evaluation.

3.2.7 Sediment Removal

Removing contaminated sediment offers the advantage of contaminant mass reduction in the aquatic environment and can reduce the bioaccumulation of PCBs in fish. Sediment removal can be performed through several different methods. Removing sediment mechanically "in the dry" can be performed by damming water to create a cell, dewatering the cell, and excavating using conventional earthmoving equipment. Sediment removal also can be achieved without dewatering using a hydraulic or mechanical dredge. Because of the shallow water depth of the Lincoln Park/Milwaukee River site, only dry excavation has been retained for further evaluation.

Dry Excavation

Excavating sediment in the dry requires diverting water from the entire project site or installing a water barrier around the perimeter of the area to be remediated, pumping out or otherwise diverting water from the "cell," and excavating sediments using a backhoe or other suitable piece of equipment. Dry excavation has been performed successfully at many sites with contaminated sediment.

The most feasible way to dewater the site would be to temporarily reroute the river channel to the alternative channel east of the site. Once the reroute is complete, the remaining water downstream would be allowed to dry or could be pumped out. The main advantage of sediment removal by dry excavation is the greater likelihood that all contaminated sediment will be removed. If unanticipated or unusual conditions are present within or beneath contaminated sediment (that is, presence of free-phase product), the dry excavation method greatly increases the likelihood of discovering these circumstances, as well as affording greater flexibility for dealing with them, as compared to excavation conducted without lowering the normal water level. Sediment resuspension is not an issue as it is for other wet excavation methods such as mechanical or hydraulic dredging. Contaminated sediment spreading downstream or elsewhere within the water body does not happen with dry excavation once dewatering begins, as an inward hydraulic gradient is maintained.

Dry excavation can present some difficulties during implementation. The location of the contaminated sediment may dictate whether dry excavation can be used. A substantial land area will be required near the dewatered cell or cells to perform a dry excavation action. Space must be available for loading/offloading and temporary storage of stabilized sediment, as well as space for support trailers, decontamination facilities, and, if necessary, water treatment facilities. If trucks are used to transport the sediment to an offsite disposal area, additional noise will be created and potential damage to roads along the haul route can occur.

An additional disadvantage of dry excavation, common to all sediment removal options, is that the aquatic environment is greatly disturbed during removal. In some cases, if all sediment is removed, placement of imported materials may be necessary to expedite the re-establishment of native aquatic species.

Depending upon the nature of the sediment after excavation, the addition of Calciment®, cement, or other drying/stabilization reagent may be required during excavation. If the sediments are fine-grained, they may not readily drain following dewatering, and may require drying/stabilization before they are transported out of the excavation cell. Perimeter air monitoring for total suspended particulates (especially if a stabilizing reagent prone to producing dust is used) and PCBs likely will be required.

During any potential sediment-disturbing activity associated with rerouting the river channel or barrier construction, turbidity monitoring in the water body also may be required. If visual checks or stratigraphy change is not sufficient or appropriate to determine the extent of excavation activities, confirmation sampling is completed to verify that cleanup goals have been achieved.

Mechanical Dredging

Mechanical dredging differs from dry excavation in that sediments are not dewatered before removing them from the water body. Mechanical dredging can be performed using a number of possible different pieces of equipment including a clamshell bucket, dragline dredge, dipper dredge, backhoe dredge, or bucket ladder dredge. Most of these can either be land-based or placed on a barge. A mechanical dredge with a specially designed environmental clamshell bucket is the most commonly used. The clamshell bucket is suspended from a derrick on a barge or platform. Another commonly used piece of equipment is the backhoe dredge, which can be a land-based excavator placed on a barge to remove sediment. Other types of equipment, including amphibious vehicles, are less desirable for excavation of contaminated sediment because of limited availability and/or the greater potential for sediment resuspension. Typically, mechanical dredges used for environmental remediation have global positioning system (GPS) equipment that tracks the locations and elevations that have been excavated.

Mechanical dredging is performed either from the shore adjacent to the area of contaminated sediment, or from a barge that is moved around the area, as needed. The depth of water typically required to float a barge with a mechanical dredge is at least 2 to 3 feet. Excavated materials are either stockpiled on shore or placed in a barge and transported to another area for offloading when the barge is full. The weight of sediment that can be placed onto a barge is limited by the depth of water available to float the barge. Unless the sediments are granular and drain readily, dewatering and/or stabilization will be required before final disposal.

Fugitive odor and dust emissions are not likely during the actual excavation activities, since the sediment is wet; however, these may occur as the sediment is processed (that is, dewatered and/or stabilized) for disposal.

Similar to dry excavation, a sizeable amount of land near the area of contaminated sediment is necessary for sediment processing, handling, and support facilities if mechanical dredging is used. Mechanical dredging also has the disadvantage of requiring multiple barges during operations including the mechanical dredge barge and multiple receiving barges.

Mechanically dredging thin sediment layers results in less sediment and more water in each bucket removed, which increases the amount of water that must be treated and the cost of dewatering the sediment.

The depth of water at the site under high pool conditions may allow a mechanical dredge barge to float, but movement would be restricted. In addition, the depth of water would only allow a limited amount of weight to be placed on the barge. This would result in a dramatic decrease in productivity, increasing the cost. Access from the shore to operate a mechanical dredge and place the sediment is limited unless the natural habitat adjacent to the river is removed in multiple areas. Therefore, mechanical dredging is not retained for further evaluation.

3.2.8 Ex Situ Treatment

Ex situ treatment methods are implemented following excavation of contaminated soil or sediment. This remedial alternative can involve biological, chemical, thermal, or physical processes. One of the primary advantages to performing treatment is to reduce the amount of soil or sediment that requires onsite consolidation or offsite disposal. Treatment can allow the sediment to be returned to its original location or to be beneficially reused. Disadvantages to treatment are the need for additional handling and a longer implementation time than offsite disposal. In addition, some of the treatment technologies do not destroy the PCBs, but rather transfer them to an alternative media that subsequently requires its own treatment. Three specific technologies are considered under this remedial alternative: particle size segregation, sediment washing, and vitrification.

Particle Size Segregation

Inclusion of a particle size separation step in a remedial alternative involving sediment removal may be useful if it is determined that PCB contamination is associated with a certain particle size in the sediment. For example, if PCB contamination is entirely within the finer-grained materials in the sediment, and a significant quantity of clean sand or larger grained material can be sorted out, then it could possibly be disposed of more cheaply than the contaminated fraction or be used as a beneficial fill. Possible methods of particle size segregation include using vibrating or fixed-based screens, including a hydrocyclone in the processing train, or using gravity separation if particles with significant density difference are present within the sediment. Typically, these methods require water to be a part of the process, which would result in creating the need for handling and treatment of the water produced.

Other potential disadvantages of this process include concentrating the contamination in a smaller portion of the sediment. Additionally, removing the course fraction within the sediment matrix may decrease the structural integrity of the sediment required to be disposed of offsite, which could result in higher disposal fees. The geotechnical results of the sediment sampling indicate that the sediment at the site is a mix of silt, clay, sand, and gravel. Therefore, this technology may be applicable and is retained for further evaluation.

Sediment Washing

This technology requires excavated sediment to be treated with bioremediating surfactants and requires specialized equipment within the treatment system consisting of washing units and tanks, shaker screens, hydrocyclones, water blasters, compressors, and water treatment equipment. This technology can be cost-effective for the site with relatively large volumes of PCBs with high concentrations; however, only small volumes of material can be treated at one time per unit. Multiple units could be implemented; however, multiple unit processes make the technology relatively complex and difficult to implement and more costly. Implementing this technology may require a staging area for sediment to be treated. Because of the potential difficulties stated above, sediment washing will not be retained for further evaluation.

Vitrification

Vitrification is the process of heating the dewatered sediment to a glass state and vaporizing the PCBs. This process requires the sediment to be excavated, dewatered to a dry state, and then transported to a vitrification facility. The material can then be used for beneficial use, such as landfill daily cover material. Implementation of this technology requires offgas collection and treatment as well as large amounts of energy to vaporize the PCBs. Vitrification will not be retained for further evaluation.

3.2.9 Offsite Disposal

If remedial action involving sediment removal is undertaken, sediment will need to be transported to the final disposal location by truck once it is removed. Two options are presented below and could be used in combination depending on the contamination level of the removed sediment.

Subtitle D Solid Waste Landfill

Contaminated materials from the Lincoln Park/Milwaukee River site could be trucked to an offsite Subtitle D landfill for disposal. Sampling and analysis has shown approximately 84,000 cubic yards of contaminated sediment volume at the site is between 1 and 50 mg/kg and therefore is not classified as a TSCA material and can be disposed of at specially licensed landfills in Wisconsin. Multiple landfills may be used to process the volume of dewatered sediment without causing issues with the landfill operations (that is, delivery of sediment at a pace in which the landfill can effectively mix the sediments into the municipal waste). Disposal of these sediments at a Subtitle D solid waste landfill(s) is a viable option and is retained for further evaluation.

TSCA Landfill

Based on prior sampling and analysis, it is estimated that approximately 14,000 cubic yards of the sediment volume targeted for removal would classify as TSCA material being above 50 mg/kg PCBs and require disposal at a landfill licensed to accept TSCA material. Therefore, transportation and disposal of these sediments to an out-of-state landfill (Michigan) is required. Disposal of these sediments at a TSCA landfill is a viable option and is retained for further evaluation.

3.2.10 Habitat Restoration

Habitat restoration efforts would take place after the remedial action and would be specific to the remedial alternative(s) chosen for the Lincoln Park/Milwaukee River site. Habitat restoration also would be designed for the planned operation of the Estabrook Park Dam and varying surface water elevations. The goal of the habitat restoration is to restore the terrestrial and aquatic habitats affected by the remedial action activities and provide an area for recreational fishing, bird watching, and other wildlife activities that can be experienced by all citizens.

Specific habitat restoration objectives that could be implemented include the following:

- Create variations in substrate out of capping materials (for example, sand, gravel, armoring material) to develop fish spawning areas and shelter
- Construct a varied riverbed elevation as part of the sediment excavation activities to create variations in the aquatic topography (for example, shelves and pools) to ensure that habitat features would continue to exist with water level fluctuations

- Provide areas of submerged vegetation for larval and adult fish habitat as well as using natural and constructed structures (for example, log/rock shelters, tree revetments, etc.) to support a high-quality fish community
- Increase the potential for mammal, bird, and reptile species by increasing the quality of the water/land interface with shoreline vegetation and nesting structures

Habitat restoration is retained as for further evaluation in combination with each alternative.

SECTION 4

Alternative Descriptions

4.1 Introduction

The remedial technologies and process options that remained after screening were assembled into a range of alternatives that address the RAOs for the site. The specific details of the remedial technologies presented in each alternative are intended to serve as representative examples for use in estimating an order-of-magnitude cost. Other viable options within the same remedial technology that achieve the same objectives may be evaluated during remedial design activities for the site. This section provides a detailed description of each proposed remedial alternative. Some technologies are common to several alternatives, so they are only described once. Each of the technologies remaining after the technology screening was incorporated into at least one of the alternatives. Table 3 provides a summary of the developed remedial alternatives.

4.2 Alternative 1—No Action

A no action alternative typically is included in the assembly of alternatives for comparison purposes. Under Alternative 1, there would be no additional remedial actions conducted at the Lincoln Park/Milwaukee River site to control the continued release of and exposure to contaminants. No containment would be completed, and no further action would be performed. This alternative does not provide any specific response actions for environmental monitoring, controlling the migration of contaminants, or mitigating their concentrations. Sediments are not likely to remain in place because they are located in a riverine environment that is prone to scour and deposition processes. Warnings and advisories would be required to address fish consumption, dermal contact with contaminated sediment, and ingestion of contaminated sediment. These warnings and advisories are in place already. Signs are posted throughout the area with more signs planned in the near future. There is no beneficial use of the sediment under this alternative. Natural PCB degradation is not likely to occur at a measurable rate or within a reasonable time period because of the persistence of PCBs, though the contaminated sediment may be covered with clean sediment over time.

4.3 Alternative 2—Monitored Natural Recovery

MNR includes a long-term monitoring program. No additional remedial actions would be conducted at the site to control the continued release of and exposure to contaminants. Sediments are not likely to remain in place because they are located in a riverine environment that is prone to scour and deposition processes. Long-term monitoring includes developing and implementing a sampling and analysis plan. The plan would involve periodic sampling, analysis, and evaluation of surface water, sediment (chemical and physical characteristics), and fish tissue. Warnings and advisories would be required to address fish consumption, dermal contact with contaminated sediment, and ingestion of contaminated sediment until natural processes reduce the contamination to acceptable risk levels. These warnings and advisories are in place already. Signs are posted throughout the area. There is no beneficial use of the sediment under this alternative. Natural PCB degradation is not likely to occur at a measurable rate or within a reasonable time period because of the persistence of PCBs, though the contaminated sediment may be covered with clean sediment over time.

4.4 Alternative 3—Containment

Alternative 3 consists of capping the sediment in Lincoln Creek and the western oxbow of the Milwaukee River (Zones 1, 2, and 3a). The cap would be constructed of a layer of sand overlain by a layer of gravel. A clean cap placed over the surface of the sediments would provide physical isolation of sediment contaminants from environmental receptors, stabilization that would prevent resuspension and transport, and chemical isolation and reduction of sediment contaminants. The expected effects of bioturbation, consolidation, and erosion must be considered in a cap design. Cap thickness is a concern in areas where a minimum water depth must be maintained. For this site, in order to place a cap of sufficient thickness in the main channels, an equal volume of sediment would be excavated from the main channels. The estimated volume of sediment for excavation is 4,500 cubic yards. Excavated sediment with PCB concentrations greater than or equal to 50 mg/kg would be transported by truck to an offsite landfill for disposal at a facility licensed to accept TSCA material. The estimated volume of sediment with PCB concentrations greater than or equal to 50 mg/kg is 450 cubic yards. Sediment with PCB concentrations less than 50 mg/kg would be placed in other areas within the western oxbow to counter the increase in elevation from the cap material in the channels. Temporary facilities for Alternatives 3 through 7 are depicted on Figure 4. The topography is depicted on Figure 5. The sediment that is placed in other areas of the western oxbow would be capped. Post-excavation verification sampling would be performed and analyzed using an onsite mobile laboratory. Air monitoring would be performed during all activities with the potential to generate emissions (that is, sediment handling and processing if reagents that may create dust are used).

Excavation is anticipated to minimize potential flooding, but would require further evaluation during design. The cap would be designed in accordance with state and federal floodplain regulations. In addition, measures would be taken to avoid impact to any threatened and endangered species according to state guidelines. Beneficial use of the sediment is not anticipated, but would be further evaluated during design.

TABLE 3
Developed Remedial Alternatives Summary
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Remedial Technologies/ Process Options		**Alternative 1 No Action**	**Alternative 2 Monitored Natural Recovery**	**Alternative 3 Containment**	**Alternative 4 In Situ Treatment**	**Alternative 5 Partial Excavation and Cap**	**Alternative 6 Excavation and Offsite Disposal**	**Alternative 7 Excavation, Ex Situ Treatment, and Offsite Disposal**
No Action	None	X						
Natural Recovery	Monitored Natural Recovery		X					
Monitoring	Sampling and Analysis		X	X	X	X	X	X
Containment	Isolation Cap			X		X		
In Situ Treatment	Reactive Cap				X			
Sediment Removal	Dry Excavation (Low Pool)					X	X	X
Ex Situ Treatment	Particle Size Segregation							X
Sediment Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle D Landfill			X		X	X	X
	Toxic Substances Control Act (TSCA) Landfill			X		X	X	X
Habitat Restoration	Specific to Alternative			X	X	X	X	X

Though the potential for sediment erosion because of propeller wash is low, a potential for erosion from storm events does exist. In addition, areas of the site are subject to groundwater discharge and would require further evaluation during design to address potential long-term impacts to the cap. The conceptual design of the cap is as follows: a minimum of 6 inches of sand (and a maximum of 9 inches with the subcontractor's overplacement allowance) overlain by a minimum of 4 inches of gravel (and a maximum of 7 inches with the overplacement allowance) would be placed over the contaminated sediment. A similar cap design was developed for the Lower Fox River in Wisconsin (Shaw and Anchor, 2007). In areas subject to the erosive effects of high velocity stormwater flow, such as the main channels, larger diameter armor stone (6 to 12 inches in diameter) would be placed over the sand and gravel.

Placement methods for the sand, gravel, and armor stone would minimize disturbance to the sediment and reduce sediment resuspension and cap/sediment mixing, but containment would be necessary to prevent downstream migration of contaminated sediment during cap placement. The variability in water elevation at the site necessitates flexibility in methods of placement. Selection of the delivery method would involve considering the relative importance of cap thickness consistency and the water depth, which will limit delivery options. Where the sediment is completely dry because of low water elevation, placement of the cap would be completed using low ground pressure earthwork equipment. In submerged areas, placement would be completed by casting the material or using low ground pressure earthwork equipment to place the material from dry areas into the submerged areas.

The cap would provide a barrier that isolates the contaminated sediments and reduces bioavailability, controls the transport and dispersal of contaminated sediments downstream, prevents excessive bioturbation by bottom fish, and provides a restored habitat. In addition, habitat restoration may include plantings to supplement existing conditions and improve habitat (submerged, emergent, and terrestrial). Habitat restoration would be designed in consultation with WDNR, Milwaukee County, GLNPO Habitat Team, and the public.

Surveys would be performed on a regular basis to monitor the long-term integrity of the cap. Cap maintenance would be performed by the property owner (Milwaukee County), which could involve the placement of additional clean materials and/or increased armoring to supplement and/or replace damaged portions of the cap.

4.5 Alternative 4—In Situ Treatment

Alternative 4 is similar to Alternative 3, but includes in situ treatment integrated with a cap. USEPA currently recognizes the following potential in situ treatment methods (USEPA, 2005):

- Biological: Enhancement of microbial degradation of contaminants by the addition of amendments or microorganisms into the sediment or into a reactive cap.
- Chemical: Destruction of contaminants through oxidation and dechlorination processes by addition of chemical reagents into the sediment or into a reactive cap.
- Immobilization*:* Solidification, stabilization, or sequestering of contaminants by adding additives to the sediment for encapsulating the contaminants in a solid matrix and/or

chemically altering the contaminants by converting them into a less bioavailable, less mobile, or less toxic form.

Innovative in situ treatment in the form of reactive caps or sediment additives is gaining acceptance and several pilot- and full-scale applications of the more promising technologies are underway. For this evaluation and developing estimated costs, a reactive geotextile mat cap technology was chosen as a representative in situ treatment technology. The reactive/adsorptive materials in the cap (such as activated carbon, apatite, coke, organoclay, zero valent iron or zeolites, depending on the contaminants of interest) will not treat contaminants that are at depth, but will treat or immobilize contaminants that are mobilized up through the cap preventing contact with the water column or benthic organisms.

The core materials would be encapsulated between textiles to form a geosynthetic mat that can be readily deployed in a controlled manner. Multiple reactive materials can be layered in series depending on the site requirements. Organoclay works well for the retention of low solubility organic compounds such as PCBs.

The primary advantages of the reactive cap technology include a reduction in dissolved contaminant transport into surface water, a reduction in overall cap thickness, verifiable coverage of sediments, control of contaminated sediment transport and dispersal, and the incorporation of a variety of reactive media to target specific pollutants. Furthermore, the geotextile provides tensile strength and a biointrusion barrier.

The disadvantage of this approach is that the cap amendments ultimately become exhausted when all of the adsorption sites are saturated, requiring eventual replacement. The duration of the cap depends on contaminant concentrations and field conditions. Laboratory testing is recommended to determine the appropriate composition and thickness of the reactive core mat. The placement of the reactive core mat can cause damage to sensitive habitat.

The typical reactive cap is approximately 6 inches thick, but would depend on the system design. Similar to Alternative 3, in order to place a cap of sufficient thickness in the main channels, an equal volume of sediment would be excavated from the main channels and placed under the cap (less than 50 mg/kg) or transported by truck to an offsite landfill for disposal at a facility licensed to accept TSCA material (greater than 50 mg/kg). Post-excavation verification sampling would be performed and analyzed using an onsite mobile laboratory. Air monitoring would be performed during all activities with the potential to generate emissions (that is, sediment handling and processing if reagents that may create dust are used).

Placement methods for the mat would minimize disturbance to the sediment and reduce sediment resuspension, but containment would be necessary to prevent downstream migration of contaminated sediments during cap placement. Similar to placement methods for a sand/gravel cap, placement of the reactive cap would be completed using low ground pressure earthwork equipment in dry and submerged areas. Six inches of sand would be placed above the reactive cap to maintain placement and promote the restoration of habitat. The cap would be designed in accordance with state and federal floodplain regulations. In addition, measures would be taken to avoid impact to any threatened and endangered species according to state guidelines. Beneficial use of the sediment is not anticipated, but would be further evaluated during design.

Surveys would be performed on a regular basis to monitor the long-term integrity of the cap. A sample of the mat can be obtained following site implementation to evaluate system performance. Cap maintenance would be performed by the property owner (Milwaukee County), which could involve repair of the mat and/or increased armoring to supplement and/or replace damaged parts of the cap.

Habitat improvements for this alternative also may include placement of fallen trees in selected locations, brush cribs, and stone cribs. These items also would reduce the potential for erosion. Habitat restoration would be designed in consultation with WDNR, Milwaukee County, GLNPO Habitat Team, and the public.

4.6 Alternative 5—Partial Excavation and Cap

Alternative 5 is the partial excavation of the sediment and capping of the remaining sediment. The goal of the combination of technologies in this alternative is to remove sediment with PCB concentrations equal to or greater than 50 mg/kg and to place a cap over the remaining areas. The estimated volume of sediment for excavation and removal is 14,000 cubic yards. The total estimated mass of PCBs that would be removed is 2,829 pounds.

4.6.1 Excavation

Excavation of the sediment would be completed using mechanical rather than hydraulic methods because of the relatively shallow water depth across the site. Alternative 5 includes isolating the targeted excavation areas and installing a temporary system to bypass the water around the excavation areas. Containment would be necessary to prevent the downstream migration of contaminated sediment during excavation.

The moisture content of the excavated sediment depends in large part upon whether the Estabrook Park Dam is open or closed. Historically, the dam is open in the winter and closed in the summer, resulting in variable water elevations at different times of the year. Based on previous studies, the depth of water in the western oxbow area when the dam is closed is generally less than 3 feet. Operation of the dam can vary the water level at the dam up to 7.5 feet, thus making large parts of the sediment in the western oxbow dry when the dam is open. Currently, the dam is open and will remain open for the foreseeable future to evaluate repairs to the dam and support implementation of a remedial action. Before isolating the area and bypassing the water during excavation, it is assumed that the dam will have been open for at least 6 months to promote drying of the sediment.

Surveys would be conducted periodically during the work to verify that the target excavation depths are being attained. Post-excavation verification sampling would be performed and analyzed using an onsite mobile laboratory. Air monitoring would be performed during all activities with the potential to generate emissions (that is, sediment handling and processing if reagents that may create dust are used).

4.6.2 Dewatering and Water Treatment

Some sediment in the main channels of Lincoln Creek and the Milwaukee River would require further drying at the time of excavation to meet the landfill requirements. This sediment would be mechanically mixed in place with a drying agent and placed on a dewatering/staging pad for loading into trucks. The size of the dewatering/staging pad would depend on several factors that include the volume of sediment to be removed, rate of removal versus rate of loading and transport to offsite landfills, required frequency of waste confirmation sampling, and overall project schedule.

Water that may require treatment would be generated from the following sources:

- Dewatering pad drainage from sediment
- Decontamination water
- Precipitation on the dewatering pad

The components needed to treat the collected water before discharge would be determined during the detailed design. However, to evaluate cost and comparison to other alternatives, it is assumed that the water treatment system would be sized for 40 gallons per minute and include a frac tank, bag filters, a granular activated carbon (GAC) treatment system, an effluent holding tank, and a discharge pump. The influent would be pumped to the frac tank for storage and solids removal. Effluent from the frac tank would be pumped through bag filters for additional solids removal, GAC vessels for treatment, and an effluent holding tank for sampling before discharge into the sanitary sewer. Regular sampling would be conducted to verify that the requirements for discharge to the sanitary sewer are met.

4.6.3 Offsite Disposal

Trucks used to transport contaminated materials offsite would be covered, and tires and exteriors decontaminated after loading and before leaving the site. The sediment excavated under this alternative would be disposed of at a facility licensed to accept TSCA waste. Beneficial use of the sediment is not anticipated, but would be further evaluated during design. Transporting the sediments by truck from the dewatering/staging pad to the landfill would cause an increase in heavy truck traffic along the haul route(s). Repair of some city streets along the haul route(s) may be necessary to counter the effects of the increased heavy truck traffic. After completing the project, the pad materials would be transported by truck to an offsite landfill for disposal. The pad materials would be characterized for disposal before transportation.

4.6.4 Cap, Restoration, and Monitoring

Following excavation, a cap would be placed as described in Alternative 3 (Containment). Surveys, cap maintenance, and inspection also would be performed as described in Alternative 3.

Disruption to the benthic community would occur during excavation activities. This is unavoidable, and re-establishment of aquatic organisms should occur naturally after the remedial activities and habitat restoration activities have been completed. Placement of the cap also would provide restored habitat. In addition, habitat restoration may include plantings to supplement existing conditions and improve habitat (submerged, emergent, and terrestrial). Habitat restoration would be designed in consultation with WDNR, Milwaukee County, GLNPO Habitat Team, and the public.

4.7 Alternative 6—Excavation and Offsite Disposal

Alternative 6 is the excavation of sediment above 1 mg/kg and offsite disposal. The estimated volume of sediment with PCB concentrations greater than 1 mg/kg, but less than 50 mg/kg is 84,000 cubic yards. The estimated volume of sediment with PCB concentrations equal to or greater than 50 mg/kg is 14,000 cubic yards. The total estimated mass of PCBs that would be removed is 4,075 pounds.

Excavation, dewatering, water treatment, and offsite disposal of the sediment would be completed as described in Alternative 5 except offsite disposal would include a Subtitle D solid waste disposal facility. Containment would be necessary to prevent downstream migration of contaminated sediments during excavation. Measures would be taken to avoid impact to any threatened and endangered species according to state guidelines. Sediment with PCB concentrations less than 50 mg/kg would be disposed of in a Subtitle D solid waste facility. Sediment with PCB concentrations equal to or greater than 50 mg/kg would be disposed of at a facility permitted to accept TSCA waste. Beneficial use of the sediment is not anticipated, but would be further evaluated during design.

Disruption to the benthic community would occur during the excavation activities. This is unavoidable, and re-establishment of aquatic organisms should occur naturally after the remedial activities and habitat restoration activities have been completed. Habitat restoration may include plantings to supplement existing conditions and improve habitat (submerged, emergent, and terrestrial). In addition, this alternative may include placement of brush cribs, stone cribs, and fallen trees in selected locations. Habitat restoration would be designed in consultation with WDNR, Milwaukee County, GLNPO Habitat Team, and the public.

4.8 Alternative 7—Excavation, Ex Situ Treatment, and Offsite Disposal

Alternative 7 is similar to Alternative 6 except the excavated material would be treated using ex situ treatment. The total estimated mass of PCBs that would be removed is 4,075 pounds. Ex situ treatment would include particle size separation of the excavated material to separate clays and silts (particles that PCBs would adhere to) from sand particles. The sand would be tested to confirm it is clean and returned to Lincoln Creek/Milwaukee River or used for clean fill material at another location to reduce the cost of offsite disposal.

Based on geotechnical analysis of sediment samples, the sediments were primarily fine grained and contained a large proportion of silt and clay. In several cases, the sediment is approximately 85 to 95 percent silt and clay. Although PCBs generally adhere to the fine-grained material, additional study would be required before the remedial action to establish a correlation between grain size and PCB concentration. Once the correlation is established, the sediment can be separated during the remedial action after dewatering using particle size separation devices. For this alternative, it is assumed that 10 percent of the excavated sediment will be clean sand and could be beneficially used.

Disruption to the benthic community would occur during the excavation activities. Re-establishment of aquatic organisms should occur naturally after the remedial activities and habitat restoration activities are completed as described in Alternative 6.

SECTION 5

Detailed Analysis of Alternatives

5.1 Introduction

The detailed analysis provides the relevant information required for comparing the remedial alternatives for the Lincoln Park/Milwaukee River site. The detailed analysis of alternatives precedes the selection of a remedy. Detailed analysis of alternatives consists of the following components:

- A detailed evaluation of each individual alternative against six evaluation criteria
- A comparative evaluation of alternatives with respect to the six evaluation criteria

The detailed evaluation is presented in table format in Table 4 and follows the alternatives as structured in the text. The comparative evaluation is presented in the text and highlights the most important factors that distinguish alternatives from each other.

5.2 Evaluation Criteria

Each alternative was evaluated by using six criteria. These criteria were established to provide grounds for comparison of the relative performance of the alternatives and to identify their advantages and disadvantages. This approach is intended to provide sufficient information for adequately comparing the alternatives and selecting the most appropriate alternative for implementation at the site as a remedial action. The evaluation criteria include the following:

- Compliance with applicable federal, state, and local regulations
- Short- and long-term effectiveness in protecting human health and the environment, including supporting removal of BUIs within the Milwaukee Estuary AOC
- Engineering implementability, reliability, and constructability
- Technical feasibility
- Cost
- Stakeholder and community acceptance

The criteria are divided into three groups: threshold, balancing, and modifying criteria. Threshold criteria must be met by a particular alternative for it to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—either they are met by a particular alternative, or that alternative is not considered acceptable. The single threshold criterion is compliance with applicable federal, state, and local regulations.

Unlike the threshold criteria, the five balancing criteria weigh the trade-offs among alternatives. For each balancing criteria, the alternatives are rated on a scale for evaluation against the criteria as well as comparison among alternatives. A low rating on one balancing criterion can be compensated by a high rating on another criterion. The four balancing criteria include the following:

- Short- and long-term effectiveness in protecting human health and the environment, including supporting removal of BUIs within the Milwaukee Estuary AOC
- Engineering implementability, reliability, and constructability
- Technical feasibility
- Cost

The modifying criteria are stakeholder and community acceptance. These are evaluated following public input on the Great Lakes Legacy Act proposed remedial action and used to modify the selection of the recommended alternative. The remaining five evaluation criteria, encompassing both threshold and balancing criteria, are briefly described below.

5.2.1 Threshold Criteria

To be eligible for selection, an alternative must meet the threshold criteria described below, or in the case of applicable federal, state, and local regulations, must justify that a waiver is appropriate.

Compliance with Applicable Federal, State, and Local Regulations

Compliance with applicable federal, state, and local regulations is one of the statutory requirements of remedy selection. Applicable federal, state, and local regulations are cleanup standards, standards of control, and other substantive environmental statutes or regulations. Applicable requirements address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a site. Relevant and appropriate requirements are those that while not applicable, address problems or situations sufficiently similar to those encountered at the site. The assessment with respect to this criterion describes how the alternative complies with applicable federal, state, and local regulations or presents the rationale for waiving an applicable federal, state, and local regulations. Applicable federal, state, and local regulations can be grouped into the following three categories:

- **Chemical-specific:** Applicable federal, state, and local regulations are health- or risk-based numerical values or methodologies, which, when applied to site-specific conditions, establish the amount or concentration of a chemical that may remain in or be discharged to the environment.
- **Location-specific:** Applicable federal, state, and local regulations restrict the concentration of hazardous substances or the conduct of activities solely because they are in specific locations, such as floodplains, wetlands, historic places, and sensitive ecosystems or habitats.
- **Action-specific:** Applicable federal, state, and local regulations include technology- or activity-based requirements that set controls, limits, or restrictions on design performance of remedial actions or management of hazardous constituents.

The analysis of the potential applicable federal, state, and local regulations relative to the remediation of the Lincoln Park/Milwaukee River site is provided in Appendix A.

5.2.2 Balancing Criteria

The four criteria listed below are used to weigh the trade-offs between alternatives.

Short- and Long-Term Effectiveness in Protecting Human Health and the Environment

This criterion reflects the emphasis on implementing remedies that will ensure protection of human health and the environment in the long term as well as in the short term. A remedy is protective if it adequately eliminates, reduces, or controls current and potential risks posed by the site through each exposure pathway. The assessment of alternatives with respect to this criterion includes the evaluation of the risks at a site during the construction and implementation of a remedy (short term) and after completing a remedial action or enacting a no action alternative (long term). Short-term criteria include protection of workers during the remedial action, protection of community during the remedial action, and environmental impacts of the remedial action. Long-term criteria include time until RAOs are achieved (including supporting removal of BUIs in the Milwaukee Estuary AOC), magnitude of residual risks, adequacy and reliability of controls, and minimization of transport of contaminated sediment downstream.

Engineering Implementability, Reliability, and Constructability

This criterion addresses the availability of the goods and services needed for its implementation, the reliability of the action, and the ease of constructing the remedial action.

Technical Feasibility

With respect to this criterion, technical feasibility of the alternative is evaluated in the assessment.

Cost

Cost encompasses all engineering, construction, and operations and maintenance (O&M) costs incurred over the life of the project. The assessment, with respect to this criterion, is based on the estimated present worth of the costs for each alternative. Present worth is a method of evaluating expenditures such as for construction and O&M that occur over different lengths of time. This allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented. The present worth of a project represents the amount of money, which if invested in the initial year of the remedy and disbursed as needed, would be sufficient to cover all costs associated with the remedial action. These estimated costs are expected to provide an accuracy of plus 50 percent to minus 30 percent. Appendix B provides a breakdown of the cost estimate for each alternative.

The level of detail required to analyze each alternative with respect to the cost criteria depends on the nature and complexity of the site, the types of technologies and alternatives being considered, and other project-specific considerations. The analysis is conducted in sufficient detail to understand the significant aspects of each alternative and to identify the uncertainties associated with the evaluation.

The cost estimates presented for each alternative have been developed strictly for comparing the alternatives. The final costs of the project and the resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, the implementation schedule, and other variables; therefore, final project costs will vary from the cost estimates. Because of these factors, project feasibility and funding needs must be reviewed carefully before specific financial decisions are made or project budgets are established to help ensure proper project evaluation and adequate funding.

The cost estimates are order-of-magnitude estimates with an intended accuracy range of plus 50 to minus 30 percent. The range applies only to the alternatives as they are described and does not account for changes in the scope of the alternatives. Selection of specific technologies or processes to configure remedial alternatives is intended not to limit flexibility during remedial design, but to provide a basis for preparing cost estimates. The specific details of remedial actions and cost estimates would be refined during the final design.

5.3 Detailed Analysis of Alternatives

The following alternatives were developed and described in Section 2:

- Alternative 1—No Action
- Alternative 2—Monitored Natural Recovery
- Alternative 3—Containment
- Alternative 4—In Situ Treatment
- Alternative 5—Partial Excavation and Cap
- Alternative 6—Excavation and Offsite Disposal
- Alternative 7—Excavation, Ex Situ Treatment, and Offsite Disposal

The option for habitat restoration is included in Alternatives 3 through 7. These alternatives were evaluated in detail using the six evaluation criteria described above. The detailed evaluations for these alternatives are summarized in Table 4.

TABLE 4
Detailed Evaluation of Remedial Alternatives
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Alternative Description: Criterion	**Alternative 1 No Action**	**Alternative 2 Monitored Natural Recovery**	**Alternative 3 Containment**	**Alternative 4 In Situ Treatment**	**Alternative 5 Partial Excavation and Cap**	**Alternative 6 Excavation and Offsite Disposal**	**Alternative 7 Excavation, Ex Situ Treatment, and Offsite Disposal**
1. Compliance with applicable federal, state, and local regulations	No remedial action; therefore, not applicable.	Compliance would be met.	Must meet substantive requirements for air pollution control using dust suppression. Requires proper protection of streams during construction.	Compliance would be met.	Must meet substantive requirements for air pollution control using dust suppression. Requires proper protection of streams during construction. Final disposition of sediment managed according to the requirements of TSCA and Wisconsin solid waste regulations.	Must meet substantive requirements for air pollution control using dust suppression. Requires proper protection of streams during construction. Final disposition of sediment managed according to the requirements of TSCA and Wisconsin solid waste regulations.	Must meet substantive requirements for air pollution control using dust suppression. Requires proper protection of streams during construction. Final disposition of sediment managed according to the requirements of TSCA and Wisconsin solid waste regulations.
2. Short- and Long-term Effectiveness in Protecting Human Health and the Environment							
(a) Overall protection of human health and the environment	RAOs to reduce the potential ingestion of PCBs through fish tissue and potential for dermal contact or ingestion of PCB-contaminated sediment not likely to be met within a reasonable timeframe.	RAOs to reduce the potential ingestion of PCBs through fish tissue and potential for dermal contact or ingestion of PCB-contaminated sediment not likely to be met within a reasonable timeframe.	Capping of contaminated sediments reduces the PCBs that bioaccumulate in fish and reduces potential for dermal contact or ingestion of PCB-contaminated sediment.	Treatment reduces the PCBs that bioaccumulate in fish and reduces potential for dermal contact or ingestion of PCB-contaminated sediment.	Removal and capping of contaminated sediments reduces the PCBs that bioaccumulate in fish and reduces potential for dermal contact or ingestion of PCB-contaminated sediment. Offsite disposal of contaminated sediment is protective of human health and the environment.	Removal of contaminated sediments eliminates the onsite risk to human health and the environment. Offsite disposal of contaminated sediment is protective of human health and the environment.	Removal of contaminated sediments eliminates the onsite risk to human health and the environment. Offsite disposal of contaminated sediment is protective of human health and the environment.
(b) Protection of workers during remedial action	No remedial action; therefore, not applicable.	Limited potential exposure to workers from sediment sampling during remedial action.	Placement of cap to follow appropriate construction procedures for safety. Limited potential exposure to workers from long-term monitoring.	Placement of mat to follow appropriate construction procedures for safety. Limited potential exposure to workers from long-term monitoring.	Placement of cap to follow appropriate construction procedures for safety. Excavation of sediment may result in potential exposure of workers via direct contact. Proper health and safety procedures such as use of appropriate personal protective equipment (PPE), truck decontamination, and air monitoring procedures can reduce impacts to workers.	Excavation of sediment may result in potential exposure of workers via direct contact. Proper health and safety procedures such as use of appropriate PPE, truck decontamination, and air monitoring procedures can reduce impacts to workers.	Excavation of sediment may result in potential exposure of workers via direct contact. Proper health and safety procedures such as use of appropriate PPE, truck decontamination, and air monitoring procedures can reduce impacts to workers.
(c) Protection of community during remedial action	No remedial action; therefore, not applicable.	No impact to community during remedial action.	If placed on dry sediment, dust emissions can be controlled with air monitoring and engineering methods to protect the community.	If placed on dry sediment, dust emissions can be controlled with air monitoring and engineering methods to protect the community.	Dust emissions can be controlled with air monitoring and engineering methods to protect the community. Decontamination of trucks used to transport contaminated materials prevents the spread of contamination along haul routes.	Dust emissions can be controlled with air monitoring and engineering methods to protect the community. Decontamination of trucks used to transport contaminated materials prevents the spread of contamination along haul routes.	Dust emissions can be controlled with air monitoring and engineering methods to protect the community. Decontamination of trucks used to transport contaminated materials prevents the spread of contamination along haul routes.

TABLE 4
Detailed Evaluation of Remedial Alternatives
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Alternative Description: Criterion	**Alternative 1 No Action**	**Alternative 2 Monitored Natural Recovery**	**Alternative 3 Containment**	**Alternative 4 In Situ Treatment**	**Alternative 5 Partial Excavation and Cap**	**Alternative 6 Excavation and Offsite Disposal**	**Alternative 7 Excavation, Ex Situ Treatment, and Offsite Disposal**
(d) Environmental impacts of remedial action	No remedial action; therefore, not applicable.	Sediment sampling during monitoring may mobilize small amounts of contaminated sediment.	Delivery methods can disturb and resuspend contaminated sediment. Without removal of contaminated sediment thickness equal to cap thickness, placement may increase flooding.	Delivery methods can disturb and resuspend contaminated sediment. Without removal of contaminated sediment thickness equal to cap thickness, placement may increase flooding. Reactive cap can damage habitat.	Impacts from excavation because of disturbance of habitats. Cap delivery methods can disturb and resuspend contaminated sediment. Without removal of contaminated sediment thickness equal to cap thickness, placement may increase flooding.	Impacts from excavation because of disturbance of habitats.	Impacts from excavation because of disturbance of habitats.
(e) Achievement of RAOs Including Delisting BUIs							
(e)(1) Support removal of BUIs within the Milwaukee Estuary AOC	Does not support removal of BUIs.	Does not support removal of BUIs.	Supports removal of BUIs except restrictions on dredging.	Supports removal of BUIs except restrictions on dredging.	Supports removal of BUIs except restrictions on dredging.	Supports removal of BUIs.	Supports removal of BUIs.
(e)(2) Minimize potential human health and environmental risks associated with remedial activities to the extent practical	No remedial action; therefore, not applicable	Minimal potential risk from sediment mobilization during sampling.	Moderate potential risk to human health from dust. Moderate potential risk to environment from earthwork and habitat disturbance.	Moderate potential risk to human health from dust. Moderate potential risk to environment from earthwork and habitat disturbance.	Excavation, handling, and transport of contaminated sediments create potential risk to human health. Moderate potential risk to environment from earthwork and habitat disturbance.	Excavation, handling, and transport of contaminated sediments create potential risk to human health. Moderate potential risk to environment from earthwork and habitat disturbance.	Excavation, handling, and transport of contaminated sediments create potential risk to human health. Total sediment handled is largest.
(e)(3) Upon completion of remedial activities, improve habitat of the site through restoration efforts	Does not support habitat improvements because contaminated sediment remains exposed in place.	Does not support habitat improvements because contaminated sediment remains exposed in place.	Habitat improvements possible but limited. No disturbance of the cap or underlying sediment is allowed.	Habitat improvements possible but limited. No disturbance of the cap or underlying sediment is allowed.	Habitat improvements possible but limited. No disturbance of the cap or underlying sediment is allowed.	Options for habitat improvements are not restricted by long-term contamination concerns.	Options for habitat improvements are not restricted by long-term contamination concerns.
(f) Magnitude of residual risks	Unchanged from existing conditions.	Unchanged from existing conditions.	Exposure to contamination reduced in top 6 to 12 inches, thereby reducing risks to human health and the environment. Does not change magnitude of contaminated sediment at depth.	Contamination reduced in top 6 to 12 inches, thereby reducing risks to human health and the environment. Does not change magnitude of contaminated sediment at depth.	Sediment with higher contaminant concentrations removed and exposure to contamination reduced in top 6 to 12 inches. Lower residual risks remain in areas not excavated under cap at depth.	Very low residual risks.	Very low residual risks.
(g) Adequacy and reliability of controls	Fish consumption advisories and warnings regarding dermal contact or ingestion of PCB-contaminated sediment can reduce, but not eliminate risks.	Fish consumption advisories and warnings regarding dermal contact or ingestion of PCB-contaminated sediment can reduce, but not eliminate risks.	Long-term maintenance and inspection of cap required for reliability. Limited control over disturbance of cap by humans or the environment.	Long-term maintenance and inspection of mat required for reliability. Limited control over disturbance of surface sediment by humans or the environment.	Long-term maintenance and inspection of cap required for reliability. Limited control over disturbance of cap by humans or the environment.	Not applicable.	Not applicable.

TABLE 4
Detailed Evaluation of Remedial Alternatives
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Alternative Description: Criterion	Alternative 1 No Action	Alternative 2 Monitored Natural Recovery	Alternative 3 Containment	Alternative 4 In Situ Treatment	Alternative 5 Partial Excavation and Cap	Alternative 6 Excavation and Offsite Disposal	Alternative 7 Excavation, Ex Situ Treatment, and Offsite Disposal
(h) Minimization of transport of contaminated sediments downstream	Unchanged from existing conditions.	Unchanged from existing conditions.	Transport minimized as long as inspections and maintenance of the cap is performed.	Transport minimized as long as inspections and maintenance of the cap is performed.	Transport minimized as long as inspections and maintenance of the cap is performed. Less degree of risk than cap alone because TSCA material is removed.	No long-term risk of transport from this site because contaminated sediment is removed.	No long-term risk of transport from this site because contaminated sediment is removed.
3. Engineering Implementability, Reliability, and Constructability							
(a) Availability of services and materials	No impediments.	No impediments.	Methods of placement limited in shallow water depth.	Methods of placement limited in shallow water depth.	Methods of placement limited in shallow water depth.	No impediments.	No impediments.
(b) Reliability	No impediments.	No impediments.	Long-term maintenance and inspection of cap required for reliability. May require replacement/repair if material is disturbed.	Long-term maintenance and inspection of mat required for reliability. May require replacement as reactive mat material is exhausted.	Excavation of sediment is very reliable. Long-term maintenance and inspection of cap required for reliability. May require replacement/repair if material is disturbed.	Excavation of sediment is very reliable.	Excavation of sediment is very reliable. Ex situ treatment requires quality control and assurance to verify reliability.
(c) Constructability	No impediments.	No impediments.	Difficult in areas of shallow water depth. Limited methods of installation. Difficult to achieve consistent thickness of cap in deeper conditions.	Methods of placement limited in shallow water depth.	Difficult in areas of shallow water depth. Limited methods of installation. Difficult to achieve consistent thickness of cap in deeper conditions.	No impediments.	Requires area for aggregate separation and bulk storage.
4. Technical Feasibility							
(a) Technical feasibility	No impediments.	No impediments.	No impediments.	Reactive cap technologies require pilot or laboratory testing to determine feasibility.	No impediments.	No impediments.	Requires correlation of grain size to PCB contamination in order to implement remedial action.
5. Total Cost	$0	$2,200,000	$6,500,000	$11,500,000	$11,200,000	$20,200,000	$20,300,000

5.3.1 Comparative Analysis

This section presents the comparative analysis of the alternatives and discussion of the criteria evaluated. Balancing criteria may not be of equal weight. The ranking system is not mathematically significant and is intended for guidance and informational purposes only. The selected alternative is based on numerous criteria, including professional judgment of GLNPO and the non-federal sponsor, WDNR.

Compliance with Applicable Federal, State, and Local Regulations

The most important federal, state, and local regulations to be met relate to TSCA requirements, protection of streams during construction, disposal of treated water from the dewatering process, and air pollution emission requirements. Specific applicable federal, state, and local regulations are listed in Appendix A. All alternatives, other than Alternative 1 (No Action), are expected to comply with applicable federal, state, and local regulations.

Compliance with Applicable Federal, State, and Local Regulations

Does Not Meet Criteria	Meets Criteria
1 (N/A)	2, 3, 4, 5, 6, 7

Short- and Long-Term Effectiveness in Protecting Human Health and the Environment

There are eight components that comprise evaluation of the overall short- and long-term effectiveness in protecting human health and the environment. They include the overall protection of human health and the environment and short- and long-term criteria. Short-term criteria include protection of workers during remedial action, protection of community during the remedial action, and the environmental impacts of remedial action. Long-term criteria include the time until RAOs are achieved, magnitude of residual risks, minimization of transport of contaminated sediments downstream, and adequacy and reliability of controls.

Overall Protection of Human Health and the Environment

Alternative 1 (No Action) and Alternative 2 (MNR) are not protective because they allow continued exposure by fish to the PCB-contaminated sediment, and the PCBs will not be prevented from bioaccumulating in the fish. Alternatives 1 and 2 also will allow continued potential for dermal contact or ingestion of PCB-contaminated sediment.

Alternatives 3 through 7 are considered protective of human health and the environment. Alternative 3 (Containment), Alternative 4 (In Situ Treatment), and Alternative 5 (Partial Excavation and Cap) are less protective in comparison to the other alternatives involving complete excavation because a cap or in situ treatment reduces the risk rather than removes the risk.

Overall Protection of Human Health and the Environment
Relative Ranking from Worst to Best

Worst 0	1	2	3	Best 4
1, 2		3, 4	5	6, 7

Protection of Workers During Remedial Action

There are no additional risks associated with the implementation of Alternative 1 because no remedial action would be taken. Alternatives 2 through 4 would have limited potential exposure to workers from high concentrations of PCBs in sediment during long-term sediment monitoring. Alternatives 3 through 5 include placement of a sand/gravel cap or reactive cap. A greater degree of protection would be provided to workers if placement occurs in water than if placement occurs on dry sediment because the water can reduce dust and direct contact with the sediment during construction. However, most of the area is anticipated to be dry during placement.

Alternatives 3 through 7 include excavation and offsite disposal. These alternatives would have a similar effect with respect to the protection of workers—sediment will be disturbed, removed, and handled, mostly using properly designed equipment that may not require direct contact, but direct contact to workers is possible during operations. A greater degree of risk is involved in ex situ treatment (particle size separation) because of the extra handling required. In addition, a greater degree of risk is involved with Alternative 6 in comparison to Alternatives 3 through 5 because of the greater volume of sediment removed and managed. The higher volume of sediment removed and managed, the greater the chance for worker risk and the lower the amount of protection provided to the worker.

Protection of Workers During Remedial Action
Relative Ranking from Worst to Best

Worst **0**	**1**	**2**	**3**	**Best** **4**
7	6	3, 4, 5	2	1 (N/A)

Protection of Community During Remedial Action

The alternatives that include a greater degree of excavation, loading, and offsite transport of sediment may result in a greater potential for exposure to the community than the alternatives that include MNR, containment, or in situ treatment. Exposure to the community from dust during placement of a cap depends on whether the sediment is dry or wet at the time of placement. However, dust emissions can be controlled using standard engineering controls, and trucks can be covered and decontaminated before leaving the site.

Protection of Community During Remedial Action
Relative Ranking from Worst to Best

Worst **0**	**1**	**2**	**3**	**Best** **4**
		5, 6, 7	3, 4	1 (N/A), 2

Environmental Impacts of Remedial Action

Short-term environmental impacts include the disturbance and resuspension of sediment contamination into the water column during monitored natural recovery or submerged capping operations for Alternatives 2, 3, 4, and 5. The resuspension of sediments during these activities may result in a short-term release of PCBs into the water column. Excavation as well as some materials used for a cap can damage habitats during construction.

The Lincoln Park/Milwaukee River site water depth is relatively shallow, even in high pool situations. In addition, though the area immediately adjacent to the river is not well developed, the site is located in a larger area of development. Therefore, Alternatives 3, 4, and 5 that include the placement of a cap could decrease the flood storage capacity. The addition of cap material without sediment removal would raise the bottom elevation of the river and may reduce the storage capacity. Reducing the flood storage capacity is not acceptable.

Environmental Impacts of Remedial Action
Relative Ranking from Worst to Best

Worst **0**	**1**	**2**	**3**	**Best** **4**
	5, 6, 7	3, 4		1 (N/A), 2

Achievement of RAOs Including Delisting BUIs

The RAOs for the sediment at the Lincoln Park/Milwaukee River site include the following:

- Support removal of BUIs within the Milwaukee Estuary AOC
  - Fish and wildlife consumption advisories
  - Degradation of benthos
  - Restrictions on dredging
  - Degradation of fish and wildlife habitat
- Minimize potential human health and environmental risks associated with remedial activities, to the extent practical
- Upon completion of remedial activities, improve habitat of the site through restoration efforts

Alternative 1 (No Action) and Alternative 2 (MNR) would rely on natural degradation of PCBs to delist BUIs. In comparison to the other alternatives, a significant period of time is required for Alternatives 1 and 2 to remove advisories and prevent degradation of benthos and fish and wildlife habitat. Restrictions on dredging would require a more significant period of time because it requires natural degradation of PCBs at depth in addition to degradation at the surface. Alternatives 3, 4, and 5 that include capping or in situ treatment of the sediment also would require restrictions on dredging activities for a significant period of time, thereby preventing delisting of this BUI. Alternatives 3 through 7 support removal of the remaining BUIs (advisories, degradation) in an equal manner.

RAO: Support Removal of BUIs Within AOC
Relative Ranking from Worst to Best

Worst **0**	**1**	**2**	**3**	**Best** **4**
1, 2	3, 4, 5			6, 7

The potential human health and environmental risks associated with the remedial action are greater for the alternatives involving excavation of the sediment because it may result in a greater potential for exposure to the community by air or direct contact. In addition, excavation results in a greater degree of disturbance to the environment. In contrast, Alternatives 1 and 2 have the least potential risk during the remedial action.

RAO: Minimize Potential Human Health and Environmental Risks During Remedial Action
Relative Ranking from Worst to Best

Worst **0**	**1**	**2**	**3**	**Best** **4**
	5, 6, 7	3, 4		1 (N/A), 2

Although the alternatives involving excavation have the potential for greater impact to human health and the environment during the remedial action, these alternatives provide greater opportunities for habitat improvement through site restoration. The greater the volume of contaminated sediment removed from the site, the greater the opportunities for habitat improvement. When contaminated sediment remains in place, habitat improvement options may be more limited to avoid disturbing a cap or sediments in place.

RAO: Improve Habitat of The Site Through Restoration Efforts
Relative Ranking from Worst to Best

Worst **0**	**1**	**2**	**3**	**Best** **4**
1, 2		3, 4, 5		6, 7

Magnitude of Residual Risks

The magnitude of residual risk is based on a long-term evaluation of each alternative and the degree of risk remaining in the future after the remedial action is completed. For Alternative 1 (No Action) and Alternative 2 (MNR), the magnitude of residual risk would remain unchanged from the existing conditions. The remedial actions completed as part of these alternatives would not change the concentration of PCB contamination in the sediment, except through natural degradation of PCBs that would occur gradually over an extended period of time.

Placement of a cap will reduce exposure to residual contamination in the surface sediment, but will not reduce residual risk at depth. Alternative 4 (In Situ Treatment) will reduce contamination in the surface sediment by absorbing the contaminants. However, similar to a cap, it will not reduce residual risk at depth.

The least amount of residual risk would occur as a result of excavation and offsite disposal, which includes Alternatives 6 and 7. Contaminated sediment with PCB concentrations greater than 1 mg/kg would be removed from the site, resulting in a very low residual risk.

Magnitude of Residual Risks
Relative Ranking from Worst to Best

Worst **0**	**1**	**2**	**3**	**Best** **4**
1, 2	3, 4	5		6, 7

Adequacy and Reliability of Controls

Long-term effectiveness of the remedial action also depends on the adequacy and reliability of controls to protect human health and the environment. Alternatives 6 and 7 involving full excavation would not require controls except possibly maintenance of short-term fish consumption advisories, which would be required during the implementation of each alternative under consideration. Alternative 1 (No Action) and Alternative 2 (MNR) require advisories and warnings regarding fish consumption, dermal contact, and ingestion of PCB-contaminated sediment. These controls are based on public adherence to the warnings for measuring adequacy and reliability.

A cap or in situ treatment requires long-term maintenance and inspection to verify placement and thickness, particularly at the Lincoln Park/Milwaukee River site because of the hydrodynamic conditions and recreational access. There is the potential for the cap to be removed or disturbed depending on water depth and erosion (low pool), scour, or people. Thus, the adequacy and reliability of controls to prevent disturbance of the cap depends on maintenance and inspection.

Adequacy and Reliability of Controls
Relative Ranking from Worst to Best

Worst 0	**1**	**2**	**3**	**Best 4**
1, 2	3, 4, 5			6, 7

Minimization of Transport of Contaminated Sediments Downstream

Protectiveness of the remedial action also includes the long-term adequacy of the remedial action to minimize the transport of contaminated sediments downstream. Alternatives 6 and 7 involving full excavation would have the greatest reliability of minimizing the transport of contaminated sediments downstream over the long term. Alternative 1 (No Action) and Alternative 2 (MNR) would have the least reliability of preventing sediment transport downstream because there would be no measures in place to prevent transport.

Minimizing transport of contaminated sediment downstream for Alternatives 3 through 5 depends on maintenance and inspection of the cap or in situ treatment. If the integrity of the cap or in situ treatment systems is damaged, the potential for transport of sediment is similar to Alternatives 1 and 2.

Minimization of Transport of Contaminated Sediments Downstream
Relative Ranking from Worst to Best

Worst 0	**1**	**2**	**3**	**Best 4**
1, 2		3, 4, 5		6, 7

Engineering Implementability, Reliability, and Constructability

Engineering implementability, reliability, and constructability involves evaluating the availability of services and materials to complete the remedial action, the reliability of the technology to execute as planned, and the constructability of the alternative.

Availability of Services and Materials

The shallow water depth at the Lincoln Park/Milwaukee River site narrows the choices of an available type of equipment for placing a cap or conducting in situ treatment. This does not remove the alternatives that include a cap from further consideration, but rather may present greater challenges for implementing the remedial action. In addition, the rate at which a landfill can accept dewatered sediments may affect the rate at which the sediments are transported from the site. The material may be requested for daily cover at the landfill, which may limit the amount of material the landfill can accept per day. This limitation can be resolved with prior planning, coordinating, and arranging for multiple disposal locations.

Availability of Services and Materials
Relative Ranking from Worst to Best

Worst 0	**1**	**2**	**3**	**Best 4**
		3, 4, 5		1, 2, 6, 7

Reliability

Reliability of the alternatives is based in part on the proven capability of the technology to operate as intended. Every alternative under consideration generally has a proven record of performance. Long-term monitoring and inspection would be required for Alternatives 3, 4, and 5 to document reliability. Reactive caps (Alternative 4) may require replacement as material is exhausted and sand/gravel caps (Alternative 3 [Containment], Alternative 5 [Partial Excavation and Cap]) may require replacement if material is shifted out of place. Excavation of dry sediment is generally more reliable when compared to excavation of wet sediment because it is easier to verify removal of the material through visual inspection; however, both methods are proven technologies. Lastly, ex situ treatment (particle size separation) requires QC and QA to verify that the selected material is separated and contaminated material is not returned to the site.

Reliability
Relative Ranking from Worst to Best

Worst 0	**1**	**2**	**3**	**Best 4**
		3, 4, 5	7	1, 2, 6

Constructability

There are no impediments to constructing Alternative 1 (No Action), Alternative 2 (MNR), and Alternative 6 (Excavation and Offsite Disposal). No construction is involved with Alternatives 1 and 2. Alternative 6 involves common construction operations. Several alternatives require a storage area for dewatering/staging, bulk dewatering amendments, and/or aggregate separation. Approximately 6 to 10 acres of open area in the vicinity of the Lincoln Park/Milwaukee River site could be used for storage.

Consistent thickness of a sand/gravel cap can be difficult to achieve in some site conditions, depending on the velocity and depth of the water during placement. As a result, an average thickness greater than the minimum required would be needed for a cap to ensure the minimum is placed.

Constructability
Relative Ranking from Worst to Best

Worst 0	**1**	**2**	**3**	**Best 4**
		3, 4, 5	7	1, 2, 6

Technical Feasibility

Supplemental studies should be conducted to evaluate the technical feasibility of some alternatives in greater detail. Reactive cap technologies typically require a pilot test or laboratory test to determine composition and thickness. There are no technical impediments to excavation, though ex situ treatment by particle size separation requires an evaluation to correlate the grain size distribution to PCB contamination.

Technical Feasibility
Relative Ranking from Worst to Best

Worst **0**	**1**	**2**	**3**	**Best** **4**
		4	7	1, 2, 3, 5, 6

5.3.2 Cost

An overview of the cost analysis and the detailed breakdowns for each of the alternatives are presented in Appendix B, with the total costs summarized in Table 5.

The alternative with the lowest total estimated cost is MNR. A majority of the total estimated cost of MNR is long-term O&M. The alternative with the lowest capital cost is containment (Alternative 3). The cost for this alternative is primarily comprised of the cost for purchasing and installing the cap materials.

Alternative 4 (In Situ Treatment) and Alternative 5 (Partial Cap Excavation and Cap) are similar in cost. The cost for in situ treatment is primarily comprised of the cost for purchasing and installing the Reactive Core Mat™. The cost for transportation and disposal of the excavated sediment and placement of the cap under Alternative 5 is similar to the cost for purchasing and installing the Reactive Core Mat™ under Alternative 4.

Alternative 7 (Excavation, Ex Situ Treatment, and Offsite Disposal) is the highest total estimated cost, primarily comprised of the ex situ treatment and transportation and offsite disposal of the excavated sediment. Alternative 6 (Excavation and Offsite Disposal) is slightly lower than the cost for Alternative 7 because the benefit of ex situ treatment and less disposal volume does not outweigh the cost for additional handling and treatment of the sediment.

TABLE 5
Summary of Detailed Cost Estimates
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Capital Item	Alternative 1–No Action	Alternative 2–Monitored Natural Recovery	Alternative 3–Containment	Alternative 4–In Situ Treatment	Alternative 5–Partial Excavation and Cap	Alternative 6–Excavation and Offsite Disposal	Alternative 7–Excavation, Ex Situ Treatment, and Offsite Disposal
Mobilization/Demobilization	$ -	$ -	$ 552,420	$ 653,311	$ 562,328	$ 620,260	$ 620,260
Temporary Dewatering/Staging Pad Construction	$ -	$ -	$ 79,844	$ 88,775	$ 80,704	$ 85,733	$ 141,971
Water Treatment Construction	$ -	$ -	$ 199,644	$ 272,883	$ 206,697	$ 211,933	$ 211,933
Sediment Removal	$ -	$ -	$ 203,678	$ 211,678	$ 506,500	$ 3,123,500	$ 2,958,860
Transportation and Disposal Offsite	$ -	$ -	$ 124,330	$ 124,330	$ 3,222,327	$ 8,778,927	$ 8,954,421
Cap Placement	$ -	$ -	$ 1,908,750	$ 4,810,218	$ 1,767,284	$ -	$ -
Site Restoration	$ -	$ -	$ 80,860	$ 80,860	$ 80,860	$ 80,860	$ 80,860
Habitat Restoration	$ -	$ -	$ 916,750	$ 979,250	$ 916,750	$ 979,250	$ 979,250
Demobilize	$ -	$ -	$ 90,000	$ 90,000	$ 90,000	$ 90,000	$ 90,000
SUBTOTAL ESTIMATED COST	**$ -**	**$ -**	**$ 4,156,276**	**$ 7,311,304**	**$ 7,433,450**	**$ 13,970,463**	**$ 14,037,555**
Contingency (15%)	$ -	$ -	$ 623,441	$ 1,096,696	$ 1,115,018	$ 2,095,569	$ 2,105,633
SUBTOTAL ESTIMATED COST	**$ -**	**$ -**	**$ 4,779,717**	**$ 8,407,999**	**$ 8,548,468**	**$ 16,066,032**	**$ 16,143,188**
Payment/Performance Bonds and Insurance (4%)	$ -	$ -	$ 166,251	$ 292,452	$ 148,669	$ 279,409	$ 280,751
Contractor Professional/Technical Services	$ -	$ 147,798	$ 1,307,490	$ 2,267,280	$ 2,270,483	$ 3,844,126	$ 3,894,356
Long-term Operation and Maintenance	$ -	$ 2,075,281	$ 208,652	$ 543,085	$ 208,652	$ -	$ -
TOTAL ESTIMATED COST[1]	**$ -**	**$ 2,200,000**	**$ 6,500,000**	**$ 11,500,000**	**$ 11,200,000**	**$ 20,200,000**	**$ 20,300,000**

Notes:
1) Based on 2009 dollars
2) All numbers rounded to near $100,000

The enclosed Engineer's Estimate is only an estimate of possible construction costs for budgeting purposes. This estimate is limited to the conditions existing at its issuance and is not a guaranty of actual price or cost. Uncertain market conditions such as, but not limited to: local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions etc may affect the accuracy of this estimate. CH2M Hill is not responsible for any variance from this estimate or actual prices and conditions obtained.

SECTION 6

Recommended Alternative

Each alternative, with the exception of Alternative 1 (No Action) which is not applicable, passes the threshold criteria evaluation. Each alternative would require engineering and/or administrative measures to maintain compliance with regulations, but specified measures are achievable.

The comparative analysis of the alternatives for balancing criteria ranks each alternative on a scale of 0 to 4, with 0 as the worst ranking and 4 as the best ranking. Each alternative is individually evaluated and ranked for each balancing criteria. Selected balancing criteria listed as not applicable (N/A) for Alternative 1 (No Action) are not included in the average. The summary of the balancing criteria ranking results is presented below.

Alternative	Balancing Criteria														**Average Ranking**
	Overall Protection of HH and Envy	Protection of workers during Remedial Action	Protection of community during Remedial Action	Environmental Impacts of Remedial Action	Support Removal of BUIs within Estuary AOC	Minimize Potential HH and Environmental Risks during Remedial Action	Improve Habitat through Restoration	Magnitude of Residual Risks	Adequacy and Reliability of Controls	Min. Transport of Contaminated Sediment	Availability of Services and Materials	Reliability	Constructability	Technical Feasibility	
1	0	N/A	N/A	N/A	0	N/A	0	0	0	0	4	4	4	4	**1.60**
2	0	3	4	4	0	4	0	0	0	0	4	4	4	4	**2.21**
3	2	2	3	2	1	2	2	1	1	2	2	2	2	4	**2.00**
4	2	2	3	2	1	2	2	1	1	2	2	2	2	2	**1.86**
5	3	2	2	1	1	1	2	2	1	2	2	2	2	4	**1.93**
6	4	1	2	1	4	1	4	4	4	4	4	4	4	4	**3.21**
7	4	0	2	1	4	1	4	4	4	4	4	3	3	3	**2.93**

The summary of balancing criteria ranking indicates that Alternative 6 (Excavation and Offsite Disposal) has the highest average ranking. Alternative 7 is the next highest average ranking, but Alternative 7 involves ex situ particle separation which is less reliable, constructable, and technically feasible in comparison to Alternative 6. The average ranking for other alternatives is about 1 point lower, resulting in a relatively significant average difference.

Although Alternative 6 ranks low in comparison to other alternatives for short-term impacts during the remedial action, the short-term impacts can be mitigated during design and implementation with standard measures. The estimated cost for Alternative 6 is equal to the estimated cost for Alternative 7, but more than the estimated cost for the other alternatives; however, based on the average rankings, the overall benefit of Alternative 6 supports strongly considering the additional cost. Alternative 6 ranks high in comparison to other alternatives for long-term benefits. The benefits of excavation and offsite disposal support overall protection of human health and the environment, faster removal of BUIs within the Milwaukee Estuary AOC and delisting of the AOC, and improvement of the habitat in the area after the remedial action is complete. In addition, excavation and offsite disposal is beneficial in minimizing residual risk and the transport of contaminated sediment downstream.

The recommended remedial alternative for the Lincoln Park/Milwaukee River site is Alternative 6 (Excavation and Offsite Disposal). The long-term benefits of excavation and offsite disposal, as well as the ability to mitigate the short-term risks, support recommendation of this alternative.

SECTION 7

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Figures

N

0 400 800
Feet

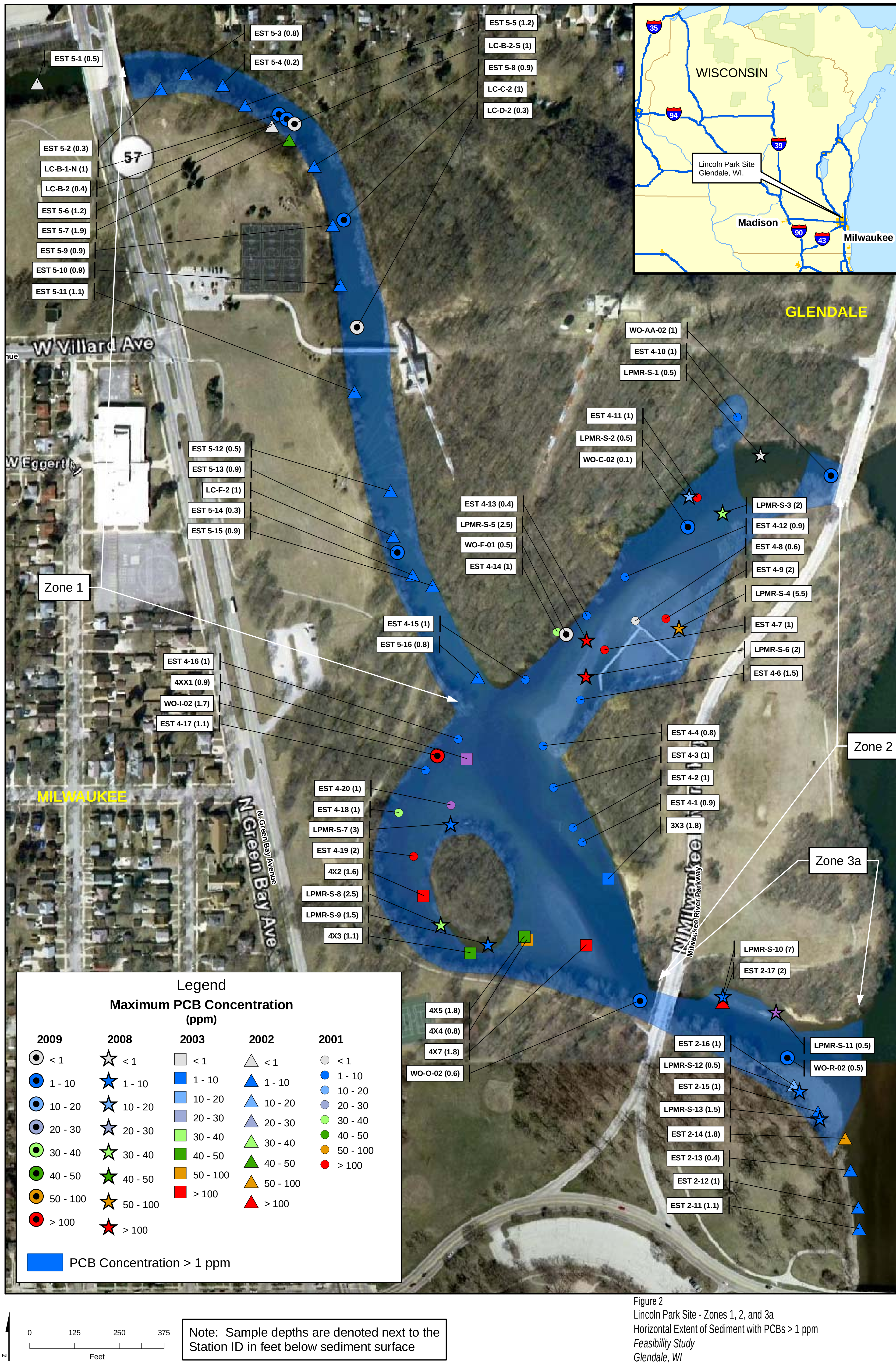
Note:

Aerial obtained by downloading image from Google Earth EC 4.2. CH2M Hill, Inc has a license agreement with Google Earth and is an Enterprise Client.

Figure 1
Lincoln Park Site
Feasibility Study
Glendale, WI

CH2MHILL

MKE \\lakefront\proj\EPA\382079_RAC2_LincolnPark_WP\MapFiles\RAC2_Figure1_LincolnParkSite_Location.mxd 11/21/2008

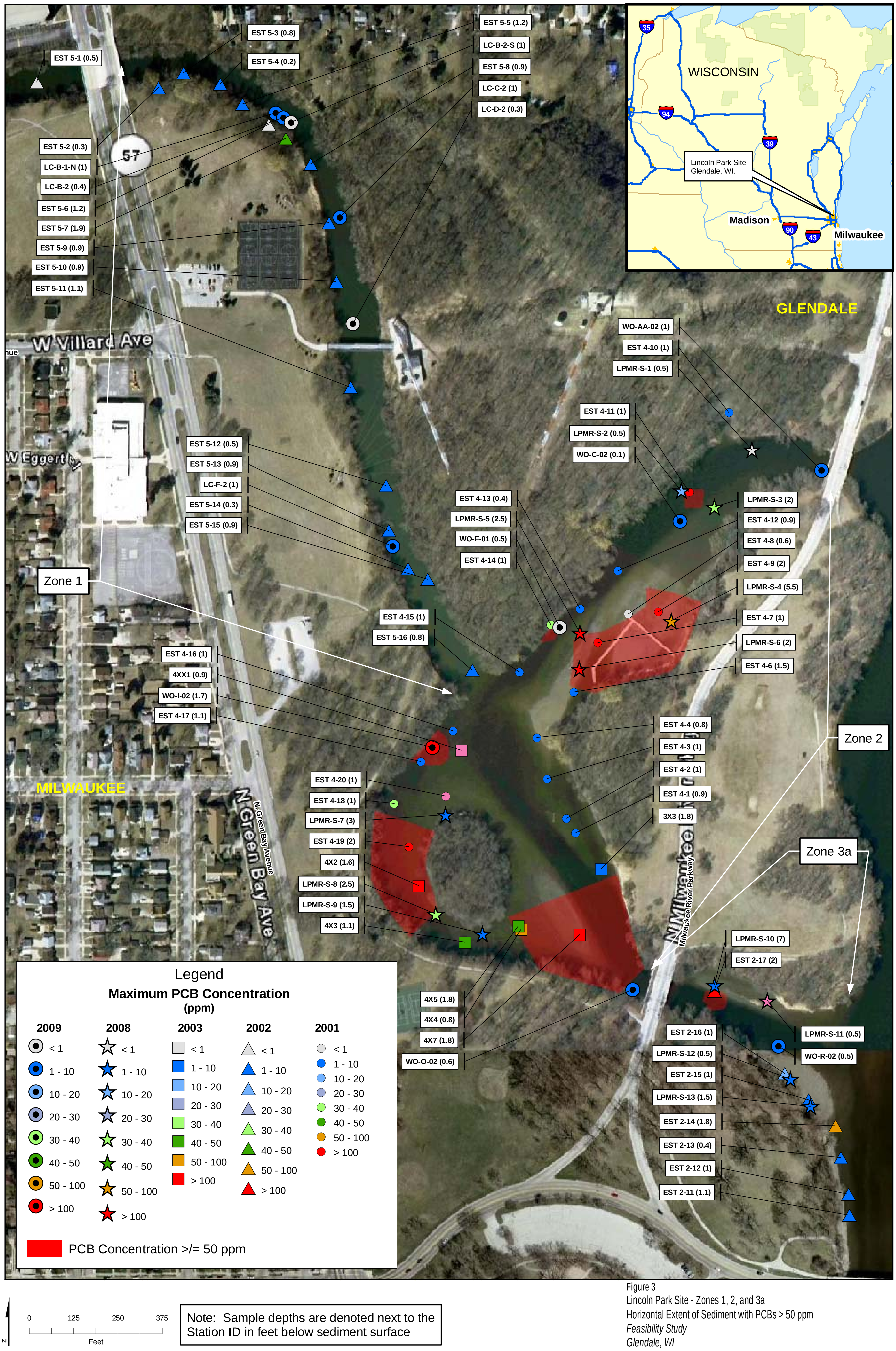


Note: Sample depths are denoted next to the Station ID in feet below sediment surface

Figure 2
Lincoln Park Site - Zones 1, 2, and 3a
Horizontal Extent of Sediment with PCBs > 1 ppm
Feasibility Study
Glendale, WI

CH2MHILL

\\LAKEFRONT\PROJ\EPA\382079_RAC2_LINCOLNPARK_WP\MAPFILES\63009_MEETING\RAC2_LINCOLNPARK_MAXPCBCONC_PER_LOC_Updated091009.MXD



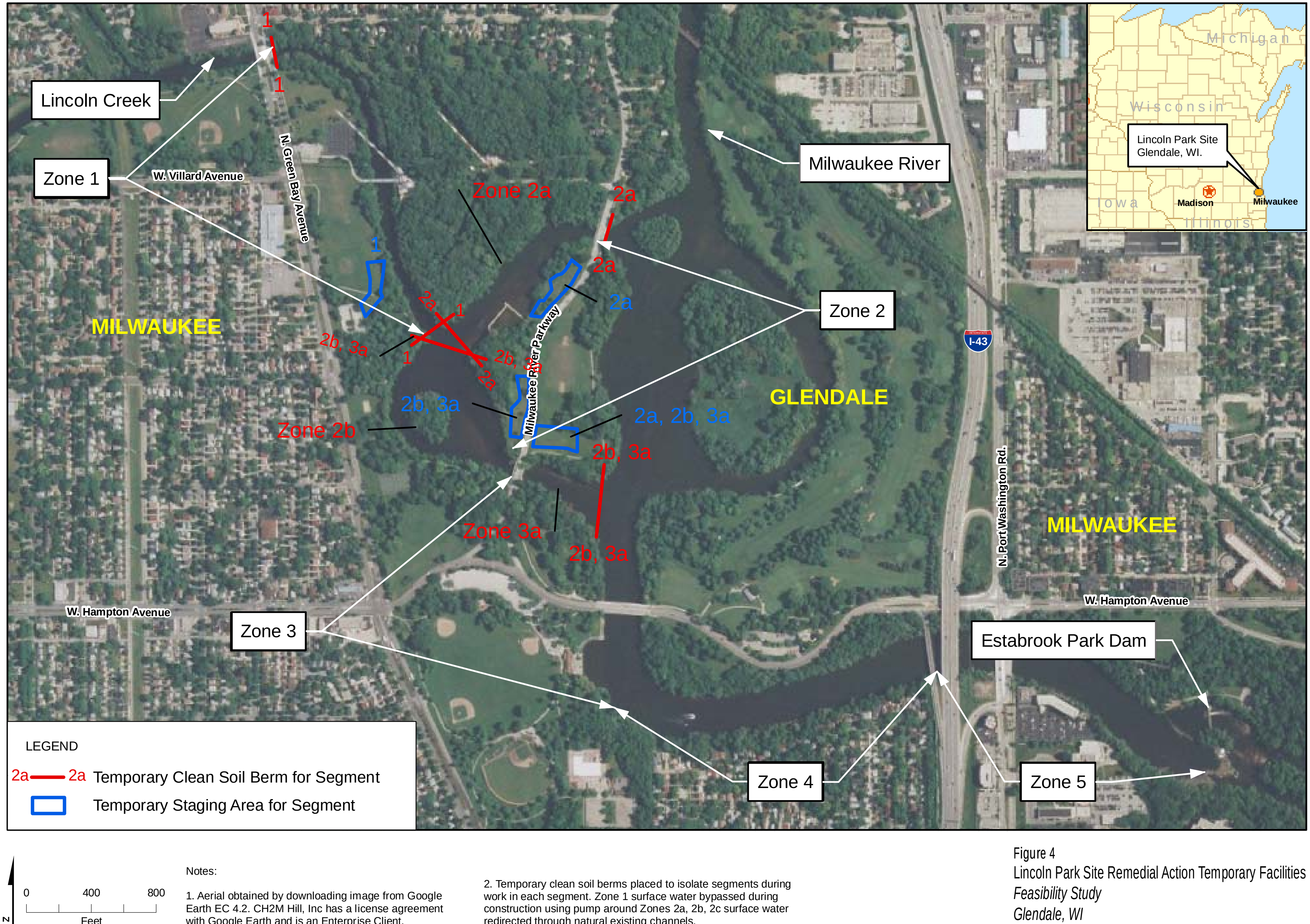
0 125 250 375
Feet

Note: Sample depths are denoted next to the Station ID in feet below sediment surface

Figure 3
Lincoln Park Site - Zones 1, 2, and 3a
Horizontal Extent of Sediment with PCBs > 50 ppm
Feasibility Study
Glendale, WI

\\LAKEFRONT\PROJ\EPA\382079_RAC2_LINCOLNPARK_WP\MAPFILES\63009_MEETING\RAC2_Figure3_LINCOLNPARK_MAXPCBCONC_PER_LOC_Updated091009.MXD

CH2MHILL



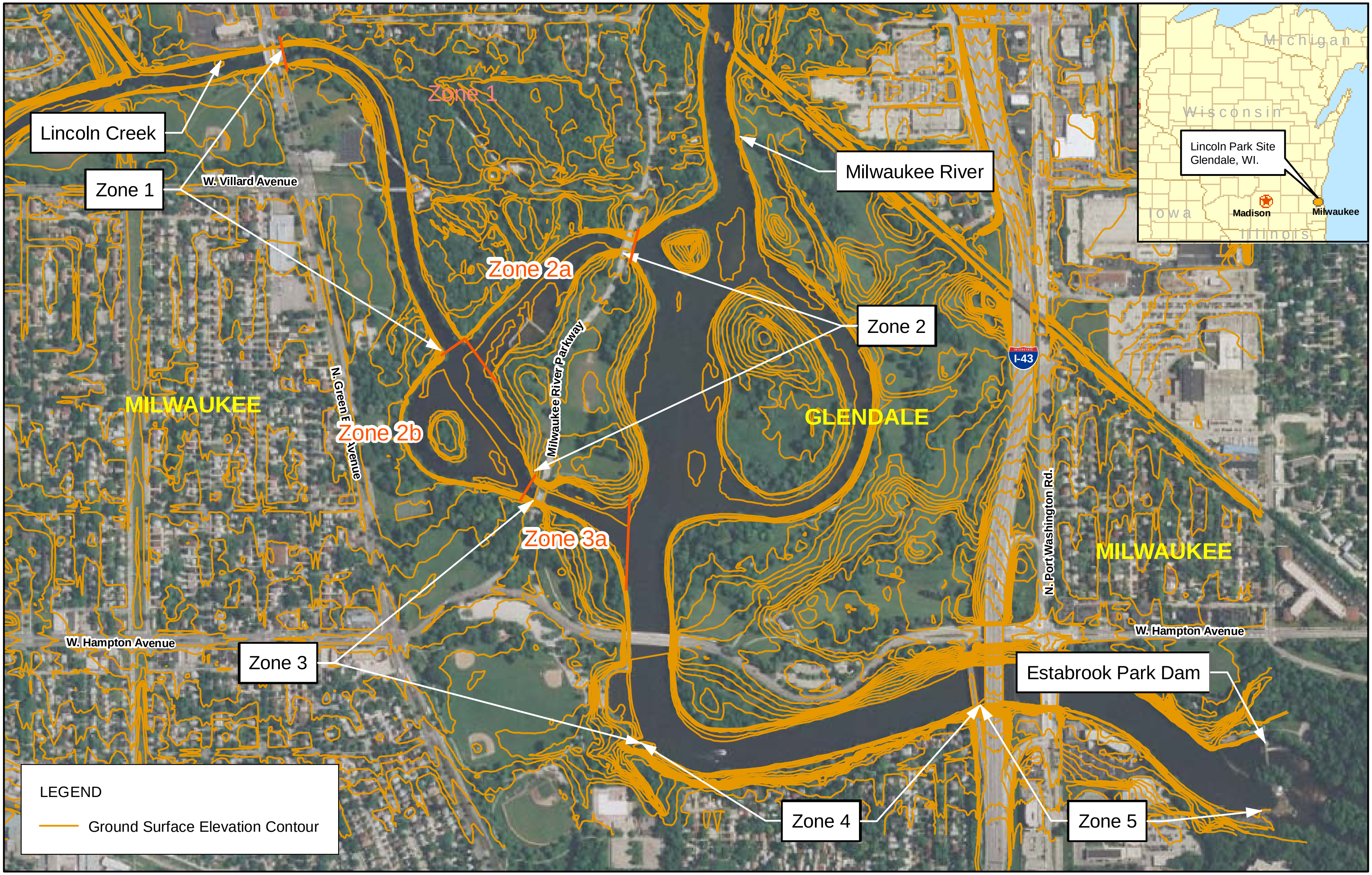
Notes:

1. Aerial obtained by downloading image from Google Earth EC 4.2. CH2M Hill, Inc has a license agreement with Google Earth and is an Enterprise Client.

2. Temporary clean soil berms placed to isolate segments during work in each segment. Zone 1 surface water bypassed during construction using pump around Zones 2a, 2b, 2c surface water redirected through natural existing channels.

Figure 4
Lincoln Park Site Remedial Action Temporary Facilities
Feasibility Study
Glendale, WI

CH2MHILL



Note:

Aerial obtained by downloading image from Google Earth EC 4.2. CH2M Hill, Inc has a license agreement with Google Earth and is an Enterprise Client.

Figure 5
Lincoln Park Site Topographic Contour Lines
Feasibility Study
Glendale, WI

CH2MHILL

MKE \\LAKEFRONT\PROJ\GIS\EPA\382079_RAC2_Figure5_LINCOLNPARK_WP\MAPFILES\RAC2_Figure5_LINCOLNPARKSITE_TOPOGRAPHY.MXD 09/10/2009

Appendix A

Summary of Applicable Federal, State, and Local Regulations

APPENDIX A
Summary of Applicable Federal, State, and Local Regulations
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Citation	Requirement/Purpose	Alternatives Affected	Regulation Status
Chemical-Specific Federal, State, and Local Regulations			
Clean Water Act Section 404 3 USC 144; 33 CFR 323 40 CFR Parts 230 33 CFR Parts 320–330 40 CFR Part 132	Requires approval from USACE for discharge of dredged or fill material into waters of the United States (CWA Section 404 Permit). The Corps and USEPA regard the use of mechanized earth-moving equipment to conduct land-clearing, ditching, channelization, in-stream mining or other earth-moving activity in waters of the United States as resulting in a discharge of dredged material unless project-specific evidence shows that the activity results in only incidental fallback. Discharges of dredged or fill materials are not permitted unless there is no practicable alternative that would have less adverse impact on the aquatic ecosystem. Any proposed discharge must avoid, to the fullest extent practicable, adverse effects, especially on aquatic ecosystems. Unavoidable impacts must be minimized, and impacts that cannot be minimized must be mitigated. 40 CFR Part 132 provides guidance for setting discharge limits for bioaccumulative contaminants such as PCBs.	3,5,6,7	The requirements of a permit for discharge of dredged materials will be met. Though actual discharge of dredged material back into the creek/river is not anticipated, excavation within the creek/river constitutes discharge of dredged material. Requirements are likely to include measures to minimize re-suspension of sediments and erosion of sediments during excavation. Discharge limits for PCBs will likely be set at non-detectable levels.
Federal Water Pollution Control Act as amended by the Clean Water Act of 1977, Section 208(b)	The proposed action must be consistent with regional water quality management plans as developed under Section 208 of Clean Water Act.	3,5,6,7	Requirements adopted by the state pursuant to Section 208 of the Clean Water Act would be applicable to direct discharge of treatment system effluent or other discharges to surface water.
40 CFR Part 131–Water Quality Standards	States are granted enforcement jurisdiction over direct discharges and may adopt reasonable standards to protect or enhance the uses and qualities of surface water bodies in the state.	3,5,6,7	Applicable to direct discharge of treatment system effluent.

APPENDIX A
Summary of Applicable Federal, State, and Local Regulations
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Citation	Requirement/Purpose	Alternatives Affected	Regulation Status
NR 102 through 105 NR 102 – Water Quality Standards for Wisconsin Surface Waters NR 103 – Wisconsin Water Quality Standards for Wetlands NR 104 – Wisconsin Uses and Designated Standards NR 105 – Wisconsin Surface Water Quality Criteria and Secondary Values for Toxic Substances	Reference surface water quality standards are established for protection of public health, fish, and wildlife.	3,4,5,6,7	Applicable to migration of contaminants to the Milwaukee River.
Action-Specific Federal, State, and Local Regulations			
Clean Air Act 40 CFR 50-99	Specifies requirements for air emissions such as particulates, sulfur dioxide, VOCs, hazardous air pollutants, and asbestos.	3,4,5,6,7	Applicable. Particulates may be generated during excavation of sediments. Best available practices to control particulates will be used, as needed, during the excavation and dewatering of sediments.
40 CFR 241–Guidelines for Land Disposal of Solid Wastes	Offsite solid waste land disposal units must meet the federal guidelines for the land disposal of solid wastes.	3,5,6,7	Applicability depends on waste classification for soil and water treatment residuals.
Subtitle D, 40 CFR 257–Criteria for Classification of Solid Waste Disposal Facility and Practices	Sets standards for land disposal facilities for nonhazardous waste.	3,5,6,7	Applicable to water treatment residuals and to transport and disposal of any nonhazardous solid waste offsite.
40 CFR 262 and 263 49 CFR 100 through 199	Establishes responsibilities for transporters of hazardous waste in handling, transportation, and management of the waste. Sets requirements for manifesting, record keeping, and emergency response action in case of a spill.		Not Applicable. The sediments are not hazardous waste.

APPENDIX A
Summary of Applicable Federal, State, and Local Regulations
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Citation	Requirement/Purpose	Alternatives Affected	Regulation Status
Subtitle C, 40 CFR 260 through 264	Regulates the generation, transport, storage, treatment, and disposal of hazardous wastes generated in the course of a remedial action. Regulates the construction, design, monitoring, operation, and closure of hazardous waste facilities.		Not Applicable. The sediments do not have to be managed as containing listed hazardous waste because specific documentation of the release of a listed waste to the sediments is not available. The sediments also are not characteristic waste, and are exempted from regulation under RCRA because CWA Section 404 applies to the cleanup activity (40 CFR 261).
40 CFR 264, Subpart K–Surface Impoundments (40 CFR 264.221 to 264.228)	Establishes the design and operating, monitoring, and closure requirements for surface impoundments containing hazardous waste. Requires that all impoundments have a liner system to prevent any migration of wastes out of the impoundment to the adjacent subsurface soil or groundwater or surface water any time during the life of the impoundment.		Not Applicable. The sediments are not hazardous waste.
40 CFR 264, Subpart M–Land Treatment (40CFR 264.271 to 264.280)	Establishes the demonstration program, design and operating, monitoring, and closure requirements for hazardous waste land treatment units.		Not Applicable. The sediments are not hazardous waste.
40 CFR 268 Land Disposal Restrictions	The land disposal restrictions require treatment before land disposal for a wide range of hazardous wastes.		Not Applicable. The sediments are not hazardous waste.
Toxic Substances Control Act (TSCA) PCB Remediation Wastes 40 CFR 761.61	Specifies requirements for self-implementing on-site cleanup of PCB remediation waste.		Not Applicable. Self-implementing requirements are not applicable to sediments.
TSCA Site Cleanup. (761.61(a)(5)(B)(2)(iii).	Remediation waste with PCBs > 50 mg/kg must be disposed of in a TSCA chemical waste landfill or a RCRA hazardous waste landfill.	3,5,6,7	Applicable. PCBs > 50 mg/kg are planned to excavation and disposal will be performed in accordance with these requirements.

APPENDIX A
Summary of Applicable Federal, State, and Local Regulations
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Citation	Requirement/Purpose	Alternatives Affected	Regulation Status
TSCA Performance-based Cleanup (761.61(b)(3)).	Material that has been dredged or excavated from waters of the United States must be managed in accordance with a permit issued under section 404 of the Clean Water Act, or the equivalent of such a permit.	3,5,6,7	Applicable. The requirements of the permit must be met.
TSCA (40CFR 761.65) Storage for Disposal	Bulk PCB remediation waste containing > 50 mg/kg PCBs may be stored onsite for up to 180 days, provided controls are in place for prevention of dispersal by wind or generation of leachate. Storage site requirements include a foundation below the liner, a liner, a cover, and a run-on control system.	3,5,6,7	Applicable. PCBs > 50 mg/kg are planned for excavation and storage piles will be designed to meet these requirements. An extension on the 180-day storage limit could be obtained if needed through a notification to EPA per 40 CFR 761.65 (a).
40 CFR Parts 122, 125	Requires the development and implementation of a stormwater pollution prevention plan or a stormwater best management plan. Also outlines monitoring and reporting requirement for a variety of facilities.	3,5,6,7	May be applicable to runoff from construction activities depending on the nature of the remedial action selected.
Wisconsin Chapter 30 – Navigable Waters, Harbors and Navigation Section 281.14, 401 Clean Water Act, 30.20, 30.12(1), Wisconsin Statutes.	Permit to remove materials from the bed of a river and permit to place structures (such as fill material, sheet pilings, coffer dams) on the bed of a river.	3,4,5,6,7	Applicable for activities including excavation and/or placement of a cap.
NR 216 – Wisconsin Storm water Discharge Permits	State permitting requirements for construction storm water pollutant discharge elimination (WPDES).	3,5,6,7	Applicable to runoff from construction activities depending on the nature of the remedial action selected.
NR 322 – Wisconsin General Permit Program for Certain Water Regulatory Activities	Standards address erosion control protection along a navigable waterway.	3,5,6,7	Applicable for modifying the river bank or performing excavation.

APPENDIX A
Summary of Applicable Federal, State, and Local Regulations
Lincoln Park/Milwaukee River Channel Sediments Site, Milwaukee Estuary AOC

Citation	Requirement/Purpose	Alternatives Affected	Regulation Status
Location-Specific Federal, State, and Local Regulations			
Great Lakes Water Quality Agreement of 1978	Calls for prohibition of the discharge of toxic substances in toxic amounts and for the virtual elimination of the discharge of persistent substances.		Potentially Applicable. Standards established by the agreement are policies to be considered.
Great Lakes Water Quality Initiative Part 132, Appendix E	Provides guidance to Great Lakes states regarding wastewater discharge, stating that lowering of water quality standards via wastewater discharge should be minimized.		Potentially Applicable. Considered as guidance.
Fish and Wildlife Coordination Act 16 USC §661 et seq. 16 USC §742 a 16 USC §2901 40 CFR 6.302 50 CFR 402–Fish and Wildlife Coordination Act	Requires consultation when a modification of a stream or other water body is proposed or authorized and requires protection of fish and wildlife from adverse effects of site action.	3,5,6,7	Applicable. Relevant and appropriate for removal of contaminated sediment at the site.
Milwaukee Metropolitan Sewerage District	Requires that a permit be granted to discharge treated groundwater and storm water to a sanitary sewer before any action is initiated.	3,4,5,6,7	Applicable for discharge to sanitary sewer.

Appendix B
Detailed Cost Estimates

APPENDIX B
Summary of Detailed Cost Estimates

Capital Item	Alternative 1 - No Action	Alternative 2 - Monitored Natural Recovery	Alternative 3 - Containment	Alternative 4 - In Situ Treatment	Alternative 5 - Partial Excavation and Cap	Alternative 6 - Excavation and Offsite Disposal	Alternative 7 - Excavation, Ex Situ Treatment, and Offsite Disposal
Mobilization/Demobilization	$ -	$ -	$ 552,420	$ 653,311	$ 562,328	$ 620,260	$ 620,260
Temporary Dewatering/Staging Pad Construction	$ -	$ -	$ 79,844	$ 88,775	$ 80,704	$ 85,733	$ 141,971
Water Treatment Construction	$ -	$ -	$ 199,644	$ 272,883	$ 206,697	$ 211,933	$ 211,933
Sediment Removal	$ -	$ -	$ 203,678	$ 211,678	$ 506,500	$ 3,123,500	$ 2,958,860
Transportation and Disposal Offsite	$ -	$ -	$ 124,330	$ 124,330	$ 3,222,327	$ 8,778,927	$ 8,954,421
Cap Placement	$ -	$ -	$ 1,908,750	$ 4,810,218	$ 1,767,284	$ -	$ -
Site Restoration	$ -	$ -	$ 80,860	$ 80,860	$ 80,860	$ 80,860	$ 80,860
Habitat Restoration	$ -	$ -	$ 916,750	$ 979,250	$ 916,750	$ 979,250	$ 979,250
Demobilize	$ -	$ -	$ 90,000	$ 90,000	$ 90,000	$ 90,000	$ 90,000
SUBTOTAL ESTIMATED COST	**$ -**	**$ -**	**$ 4,156,276**	**$ 7,311,304**	**$ 7,433,450**	**$ 13,970,463**	**$ 14,037,555**
Contingency (15%)	$ -	$ -	$ 623,441	$ 1,096,696	$ 1,115,018	$ 2,095,569	$ 2,105,633
SUBTOTAL ESTIMATED COST	**$ -**	**$ -**	**$ 4,779,717**	**$ 8,407,999**	**$ 8,548,468**	**$ 16,066,032**	**$ 16,143,188**
Payment/Performance Bonds and Insurance (4%)	$ -	$ -	$ 166,251	$ 292,452	$ 148,669	$ 279,409	$ 280,751
Contractor Professional/Technical Services	$ -	$ 147,798	$ 1,307,490	$ 2,267,280	$ 2,270,483	$ 3,844,126	$ 3,894,356
Long-term Operation & Maintenance	$ -	$ 2,075,281	$ 208,652	$ 543,085	$ 208,652	$ -	$ -
TOTAL ESTIMATED COST[1]	**$ -**	**$ 2,200,000**	**$ 6,500,000**	**$ 11,500,000**	**$ 11,200,000**	**$ 20,200,000**	**$ 20,300,000**

Notes
1) Based on 2009 dollars
2) All numbers rounded to near $100,000

The enclosed Engineer's Estimate is only an estimate of possible construction costs for budgeting purposes. This estimate is limited to the conditions existing at its issuance and is not a guaranty of actual price or cost. Uncertain market conditions such as, but not limited to: local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions etc may affect the accuracy of this estimate. CH2M Hill is not responsible for any variance from this estimate or actual prices and conditions obtained.

Appendix C

Summary of Sediment PCB and Probe Data

TABLE C-1
PCB Data Summary
Lincoln Park/Milwaukee River Channel Sediments Site

Sample Date	Station ID	Sample ID	X (WI SPS)	Y (WI SPS)	Sample Interval Start Depth (ft)	Sample Interval End Depth (ft)	Sample Interval Mid-point Depth (ft)	Total PCB (ppm)
Oct-01	EST 4-1	EST 4-1-0.0-0.9	2521538.589	410639.0331	0.0	0.9	0.5	1.3
Oct-01	EST 4-10	EST 4-10-0.0-1.0	2521969.851	411823.9098	0.0	1.0	0.5	3.1
Oct-01	EST 4-10	EST 4-10-1.0-1.6	2521969.851	411823.9098	1.0	1.6	1.3	0.25
Oct-01	EST 4-11	EST 4-11-0.0-1.0	2521858.513	411599.3996	0.0	1.0	0.5	460
Oct-01	EST 4-11	EST 4-11-1.0-1.8	2521858.513	411599.3996	1.0	1.8	1.4	13
Oct-01	EST 4-12	EST 4-12-0.0-0.9	2521657.218	411377.8608	0.0	0.9	0.5	6.4
Oct-01	EST 4-13	EST 4-13-0.0-0.4	2521550.998	411270.4305	0.0	0.4	0.2	4.4
Oct-01	EST 4-14	EST 4-14-0.0-1.0	2521468.603	411225.4721	0.0	1.0	0.5	38
Oct-01	EST 4-14	EST 4-14-1.0-1.5	2521468.603	411225.4721	1.0	1.5	1.3	3.7
Oct-01	EST 4-15	EST 4-15-0.0-1.0	2521380.231	411091.8611	0.0	1.0	0.5	2.2
Oct-01	EST 4-15	EST 4-15-1.0-2.1	2521380.231	411091.8611	1.0	2.1	1.6	0.65
Oct-01	EST 4-16	EST 4-16-0.0-1.0	2521192.403	410926.0325	0.0	1.0	0.5	3.6
Oct-01	EST 4-16	EST 4-16-1.0-1.4	2521192.403	410926.0325	1.0	1.4	1.2	0.3
Oct-01	EST 4-17	EST 4-17-0.0-1.1	2521102.754	410839.797	0.0	1.1	0.6	2.8
Oct-01	EST 4-18	EST 4-18-0.0-1.0	2521027.558	410721.3145	0.0	1.0	0.5	32
Oct-01	EST 4-18	EST 4-18-1.0-1.5	2521027.558	410721.3145	1.0	1.5	1.3	10
Oct-01	EST 4-19	EST 4-19-0.0-1.0	2521069.45	410599.5184	0.0	1.0	0.5	12
Oct-01	EST 4-19	EST 4-19-1.0-2.0	2521069.45	410599.5184	1.0	2.0	1.5	130
Oct-01	EST 4-19	EST 4-19-2.0-2.5	2521069.45	410599.5184	2.0	2.5	2.3	1
Oct-01	EST 4-2	EST 4-2-0.0-1.0	2521512.301	410679.747	0.0	1.0	0.5	3.8
Oct-01	EST 4-20	EST 4-20-0.0-1.0	2521172.904	410741.796	0.0	1.0	0.5	23
Oct-01	EST 4-20	EST 4-20-1.0-2.0	2521172.904	410741.796	1.0	2.0	1.5	0.6
Oct-01	EST 4-20	EST 4-20-2.0-2.4	2521172.904	410741.796	2.0	2.4	2.2	1.2
Oct-01	EST 4-3	EST 4-3-0.0-0.8	2521458.2	410791.5845	0.0	1.0	0.5	1.3
Oct-01	EST 4-4	EST 4-4-0.0-0.8	2521429.332	410907.0683	0.0	0.8	0.4	3.2
Oct-01	EST 4-6	EST 4-6-0.0-1.0	2521533.052	411035.2082	0.0	1.0	0.5	1.9
Oct-01	EST 4-6	EST 4-6-1.0-1.5	2521533.052	411035.2082	1.0	1.5	1.3	2.4
Oct-01	EST 4-7	EST 4-7-0.0-1.0	2521600.962	411175.3289	0.0	1.0	0.5	240
Oct-01	EST 4-7	EST 4-7-1.0-1.5	2521600.962	411175.3289	1.0	1.5	1.3	140

TABLE C-1
PCB Data Summary
Lincoln Park/Milwaukee River Channel Sediments Site

Sample Date	Station ID	Sample ID	X (WI SPS)	Y (WI SPS)	Sample Interval Start Depth (ft)	Sample Interval End Depth (ft)	Sample Interval Mid-point Depth (ft)	Total PCB (ppm)
Oct-01	EST 4-8	EST 4-8-0.0-0.6	2521686.6	411256.1173	0.0	0.6	0.3	0.65
Oct-01	EST 4-9	EST 4-9-0.0-1.0	2521771.284	411261.8407	0.0	1.0	0.5	0.84
Oct-01	EST 4-9	EST 4-9-1.0-2.0	2521771.284	411261.8407	1.0	2.0	1.5	190
Sep-02	EST 1-2	EST 1-2-0.0-1.0	2525891.42	408278.9297	0.0	1.0	0.5	1.7
Sep-02	EST 1-2	EST 1-2-1.0-2.1	2525891.42	408278.9297	1.0	2.1	1.6	6.5
Sep-02	EST 1-3	EST 1-3-0.0-1.0	2525679.828	408382.3287	0.0	1.0	0.5	14
Sep-02	EST 1-3	EST 1-3-1.0-1.4	2525679.828	408382.3287	1.0	1.4	1.2	2.9
Sep-02	EST 1-5	EST 1-5-0.0-1.0	2525435.815	408585.0635	0.0	1.0	0.5	9.8
Sep-02	EST 1-5	EST 1-5-1.0-1.3	2525435.815	408585.0635	1.0	1.3	1.2	1.6
Sep-02	EST 5-1	EST 5-1-0.0-0.5	2520020.885	412754.8668	0.0	0.5	0.3	0.21
Sep-02	EST 5-10	EST 5-10-0.0-0.9	2520863.924	412193.3068	0.0	0.9	0.4	1.6
Sep-02	EST 5-11	EST 5-11-0.0-1.1	2520903.819	411894.3716	0.0	1.1	0.6	2.1
Sep-02	EST 5-12	EST 5-12-0.0-0.5	2521004.012	411618.3448	0.0	0.5	0.3	1.9
Sep-02	EST 5-13	EST 5-13-0.0-0.9	2521011.791	411491.4682	0.0	0.9	0.4	2.5
Sep-02	EST 5-14	EST 5-14-0.0-0.3	2521065.712	411384.2319	0.0	0.3	0.1	2
Sep-02	EST 5-15	EST 5-15-0.0-0.9	2521121.545	411353.5289	0.0	0.9	0.5	1.1
Sep-02	EST 5-16	EST 5-16-0.0-0.8	2521246.804	411097.6943	0.0	0.8	0.4	1.4
Sep-02	EST 5-2	EST 5-2-0.0-0.3	2520363.353	412739.8861	0.0	0.3	0.2	1.3
Sep-02	EST 5-3	EST 5-3-0.0-0.8	2520433.973	412781.7695	0.0	0.8	0.4	1.2
Sep-02	EST 5-4	EST 5-4-0.0-0.2	2520537.941	412749.3372	0.0	0.2	0.1	1.2
Sep-02	EST 5-5	EST 5-5-0.0-1.2	2520600.245	412693.2564	0.0	1.2	0.6	1.1
Sep-02	EST 5-6	EST 5-6-0.0-1.2	2520673.126	412635.1321	0.0	1.2	0.6	0.79
Sep-02	EST 5-7	EST 5-7-0.0-1.0	2520721.643	412596.4438	0.0	1.0	0.5	0.77
Sep-02	EST 5-7	EST 5-7-1.0-1.9	2520721.643	412596.4438	1.0	1.9	1.5	44
Sep-02	EST 5-8	EST 5-8-0.0-0.9	2520791.323	412523.8438	0.0	0.9	0.5	1.9
Sep-02	EST 5-9	EST 5-9-0.0-0.9	2520843.168	412359.1823	0.0	0.9	0.5	1.8
Oct-02	EST 2-10	EST 2-10-0.0-0.9	2522299.006	409202.6784	0.0	0.9	0.5	0.039
Oct-02	EST 2-11	EST 2-11-0.0-1.1	2522308.437	409561.1983	0.0	1.1	0.6	1.5
Oct-02	EST 2-12	EST 2-12-0.0-1.0	2522305.518	409620.5644	0.0	1.0	0.5	3

TABLE C-1
PCB Data Summary
Lincoln Park/Milwaukee River Channel Sediments Site

Sample Date	Station ID	Sample ID	X (WI SPS)	Y (WI SPS)	Sample Interval Start Depth (ft)	Sample Interval End Depth (ft)	Sample Interval Mid-point Depth (ft)	Total PCB (ppm)
Oct-02	EST 2-12	EST 2-12-1.0-1.5	2522305.518	409620.5644	1.0	1.5	1.3	0.81
Oct-02	EST 2-13	EST 2-13-0.0-0.4	2522284.615	409724.1315	0.0	0.4	0.2	1.8
Oct-02	EST 2-14	EST 2-14-0.0-1.0	2522268.89	409812.6131	0.0	1.0	0.5	23
Oct-02	EST 2-14	EST 2-14-1.0-1.8	2522268.89	409812.6131	1.0	1.8	1.4	62
Oct-02	EST 2-15	EST 2-15-0.0-1.0	2522194.164	409886.6987	0.0	1.0	0.5	2.9
Oct-02	EST 2-16	EST 2-16-0.0-1.0	2522126.477	409960.8082	0.0	1.0	0.5	11
Oct-02	EST 2-16	EST 2-16-1.0-2.1	2522126.477	409960.8082	1.0	2.1	1.6	0.63
Oct-02	EST 2-17	EST 2-17-1.0-2.1	2521928.75	410192.7542	0.0	1.0	0.5	3.6
Oct-02	EST 2-17	EST 2-17-1.0-2.1	2521928.75	410192.7542	1.0	2.0	1.5	200
Oct-02	EST 2-17	EST 2-17-2.0-2.3	2521928.75	410192.7542	2.0	2.3	2.2	17
Oct-02	EST 2-2	EST 2-2-0.0-1.0	2522255.945	409037.1479	0.0	1.0	0.5	1.5
Oct-02	EST 2-2	EST 2-2-1.0-1.8	2522255.945	409037.1479	1.0	1.8	1.4	160
Oct-02	EST 2-23	EST 2-23-0.0-1.0	2522919.027	408793.4785	0.0	1.0	0.5	2.4
Oct-02	EST 2-24	EST 2-24-0.0-0.5	2523192.124	408804.079	0.0	0.5	0.3	14
Oct-02	EST 2-3	EST 2-3-0.0-1.0	2522260.789	409103.2377	0.0	1.0	0.5	55
Oct-02	EST 2-3	EST 2-3-1.0-1.8	2522260.789	409103.2377	1.0	1.8	1.4	1.2
Oct-02	EST 2-4	EST 2-4-0.0-1.0	2522193.605	409065.2413	0.0	1.0	0.5	56
Oct-02	EST 2-4	EST 2-4-1.0-1.5	2522193.605	409065.2413	1.0	1.5	1.3	20
Oct-02	EST 2-5	EST 2-5-0.0-1.0	2522197.31	408990.5828	0.0	1.0	0.5	3.2
Oct-02	EST 2-5	EST 2-5-1.0-1.6	2522197.31	408990.5828	1.0	1.6	1.3	150
Oct-02	EST 2-6	EST 2-6-0.0-1.0	2522192.374	408917.616	0.0	1.0	0.5	3.3
Oct-02	EST 2-6	EST 2-61.0-1.8	2522192.374	408917.616	1.0	1.8	1.4	110
Oct-02	EST 2-7	EST 2-7-0.0-1.0	2522257.393	408929.6458	0.0	1.0	0.5	2.7
Oct-02	EST 2-7	EST 2-7-1.0-2.0	2522257.393	408929.6458	1.0	2.0	1.5	170
Oct-02	EST 2-7	EST 2-7-2.0-2.4	2522257.393	408929.6458	2.0	2.4	2.2	2.1
Oct-02	EST 2-8	EST 2-8-0.0-1.0	2522297.868	408970.5994	0.0	1.0	0.5	56
Oct-02	EST 2-8	EST 2-8-1.0-2.0	2522297.868	408970.5994	1.0	2.0	1.5	2.8
Oct-02	EST 2-8	EST 2-8-2.0-2.2	2522297.868	408970.5994	2.0	2.2	2.1	0.75
Oct-02	EST 2-9	EST 2-9-0.0-0.8	2522310.701	409067.0463	0.0	0.8	0.4	1.3

TABLE C-1
PCB Data Summary
Lincoln Park/Milwaukee River Channel Sediments Site

Sample Date	Station ID	Sample ID	X (WI SPS)	Y (WI SPS)	Sample Interval Start Depth (ft)	Sample Interval End Depth (ft)	Sample Interval Mid-point Depth (ft)	Total PCB (ppm)
Aug-03	4X2	4X2-0-0.8	2521096.436	410489.5493	0.0	0.8	0.4	9.3
Aug-03	4X2	4X2-0.8-1.6	2521096.436	410489.5493	0.8	1.6	1.2	150
Aug-03	4X2	4X2-1.6-1.9	2521096.436	410489.5493	1.6	1.9	1.8	8.1
Aug-03	4X2	4X2-1.9-2.2	2521096.436	410489.5493	1.9	2.2	2.1	1.6
Aug-03	4X2	4X2-2.2-2.5	2521096.436	410489.5493	2.2	2.5	2.4	0.35
Aug-03	4X2	4X2-2.5-2.8	2521096.436	410489.5493	2.5	2.8	2.7	0.62
Aug-03	4X3	4X3-0-1.1	2521226.408	410330.6985	0.0	1.1	0.6	46
Aug-03	4X3	4X3-1.1-1.6	2521226.408	410330.6985	1.1	1.6	1.4	16
Aug-03	4X3	4X3-1.6-2.2	2521226.408	410330.6985	1.6	2.2	1.9	1.7
Aug-03	4X3	4X3-2.2-2.5	2521226.408	410330.6985	2.2	2.5	2.4	0.29
Aug-03	4X4	4X4-0-0.8	2521384.981	410367.2169	0.0	0.8	0.4	79
Aug-03	4X4	4X4-0.8-1.8	2521384.981	410367.2169	0.8	1.8	1.3	19
Aug-03	4X4	4X4-1.8-2.3	2521384.981	410367.2169	1.8	2.3	2.1	1.1
Aug-03	4X4	4X4-2.3-2.8	2521384.981	410367.2169	2.3	2.8	2.6	4.6
Aug-03	4X4	4X4-2.8-3.3	2521384.981	410367.2169	2.8	3.3	3.1	0.8
Aug-03	4X4	4X4-3.3-3.5	2521384.981	410367.2169	3.3	3.5	3.4	0.048
Aug-03	4X5	4X5-0-0.8	2521377.341	410376.624	0.0	0.8	0.4	4
Aug-03	4X5	4X5-0.8-1.8	2521377.341	410376.624	0.8	1.8	1.3	42
Aug-03	4X5	4X5-1.8-2.3	2521377.341	410376.624	1.8	2.3	2.1	0.4
Aug-03	4X5	4X5-2.3-2.8	2521377.341	410376.624	2.3	2.8	2.6	0.62
Aug-03	4X5	4X5-2.8-3.3	2521377.341	410376.624	2.8	3.3	3.1	1.2
Aug-03	4X5	4X5-3.3-3.5	2521377.341	410376.624	3.3	3.5	3.4	0.098
Aug-03	4XX1	4XX1-0-0.9	2521216.906	410871.2314	0.0	0.9	0.5	22
Aug-03	4XX1	4XX1-0.9-1.4	2521216.906	410871.2314	0.9	1.4	1.2	0.45
Aug-03	1X1	1X1-0-1.4	2525807.239	408333.6443	0.0	1.4	0.7	6.7
Aug-03	3X3	3X3-0-0.6	2521610.719	410537.1772	0.0	0.6	0.3	2.2
Aug-03	3X3	3X3-0.6-1.2	2521610.719	410537.1772	0.6	1.2	0.9	4.4
Aug-03	3X3	3X3-1.2-1.8	2521610.719	410537.1772	1.2	1.8	1.5	6.2
Aug-03	3X3	3X3-1.8-2.2	2521610.719	410537.1772	1.8	2.2	2.0	2.7

TABLE C-1
PCB Data Summary
Lincoln Park/Milwaukee River Channel Sediments Site

Sample Date	Station ID	Sample ID	X (WI SPS)	Y (WI SPS)	Sample Interval Start Depth (ft)	Sample Interval End Depth (ft)	Sample Interval Mid-point Depth (ft)	Total PCB (ppm)
Aug-03	3X3	3X3-2.2-2.6	2521610.719	410537.1772	2.2	2.6	2.4	0.43
Aug-03	4X10	4X10-0-0.6	2522281.829	408894.8934	0.0	0.6	0.3	2.5
Aug-03	4X10	4X10-0.6-1.2	2522281.829	408894.8934	0.6	1.2	0.9	16
Aug-03	4X10	4X10-1.2-1.8	2522281.829	408894.8934	1.2	1.8	1.5	170
Aug-03	4X10	4X10-1.8-2.4	2522281.829	408894.8934	1.8	2.4	2.1	6.2
Aug-03	4X10	4X10-2.4-3.2	2522281.829	408894.8934	2.4	3.2	2.8	1.1
Aug-03	4X7	4X7-0-0.6	2521549.978	410352.384	0.0	0.6	0.3	8.7
Aug-03	4X7	4X7-0.6-1.2	2521549.978	410352.384	0.6	1.2	0.9	72
Aug-03	4X7	4X7-1.2-1.8	2521549.978	410352.384	1.2	1.8	1.5	380
Aug-03	4X7	4X7-1.8-2.4	2521549.978	410352.384	1.8	2.4	2.1	17
Aug-03	4X8	4X8-0-0.6	2522241.881	409109.9875	0.0	0.6	0.3	2.6
Aug-03	4X8	4X8-0.6-1.2	2522241.881	409109.9875	0.6	1.2	0.9	42
Aug-03	4X8	4X8-1.2-1.9	2522241.881	409109.9875	1.2	1.9	1.6	0.7
Aug-03	4X8	4X81.9-2.6	2522241.881	409109.9875	1.9	2.6	2.3	0.27
Aug-03	4X9	4X9-0-0.6	2522244.773	409002.336	0.0	0.6	0.3	1.5
Aug-03	4X9	4X9-0.6-1.2	2522244.773	409002.336	0.6	1.2	0.9	2.2
Aug-03	4X9	4X9-1.2-1.8	2522244.773	409002.336	1.2	1.8	1.5	210
Aug-03	4X9	4X9-1.8-2.4	2522244.773	409002.336	1.8	2.4	2.1	5.4
Aug-03	4X9	4X9-2.4-2.7	2522244.773	409002.336	2.4	2.7	2.6	0.84
Feb-08	LPMR-S-1	LPMR-S-1-0.5-2	2522034.169	411718.7783	0.5	2	1.3	0
Feb-08	LPMR-S-1	LPMR-S-1-0-0.5	2522034.169	411718.7783	0	0.5	0.3	0.292
Feb-08	LPMR-S-10	LPMR-S-10-0-0.5	2521929.482	410209.8615	0	0.5	0.3	1.12
Feb-08	LPMR-S-10	LPMR-S-10-5-7	2521929.482	410209.8615	5	7	6.0	1.83
Feb-08	LPMR-S-11	LPMR-S-11-0.5-1.5	2522077.371	410166.443	0.5	1.5	1.0	19
Feb-08	LPMR-S-11	LPMR-S-11-0-0.5	2522077.371	410166.443	0	0.5	0.3	29.6
Feb-08	LPMR-S-11	LPMR-S-11-1.5-4	2522077.371	410166.443	1.5	4	2.8	3.39
Feb-08	LPMR-S-12	LPMR-S-12-0.5-1.5	2522142.467	409944.9872	0.5	1.5	1.0	1.53
Feb-08	LPMR-S-12	LPMR-S-12-0-0.5	2522142.467	409944.9872	0	0.5	0.3	2.42
Feb-08	LPMR-S-13	LPMR-S-13-0.5-1.5	2522199.165	409867.6865	0.5	1.5	1.0	9.2

TABLE C-1
PCB Data Summary
Lincoln Park/Milwaukee River Channel Sediments Site

Sample Date	Station ID	Sample ID	X (WI SPS)	Y (WI SPS)	Sample Interval Start Depth (ft)	Sample Interval End Depth (ft)	Sample Interval Mid-point Depth (ft)	Total PCB (ppm)
Feb-08	LPMR-S-13	LPMR-S-13-0-0.5	2522199.165	409867.6865	0	0.5	0.3	4.13
Feb-08	LPMR-S-2	LPMR-S-2-0-0.5	2521835.212	411604.2143	0	0.5	0.3	17.9
Feb-08	LPMR-S-2	LPMR-S-2-2.5-7	2521835.212	411604.2143	2.5	7	4.8	0.56
Feb-08	LPMR-S-3	LPMR-S-3-0.5-2	2521928.025	411557.2735	0.5	2	1.3	30.5
Feb-08	LPMR-S-3	LPMR-S-3-0-0.5	2521928.025	411557.2735	0	0.5	0.3	2.9
Feb-08	LPMR-S-3	LPMR-S-3-4-6	2521928.025	411557.2735	4	6	5.0	3.29
Feb-08	LPMR-S-4	LPMR-S-4-0-0.5	2521806.431	411236.3079	0	0.5	0.3	1.74
Feb-08	LPMR-S-4	LPMR-S-4-4.5-5.5	2521806.431	411236.3079	4.5	5.5	5.0	87.5
Feb-08	LPMR-S-4	LPMR-S-4-7.5-9	2521806.431	411236.3079	7.5	9	8.3	0.038
Feb-08	LPMR-S-5	LPMR-S-5-0-0.5	2521549.714	411202.9799	0	0.5	0.3	4.15
Feb-08	LPMR-S-5	LPMR-S-5-1-2.5	2521549.714	411202.9799	1	2.5	1.8	135
Feb-08	LPMR-S-5	LPMR-S-5-8-9	2521549.714	411202.9799	8	9	8.5	0.113
Feb-08	LPMR-S-6	LPMR-S-6-0-0.5	2521548.402	411101.4945	0	0.5	0.3	8.8
Feb-08	LPMR-S-6	LPMR-S-6-1-2	2521548.402	411101.4945	1	2	1.5	823
Feb-08	LPMR-S-6	LPMR-S-6-4-6	2521548.402	411101.4945	4	6	5.0	1.19
Feb-08	LPMR-S-7	LPMR-S-7-0-0.5	2521170.677	410689.7875	0	0.5	0.3	4.4
Feb-08	LPMR-S-7	LPMR-S-7-1-3	2521170.677	410689.7875	1	3	2.0	6.8
Feb-08	LPMR-S-8	LPMR-S-8-0.5-2.5	2521144.116	410409.9682	0.5	2.5	1.5	38.6
Feb-08	LPMR-S-8	LPMR-S-8-0-0.5	2521144.116	410409.9682	0	0.5	0.3	22.2
Feb-08	LPMR-S-8	LPMR-S-8-4-7	2521144.116	410409.9682	4	7	5.5	1.17
Feb-08	LPMR-S-9	LPMR-S-9-0.5-1.5	2521274.753	410354.9946	0.5	1.5	1.0	8
Feb-08	LPMR-S-9	LPMR-S-9-0-0.5	2521274.753	410354.9946	0	0.5	0.3	6.1
Feb-08	LPMR-S-9	LPMR-S-9-3-8	2521274.753	410354.9946	3	8	5.5	0.31
Mar-09	MRZZ-01	MRZZ-01-0-0.5	2526108.386	408356.5573	0	0.5	0.3	41
Mar-09	WO-C-02	WO-C-2-top	2521831.702	411517.378	0	0.1	0.1	2.2
Mar-09	WO-F-01	WO-F-1-bottom half	2521493.031	411217.9458	1.2	2	1.6	0
Mar-09	WO-F-01	WO-F-1 middle	2521493.031	411217.9458	0.5	1.2	0.9	0
Mar-09	WO-F-01	WO-F-1-top half	2521493.031	411217.9458	0	0.5	0.3	0.91
Mar-09	WO-I-02	WO-I-2-bottom half	2521135.286	410879.4811	1.7	3	2.4	15

TABLE C-1
PCB Data Summary
Lincoln Park/Milwaukee River Channel Sediments Site

Sample Date	Station ID	Sample ID	X (WI SPS)	Y (WI SPS)	Sample Interval Start Depth (ft)	Sample Interval End Depth (ft)	Sample Interval Mid-point Depth (ft)	Total PCB (ppm)
Mar-09	WO-I-02	WO-I-2-top half	2521135.286	410879.4811	0.3	1.7	1.0	120
Mar-09	WO-AA-02	WO-AA-02	2522231.072	411660.4084	0	1	0.5	7
Mar-09	WO-O-02	WO-O-2- top half	2521699.252	410197.0064	0	0.6	0.3	1.2
Mar-09	WO-O-02	WO-O-2-bottom half	2521699.252	410197.0064	0.6	1.2	0.9	0.98
Mar-09	WO-R-02	WO-R-2-bottom	2522109.111	410037.3803	0.5	2	1.3	1.9
Mar-09	WO-R-02	WO-R-2-top half	2522109.111	410037.3803	0	0.5	0.3	3.1
Mar-09	LC-B-1-N	LC-B-1-N	2520693.74	412667.8689	0	1	0.5	5.4
Mar-09	LC-B-2	LC-B-2	2520715.041	412654.7717	0	0.4	0.2	0.97
Mar-09	LC-B-2-S	LC-B-2-S	2520736.443	412641.7744	0	1	0.5	0.91
Mar-09	LC-C-2	LC-C-2	2520874.176	412373.7927	0	1	0.5	1.3
Mar-09	LC-D-2	LC-D-2	2520911.114	412074.0984	0	0.3	0.2	0.82
Mar-09	LC-E-2	LC-E-2	2521227.654	411753.4399	0	0.6	0.3	0.272
Mar-09	LC-F-2	LC-F-2	2521023.694	411446.1149	0	1	0.5	1.2

TABLE C-2
Sediment Probe Data Summary
Lincoln Park/Milwaukee River Channel Sediments Site

Sample Date	Station ID	Y (WI SPS)	X (WI SPS)	Sediment Top Elevation	Sediment Bottom Elevation	Sediment Thickness (ft)
2008	LPMR-ST-15	410835.6834	2521201.59	615.17	609.17	6.00
2008	LPMR-ST-16	410742.7204	2521517.882	614.97	610.97	4.00
2008	LPMR-ST-17	410633.4549	2521337.518	615.52	610.52	5.00
2008	LPMR-ST-18	410606.4263	2521597.913	615.19	609.89	5.30
2008	LPMR-ST-19	410529.2329	2521452.881	615.57	609.07	6.50
2008	LPMR-ST-2	411579.7026	2521970.074	614.89	609.39	5.50
2008	LPMR-ST-20	410508.2549	2521652.275	615.78	613.58	2.20
2008	LPMR-ST-21	410428.9472	2521512.376	616.05	609.05	7.00
2008	LPMR-ST-22	410766.7537	2521036.13	614.37	608.37	6.00
2008	LPMR-ST-23	410600.9703	2521026.587	615.03	609.53	5.50
2008	LPMR-ST-24	410549.9918	2521032.623	614.99	614.99	0.00
2008	LPMR-ST-25	410491.9596	2521123.832	615.65	611.65	4.00
2008	LPMR-ST-26	410503.5415	2521043.125	615.03	615.03	0.00
2008	LPMR-ST-27	410370.7352	2521180.926	615.2	615.2	0.00
2008	LPMR-ST-28	410360.3015	2521327.4	615.51	609.01	6.50
2008	LPMR-ST-29	410342.4417	2521387.84	615.5	615.5	0.00
2008	LPMR-ST-3	411527.7643	2522027.076	616.27	610.77	5.50
2008	LPMR-ST-30	410333.1138	2521577.884	615.87	609.87	6.00
2008	LPMR-ST-31	410379.5837	2521683.99	614.12	610.62	3.50
2008	LPMR-ST-33	410200.2906	2521653.982	614.82	614.82	0.00
2008	LPMR-ST-34	410215.8538	2521886.051	616.03	609.03	7.00
2008	LPMR-ST-36	410183.3519	2522028.852	616.16	610.16	6.00
2008	LPMR-ST-38	410115.0508	2522146.832	615.86	609.46	6.40
2008	LPMR-ST-39	409970.1449	2522106.918	614.36	610.66	3.70
2008	LPMR-ST-4	411512.7018	2521857.382	614.5	609	5.50
2008	LPMR-ST-40	409897.8973	2522179.953	614.34	609.34	5.00
2008	LPMR-ST-5	411421.1007	2521913.642	615.59	608.79	6.80
2008	LPMR-ST-6	411406.0432	2521766.935	615.51	607.61	7.90
2008	LPMR-ST-7	411308.2914	2521843.94	615.95	608.95	7.00
2008	LPMR-ST-8	411265.3686	2521621.786	615.33	606.73	8.60
2008	LPMR-ST-9	411214.4553	2521657.965	615.85	607.85	8.00
2008	LPMR-TP-1	411604.5162	2522010.854	614.58	608.78	5.80
2008	LPMR-TP-2	411269.329	2521741.144	616.22	609.22	7.00
2008	LPMR-TP-3	410600.4941	2521002.37	614.94	607.94	7.00
2008	LPMR-TP-4	410416.6968	2521410.885	615.76	609.26	6.50
2009	LC-A-01	969525.11	2257847.5	613.478	611.678	1.8
2009	LC-A-02	969561.2	2257849	611.2	610.5	0.7
2009	LC-A-03	969597.3	2257850	610.6	610.6	0
2009	LC-B-1	969408.33	2258102.9	613.666	612.066	1.6
2009	LC-B-2	969440.5	2258122.5	612	610.7	1.3
2009	LC-B-3	969472.79	2258142.25	610.2	610.2	0
2009	LC-C-1	969152.16	2258252.64	613.612	610.71	2.902
2009	LC-C-2	969159.5	2258281.6	611.31	609.8	1.51
2009	LC-D-1	968851.85	2258281.09	613.137	611.537	1.6
2009	LC-D-2	968859.8	2258318.5	612.3	607.5	4.8

TABLE C-2
Sediment Probe Data Summary
Lincoln Park/Milwaukee River Channel Sediments Site

Sample Date	Station ID	Y (WI SPS)	X (WI SPS)	Sediment Top Elevation	Sediment Bottom Elevation	Sediment Thickness (ft)
2009	LC-D-3	968867.7	2258355.6	612.1	610.1	2
2009	LC-D-4	968875.58	2258392.81	609.786	608.086	1.7
2009	LC-E-1	968536.42	2258332.77	612.967	611.267	1.7
2009	LC-E-2	968539.1	2258635	611.06	610.9	0.16
2009	LC-E-3	968541.8	2258397.7	610.95	610.25	0.7
2009	LC-E-4	968544.49	2258429.06	612.944	610.944	2
2009	LC-F-1	968222.42	2258397.37	619.692	619.692	0
2009	LC-F-2	968231.8	2258431	610.7	610.5	0.2
2009	LC-F-3	968241.2	2258464.7	611.9	610.2	1.7
2009	LC-F-4	968250.63	2258498.32	612.997	611.197	1.8
2009	LC-G-01	967973.6	2258516.92	611.948	611.748	0.2
2009	LC-G-02	967989.7	2258545.6	611	610.7	0.3
2009	LC-G-03	968005.8	2258574.4	612	611.1	0.9
2009	LC-G-04	968021.93	2258603.08	613.542	609.942	3.6
2009	WO-A-00	968491.99	2259506.65	610	605.9	4.1
2009	WO-A-01	968470.79	2259510.87	610.6	605.6	5
2009	WO-A-02	968449.59	2259515.07	612.793	612.193	0.6
2009	WO-A-03	968428.39	2259519.29	613.743	611.343	2.4
2009	WO-A-04	968408.21	2259525.15	614.299	609.499	4.8
2009	WO-A-05	968387.17	2259528.27	615.108	612.808	2.3
2009	WO-AA-01	968464.78	2259644.58	610.102	609.202	0.9
2009	WO-AA-02	968445.94	2259638.41	610.264	605.064	5.2
2009	WO-AA-03	968427.78	2259632.73	611.305	608.005	3.3
2009	WO-AA-04	968410.77	2259627.9	614.54	611.04	3.5
2009	WO-B-01	968418.9	2259336.95	610.77	606.27	4.5
2009	WO-B-02	968403.79	2259349.92	611.67	607.77	3.9
2009	WO-B-03	968388.62	2259362.89	613.469	610.169	3.3
2009	WO-B-04	968373.46	2259375.86	614.24	609.34	4.9
2009	WO-B-05	968358.47	2259388.95	614.509	611.209	3.3
2009	WO-B-06	968343.29	2259402.11	614.895	610.295	4.6
2009	WO-B-07	968328.43	2259415.39	615.219	612.219	3
2009	WO-C-00	968332.42	2259211.98	611.67	605	6.67
2009	WO-C-01	968317.69	2259225.5	610.87	605.97	4.9
2009	WO-C-02	968302.96	2259239.02	611.47	607.27	4.2
2009	WO-C-03	968287.89	2259252.34	614.061	607.761	6.3
2009	WO-C-04	968273.49	2259266.05	614.929	610.729	4.2
2009	WO-C-05	968258.67	2259279.5	615.24	610.94	4.3
2009	WO-C-06	968244.06	2259293.18	615.076	609.276	5.8
2009	WO-C-07	968229.4	2259306.64	615.109	607.109	8
2009	WO-C-08	968214.57	2259320.13	615.244	609.444	5.8
2009	WO-C-09	968200.08	2259333.55	614.88	610.88	4
2009	WO-D-01	968317.7	2259225.5	613.57	610.37	3.2
2009	WO-D-02	968303	2259239	611.17	607.77	3.4
2009	WO-D-03	968288.2	2259252.5	611.46	610.46	1
2009	WO-D-04	968182.55	2259145.23	614.679	611.479	3.2

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Sample Date	Station ID	Y (WI SPS)	X (WI SPS)	Sediment Top Elevation	Sediment Bottom Elevation	Sediment Thickness (ft)
2009	WO-D-05	968169.09	2259159.9	615.247	611.647	3.6
2009	WO-D-06	968155.28	2259174.62	615.415	610.215	5.2
2009	WO-D-07	968141.76	2259188.98	615.512	611.412	4.1
2009	WO-D-08	968128.25	2259203.84	615.608	611.408	4.2
2009	WO-D-09	968114.81	2259218.7	615.597	609.797	5.8
2009	WO-D-10	968101.37	2259233.53	615.603	608.803	6.8
2009	WO-D-11	968088.01	2259248.35	615.563	610.263	5.3
2009	WO-D-12	968074.77	2259263.26	615.428	614.128	1.3
2009	WO-E-01	968114.43	2258994.04	612.14	609.74	2.4
2009	WO-E-02	968092.89	2259018.25	610.398	607.898	2.5
2009	WO-E-03	968073.49	2259040.84	614.651	609.851	4.8
2009	WO-E-04	968060.77	2259056.47	615.314	609.514	5.8
2009	WO-E-05	968048.06	2259071.94	615.557	611.157	4.4
2009	WO-E-06	968035.22	2259087.27	615.565	611.665	3.9
2009	WO-E-07	968022.25	2259102.4	615.627	611.127	4.5
2009	WO-E-08	968009.48	2259117.85	615.768	612.868	2.9
2009	WO-E-09	967996.75	2259133.15	615.774	612.374	3.4
2009	WO-E-10	967983.84	2259148.4	615.731	608.531	7.2
2009	WO-E-11	967970.99	2259163.82	616.103	608.703	7.4
2009	WO-E-12	967958.01	2259179.01	615.787	609.787	6
2009	WO-E-13	967945.29	2259194.31	615.75	610.15	5.6
2009	WO-E-14	967932.09	2259209.64	615.758	610.958	4.8
2009	WO-E-15	967919.72	2259224.71	615.72	614.62	1.1
2009	WO-F-01	968003.57	2258900.31	611.51	607.91	3.6
2009	WO-F-02	967990.38	2258913.21	611.61	605.91	5.7
2009	WO-F-03	967977.19	2258926.1	610.114	604.914	5.2
2009	WO-F-04	967964.01	2258938.99	614.793	607.993	6.8
2009	WO-F-05	967949.24	2258953.97	615.227	607.527	7.7
2009	WO-F-06	967934.68	2258968.06	615.653	612.253	3.4
2009	WO-F-07	967920.45	2258981.98	615.854	612.054	3.8
2009	WO-F-08	967906.02	2258996.07	615.236	608.336	6.9
2009	WO-F-09	967892.12	2259009.82	612.048	609.148	2.9
2009	WO-F-10	967877.71	2259024.21	613.945	610.945	3
2009	WO-G-00	967892.14	2258793.61	612.41	608.11	4.3
2009	WO-G-01	967878.9	2258823.69	612.01	608.11	3.9
2009	WO-G-02	967852.43	2258838.74	611.01	607.51	3.5
2009	WO-G-03	967852.35	2258838.93	613.983	609.583	4.4
2009	WO-G-04	967839.19	2258853.77	615.133	611.233	3.9
2009	WO-G-05	967825.88	2258868.88	615.535	609.135	6.4
2009	WO-G-06	967812.9	2258884.07	615.942	610.242	5.7
2009	WO-G-07	967800.15	2258899.43	615.991	611.891	4.1
2009	WO-G-08	967786.24	2258913.95	616.324	613.024	3.3
2009	WO-G-09	967773.59	2258928.87	615.475	611.975	3.5
2009	WO-G-10	967761.18	2258943.7	614.073	610.273	3.8
2009	WO-H-01	967771.17	2258626.42	611.79	607.99	3.8

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Sample Date	Station ID	Y (WI SPS)	X (WI SPS)	Sediment Top Elevation	Sediment Bottom Elevation	Sediment Thickness (ft)
2009	WO-H-02	967765.19	2258645.68	610.49	606.79	3.7
2009	WO-H-03	967759.22	2258664.93	611.69	609.59	2.1
2009	WO-H-04	967753.24	2258684.18	611.588	610.488	1.1
2009	WO-H-05	967747.63	2258704.05	611.451	610.651	0.8
2009	WO-H-06	967741.33	2258723.09	612.041	611.241	0.8
2009	WO-H-07	967735.31	2258741.95	612.633	610.533	2.1
2009	WO-H-08	967729.13	2258761.18	612.317	611.217	1.1
2009	WO-H-09	967722.86	2258779.99	613.61	609.71	3.9
2009	WO-H-10	967716.41	2258799.14	613.819	609.819	4
2009	WO-H-11	967711.12	2258818.17	613.556	611.256	2.3
2009	WO-H-12	967705.38	2258837.33	614.924	613.624	1.3
2009	WO-H-13	967699.6	2258856.28	616.868	615.568	1.3
2009	WO-H-14	967694.02	2258875.38	617.372	615.772	1.6
2009	WO-I-01	967682.26	2258532	613.5	611.2	2.3
2009	WO-I-02	967665.15	2258542.52	613.503	608.803	4.7
2009	WO-I-03	967648.06	2258553.04	614.314	609.014	5.3
2009	WO-I-04	967631.15	2258563.75	614.445	609.145	5.3
2009	WO-I-05	967614.46	2258574.61	614.523	609.223	5.3
2009	WO-I-06	967597.74	2258585.63	614.619	609.119	5.5
2009	WO-I-07	967581.1	2258596.76	614.69	608.69	6
2009	WO-I-08	967564.36	2258607.69	614.803	609.703	5.1
2009	WO-I-09	967547.85	2258618.77	614.977	610.077	4.9
2009	WO-I-10	967531.04	2258629.93	614.946	610.146	4.8
2009	WO-I-11	967514.42	2258640.97	615.095	609.695	5.4
2009	WO-I-12	967497.84	2258651.84	615.089	609.489	5.6
2009	WO-I-13	967481.15	2258663.12	615.01	612.51	2.5
2009	WO-I-14	967464.7	2258674.6	615.342	613.842	1.5
2009	WO-I-15	967473.25	2258692.39	615.078	610.778	4.3
2009	WO-I-16	967482.3	2258710.27	614.856	610.556	4.3
2009	WO-I-17	967491.43	2258728.66	613.101	610.801	2.3
2009	WO-I-18	967499.7	2258746.61	611.02	610.62	0.4
2009	WO-I-19	967508.39	2258764.77	611.72	610.52	1.2
2009	WO-I-20	967517.08	2258782.93	613.4	610.1	3.3
2009	WO-I-21	967525.93	2258801.14	614.191	610.091	4.1
2009	WO-I-22	967534.69	2258819.24	615.002	612.202	2.8
2009	WO-I-23	967542.93	2258837.31	615.453	610.653	4.8
2009	WO-I-24	967551.76	2258855.35	615.147	609.847	5.3
2009	WO-I-25	967560.43	2258873.28	615.156	610.156	5
2009	WO-I-26	967568.93	2258891.33	614.875	609.775	5.1
2009	WO-I-27	967577.6	2258909.37	614.324	611.224	3.1
2009	WO-I-28	967586.19	2258927.54	614.926	612.126	2.8
2009	WO-J-01	967417.11	2258387.38	614.417	610.617	3.8
2009	WO-J-02	967412.51	2258406.73	613.76	608.56	5.2
2009	WO-J-03	967408	2258426.08	613.803	608.003	5.8
2009	WO-J-04	967403.11	2258445.49	614.393	608.393	6

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Sample Date	Station ID	Y (WI SPS)	X (WI SPS)	Sediment Top Elevation	Sediment Bottom Elevation	Sediment Thickness (ft)
2009	WO-J-05	967398.28	2258464.71	614.747	609.047	5.7
2009	WO-J-06	967393.66	2258484.6	614.692	609.992	4.7
2009	WO-J-07	967388.78	2258503.78	614.921	611.021	3.9
2009	WO-J-08	967384.11	2258523.05	615.013	613.213	1.8
2009	WO-K-01	967198.9	2258441.78	614.87	610.07	4.8
2009	WO-K-02	967210.13	2258458.78	614.323	604.923	9.4
2009	WO-K-03	967221.36	2258475.2	613.726	608.826	4.9
2009	WO-K-04	967232.8	2258491.68	614.171	609.271	4.9
2009	WO-K-05	967243.25	2258508.9	614.447	609.147	5.3
2009	WO-K-06	967252.99	2258526.24	615.017	609.717	5.3
2009	WO-K-07	967264.19	2258545.61	612.566	610.266	2.3
2009	WO-K-08	967350.23	2258747.49	614.862	612.962	1.9
2009	WO-K-09	967360.48	2258764.54	615.024	611.024	4
2009	WO-K-10	967368.87	2258783.07	614.994	610.594	4.4
2009	WO-K-11	967379.22	2258799.97	615.02	610.62	4.4
2009	WO-K-12	967386.93	2258817.96	613.163	610.263	2.9
2009	WO-K-13	967396.83	2258835.43	611.09	609.69	1.4
2009	WO-K-14	967406.73	2258852.89	610.99	609.49	1.5
2009	WO-K-15	967416.63	2258870.35	612.591	609.591	3
2009	WO-K-16	967426.46	2258887.7	614.847	610.747	4.1
2009	WO-K-17	967436.11	2258905.15	615.093	612.293	2.8
2009	WO-K-18	967446.4	2258922.52	614.886	611.286	3.6
2009	WO-K-19	967456.31	2258940.01	614.459	609.859	4.6
2009	WO-K-20	967466.14	2258957.48	614.048	610.048	4
2009	WO-K-21	967475.45	2258974.91	614.943	611.143	3.8
2009	WO-L-01	967115.79	2258539.52	614.447	610.447	4
2009	WO-L-02	967129.54	2258553.71	613.603	609.003	4.6
2009	WO-L-03	967143.79	2258567.76	614.13	609.73	4.4
2009	WO-L-04	967158.43	2258581.15	614.386	610.586	3.8
2009	WO-L-05	967173.51	2258593.98	615.238	613.438	1.8
2009	WO-M-01	967061.61	2258728.38	614.07	605.97	8.1
2009	WO-M-02	967082.42	2258727.26	614.004	607.004	7
2009	WO-M-03	967102.3	2258725.63	614.412	608.412	6
2009	WO-M-04	967122.82	2258724.23	614.863	611.063	3.8
2009	WO-M-05	967141.73	2258722.44	615.069	611.269	3.8
2009	WO-M-06	967158.28	2258719.15	615.31	612.31	3
2009	WO-M-07	967204.32	2258756.76	615.062	612.262	2.8
2009	WO-M-08	967217.71	2258772.61	614.982	611.182	3.8
2009	WO-M-09	967228.68	2258789.06	614.963	610.163	4.8
2009	WO-M-10	967239.84	2258805.71	614.606	609.506	5.1
2009	WO-M-11	967251.18	2258822.06	615.301	613.001	2.3
2009	WO-M-12	967262.48	2258838.47	615.452	610.252	5.2
2009	WO-M-13	967273.6	2258855.19	615.514	610.714	4.8
2009	WO-M-14	967285.1	2258871.63	615.379	610.379	5
2009	WO-M-15	967296.63	2258887.91	614.85	609.95	4.9

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Sample Date	Station ID	Y (WI SPS)	X (WI SPS)	Sediment Top Elevation	Sediment Bottom Elevation	Sediment Thickness (ft)
2009	WO-M-16	967307.74	2258904.3	611.2	609.6	1.6
2009	WO-M-17	967318.85	2258920.69	611.4	608.8	2.6
2009	WO-M-18	967329.96	2258937.08	611.5	608.4	3.1
2009	WO-M-19	967340.83	2258954.09	613.99	612.29	1.7
2009	WO-M-20	967352.13	2258969.81	614.743	612.743	2
2009	WO-M-21	967363.52	2258986.33	614.349	611.149	3.2
2009	WO-M-22	967374.54	2259003	614.173	609.773	4.4
2009	WO-M-23	967385.17	2259019.95	615.024	610.224	4.8
2009	WO-M-24	967308.21	2259041.15	665.76	662.76	3
2009	WO-N-01	967037.74	2258865.22	614.255	608.655	5.6
2009	WO-N-02	967057.32	2258870.25	614.086	611.086	3
2009	WO-N-03	967076.31	2258875.37	614.77	608.77	6
2009	WO-N-04	967086.09	2258892.8	614.988	608.488	6.5
2009	WO-N-05	967095.9	2258910.09	615.29	608.49	6.8
2009	WO-N-06	967105.74	2258927.48	615.588	608.588	7
2009	WO-N-07	967115.44	2258945.01	615.794	610.894	4.9
2009	WO-N-08	967125.29	2258962.43	615.653	610.753	4.9
2009	WO-N-09	967135.77	2258979.27	615.238	609.938	5.3
2009	WO-N-10	967144.61	2258997.04	612.893	609.993	2.9
2009	WO-N-11	967154.33	2259014.44	612.228	611.028	1.2
2009	WO-N-12	967164.05	2259031.82	611.628	607.528	4.1
2009	WO-N-13	967173.76	2259049.21	611.428	608.128	3.3
2009	WO-N-14	967183.48	2259066.6	611.528	610.428	1.1
2009	WO-N-15	967195.74	2259082.65	613.741	611.541	2.2
2009	WO-O-01	966968.23	2259092.55	612.988	611.588	1.4
2009	WO-O-02	966982.6	2259106.4	611.151	609.251	1.9
2009	WO-O-03	966996.96	2259120.3	610.951	609.151	1.8
2009	WO-O-04	967011.32	2259134.2	611.051	608.951	2.1
2009	WO-O-05	967025.67	2259148.19	613.096	613.096	0
2009	WO-P-01	966935.16	2259246.02	608.735	608.635	0.1
2009	WO-P-02	966971.66	2259262.39	610.835	609.035	1.8
2009	WO-Q-01	966856.44	2259381.24	610.35	609.85	0.5
2009	WO-Q-02	966884.99	2259394.81	610.35	607.85	2.5
2009	WO-Q-03	966915.16	2259409.14	612.35	609.35	3
2009	WO-R-01	966793.29	2259495.08	611.347	609.647	1.7
2009	WO-R-02	966822.92	2259516.24	610.647	608.947	1.7
2009	WO-R-03	966859.68	2259542.49	611.847	609.547	2.3
2009	WO-S-00	966690.85	2259620.5	611.547	609.947	1.6
2009	WO-S-01	966721.16	2259638	611.147	609.547	1.6
2009	WO-S-02	966747.14	2259653	610.147	608.147	2
2009	WO-S-03	966761.86	2259661.5	610.447	608.347	2.1
2009	WO-S-04	966787.84	2259676.5	611.547	608.047	3.5