TETRA TECH

December 13, 2018

Heather Williams
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U.S. Environmental Protection Agency (EPA)
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Chicago, Illinois 60604

Subject: Feasibility Study Report (Final)
Indiana Harbor Canal TSCA Sediment Feasibility Study
START Contract No. EP-S5-13-01
Technical Direction Document No. 0021/S05-0021-1710-002

Dear Ms. Williams:

Tetra Tech is pleased to submit the Feasibility Study report for the Indiana Harbor Canal TSCA Sediment in East Chicago, Indiana. The Feasibility Study conducted a detailed evaluation of eight remedial alternatives, including the No Action alternative. The Feasibility Study rank orders the remedial alternatives and recommends Alternative 5.

If you have any questions about the enclosed document, please call me at (312) 201-7781.

Sincerely,

James Wescott

James Wescott
Project Manager

Enclosures

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FEASIBILITY STUDY REPORT FOR INDIANA HARBOR CANAL TOXIC SUBSTANCES CONTROL ACT (TSCA) SEDIMENT EAST CHICAGO, INDIANA

Prepared for
U.S. Environmental Protection Agency
Region 5
77 West Jackson
Chicago, Illinois 60604

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Contract No.	:	EP-S5-13-01
Date Prepared	:	December 2018
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ACRONYMS

AOC	Area of concern
bgs	Below ground surface
BUI	Beneficial use impairment
CDF	Confined disposal facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMP	Comprehensive Management Plan
COC	Chemical of concern
CY	Cubic yard
DDAA	Dredging and disposal alternative analysis
DDR	Design Documentation Report
ECSD	East Chicago Sanitary District
ECWMD	East Chicago Waterway Management District
EPA	U.S. Environmental Protection Agency
FS	Feasibility study
GLLA	Great Lakes Legacy Act
GLNPO	Great Lakes National Program Office
GRA	General response action
HHRA	Human health risk assessment
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IHC	Indiana Harbor Canal
LUC	Land use control
LS	lump sum
LWD	Low water datum
mg/kg	Milligram per kilogram
NA	Not applicable
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and maintenance
OU	Operable unit
PCB	Polychlorinated biphenyl
POTW	Publicly owned treatment works
PRP	Potentially responsible parties

RAO	Remedial action objective
RAL	Removal action level
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation
TC	Toxicity characteristic
TSCA	Toxic Substances Control Act
USACE	United States Army Corps of Engineers

1.0 INTRODUCTION

Tetra Tech prepared this feasibility study (FS) report for the U.S. Environmental Protection Agency (EPA) Great Lakes National Program Office (GLNPO) under EPA Remedial Action Contract No. EP-S5-13-01 (START), Technical Direction Document (TDD) No. S05-0021-1710-002. The FS is a Great Lakes Legacy Act (GLLA) project with GLNPO as the federal partner and the Indiana Department of Environmental Management (IDEM), Indiana Department of Natural Resources (IDNR), and ArcelorMittal comprising the non-federal partners. Under this TDD, the EPA tasked Tetra Tech to prepare this FS report presenting the development, screening, and evaluation of potential remedial alternatives for contaminated sediments in the authorized federal channel of the Indiana Harbor and Canal (IHC). The FS is focused on addressing “TSCA sediments”, i.e., sediments that contain polychlorinated biphenyls (PCBs) in concentrations that meet or exceed the Toxic Substance Control Act (TSCA) threshold of 50 mg/kg but also addresses “non-TSCA sediments” that contain lower levels of PCBs that overlie the TSCA sediments. The FS also addresses TSCA sediment which may remain in the federal channel following removal of accessible TSCA sediments.

Tetra Tech prepared this report to satisfy the GLLA requirements for reviewing the short-term and long-term effects of the remedial alternatives on human health and the environment.

The FS process consists of the following eight steps that are addressed in this report:

1. Development of remedial action objectives (RAOs) and identification of applicable or relevant and appropriate requirements (ARARs)
2. Estimation of areas and volumes of sediment that require remediation
3. Development of general response actions (GRAs)
4. Screening of remedial technology types and process options for each GRA to eliminate GRAs that are not applicable or cannot be technically implemented at the site
5. Development of remedial alternatives
6. Screening of remedial alternatives
7. Detailed analysis of each alternative
8. Comparative analysis of the remedial alternatives

1.1 SITE DESCRIPTION

The IHC is located on the southwest shore of Lake Michigan, in East Chicago, Indiana, about 4-1/2 miles east of the Indiana-Illinois State line and 17 miles from downtown Chicago. The location is shown in Figure 1-1. Indiana Harbor has an outer harbor protected by breakwaters, an entrance channel, and an inner harbor. The inner harbor area consists of an anchorage and maneuvering basin and a portion of the IHC extending to the E.J. & E. Railway Bridge. The IHC extends southwest of the inner harbor from the lakeward side of the E. J. & E. Railway Bridge to the Forks, a distance of 7,400 feet. Near the Forks, a small turning basin is located on the southeast side of the canal about 600 feet lakeward of Canal Street. From the Forks, the Lake George Branch extends west for a distance of 6,800 feet and the Calumet River Branch extends south for about 2 miles where it joins the Grand Calumet River (GCR) (USACE 2007). An authorized federal navigation channel exists within the IHC from the outer harbor south and extends into a portion of the Lake George Branch and Calumet River Branch. Most of the IHC encompassing the federal channel is bounded by sheet pile bulkhead walls.

The ArcelorMittal Indiana Harbor complex occupies much of the property along the sides on the IHC from Lake Michigan to the Forks. The complex is the largest integrated steelmaking facility in North America.

The project area consists of the authorized federal navigation channel within the IHC, where concentrations of PCBs in sediment meet or exceed the TSCA threshold of 50 mg/kg. There are ten areas where sediments contain levels of PCBs that meet or exceed the TSCA threshold, which are shown on Figure 1-2. The depth of the authorized federal navigation channel within the project area is 22 feet below the low water datum (LWD) of 577.5 feet mean sea level. The depth of excavation in some areas may extend to 26 feet to accommodate over-dredging and placement of a cap over TSCA sediment remaining below 26 feet.

1.2 SITE BACKGROUND

The IHC in the project area contains an authorized federal navigation channel and any work conducted in this area is considered a federal navigation project, regulated under the Rivers and Harbors Act of 1910. Sediment contamination prevented dredging and maintenance of the IHC between 1972 and 2012. The U.S. Army Corps of Engineers Chicago District (USACE) restarted dredging in 2012 with dredged sediment placed in the IHC Confined Disposal Facility (CDF), shown on Figure 1-1. The IHC CDF is located on the site of a former petroleum products refinery and is designed to permanently contain sediments dredged from the IHC. The CDF is on the north side of the Lake George Branch of the IHC with Indianapolis Boulevard to the east, Cline Avenue to the north, and the British Petroleum refinery to the west. The CDF is owned by the East Chicago Waterway Management District (ECWMD) and is operated, managed and maintained by the USACE (USACE 2007).

Approximately 1.4 million cubic yards of non-TSCA sediment have been dredged and placed in the IHC CDF since 2012. Sediment sampling conducted since 1972 identified several locations within the authorized federal navigation channel that contained sediment with PCB concentrations at or over 50 mg/kg. Prior studies of the IHC CDF have focused on design and operation details related to TSCA sediment:

- In 1999, a Comprehensive Management Plan (CMP) was developed by the USACE describing how TSCA sediment would be dredged separately and placed in a separate TSCA cell within the IHC CDF. The TSCA cell would be constructed out of non-TSCA dredged sediment; TSCA sediment could be placed within the cell and the sediment would then be covered with non-TSCA sediment (USACE 2010).
- In 2014, USACE, as operator of the IHC CDF, submitted to EPA a risk-based application, pursuant to TSCA and Title 40 of the Code of Federal Regulations (CFR) Section 761.61(c), for the disposal of TSCA-regulated, PCB-contaminated dredged sediment from the IHC within the IHC CDF.

In response to public comments in 2017 on the application for the placement of TSCA sediment in the CDF, USEPA, IDEM and other non-federal partners on this GLLA FS project, agreed to evaluate TSCA sediment management options including options other than disposal in the IHC CDF that would be led by either GLNPO and the non-federal partners or by USACE.

1.3 EXTENT OF TSCA SEDIMENT IN THE FEDERAL CHANNEL

The TSCA sediment is present in ten areas of the federal navigation channel, as shown on Figure 1.2. Most of the TSCA sediment is covered by several feet of more recently deposited non-TSCA sediment. The primary concern is that TSCA sediment could be exposed during required maintenance dredging of the federal navigation channel. Based on sampling completed by the USACE between 1977 and 2006, the total volume of TSCA sediment within the federal channel was originally estimated at up to 60,000 cubic yards (CY) (USACE 2014).

During recent sediment sampling completed by GLNPO in 2018, over 150 additional samples were collected to more accurately delineate and estimate the volume of TSCA sediment. The sampling confirmed previous findings that identified TSCA sediment at 18 feet or greater below the LWD. The additional 2018 data resulted in a reduction of the delineated lateral extent of the TSCA sediment, which, in turn, reduced the estimated volume of TSCA sediment to a neat line volume of approximately 3,669 CY.

Removal of the TSCA sediment for off-site landfill disposal options would also require removal of an additional one-foot "buffer layer" that would be managed as TSCA sediment under any of the GLNPO-led alternatives as well as additional non-TSCA sediment overlying the TSCA sediment. The buffer layer is applied as a safety factor to ensure that TSCA sediment is not present in dredged non-TSCA overburden sediment. The overburden sediment is typically present between 16 feet below the LWD and the top of the TSCA sediment buffer material. Removal of the TSCA sediment under the USACE-led CDF alternative would include removal of surrounding non-TSCA sediment along with delineated TSCA sediment. This approach utilizes the existing USACE contractor excavation requirements, including the large excavation bucket used in the IHC.

1.4 SOURCE EVALUATION

PCBs were used extensively in a variety of manufactured products, such as electrical equipment and industrial applications, due to its chemical stability and low flammability under high pressure and temperature conditions. Potential adverse human health and ecological effects associated with PCB use led to the 1979 United States ban on further production of materials containing PCBs. The source of the TSCA sediment in the IHC is likely from a variety of industrial activities and discharges from multiple industries that took place in northwest Indiana prior to the chemical's ban in 1979.

Potential ongoing sources of PCBs, as well as areas exhibiting PCB contamination, are monitored by a variety of local, state, and federal entities, including the East Chicago Sanitary District (ECSD), IDEM, and EPA. A source control evaluation completed in 2015, in conjunction with a sediment investigation in the Grand Calumet River and IHC, did not detect any ongoing sources of PCB contamination that could potentially re-contaminate the IHC (Tetra Tech 2015). There are no potentially responsible parties (PRPs) or potential GLLA non-federal sponsors associated with PCB contamination in the IHC.

2.0 REMEDIAL ACTION OBJECTIVES, REGULATORY REQUIREMENTS, AND AREAS/VOLUMES REQUIRING REMEDIATION

The process of identifying and screening technologies begins with the development of site-specific RAOs and identification of ARARs. All GLLA projects must comply with applicable regulatory requirements during planning and implementation, including obtaining and complying with any necessary federal, state, and local permits. These projects must also achieve overall program RAOs, which consist of performance goals for protecting human health and the environment; and lead to removal of Beneficial Use Impairments (BUIs) within the Grand Calumet River Area of Concern (AOC). The Grand Calumet River AOC currently is subject to 12 BUIs, including restrictions on dredging activities. Removing or encapsulating TSCA sediment in the IHC will improve the possibility of removing the restriction on the dredging activity BUI and eventually de-listing the AOC. However, the action proposed under this scope of work is to address only the ten identified TSCA sediment areas within the federal navigation channel and is not considered a final remedy for the AOC.

2.1 REGULATORY REQUIREMENTS

This section discusses the identification of ARARs for the site.

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires that remedial actions must be protective of human health and the environment. State requirements, which are more stringent than corresponding federal requirements, may govern the elements of the proposed remedial action. Three types of regulatory requirements have been identified on a site-specific basis for the site: chemical-, location-, and action-specific. Each type of requirement is briefly described below.

Chemical-specific requirements are health- and risk-based numerical values and methodologies that, when applied to site-specific conditions, result in the establishment of numerical values. These values and methodologies (such as promulgated standards and risk assessments, respectively) establish acceptable concentrations of a chemical contaminant that may remain in the environment. The chemical-specific requirement for TSCA waste (including TSCA sediment) is set by federal regulations at a concentration of 50 mg/kg total PCB congeners. The State of Indiana does not have a more stringent standard for TSCA waste. A TSCA permit application and approval is required to remove, cap, and dispose TSCA waste.

Location-specific requirements are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because the site-specific location is of environmental importance. One location-specific requirement is established by inclusion of the project area in the Grand Calumet River

AOC. A second location-specific requirement specifies that the federal navigation channel be maintained at a prescribed depth.

Action-specific requirements are technology- or activity-based requirements or limitations on actions to be taken with respect to hazardous substances or TSCA remediation waste or sediment. These requirements are triggered by particular remedial activities selected to accomplish a remedy. The applicable action-specific requirement in this case is the removal of TSCA sediment from its current location in the IHC, which results in the sediment becoming a state solid waste which is subject to state and federal TSCA requirements. The waste must then be managed in accordance with state and federal TSCA requirements for land management, treatment, or disposal.

This FS report considers all federal and state requirements for the site. The applicable requirements are presented in Table 2-1.

2.2 REMEDIAL ACTION OBJECTIVES

RAOs are goals specific to media for protecting human health and the environment based on human health or ecological risk. Risk can be associated with current or potential future exposures. RAOs should be as specific as possible, but not so specific that the range of alternatives to be developed is unduly limited. Objectives aimed at protecting human health and the environment should specify: (1) chemicals of concern (COCs); (2) exposure routes and receptors; and (3) an acceptable contaminant level or range of levels for each exposure route (EPA 1998).

Two RAOs are associated with the IHC TSCA sediment:

- Allow for future unrestricted operation and maintenance dredging of the federal navigation channel, which removes one of the 12 BUIs associated with the AOC.
- Reduce the human health and ecological risks (via ingestion, direct contact, or inhalation exposure pathways) to PCBs in sediment, assuming reasonably anticipated future use scenarios.

2.3 AREAS AND VOLUMES REQUIRING REMEDIATION

The TSCA sediment is present in ten distinct locations within the federal navigation channel, as shown on Figure 1.2. Most of the TSCA sediment is covered by several feet of more recently deposited non-TSCA sediment. The primary concern is that TSCA sediment could be exposed during maintenance dredging of the federal navigation channel. The TSCA sediment is generally located within a narrow elevation range along the bottom of the navigation channel. The TSCA sediment is typically covered by non-TSCA overburden sediment from 16 feet below the LWD to the top of the TSCA sediment. Removal of the TSCA sediment and placement using potential off-site disposal options also includes removal of a one-foot buffer layer that would be managed as TSCA sediment for GLNPO-led alternatives.

The surface area of the ten TSCA areas was delineated from sediment samples collected by USACE between 1977 and 2005 and from samples collected by GLNPO in April and October 2018. The surface area for the ten TSCA areas is shown in Figures 2-1, 2-2, and 2-3. The volume for each area of TSCA sediment in the federal navigation channel was calculated assuming the surface area was removed to a maximum depth not to exceed 26 feet below LLW data. The maximum depth of the channel is 22 feet below the LLW datum. The depth could extend to 26 feet to accommodate over-dredging and placement of a cap over remaining TSCA sediment. The sediment removal requires that a 4 to 1 slope be maintained from the base of the excavation. In areas where an excavation side slope intersects the side of the IHC, such as a sheet pile wall, the dredge volumes assume dredging would continue up the vertical edge of the wall to the terminal surface elevation. The surface areas and volumes from each TSCA area are provided in Table 2-2; which shows the dredge volumes for TSCA sediment, overburden sediment, and TSCA sediment and a 1-foot buffer layer.

TABLE 2-1. REGULATORY REQUIREMENTS

Brief Description	Citation	Requirement	Comments
CHEMICAL-SPECIFIC			
National Primary Drinking Water Regulations Maximum Contaminant Levels (MCLs)	Safe Drinking Water Act, 42 U.S.C. §§ 300f et seq. 40 C.F.R. Part 141	Human health-based standards, MCLs for public water systems	**Potentially Relevant and Appropriate** — although groundwater and surface water at the Site are not currently used as drinking water, although unlikely, they are potential future drinking water sources.
Toxic Substances Control Act (TSCA)	15 USC §§ 2601 et seq., 40 CFR Part 761.61	PCB remediation, disposal, and capping require TSCA approval.	**Applicable** – PCB-contaminated sediments may remain in place after completion of remedy. Disposal of PCBs in IHC CDF.
National Secondary Drinking Water Regulations, Secondary MCLs	Safe Drinking Water Act, 42 U.S.C. §§ 300f et seq. 40 C.F.R. Part 143	Establishes aesthetic standards (secondary MCLs) for public water systems	**Potentially Relevant and Appropriate** — in evaluating cleanup levels for groundwater and surface water. Although groundwater and surface water at the site are not currently used as drinking water, they are designated as potential future drinking water sources.
LOCATION-SPECIFIC			
Migratory Bird Treaty Act	16 USC § 703	Protects more than 800 species of birds from unregulated taking.	**Relevant and appropriate** – to site remediation involving activities that could affect migratory birds.
Responsibilities of Federal Agencies to Protect Migratory Birds	Executive Order 13186, 66 Fed. Reg. 3853 (Jan. 17, 2001)	Directs executive departments and agencies to take certain actions to further implement the Migratory Bird Treaty Act, including supporting the conservation intent of the migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing adverse impacts on migratory bird resources when conducting agency actions.	**TBC** – in designing and implementing site remediation activities that could affect migratory birds.
Endangered Species Act	16 USC §§ 1531 – 1544 50 CFR Part 402	Establishes requirements for the protection of federally listed threatened and endangered species and their habitat.	**Applicable** – to site remediation activities that could affect Endangered Species Act-listed or designated critical habitat.
National Historic Preservation Act	54 USC §§ 300101 et seq. 36 CFR Part 800	Establishes requirements for the identification and preservation of historic and cultural resources.	**Applicable** - to site remediation activities that could impact historic or cultural resources.
Fish and Wildlife Coordination Act	16 USC §§ 661 et seq.	Requires consideration of impacts to wildlife resources resulting from the modification of waterways.	**Applicable** - to site remediation activities involving the diversion or other modification of rivers or streams.
Rivers and Harbors Act, Section 10 and Regulations	33 USC § 403 33 CFR Parts 320-330	Requirements for evaluating excavation activities or the placement of structures or fill material within tidal navigable waters.	**Applicable** - to Site remediation activities involving excavation or filling in the IHC.
ACTION-SPECIFIC			
Clean Water Act Effluent Guidelines and Standards	33 USC §§ 1251 and 1311 et seq. 40 CFR Part 401	Provides requirements for point source discharges of pollutants.	**Applicable** – to site remediation activities that result in the point source discharge of pollutants to surface water bodies.
Clean Water Act Stormwater Program	33 USC § 1342 40 CFR Part 122	Regulates the discharge of stormwater from industrial and construction activities. Requires implementation of best management practices, *inter alia,* such as use of stormwater fencing and other measures to prevent the discharge of sediments to surface waters.	**Applicable** - to discharges of stormwater to surface waters from remediation that results in soil disturbance of more than one acre of land; relevant and appropriate for smaller land disturbances; EPA-issued General Permit for Stormwater Discharges from Construction Activities may be TBC
USDOT Hazardous Materials Transportation Act Regulations	49 USC §§ 5101 et seq. 49 CFR 171-180	Establishes classification, packaging and labeling requirements for shipments of hazardous materials.	**Applicable** – to off-site transportation of TSCA waste.
RCRA Subtitle C Treatment, Storage, and Disposal of Hazardous Waste	42 USC §§ 6901 et seq. 40 CFR Part 264	Specifies requirements for the operation of hazardous waste treatment, storage, and disposal facilities.	**Not Applicable** –TSCA wastes are not subject to RCRA hazardous waste requirements.
Indiana Solid Waste Rules	IAC Title 329	Applies to remedies that involve off-site disposal of solid waste. Contaminated sediment would be tested for hazardous waste characteristics and requirements of the Rules followed if hazardous waste is found	**Applicable** – to remedial activities that require hazardous waste management, storage or disposal.
Indiana Air Emission Rules	IAC Title 326	Applies to remedies that involve on-site treatment of TSCA sediment. Treatment processes would operate under applicable permit.	**Applicable –** to on-site treatment.
Motor Vehicle Fugitive Dust Sources	(327 IAC 6-4-4)	No vehicle driven on any public right of way may allow its contents to escape and form a fugitive dust	**Applicable** – to remedial activities that require transport or disposal.

Notes:
CFR: Code of Federal Regulations
IAC: Indiana Administrative Code
MCL: Maximum contaminant level
NA: Not applicable
RCRA: Resource Conservation and Recovery Act
TBC: To be considered
TSCA: Toxic Substance Control Act
USC: United States Code

TABLE 2-2. TSCA AREAS AND VOLUMES

TSCA Sediment Area	Surface Area (SF)	TSCA Sediment Volume (CY)	TSCA Depth Range (ft below LLW)	Cap Required	TSCA Sediment and 1-ft Buffer (CY)	Overburden Volume (CY)	Overburden Depth Range (ft below LLW)
1	992	1,170	-18 to -26	Yes	1,465	335	-16 to -17
2	1,463	160	-22 to -24	No	284	74	-16 to -21
3	1,307	145	-24 to -26	Yes	259	0	Not Applicable
4	4,123	387	-24 to -26	Yes	648	2.811	-16 to -23
5	2,535	219	-24 to -26	Yes	353	1,487	-16 to -23
6	2,798	277	-24 to -26	Yes	474	2,808	-16 to -23
7	3,727	882	-20 to -24	No	1,221	1,284	-16 to -19
8	979	115	-24 to -26	Yes	209	1,698	-16 to -23
9	2,387	242	-24 to -26	Yes	417	2,340	-16 to -23
10	535	72	-22 to -24	No	71	331	-16 to -21
Total	20,846	3,669			5,401	13,168	

Notes:
CY Cubic yard
Ft Foot
LLW Low level water
SF Square foot

3.0 GENERAL RESPONSE ACTIONS AND REMEDIAL ACTION SCREENING

This section discusses the general response actions (GRAs) relevant to the IHC TSCA remediation areas and screens alternatives considered applicable to the proposed remedial action.

3.1 GENERAL RESPONSE ACTIONS

GRAs broadly describe the kinds of media-specific remedial measures that could be applied to meet the two project RAOs. Possible responses to the observed site conditions in the IHC could range from no action to complete removal within the navigation channel with treatment or disposal. GRAs considered include only those appropriate for remediating contaminated sediment, thus reducing and focusing the list of technologies to be screened.

Technology types are the general technologies that describe a means for achieving a GRA. Examples of technology types include dredging, dry excavation, and physical and chemical treatment. Removal is a GRA that can be achieved using excavation or dredging technologies, whereas treatment is a GRA achieved using thermal, physical, or chemical treatment technologies.

GRAs and remedial technologies identified for sediment are discussed below.

3.1.1 No Action

The no action GRA will be carried forward as a baseline condition that will be used for comparison with other actions.

3.1.2 Institutional Controls

Institutional controls are typically administrative and legal instruments that restrict land use. However, they may also include physical access restrictions, such as fencing, no boating in areas, or use restrictions based on identified hazards. These are generally well defined by the BUIs currently in place in the AOC. Institutional controls may be used to reduce the potential for exposure to contamination or protect the integrity of a response action. Institutional controls at the IHC could include advisories, education, and administrative constraints on potential land use to limit direct contact of potential receptors with contaminated sediment over the long term or prevent damage to installed components of the remedy.

3.1.3 Monitored Natural Recovery

Monitored natural recovery (MNR) relies on natural physical processes such as burial or dispersion to remove or encapsulate contaminated sediment; chemical processes, such as sequestration or transformation to reduce contaminant mobility, concentration, or toxicity; and biological processes such as biodegradation to reduce concentration or toxicity. This GRA would involve long-term monitoring to evaluate progress and protectiveness. Physical processes are likely not sufficient to bury or encapsulate the exposed TSCA sediment in a reasonable time frame. Chemical and biological processes are not typically effective in reducing PCB concentrations. This GRA could be an ancillary component to a remedy that primarily uses one or more different GRAs.

3.1.4 Containment

Containment of sediment may include installation of a cap to prevent direct contact of potential receptors to contaminated sediment. A cap may consist of one or more layers that chemically or physically isolate contaminants. Caps can be installed under wet, flowing conditions, such as those present in the project area. Cap placement must consider the final water depth to ensure placement does not interfere with other commercial activities. Within the authorized navigation channel, the cap will be placed such that the top of the cap is 24 feet below the LWD so that the cap is not disturbed by future navigation maintenance dredging.

The containment cap would typically be composed of clean aggregate including sand and gravel at a size sufficient to withstand prop wash, or a manufactured product such as an articulated concrete mat, that both encapsulates the PCBs and provides a clean surface for the establishment of benthic organisms. In high-energy areas, a sand cap could be covered by an armored second layer cap composed of larger stone to withstand shear forces and maintain the integrity of the underlying sand cap. A geotextile layer may be placed between the sediment and cap material to keep the cap material from sinking into the sediment. Amendments, such as activated carbon or organoclay, can also be added to the sand layer or incorporated into the geotextile to treat the contaminated pore water flowing through the sediment into the IHC by sequestering PCBs within the amendment.

3.1.5 Removal

The removal GRA refers to physical removal of the contaminated sediment. Removal may be implemented using technologies such as hydraulic or mechanical dredging. This GRA would eliminate long-term potential exposure of receptors to contaminated media by removing the contaminated sediment.

Removed sediment requires dewatering and pretreatment prior to disposal. Removal also requires a fixed land location or the use of support barges to dewater and stabilize sediment for transportation and disposal.

Hydraulic dredging uses a cutterhead to agitate the surface sediment, which is then pumped as a sediment/water slurry through a suction hose and hydraulically transported to a nearby land-based dewatering or disposal facility. Booster pumps can be used to transport the sediment slurry greater distances, but at additional cost. Environmental hydraulic dredges are typically 8 to 12 inches in intake pipe size and can remove 50 to 150 CY of sediment during each hour of operation.

Mechanical dredging uses a crane or excavator equipment on a floating barge to physically remove the sediment. A clamshell or bucket is lowered to the sediment surface and then closes around sediment for removal. Environmental buckets and other best management practices can be utilized during dredging to minimize the resuspension of contaminated sediment. The sediment is then placed in a barge, potentially co-located with the digging equipment. When full, the sediment barge is then moved to an unloading facility in the general vicinity. Alternatively, water can be added to the sediment and the resulting slurry pumped to a dewatering or disposal site. Depending on the specific equipment used, mechanical dredging can remove 2 to18 CY of sediment with each lift.

All removal options require some level of dewatering and water treatment to allow final handling of the sediment. Depending on the dredging method selected, the ancillary water treatment system may need to treat as little as a few hundred gallons to over 1 million gallons of water each day.

3.1.6 Ex-Situ Treatment

Ex-situ treatment of sediment occurs after sediment is removed and placed in an upland dewatering area. Ex-situ treatment includes thermal, chemical, or physical processes that reduce or eliminate characteristics of the sediment causing unacceptable risks. After treatment, the TSCA sediment can potentially be disposed of at a Subtitle D or other landfill approved to accept PCB remediation waste.

Thermal treatment uses thermal energy to combust and destroy organic compounds. Sediment can either be placed in a combustion chamber or electrodes can be inserted into sediment stockpiles to heat the surrounding material. Emissions from the volatilization process will likely need to be captured for further treatment. Incineration treatment for PCBs is typically conducted at off-site locations that already have approved permits, as obtaining an onsite treatment permit would be difficult and public concern would be high. The nearest thermal treatment facility would be in East Liverpool, Ohio, about 400 miles east of the site. Thermal desorption, which operates at a lower temperature, can be conducted at a land-based sediment management area.

Chemical treatment includes extractive, oxidative, and dechlorination processes that chemically degrade or destroy PCBs. In situ treatment technologies that effectively treat PCBs are not available. Extractive methods typically place the sediment into a reactor vessel where a surfactant or solvent removes the PCBs from the sediment. The extracted media would then require further treatment or disposal.

Physical processes focus on either separating contaminated particles from clean particles in the sediment matrix or adding amendments to the sediment to solidify and immobilize the PCBs. Separation uses gravity and sieving to divide the clean material from the impacted sediment. Separation is typically effective when the matrix is composed of several particle sizes so that coarser, potentially uncontaminated sediment can be isolated from the finer-grained or organic material to which the PCBs adsorb. Solidification can be accomplished using several mixing systems, including manual mixing with an excavator, rake injector, excavator-mounted rotary blender, or pug mill.

Ex-situ process options typically require the construction of land-based facilities, including pads, tanks, and other ancillary equipment. In some cases, treatment facilities can be constructed on support barges, however, this may not facilitate material management rates required to address larger volumes of sediment. Additional permitting may be required to implement the ex-situ treatment.

Ex-situ treatment technologies are screened in Table 3-1 found at the end of this section. Sediment washing, incineration, and thermal desorption would be viable technologies to reduce PCB concentrations in the sediment to concentrations below 50 mg/kg. The remaining technologies listed in the table have been eliminated because the physical composition of the sediment is not suitable, expected difficulty implementing the technology at either a local or remote location, or relative cost. Both sediment washing and thermal desorption can be implemented locally and space is available at the nearby ArcelorMittal facility. Incineration would be completed at an off-site location.

3.1.7 Disposal

Disposal is a GRA for management of sediment after it has been removed from the canal and processed. Dredged or excavated material can be disposed of locally or at a remote off-site location. In this case, local disposal would involve placing TSCA sediment into the IHC CDF, if final authorization is granted by EPA and IDEM.

Off-site disposal typically involves transporting and disposing of dredged or excavated sediment at a licensed waste disposal facility, such as a landfill licensed to accept TSCA waste. Any off-site disposal facility must be permitted and in compliance with the CERCLA off-site rule (40 CFR 300.440) meaning the facility must comply with all substantive permit requirements. Based on existing data, the sediment would be expected to be managed as a TSCA waste. At least two off-site landfills capable of accepting the TSCA sediment are located within 300 miles of East Chicago, Indiana. The U.S. Ecology Wayne Disposal facility is located near Detroit in Belleville, Michigan. The Heritage-Roachdale facility is located near Indianapolis in Roachdale, Indiana. Treatment of sediment after removal may allow disposal of the sediment at a Subtitle D or other landfill approved to accept PCB remediation waste. Transportation of the sediment is a component of the disposal process. Transport to an off-site landfill would likely be accomplished by truck after the sediment meets the landfill waste acceptance criteria. Barge transport would not be used because the facilities are not accessible by barge.

Technically feasible GRAs have been combined to form remedial alternatives that may be applicable to the IHC and the contaminated sediment media. Technologies potentially capable of attaining the proposed RAOs have been assembled, either singly or in combination, into remedial alternatives, which are detailed in Section 3.2.

3.1.8 Ancillary Technologies

Ancillary technologies are those technologies necessary to implement the response actions listed above. Ancillary technologies include water management, dispersal control measures during dredging, physical treatment, discharge, and transportation. Water management would typically involve clarification, filtering, and other treatment of water prior to discharge using a NPDES permit or to discharge to a publicly owned treatment works (POTW).

Sediment dispersal control technologies can be implemented during dredging to control potential re-release of contaminated sediment during dredging activities. All dredging technologies can be implemented with proper dispersion controls, engineering controls, and using best management practices such as reducing the rate of dredging or ceasing operations during windy or turbulent conditions.

Transportation generally involves using pipelines to transport slurry from the hydraulic dredge to a land-based facility, using dredges to transport mechanically excavated sediment from the excavation area to a land-based location for processing and treatment, and using trucks to transport treated sediment to the disposal facility.

3.2 REMEDIAL ALTERNATIVE DEVELOPMENT

Remedial alternatives for TSCA sediment must address the potential for emissions or discharges during sediment remediation and should also address potential human or ecological risks via the ingestion, direct contact, and inhalation exposure pathways. The remedial alternatives must also allow for current and future operation and maintenance in the authorized federal navigation channel. The following remedial alternatives were developed based on the technologies that have passed screening and carried forward to address TSCA sediments in the IHC:

- **Alternative 1 – No action**. No action will be taken to mitigate risk. The NCP requires that this alternative be evaluated as a baseline for comparison with other alternatives.
- **Alternative 2 – Containment with institutional controls**. This GLNPO and non-federal partner-based alternative under the GLLA would involve installing a containment cap over the TSCA sediment. The cap would consist of a geotextile layer and articulated concrete mat. The geotextile would contain activated carbon embedded in the material to treat contaminants from groundwater that flows up through the cap. The cap can be placed using mechanical technologies, and divers would likely be required to assist with cap placement. Staging areas for the cap material are available within the immediate area. Placement of the cap would take approximately 1 month. Institutional controls would need to be implemented to maintain the integrity of the cap and protect site users from exposure to COCs in sediment. Maintenance of the cap would be performed in accordance with a long-term management plan typically developed and implemented by the project partners. Due to the presence of the federal navigation channel, Alternative 2 would require USACE concurrence and a change, by act of Congress, of the federal navigation channel depth from the current -22 feet limit to facilitate placement of a containment cap over the TSCA sediment.
- **Alternative 3A – Hydraulic dredging with off-site disposal at a TSCA landfill for TSCA sediment and a Subtitle D landfill for overburden sediment, containment, and institutional controls**. This GLNPO and non-federal partner-based alternative under the GLLA would involve dredging the sediment within the authorized federal channel using a hydraulic cutterhead and conveying the sediment slurry through a pipeline to a land-based lined sediment dewatering area. A single 8-inch hydraulic dredge would convey approximately 600 CY of sediment each day to the dewatering area. TSCA sediment remaining four feet below the federal channel elevation would be capped and managed in place as discussed in Alternative 2. Dewatered sediment would be processed to meet the landfill acceptance criteria and then transported by truck to an approved landfill. Sediment would require at least 3 weeks to dry after removal. Liquids generated by dewatering would be treated and then discharged to the local POTW. Institutional controls would be implemented to maintain the integrity of the cap and protect IHC users from exposure to the

remaining TSCA sediment. Maintenance of the cap would be performed in accordance with a long-term management plan to be developed by the project partners.

- **Alternative 3B – Mechanical dredging with off-site disposal at a TSCA landfill for TSCA sediment and a Subtitle D landfill for overburden sediment, containment, and institutional controls.** This GLNPO and non-federal partner-based alternative under the GLLA would involve dredging the sediment within the authorized federal channel using a mechanical dredging bucket or clamshell and loading the sediment on support barges. The barge would convey the sediment to an unloading area where the TSCA sediment is placed in a lined dewatering pad. Approximately 3,000 CY of sediment can be removed each day using equipment similar to current IHC navigation maintenance dredging. TSCA sediment remaining 4 feet below the federal channel elevation would be capped and managed in place, as discussed in Alternative 3A. Dewatered sediment would be processed to meet the landfill acceptance criteria and then transported by truck to an approved landfill. Liquids generated by dewatering would be treated and then discharged to the local POTW. Institutional controls would need to be implemented to maintain the integrity of the cap and protect IHC users from exposure to the remaining TSCA sediment. Maintenance of the cap would be performed in accordance with a long-term management plan to be developed by the project partners.

- **Alternative 4A – Hydraulic dredging, ex-situ sediment washing, off-site disposal at Subtitle D landfill, containment, and institutional controls.** This GLNPO and non-federal partner-based alternative under the GLLA would involve removing the sediment by hydraulic means and pumping the sediment slurry to a sediment washing treatment system, set up on the nearby ArcelorMittal property to reduce the PCB concentrations prior to disposal. Dredging and soil washing production rates would be matched to allow pumping directly into the soil washing system. Reducing the PCB concentrations would potentially allow less expensive disposal options. TSCA sediment remaining 4 feet below the federal channel elevation would be capped and managed in place, as discussed in Alternative 2. Dewatered sediment would be processed to meet the landfill acceptance criteria and then transported by truck to an approved landfill. Soil washing would be expected to reduce the volume of TSCA sediment by 70 percent. Treated sediment at or above 50 mg/kg PCBs would be sent to a TSCA or Subtitle C disposal facility. Liquids generated during soil washing and by dewatering would be treated and then discharged directly to the canal or a local POTW. Institutional controls would need to be implemented to maintain the integrity of the cap and protect IHC users from exposure to the remaining TSCA sediment. Maintenance of the cap would be performed in accordance with a long-term management plan to be developed by the project partners.

- **Alternative 4B – Mechanical dredging, ex-situ incineration at remote permitted facility for TSCA sediment, off-site disposal at a licensed landfill, containment, and institutional controls.** This GLNPO and non-federal partner-based alternative under the GLLA would involve removing the sediment by mechanical dredging, dewatering the sediment for transport, and shipping the dry TSCA sediment to an incineration facility licensed to receive TSCA waste. Overburden sediment would be shipped directly to a licensed Subtitle D facility. TSCA sediment remaining 4 feet below the federal channel elevation would be capped and managed in place, as discussed in Alternative 2. Dewatered sediment would be processed to meet the landfill acceptance criteria and then transported by truck to an approved landfill. Liquids generated by dewatering would be treated and then discharged directly to the canal or a local POTW. Institutional controls would need to be implemented to maintain the integrity of the cap and protect IHC users from exposure to the remaining TSCA sediment. Maintenance of the cap would be performed in accordance with a long-term management plan to be developed by the project partners.

- **Alternative 4C – Mechanical dredging, ex-situ treatment by thermal desorption for TSCA sediment, off-site disposal at Subtitle D landfill, containment, and institutional controls.** This GLNPO and non-federal partner-based alternative under the GLLA would involve removing the sediment by mechanical means, and then treating the sediment at a land-based location by thermal desorption to reduce the PCB concentrations prior to disposal. Thermal desorption processing would be expected at a rate of approximately 25 CY/hour. Sediment would be stockpiled and dried prior to treatment. Reducing the PCB concentrations will potentially allow less expensive disposal. Thermal desorption would be expected to reduce the volume of TSCA sediment by 90 percent. TSCA sediment remaining 4 feet below the federal channel elevation would be capped and managed in place, as discussed in Alternative 2. Dewatered sediment would be processed to meet the landfill acceptance criteria and then transported by truck to an approved landfill. Liquids generated by dewatering would be treated and then discharged to the local POTW. Institutional controls would need to be implemented to maintain the integrity of the cap and protect IHC users from exposure to the remaining TSCA sediment. Maintenance of the cap would be performed in accordance with a long-term management plan to be developed by the project partners.

- **Alternative 5 - Mechanical dredging with disposal at the IHC CDF, containment, and institutional controls.** This USACE-based alternative would involve dredging the sediment within the authorized federal channel using a mechanical dredging bucket or clamshell and loading the sediment onto support barges. The barges would convey the sediment to an unloading area where the TSCA sediment would then be pumped into the IHC CDF. Approximately 3,000 CY of sediment generally can be removed each day using locally or regionally available equipment and contractors. Liquids generated by any required dewatering would be treated to meet requirements in the USACE permit and then discharged to the canal. TSCA sediment remaining 4 feet below the federal channel elevation would be capped and managed in place. Institutional controls would be required to maintain the integrity of the cap and protect IHC users from exposure to the remaining TSCA sediment. Maintenance of the cap would be performed in accordance with a long-term management plan to be developed by USACE.

3.3 REMEDIAL ALTERNATIVE SCREENING

Tetra Tech screened the potential remedial alternatives identified above against three broad criteria: short- and long-term effectiveness, implementability (including technical and administrative feasibility), and relative cost (capital and operation and maintenance [O&M]) in accordance with EPA guidance. The purpose of the screening evaluation is to more generally evaluate technologies and then reduce the number of alternatives chosen for a more thorough and extensive analysis (EPA 1998).

The alternatives developed above reflect options that are viable for the site; however, other similar or newly available options may be considered and prove to be more effective, easier to implement, and/or have lower relative costs. Alternatives are focused only on the most viable options for site remediation. A streamlined alternative screening is presented in Table 3-1 at the end of this section.

In evaluating effectiveness, the “short-term” is considered to be the remedial construction and implementation period, while “long-term” begins once the remedial action is complete and RAOs have been met (EPA 1989). Technical feasibility includes the ability to construct, reliably operate, and meet regulations and RAOs, as well as the ability to meet the O&M, replacement, and monitoring requirements after completion of the remedial action (EPA 1989). Administrative feasibility includes the ability to obtain approvals from other agencies; the availability of treatment, storage, and disposal services; and the availability of equipment and technical expertise (EPA 1989). The objective of the cost evaluation is to eliminate from further consideration those alternatives where costs are grossly excessive for the effectiveness they provide. Cost estimates for alternatives should be sufficiently accurate to continue to support resulting decisions when their accuracy improves beyond the screening level. The cost in the streamlined screening of alternatives evaluates the capital and O&M costs on a relative basis (EPA 1989).

The following alternatives passed the initial screening and will be developed further in the Detailed Analysis of Retained Alternatives Section as part of the feasibility study:

- Alternative 1 – No Action
- Alternative 2 – Containment with institutional controls
- Alternative 3A – Hydraulic dredging with off-site disposal at a TSCA landfill for TSCA sediment and a Subtitle D facility for overburden material, containment, and institutional controls
- Alternative 3B – Mechanical dredging with off-site disposal at TSCA landfill for TSCA sediment and a Subtitle D facility for overburden material, containment, and institutional controls
- Alternative 4A – Hydraulic dredging, ex-situ treatment by sediment washing for all sediment, off-site disposal at permitted landfill, containment, and institutional control
- Alternative 4B – Mechanical dredging, ex-situ thermal treatment by incineration for TSCA sediment, off-site disposal at a permitted landfill, containment, and institutional controls
- Alternative 4C – Mechanical dredging, ex-situ treatment by thermal desorption for TSCA sediment, off-site disposal at a permitted landfill, containment, and institutional controls
- Alternative 5 - Mechanical dredging with disposal at the IHC CDF, containment, and institutional controls

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TABLE 3-1. EX SITU TREATMENT TECHNOLOGIES

Process Options	Description	Effectiveness	Implementability	Relative Cost of Treatment	Retained
Particle Separation	Particle separation is a procedure where, through a series of mechanical processes, sediment particles are separated into fractions according to their particle size or density. Several techniques are available to facilitate separation including: gravity settling, sieving, and hydraulic separation through the use of hydrocyclones.	Typically not effective for sediment with high fines content such as the material impacted with PCBs at the IHC. Particle separation would need to be followed by additional ex situ treatment options to reduce the PCB concentration in the sediment below 50 ppm.	Most compatible with hydraulic dredging methods. BMPs may be necessary to ensure air quality impacts are minimized.	Moderate	No
Sediment Washing	In general, sediment washing is similar to physical separation. Sediment washing as a treatment technology for contaminated sediments typically refers to a process that involves slurrying the contaminated sediment and reacting with chemical additives such as chelating agents, surfactants, and peroxides.	In general, reductions in COC concentrations up to 75% to 85% could be achieved depending on site conditions, such as fines content and range of COCs present. A number of process options exist for sediment washing, but few have transitioned to full-scale applications.	Most compatible with hydraulic dredging methods. Process water and residual wastes require treatment and disposal, which could significantly increase the overall cost of treatment. Bench-scale testing would be required during design.	Moderate to High	Yes
Chemical Extraction	Chemical extraction is a treatment method that utilizes extractants to separate contaminants from sediments but does not completely destroy them. The technology differs from soil washing in that chemicals are used, rather than water or additive-enhanced water.	In general, reductions in COC concentrations greater than 90% could be achieved depending on site conditions. However, multiple extraction stages may be required depending on levels to be achieved. Bench-scale treatability tests would be needed during design for this technology.	Most compatible with hydraulic dredging methods. Process water and residual wastes require treatment and disposal, which could significantly increase the overall cost of treatment.	High	No
Dehalogenation	Dehalogenation is the process of removing the halogen molecules (e.g., chlorine) from a contaminant in the sediment. In this process, dewatered contaminated sediment is screened, pulverized, and mixed with reagents prior to being heated in a reactor. Reagents used in the process consist of sodium bicarbonate (BCD) or potassium polyethylene glycol (APEG).	Demonstration projects have produced mixed results for this process option. An example of a dehalogenation process option is the Solvated Electron Technology (SET™) process, which uses an alkali metal dissolved in liquid anhydrous ammonia to generate a solvated electron solution.	Most compatible with mechanical dredging methods. Process water and residual wastes require treatment and disposal, which could significantly increase the overall cost of treatment. Bench-scale testing would be required during design.	High to Very High	No
Incineration	Incineration uses high temperatures, between 1,400 and 2,200°F, to volatilize and combust (in the presence of oxygen) halogenated and other refractory organics in hazardous wastes. The efficiency of the process depends on three main parameters: temperature of the combustion chamber, residence time of the sediment in the combustion chamber, and turbulent mixing of the sediment.	In general, reductions in COC concentrations up to 95% or greater could be achieved depending on site conditions. Thermal methods are the most expensive technologies due to high energy requirements and may require off-gas treatment to meet air permit requirements.	Most compatible with mechanical dredging methods. Sediment needs to be dried prior to shipment to incinerator. Nearest existing, permitted facility is greater than 400 miles from the project site at East Liverpool, Ohio. High energy consumption. Potential for dioxin generation is a concern.	High to Very High	Yes
Pyrolysis	Pyrolysis is similar to incineration in that organic materials are destroyed by heat; however, the process is conducted in the absence of oxygen. In practice, since it is not possible to achieve a completely oxygen-free atmosphere, some oxygen will be present in any pyrolytic system and nominal oxidation will occur.	Theoretically this process should have a similar effectiveness as incineration; however, pyrolysis has not been as widely applied to waste remediation and has only been demonstrated at the pilot scale for sediments. Consequently, treatability studies would be needed, at least during design, if this technology were to be used.	Most compatible with mechanical dredging methods. Very low moisture content of feedstock sediment is required. Potential for dioxin generation is a concern.	High to Very High	No
Thermal Desorption	Thermal desorption systems separate contaminants from sediment by applying direct and indirect heat. It is a thermal-induced physical process and is not designed to destroy contaminants. Contaminants and water are vaporized from a solid matrix and transported to a gas treatment system. The bed temperatures and residence times designed into these systems will volatilize selected contaminants but will typically not oxidize them.	In general, reductions in COC concentrations up to 80% to 90% could be achieved depending on site conditions. Sediments must be dewatered prior to treatment. Example of the process include TerraTherm's In-Pile Thermal Desorption (IPTD) technology.	Most compatible with mechanical dredging methods. BMPs are necessary to ensure air quality impacts are minimized. Pre-permitting consultation and acceptance of BU products is crucial to economic viability of PO. Potential for dioxin generation is a concern.	High-Range of Moderate to Very High	Yes
Vitrification	Vitrification is a thermal solidification process, conducted at temperatures greater than 1,500°C to melt the sediment particles, that results in the formation of a glass aggregate. The high temperatures destroy any organic constituents with very few by-products and metals are incorporated into a glass structure that is resistant to leaching.	Vendors have completed full-scale demonstrations indicating that remediation efficiencies of greater than 99 percent are regularly achievable. Very limited information on sediment treatment.	Most compatible with mechanical dredging methods. BMPs are necessary to ensure air quality impacts are minimized. Pre-permitting consultation and acceptance is crucial. Potential for dioxin generation is a concern. Power requirements may exceed existing infrastructure at proposed staging area.	Moderate to Very High	No

TABLE 3-2. REMEDIAL ALTERNATIVE SCREENING SUMMARY

Alternative	Effectiveness		Implementability		Cost		Retained	
	Short-Term	Long-Term	Technical	Administrative	Capital	O&M	Yes	No
1. No Controls	No construction and remediation period	Remediation not complete; does not reduce toxicity, mobility, or volume of contamination	Nothing to construct or operate	Will not achieve RAO	No capital costs associated	No O&M costs associated	✔	
2. Containment with Institutional controls	Provides protection by reducing direct contact with impacted material; will require increased level of truck traffic to import cap material	Requires institutional controls and long-term O&M; would limit dredging within the authorized federal channel; does not use treatment to reduce toxicity, mobility, or volume of contamination. Does not address the RAO to maintain federal channel and is thus not effective without act of congress to change navigation depth.	Cap material is readily available and has been used on the Grand Calumet River in conditions similar to the IHC.	Capping at the current sediment elevation will require act of Congress to change to the federal channel depth. State and community, as well as property owner, would need to accept impacted material remaining onsite	Main capital costs associated with cap and costs associated with administrative fees. Low cost compared to other options.	O&M will be required to retain integrity of cap and reporting requirements. Moderate cost compared to other options	✔	
3A. Hydraulic dredging with off-site disposal at a TSCA landfill for TSCA sediment and a Subtitle D facility for overburden material, containment, and institutional controls	Provides protection by reducing direct contact with impacted material; will require increased level of truck traffic entering and exiting the site. Requires site for sediment dewatering and processing	Requires institutional controls and long-term O&M; does not use treatment to reduce toxicity, mobility, or volume of contamination	Adequate capacity exists at disposal facilities; requires staging area nearby to load material for off- site disposal	Requires appropriate waste manifests and documentation for transportation and disposal purposes; acceptance of impacted material remaining onsite. Applicant required for TSCA approval of removal and long-term management of TSCA residual.	Main capital costs associated with dredging, dewatering, disposal, and containment of remaining TSCA sediment. Moderate cost compared to other options.	O&M will be required to retain integrity of cap and reporting requirements Moderate cost compared to other options	✔	
3B. Mechanical dredging with off-site disposal at TSCA landfill for TSCA sediment and a Subtitle D facility for overburden material, containment, and institutional controls	Provides protection by reducing direct contact with impacted material; will require increased level of truck traffic entering and exiting the site. Requires site for sediment dewatering and processing	Requires institutional controls and long-term O&M; does not use treatment to reduce toxicity, mobility, or volume of contamination	Adequate capacity exists at disposal facilities; requires staging area nearby to load material for off- site disposal	Requires appropriate waste manifests and documentation for transportation and disposal purposes; acceptance of impacted material remaining onsite. Applicant required for TSCA approval of removal and long-term management of TSCA residual.	Main capital costs associated with dredging, dewatering, disposal, and containment of remaining TSCA sediment. Moderate cost compared to other options.	O&M will be required to retain integrity of cap and reporting requirements. Moderate cost compared to other options	✔	
4A. Hydraulic dredging, ex situ treatment by sediment washing for all sediment, off-site disposal at permitted landfill, containment, and institutional control	Provides protection by reducing direct contact with impacted material; will require increased level of truck traffic entering and exiting the site. Requires site for sediment dewatering and processing. High fine content in sediment may limit soil washing effectiveness. Expect 25% of TSCA sediment will remain at or above 50 mg/kg limit after treatment.	Requires institutional controls and long-term O&M; reduces toxicity, mobility, or volume of contamination through treatment.	Will require ex *situ* mixing sediment slurry with chemical additives to remove PCBs from sediment particles. Requires handling chemical additives on-site and multiple cycles to achieve results. Significant wastewater volume generated during dredging and treatment.	Treatment may require permit. May encounter local resistance to on-site treatment. Requires appropriate waste manifests and documentation for transportation and disposal purposes; acceptance of impacted material remaining onsite. Applicant required for TSCA approval of removal and long-term management of TSCA residual.	Main capital costs associated with dredging, dewatering, treatment, disposal, and containment of remaining TSCA sediment. High cost compared to other options.	O&M will be required to retain integrity of cap and reporting requirements. Moderate cost compared to other options	✔	

TABLE 3-2. REMEDIAL ALTERNATIVE SCREENING SUMMARY

Alternative	Effectiveness		Implementability		Cost		Retained	
	Short-Term	Long-Term	Technical	Administrative	Capital	O&M	Yes	No
4B. Mechanical dredging, ex situ treatment by incineration for TSCA sediment, off-site disposal at a permitted landfill, containment, and institutional controls	Provides protection by reducing direct contact with impacted material; will require increased level of truck traffic entering and exiting the site. Requires site for sediment dewatering and processing.	Requires institutional controls and long-term O&M; reduces toxicity, mobility, or volume of contamination through treatment.	Will require ex situ treatment to reduce PCB concentrations in sediment particles. Material will have to be completely dry prior to incineration. On-site drying/dewatering to meet incineration requirements may add significant time to schedule.	Off-site treatment facilities are already permitted. Sediment would need to meet site waste acceptance criteria. Requires appropriate waste manifests and documentation for transportation and disposal purposes; acceptance of impacted material remaining onsite. Applicant required for TSCA approval of removal and long-term management of TSCA residual.	Main capital costs associated with dredging, dewatering, treatment, disposal, and containment of remaining TSCA sediment. High cost compared to other options.	O&M will be required to retain integrity of cap and reporting requirements. Moderate cost compared to other options	✔	
4C. Mechanical dredging, ex situ treatment by thermal desorption for TSCA sediment, off-site disposal at a permitted landfill, containment, and institutional controls	Provides protection by reducing direct contact with impacted material; will require increased level of truck traffic entering and exiting the site. Requires site for sediment dewatering and processing.	Requires institutional controls and long-term O&M; reduces toxicity, mobility, or volume of contamination through treatment.	Will require ex situ treatment to reduce PCB concentrations in sediment particles. Material will have to be completely dry prior to desorption. Drying and treatment will likely require several months longer than other remedial options.	Treatment may require permit. May encounter local resistance to on-site treatment. Requires appropriate waste manifests and documentation for transportation and disposal purposes; acceptance of impacted material remaining onsite. Applicant required for TSCA approval of removal and long-term management of TSCA residual.	Main capital costs associated with dredging, dewatering, treatment, disposal, and containment of remaining TSCA sediment. Very high cost compared to other options.	O&M will be required to retain integrity of cap and reporting requirements. Moderate cost compared to other options	✔	
5. Mechanical dredging with disposal at the IHC CDF, containment, and institutional controls	Provides protection by reducing direct contact with impacted material. Requires site for sediment dewatering and processing	Requires institutional controls and long-term O&M; does not use a treatment to reduce toxicity, mobility, or volume of contamination	Adequate capacity exists at the IHC CDF; may require additional non-TSCA sediment to cover TSCA sediment	Requires approval for disposal of TSCA sediment and requires capping and long-term management of the cap by USACE in the federal channel.	Main capital costs associated with dredging and disposal, and containment of remaining TSCA sediment. Low cost compared to other options.	O&M will be required to retain integrity of cap and reporting requirements. Moderate cost compared to other options	✔	

4.0 DETAILED ANALYSIS OF EACH REMEDIAL ALTERNATIVE

This section presents the detailed analysis of the remedial alternatives and is organized with an Introduction (Section 4.1) followed by an Alternative Analysis (Section 4.2). Within Section 4.2, each remedial alternative is sequentially presented (for example, Alternative 1 is Section 4.2.1) and is subdivided into an alternative description (Section 4.2.1.1) and alternative assessment (Section 4.2.1.2).

4.1 INTRODUCTION

This section presents the detailed analysis of remedial action alternatives for addressing the TSCA sediment in the federal navigation channel in the IHC. The detailed analysis is intended to provide decision-makers with information to aid in selecting a remedial alternative that best meets the following requirements:

- Protects human health and the environment
- Attains ARARs (or provides adequate basis for invoking a waiver)
- Utilizes permanent solutions and alternative treatment technologies or resource-recovery technologies to the maximum extent practical
- Satisfies the preference for treatment that reduces toxicity, mobility, or volume of hazardous substances as a principal element
- Is cost effective

The detailed analysis contains the following:

- A detailed description of each remedial alternative, emphasizing the application of various component technologies
- An assessment of each alternative compared to the evaluation criteria described in the NCP

The detailed descriptions provide a conceptual design for each alternative. The description of each alternative includes limitations, assumptions, and uncertainties for each component. Remedial alternatives are then evaluated according to the evaluation criteria. The criteria are subdivided into two categories: threshold criteria and primary balancing criteria. The threshold and primary balancing criteria are the focus of this screening process. Threshold criteria (overall protection of human health and the environment; compliance with ARARs) relate to statutory requirements that each alternative must satisfy in order to be eligible for selection. Primary balancing criteria (long-term effectiveness; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost) are the technical criteria upon which the detailed analysis is primarily based. The evaluation criteria are defined in the following paragraphs as they pertain to this FS.

4.1.1 Threshold Criteria

Overall Protection of Human Health and the Environment – This criterion assesses how well an alternative achieves and maintains protection of human health and the environment.

Compliance with ARARs – This criterion assesses how the alternative complies with location-, chemical-, and action-specific ARARs, and whether a waiver is required or justified.

4.1.2 Primary Balancing Criteria

Long-Term Effectiveness and Permanence – This criterion evaluates the effectiveness of an alternative in protecting human health and the environment after response objectives have been met. It also considers the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

Reduction of Toxicity, Mobility, or Volume through Treatment – This criterion evaluates the anticipated performance of treatment technologies the remedy may employ. Treatment technologies should generally achieve 90 to 99 percent reduction in the concentrations of the contaminants of concern.

Short-Term Effectiveness – This criterion examines the effectiveness of an alternative in protecting human health and the environment during the construction and implementation of a remedy until response objectives have been met. It also considers the protection of the community, workers, and the environment during the implementation of remedial actions. The detailed analysis of each alternative includes an estimate of the time necessary for completion (i.e., remedial duration). The time-frame estimates are based on published construction scheduling material and professional judgment.

Implementability – This criterion assesses the technical and administrative feasibility of an alternative and the availability of required goods and services. *Technical feasibility* considers the ability to construct and operate a technology and its reliability, the ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of a remedy. *Administrative feasibility* considers the ability to obtain approvals from other parties or agencies and the extent of required coordination with other parties or agencies.

Cost – This criterion evaluates the capital, and operation and maintenance (O & M) costs of each alternative. Present-worth costs are presented to help compare costs among alternatives.

Costs are shown as a present worth and as a total cost for the lifetime of the remedial alternative based on the estimated clean-up time (EPA 1998). Tables presenting a summary of the costs for each alternative and identifying capital, O&M, total, and present-worth costs are included in each alternative's cost description.

Costs are intended to be within the target accuracy range of minus 30 percent to plus 50 percent of actual cost (EPA 1998). Assumptions used to develop cost alternatives may or may not remain valid during alternative implementation. Cost estimates use volumes and surface areas developed in Section 2.3.

Each cost estimate includes a present-worth analysis to evaluate expenditures that may occur over different time periods. The analysis discounts future costs to a present worth and allows the cost of remedial alternatives to be compared on an equal basis. Present worth represents the amount of money that, if invested now and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life.

Each cost estimate includes the following items, as applicable:

- Engineering design, project and construction management (including health and safety, legal, and administrative fees), as a percentage of direct capital costs
- A contingency to account for unforeseen project complexities such as adverse weather, the need for additional and unexpected site characterization, and increased construction standby times as a percentage of direct capital costs. Contingency will vary for each remedial alternative based on complexity and uncertainty.
- Operation, maintenance, and monitoring costs

Details and assumptions pertaining to the cost estimate are discussed in each alternative's cost description.

4.1.3 Additional Criteria

State Acceptance – This FS criterion considers the state's preferences or concerns about the alternatives, including comments on ARARs or proposed use of waivers. IDEM and IDNR are project partners on this GLLA FS and were involved in all aspects of alternative evaluation and the recommendation of a preferred alternative.

Community Acceptance – This FS criterion considers the community's preferences or concerns about the alternatives. This GLLA FS was completed in response to concerns raised by community members.

4.2 INDIVIDUAL ALTERNATIVE ANALYSIS

As noted in Section 2.0, the project is only addressing TSCA sediment within the federal navigation channel. A summary of the remedial alternatives evaluation is shown in Table 4-1.

4.2.1 Alternative 1 – No Action

4.2.1.1 Alternative 1 Description

Alternative 1, the No Action alternative, was retained as a baseline against which to compare all other alternatives, as required by the NCP. This alternative would not include remedial action components to contain or reduce contaminant concentrations in the soil, nor would Alternative 1 control potential risks from exposure to contaminated soil by implementing institutional controls or environmental monitoring. Site reviews would not be performed as part of this alternative.

4.2.1.2 Alternative 1 Assessment

- Overall Protection of Human Health and the Environment

Alternative 1 would not include any actions to control potential risks or hazards posed to human receptors. As a result, Alternative 1 is not considered protective of human health and the environment.

- Compliance with ARARs

The No Action alternative would not include any actions to reduce exposure to contamination in soil; therefore, ARARs will not be attained.

- Long-Term Effectiveness and Permanence

No controls for exposure and no long-term management measures would be undertaken. As a result, Alternative 1 will be ineffective.

- Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 1 would not provide any reduction in toxicity, mobility, or volume of contaminated soil through removal or treatment.

- Short-Term Effectiveness

Alternative 1 would not have any impacts on the community, workers, or the environment during implementation since no remedial actions would be taken.

- Implementability

Alternative 1 would be considered easily implementable, because no remedial actions would be taken.

- Cost

Since no action would be taken, no cost is associated with Alternative 1.

4.2.2 Alternative 2 – Containment + Institutional Controls

4.2.2.1 Alternative 2 Description

This GLNPO and non-federal partner alternative would involve installing a cap as described in Section 3.2 over the TSCA areas in Figure 1-2. Geotextile fabric with activated carbon would be placed over the sediment to filter contaminated pore water migrating through the cap, followed by an articulated concrete mat to protect the treatment media. TSCA contamination would be left in place and covered to limit direct contact. Capping the approximately 1-acre total area would take approximately 1 month. Institutional controls would be implemented to maintain the integrity of the containment system for the protection of site users from exposure to TSCA sediment.

4.2.2.2 Alternative 2 Assessment

- Overall Protection of Human Health and the Environment

A cap would eliminate direct contact with TSCA sediment. All TSCA sediment would be left in place. Alternative 2 includes remedial actions that will reduce future exposure to the sediment and is considered protective of human health and the environment. The exposure to contaminated sediment would be reduced but not eliminated, since the contamination will remain onsite.

- Compliance with ARARs

The containment system would be placed within the federal navigation channel above the authorized depth, changing the functional navigation depth and thus failing to meet ARARs and the RAOs. A modification to the federally authorized navigation depth would be required prior to installation to maintain compliance with the Rivers and Harbors Act. Changing the navigation depth will require an act of Congress. This alternative is carried through this FS because it would reduce exposure to contamination in sediment through remedial actions.

- Long-Term Effectiveness and Permanence

Controls for exposure and long-term management measures would be implemented through a remedial action to add a cap over the impacted sediment and impose institutional controls to minimize disturbances of the cap. Inspections and repairs would be required to maintain integrity of the cap and will be conducted at periodic intervals. Long-term effectiveness is contingent on maintenance of the containment system. Inspections and maintenance of the cap would need to be conducted as long as the containment system is in place. Containment will be somewhat effective since the PCBs are encapsulated but remain in place within the IHC.

- Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 2 would be somewhat effective in reducing toxicity, mobility, or volume through treatment for PCB-impacted groundwater that flows up through the cap. The activated carbon in the cap would remove the PCBs from the groundwater before it enters the IHC by sequestering the PCBs within the activated carbon.

- Short-Term Effectiveness

Sediment disturbance and contact would be limited to placement of the cap with slight impacts during implementation. Workers would not be exposed to the sediment, except for divers that may be required to assist with placement below the water surface; divers will wear all necessary protective equipment. Truck traffic would be limited to delivery of cap materials and construction activities would be expected to take 1 month.

- Implementability

The installation of a sediment cap is an established technology. No new technologies need to be used or implemented. Materials for the cap could be easily obtained and installed. However, capping the TSCA sediment at the current elevation will require a modification of the navigation channel depth. This change requires an act of Congress and may be difficult or impossible to implement given local industries using the IHC require a minimum water depth to support their operations. An applicant for approval of TSCA removal, capping, and long-term cap maintenance would be required. GLNPO has not identified a potential applicant willing to seek the approval of TSCA dredging and capping of residual sediment, , precluding implementation of this alternative.

- Cost

The construction, management, and O&M costs of Alternative 2 are presented in Table 4-3. The present-worth cost for Alternative 2 is estimated to be approximately $1,720,000. The cost assumes that long-term O&M will be conducted semi-annually to annually for 30 years, recognizing that the cap must be maintained in perpetuity.

4.2.3 Alternative 3A– Hydraulic Dredging and Off-Site Disposal

4.2.3.1 Alternative 3A Description

This GLNPO and non-federal partner alternative involves hydraulically dredging the TSCA sediment to a maximum of 26 feet below the IHC LWD. Sediment would be pumped to the ArcelorMittal property where it would then be dewatered (see Figure 4.1). Overburden sediment would be kept separate from TSCA sediment. All sediment would be dewatered inside geotextile tubes. Waste water would be treated and either discharged back to the IHC or to local POTW. Once dry, overburden sediment would be sent to a licensed Subtitle D landfill and TSCA sediment would be sent to a facility approved to receive TSCA material. Residual sediment in the IHC below the dredge limit will be capped. This alternative includes remedial actions that will reduce future exposure to the sediment and would take approximately 2 months to construct.

4.2.3.2 Alternative 3A Assessment

- Overall Protection of Human Health and the Environment

Removal of TSCA sediment in the navigation channel and placing a cap over the residuals below the navigation depth would eliminate direct contact with TSCA sediment. Alternative 3A includes remedial actions that will reduce future exposure to the sediment and is considered protective of human health and the environment. The exposure to contaminated sediment would be reduced but not eliminated, since some contamination will remain in the channel.

- Compliance with ARARs

Alternative 3A would be compliant with all chemical-, location-, and action-specific ARARs. This alternative would reduce exposure to contamination in sediment through remedial actions; therefore, all ARARs will be attained.

- Long-Term Effectiveness and Permanence

All TSCA sediment in the navigation channel would be removed and disposed of in a licensed facility. Residual material below the navigation channel would be capped. Long-term effectiveness is contingent on maintenance of the containment system. Inspections and maintenance of the cover would need to be conducted as long as the containment system is in place. Alternative 3A will be effective in the long-term since all the PCBs within the navigation channel limits are removed and residuals below the navigation channel are capped and managed long-term.

- Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 3A would be somewhat effective in reducing toxicity, mobility, or volume through treatment for PCB-impacted groundwater that flows up through the cap. The activated carbon in the cap would sequester the PCBs from the groundwater before it enters the IHC. Removed sediment would not be treated.

- Short-Term Effectiveness

Sediment will be wet during removal and would be conveyed to the dewatering facility in an enclosed pipeline, limiting air emissions. Workers would not contact the sediment during dredging. Sediment would be pumped into geotextile tubes, limiting worker contact at the dewatering facility. Sediment would require at least 3 weeks after consolidation in the geotextile tubes to dry sufficiently for removal and off-site disposal. After it is dry, sediment will be exposed and loaded onto trucks for off-site disposal. Workers will wear appropriate protective equipment at all times during active operations. Upon removal, sediment would be wet and not present a dust hazard; however, during loadout, dust control measures would be used to minimize emissions. Volatile emission controls and air monitoring would be required. Trucks would be required to remove the dredged sediment and import cap materials. Construction activities would be expected to take 2 months with minimal short-term impacts.

- Implementability

Hydraulic dredging and dewatering with geotextile tubes has been used successfully on the Grand Calumet River in the last 5 years; cap placement has also been used effectively. This alternative is readily implementable. Similar dredging and dewatering activities have been conducted at the ArcelorMittal property in the last 20 years. All materials are available and several construction contractors capable of performing this work are located in the Midwest. Sufficient landfills capacity for overburden material is located within 100 miles of the project site. Two licensed facilities capable of accepting the TSCA sediment are located within 300 miles; one near Detroit, Michigan, and the other near Indianapolis, Indiana. As in Alternative 2, an applicant for approval of TSCA removal, capping, and long-term cap maintenance would be required. GLNPO has not identified a potential applicant willing to seek the approval of TSCA dredging and capping of residual sediment, precluding implementation of this alternative.

- Cost

The construction, management, and O&M costs of Alternative 3A are presented in Table 4-4. The present-worth cost for Alternative 3A is estimated to be approximately \$6,200,000. The cost assumes that the long-term O&M will be conducted semi-annually to annually for 30 years, recognizing that the cap must be maintained in perpetuity.

4.2.4 Alternative 3B – Mechanical Dredging and Off-Site Disposal

4.2.4.1 Alternative 3B Description

This GLNPO and non-federal partner-based alternative involves mechanically dredging the TSCA sediment to a maximum of 26 feet below the IHC LWD. Sediment will be transported by barge to the ArcelorMittal property were the sediment will be off-loaded to a pad. See Figure 4.2. Overburden sediment will be kept separate from TSCA sediment during dewatering and loadout. Amendments may be added to the sediment to facilitate the drying process. Waste water not absorbed by an amendment will be treated and discharged to a local water treatment plant. Once dry, overburden sediment will be sent to a licensed Subtitle D landfill and TSCA sediment will be sent to a facility approved for TSCA material. Residual sediment below the dredge limit in the IHC will be capped, as discussed in Alternative 2. This alternative will take approximately 1 month to perform the work, with additional mobilization and demobilization time required.

4.2.4.2 Alternative 3B Assessment

- Overall Protection of Human Health and the Environment

Removal of TSCA sediment from the navigation channel and placing a cap over the residual material below the navigation depth eliminates direct contact with TSCA sediment. Alternative 3B includes remedial actions that will reduce future exposure to the sediment and is considered protective of human health and the environment. The exposure to contaminated sediment will be reduced but not eliminated, since some contamination will remain onsite.

- Compliance with ARARs

Alternative 3B is compliant with all chemical-, location-, and action-specific ARARs. This alternative will reduce exposure to contamination in soil through remedial actions; therefore, all ARARs will be attained.

- Long-Term Effectiveness and Permanence

TSCA sediment in the navigation channel will be removed and disposed of in a licensed facility. Residual material below the navigation channel will be capped. Long-term effectiveness is contingent on maintenance of the containment system. Inspections and maintenance of the cover will need to be conducted as long as the cap is in place. Alternative 3B will be effective in the long-term since PCBs within the navigation channel limits are removed and residuals below the navigation channel are capped and managed long-term.

- Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 3B will be somewhat effective in reducing toxicity, mobility, or volume through treatment for PCB impacted groundwater that flows up through the cap. The activated carbon in the cap will sequester the PCBs from the groundwater before it enters the IHC. Removed sediment will not be treated.

- Short-Term Effectiveness

Sediment will be wet during removal and conveyed to the dewatering facility by barge. The sediment will be wet, thereby limiting dust and air emissions. Workers will not contact the sediment during dredging. Sediment will be off-loaded from the barge using a mechanical excavator. Sediment will be exposed during the drying process and loaded onto trucks for off-site disposal. Sediment is only expected to be on site 2 to 3 days before removal to a disposal facility. Workers will wear appropriate protective equipment during active operations. Upon removal, sediment is wet and will not present a dust hazard; however, during loadout, dust control measures will be used to minimize emissions. Volatile emission controls and air monitoring would be required. Trucks would be required to remove the dredged sediment and import cap materials. Construction activities would be expected to take 1 month to perform, with additional mobilization and demobilization time required, and with minimal short-term impacts.

- Implementability

The implementability of mechanical dredging and cap placement are established technologies and commonplace in the Great Lakes regions. Dredging and dewatering activities similar to those in Alternative 3B have been conducted at the ArcelorMittal property in the last 5 years (for non-TSCA regulated sediment). No new technologies will need to be used or implemented. Equipment and materials for dredging, capping, and disposal can be easily obtained. As in previous Alternatives, an applicant for approval of TSCA removal, capping, and long-term cap maintenance would be required. GLNPO has not identified a potential applicant willing to seek the approval of TSCA dredging and capping of residual sediment, precluding implementation of this Alternative.

- Cost

The construction, management, and O&M costs of Alternative 3B are presented in Table 4-5. The present-worth cost for Alternative 4B is estimated to be approximately $5,310,000. The cost assumes that the long-term O&M will be conducted semi-annually to annually for 30 years, recognizing that the cap must be maintained in perpetuity.

4.2.5 Alternative 4A – Hydraulic Dredging, Soil Washing, and Off-Site Disposal

4.2.5.1 Alternative 4A Description

This GLNPO and non-federal partner-based alternative involves hydraulically dredging the TSCA sediment to a maximum of 26 feet below the IHC LWD. Sediment will be pumped to the ArcelorMittal property and piped directly into a soil washing treatment system. See Figure 4.3. All sediment will be subjected to chemical washing to remove PCBs from the sediment particles. After soil washing, sediment will be processed through a series of hydrocyclones to separate the treated sediment from the waste water. Waste water containing the removed PCBs and other contaminants common to the IHC will be treated and either discharged back to the IHC or to a local POTW. Once dry, all sediment below the TSCA limit will be sent to a licensed Subtitle D landfill. Sediment remaining above the TSCA limit will be treated a second time until it is below TSCA criteria or sent to a facility approved for TSCA material. Residual sediment below the dredge limit in the IHC will be capped, as discussed in Alternative 2. This alternative will take approximately 4 months to perform, with additional mobilization and demobilization time required.

4.2.5.2 Alternative 4A Assessment

- Overall Protection of Human Health and the Environment

Removal of TSCA sediment in the navigation channel and placing a cap over the residuals below the navigation depth eliminates direct contact with TSCA sediment. Alternative 4A includes remedial actions that will reduce future exposure to the sediment and is considered protective of human health and the environment. The exposure to contaminated sediment will be reduced but not eliminated, since some contamination will remain onsite.

- Compliance with ARARs

Alternative 4A is compliant with all chemical-, location-, and action-specific ARARs. This alternative will reduce exposure to contamination in soil through remedial actions; therefore, all ARARs will be attained.

- Long-Term Effectiveness and Permanence

TSCA sediment in the navigation channel will be removed and disposed in a licensed facility. Residual material below the navigation channel will be capped. Long-term effectiveness is contingent on maintenance of the containment system. Inspections and maintenance of the cover will need to be conducted as long as the cap is in place. Alternative 4A will be effective in the long-term since PCBs within the navigation channel limits are removed and residuals below the navigation channel are capped and managed long-term.

- Reduction of Toxicity, Mobility, and Volume through Treatment

Through *ex situ* treatment, Alternative 4A will effectively reduce the mobility and toxicity of PCBs in sediment by separating much of the PCBs. The PCBs will not be destroyed, but the volume of TSCA sediment will be significantly reduced. Soil washing is not effective for treating material high in clay and silt content, which is the case with the TSCA sediment. As such, approximately 30 percent of the TSCA sediment volume will remain above the TSCA limit after treatment. The activated carbon in the cap will work to sequester the PCBs from the groundwater before it enters the IHC; this would act to reduce mobility and toxicity of PCBs in the residual sediment.

- Short-Term Effectiveness

Sediment will be wet during removal and conveyed to the dewatering facility in an enclosed pipeline, limiting air emissions. Workers will not contact the sediment during dredging. Sediment will be pumped into the soil washing system. The treatment process requires workers to handle a variety of chemical additives to remove the PCBs from the sediment. Sediment will be exposed once it is dry and loaded onto trucks for off-site disposal. Workers will wear appropriate protective equipment during treatment and management of sediment. Volatile emission controls and air monitoring would be required. During loadout, dust control measures will be used to minimize emissions. Trucks would be required to remove the dredged sediment and import cap materials. Construction activities are expected to take 4 months to perform, with additional mobilization and demobilization time required, and with minimal short-term impacts.

- Implementability

Hydraulic dredging and capping are both readily implementable. Although technically feasible, soil washing is not typically used to treat sediment. There are a limited number of vendors with the equipment and competency to complete soil washing in the United States. Higher clay and silt content in the sediment will also negatively affect performance. Some percentage of TSCA sediment would remain at or above 50 mg/kg PCBs after treatment because of the high silt and clay content. Based on silt and clay content and results from soil washing in similar projects, approximately 30 percent of the sediment will likely remain above TSCA levels after treatment. The process will also generate a significant amount of waste water with elevated PCB concentrations and other contaminants that will require treatment before release. Permits required for discharge may be difficult to obtain, as meeting discharge criteria may require significant treatment and proof of process monitoring. As in previous Alternatives, an applicant for approval of TSCA removal, capping, and long-term cap maintenance would be required. GLNPO has not identified a potential applicant willing to seek the approval of TSCA dredging and capping of residual sediment, precluding implementation of this Alternative.

- Cost

The construction, management, and O&M costs of Alternative 4A are presented in Table 4-6. The present-worth cost for Alternative 4A is estimated to be approximately $15,320,000. The cost assumes that the long-term O&M will be conducted semi-annually to annually for 30 years, recognizing that the cap must be maintained in perpetuity.

4.2.6 Alternative 4B – Mechanical Dredging, Off-Site Incineration of TSCA Sediment, and Off-Site Disposal of All Sediment

4.2.6.1 Alternative 4B Description

This GLNPO and non-federal partner-based alternative involves dredging, dewatering, material loadout, and capping, as discussed in Alternative 3B and shown in Figure 4-2. The only variation from Alternative 3B is that TSCA sediment would be sent to a TSCA permitted off-site incinerator with the capability to destroy approximately 100 percent of the PCBs. Treatment residuals would then be disposed at an off-site landfill. Overburden material would be shipped to an off-site Subtitle D landfill. Residual sediment in the IHC will be capped, as discussed in Alternative 2. This alternative will take approximately 1 month to perform, with additional mobilization and demobilization time required.

4.2.6.2 Alternative 4B Assessment

- Overall Protection of Human Health and the Environment

Removal of TSCA sediment in the navigation channel and capping residuals below the navigation depth eliminates direct contact with TSCA sediment. Alternative 4B includes remedial actions that will reduce future exposure to the sediment and is considered protective of human health and the environment. The exposure to contaminated sediment will be reduced but not eliminated, since some contamination will remain onsite.

- Compliance with ARARs

Alternative 4B is compliant with all chemical-, location-, and action-specific ARARs. This alternative will reduce exposure to contamination in soil through remedial actions; therefore, all ARARs will be attained.

- Long-Term Effectiveness and Permanence

All TSCA sediment in the navigation channel will be removed and disposed of in a licensed facility. Residual material below the navigation channel will be capped. Long-term effectiveness is contingent on maintenance of the containment system. Inspections and maintenance of the cover will be necessary as long as the containment system is in place. Alternative 4B will be effective in the long-term since all the

PCBs within the navigation channel limits are removed and residual materials below the navigation channel are capped and managed long-term.

- Reduction of Toxicity, Mobility, and Volume through Treatment

Through ex situ treatment, Alternative 4B will be highly effective destroying approximately 100 percent of the PCBs in the TSCA sediment. Overburden material will not be treated. The activated carbon in the cap will sequester the PCBs from the groundwater before it enters the IHC. As with other alternatives, this reduces the mobility and toxicity of PCBs in residual sediment.

- Short-Term Effectiveness

Sediment will be wet during removal and conveyed to the dewatering facility in barge. The sediment will be wet, thereby limiting dust and air emissions. Workers will not contact the sediment during dredging. Sediment will be off-loaded from the barge using a mechanical excavator. Sediment will be exposed during the drying process and loaded onto trucks for off-site disposal. Sediment is only expected to be on site 2-3 days before removal to a disposal facility. Workers will wear appropriate protective equipment while managing sediment. Volatile emission controls and air monitoring would be required. Upon removal, sediment is wet and will not present a dust hazard. During loadout, dust control measures will be used to minimize emissions. Trucks would be required to remove and transport the dredged sediment for offsite disposal or treatment as well as to import cap materials. Construction activities are expected to take 1 month to perform, with additional mobilization and demobilization time required, and with minimal short-term impacts.

- Implementability

The implementability of mechanical dredging and cap placement are established technologies and commonplace in the Great Lakes. Dredging and dewatering activities similar to those in Alternative 4B have been conducted at the ArcelorMittal property in the last 5 years. No new or unproven technologies will be used or implemented. Equipment and materials for dredging, capping, and disposal can be easily obtained. Two incinerators capable of treating the TSCA sediment are located within a reasonable distance; one in East Liverpool, Ohio and the other in Coffeyville, Kansas. As in previous Alternatives, an applicant for approval of TSCA removal, capping, and long-term cap maintenance would be required. GLNPO has not identified a potential applicant willing to seek the approval of TSCA dredging and capping of residual sediment, precluding implementation of this Alternative.

- Cost

The construction, management, and O&M costs of Alternative 4B are presented in Table 4-7. The present-worth cost for Alternative 4B is estimated to be approximately $13,680,000. The cost assumes that the long-term O&M will be conducted semi-annually to annually for 30 years, recognizing that the cap must be maintained in perpetuity.

4.2.7 Alternative 4C – Mechanical Dredging, On-site Thermal Desorption of TSCA Sediment, and Off-Site Disposal of Sediment

4.2.7.1 Alternative 4C Description

This GLNPO and non-federal partner-based alternative involves dredging and dewatering of sediment as discussed in Alternative 3B. TSCA sediment would be treated on-site in a thermal desorption system to remove PCBs from the sediment and reduce the concentration of PCBs in dredged sediment to below 50 mg/kg. Treated sediment below 50 mg/kg would then be disposed of with the overburden material at a Subtitle D landfill. Sediment remaining with concentrations at or above 50 mg/kg would be disposed at a TSCA or Subtitle C landfill. The site layout for Alternative 4C is shown in Figure 4-4. Residual sediment below the dredge limits in the IHC will be capped, as discussed in prior alternatives. This alternative will take approximately 6 months to complete, longest of the evaluated alternatives, as the thermal system can only process approximately 25 CY each hour and the TSCA sediment must be thoroughly dry prior to processing. TSCA sediment will also be stock piled on site prior to treatment.

4.2.7.2 Alternative 4C Assessment

- Overall Protection of Human Health and the Environment

Removal of TSCA sediment in the navigation channel and placing a cap over the residuals below the navigation depth eliminates direct contact with TSCA sediment. Alternative 4C includes remedial actions that reduce future exposure to the sediment and is considered protective of human health and the environment. The potential for exposure to contaminated sediment will be reduced but not eliminated, since some contamination will remain onsite.

- Compliance with ARARs

Alternative 4C is compliant with all chemical-, location-, and action-specific ARARs. This alternative will reduce exposure to contamination in soil through remedial actions; therefore, all ARARs will be attained.

- Long-Term Effectiveness and Permanence

All TSCA sediment in the navigation channel will be removed, treated, and disposed of in a licensed facility. Residual material below the navigation channel will be capped. Long-term effectiveness is contingent on maintenance of the containment system. Inspections and maintenance of the cover will need to be conducted as long as the containment system is in place. Alternative 4C will be effective in the long-term since all the PCBs within the navigation channel limits are removed and residual materials below the navigation channel are capped and managed long-term.

- Reduction of Toxicity, Mobility, and Volume through Treatment

Through ex situ treatment, Alternative 4C will be highly effective reducing the mobility and toxicity of PCBs in sediment by separating much of the PCBs. The PCBs will not be destroyed, but the volume of TSCA sediment will be significantly reduced. Thermal desorption systems operate at temperatures lower than incineration. Removal effectiveness is between 90 and 99 percent. As such, approximately 10 percent of the sediment volume will remain above the TSCA limit after treatment and require disposal as TSCA waste. The activated carbon in the cap will sequester the PCBs from the groundwater before it enters the IHC which also reduces the toxicity and mobility of PCBs in residual sediment.

- Short-Term Effectiveness

Sediment will be wet during removal and conveyed to the dewatering facility in barge thereby limiting dust and air emissions. Workers will not contact the sediment during dredging. Sediment will be off-loaded from the barge using a mechanical excavator. Sediment will be exposed during the drying process and loaded onto trucks for off-site disposal. TSCA sediment will need to be stockpiled on-site and managed prior to thermal desorption. Workers will wear appropriate protective equipment when managing sediment. During loadout, dust control measures will be used to minimize emissions. Volatile emission controls and air monitoring would be required. Trucks would be required to remove the treated and dredged sediment and transport material to an appropriate landfill as well as for import of cap materials. Construction activities are expected to take 6 months because of the thermal desorption system capacity and feed requirements with additional mobilization and demobilization time required. There will be minimal short-term impacts.

- Implementability

The implementability of mechanical dredging and cap placement are established technologies and commonplace in the Great Lakes region. Dredging and dewatering activities similar to those in Alternative 4C have been conducted at the ArcelorMittal property in the last 5 years. No new technologies will need to be implemented. Equipment and materials for dredging, capping, and disposal can be easily obtained. Although technically feasible, thermal desorption is not typically used to treat sediment due to high water content and low treatment efficiency. There are a limited number of vendors with the equipment and competency to complete this project in the United States. The material must be dry prior to treatment, which may be difficult to accomplish with the IHC sediment. Permits required for operating the thermal treatment system may be difficult to obtain due to emission concerns. As in previous Alternatives, an applicant for approval of TSCA removal, capping, and long-term cap maintenance would be required. GLNPO has not identified a potential applicant willing to seek the approval of TSCA dredging and capping of residual sediment, precluding implementation of this Alternative.

- Cost

The construction, management, and O&M costs of Alternative 4C are presented in Table 4-8. The present-worth cost for Alternative 4C is estimated to be approximately $18,160,000. The cost assumes that the long-term O&M will be conducted semi-annually to annually for 30 years, recognizing that the cap must be maintained in perpetuity.

4.2.8 Alternative 5 – Mechanical Dredging and Disposal at IHC CDF

4.2.8.1 Alternative 5 Description

This USACE-based alternative involves mechanically dredging the TSCA sediment to a maximum of 26 feet below the LWD. TSCA sediment and overburden material will be transported by barge to the IHC CDF where the sediment will be pumped into the CDF. See Figure 1-1. Residual sediment below the dredge limit in the IHC will be capped by USACE with a geotextile membrane covered with large stone. This alternative will take approximately 1 month to implement, with potentially additional time required for project sequencing and coordination with other USACE IHC work. Approval for cap placement and disposal of TSCA material in the CDF would be required prior to implementation of this alternative.

4.2.8.2 Alternative 5 Assessment

- Overall Protection of Human Health and the Environment

Removal of TSCA sediment in the navigation channel and placing a cap over the residual material below the navigation depth eliminates direct contact with TSCA sediment. Alternative 5 includes remedial actions that will reduce future exposure to the sediment and is considered protective of human health and the environment. The exposure to contaminated sediment will be reduced but not eliminated, since some contamination will remain onsite.

- Compliance with ARARs

Alternative 5 will require approval for disposal of TSCA material in the CDF to be compliant with all chemical-, location-, and action-specific ARARs. This alternative will reduce exposure to contamination in sediment through remedial actions; therefore, all ARARs will be attained if approval for placement of TSCA sediment in the CDF is issued.

- Long-Term Effectiveness and Permanence

All TSCA sediment in the navigation channel will be removed and disposed of in an approved facility. Residual material below the navigation channel will be capped. Long-term effectiveness is contingent on USACE's continued maintenance of the containment system. Inspections and maintenance of the cover will be required by USACE as long as the containment system is in place. Alternative 5 will be effective in the long-term since all the PCBs within the navigation channel limits are removed and residuals below the navigation channel are capped and managed long-term.

- Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 5 will be somewhat effective in reducing toxicity, mobility, or volume by covering residual sediment remaining below the dredge limit with a geotextile membrane and placement of large stone. Sediment that is removed will not be treated; therefore, no reduction in toxicity or volume through treatment will occur.

- Short-Term Effectiveness

Sediment will be wet during removal and conveyed to the CDF by barge; thereby limiting dust and air emissions. Workers will not contact the sediment during dredging. Sediment will be converted to a slurry and off-loaded from the barge using pumps. Sediment will be pumped through a pipeline directly to the CDF. Sediment will be wet at all times and air and dust emissions will be limited. Workers will wear appropriate protective equipment during sediment management. Trucks or barges would be required to import cap materials. Construction activities are expected to take a few weeks to 1 month to perform with time required for project sequencing and coordination with other USACE IHC work with minimal short-term impacts.

- Implementability

The implementability of mechanical dredging and cap placement are established technologies and commonplace in the Great Lakes. The Chicago District USACE has been dredging the IHC and placing non-TSCA sediment in the CDF since 2012. No new technologies would be needed. Equipment and materials for dredging, capping, and disposal could be easily obtained. Administrative implementation would require TSCA approval for placement of the TSCA sediment in the CDF. This alternative is considered implementable.

- Cost

The construction, management, and O&M costs of Alternative 5 are presented in Table 4-9. The present-worth cost for Alternative 5 is estimated to be approximately $1,860,000. The cost assumes that the long-term O&M will be conducted semi-annually to annually for 30 years, recognizing that the cap must be maintained in perpetuity.

TABLE 4-1. REMEDIAL ALTERNATIVE EVALUATION SUMMARY

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Containment with Institutional Controls	Alternative 3A Hydraulic Dredging Off-site Disposal	Alternative 3B Mechanical Dredging Off-site Disposal	Alternative 4A Hydraulic Dredging Soil Washing	Alternative 4B Mechanical Dredging Incineration	Alternative 4C Mechanical Dredging Thermal Desorption	Alternative 5 Mechanical Dredging CDF Disposal
Overall Protection of Human Health and the Environment								
Protection of human health and the environment	Not protective	Somewhat protective	Protective	Protective	Protective	Protective	Protective	Protective
Compliance with ARARs								
Chemical-specific ARARs	Not in compliance	Requires TSCA Approval	Requires TSCA Approval	Requires TSCA Approval	Requires TSCA Approval	Requires TSCA Approval	Requires TSCA Approval	Requires TSCA Approval
Location-specific ARARs	Not in compliance	Requires Navigation Depth Change	In compliance	In compliance	In compliance	In compliance	In compliance	In compliance
Action-specific ARARs	Not in compliance	In compliance	In compliance	In compliance	In compliance	In compliance	In compliance	In compliance
Long-Term Effectiveness and Permanence								
Magnitude of residual risk	Residual risk remains	Some residual risk	Some residual risk	Some residual risk	Some residual risk	Some residual risk	Some residual risk	Some residual risk
Adequacy and reliability of controls	No controls	Somewhat reliable	Somewhat reliable	Somewhat reliable	Somewhat reliable	Somewhat reliable	Somewhat reliable	Somewhat reliable
Reduction of Toxicity, Mobility, or Volume through Treatment								
Treatment processes used and materials treated	None	Reactive cap for residual TSCA sediment	Reactive cap for residual TSCA sediment	Reactive cap for residual TSCA sediment	All removed sediment soil washed, reactive cap for residual TSCA sediment	TSCA sediment removed & incinerated, reactive cap for residual TSCA sediment	TSCA sediment removed & thermally treated, reactive cap for residual TSCA sediment	Cap with geotextile membrane and large stone for residual TSCA sediment
Amount of hazardous material destroyed or treated	None	Limited to residuals under cap	Limited to residuals under cap	Limited to residuals under cap	18,569 CY removed and residuals under cap	5,401 CY removed and residuals under cap	5,401 CY removed and residuals under cap	No treatment; placement of sediment in CDF and capping residuals.
Expected reduction in toxicity, mobility, or volume of the waste	None	Minimal	Minimal	Minimal	70% below TSCA	100% below TSCA	90% below TSCA	Minimal
Irreversibility of treatment	Not Applicable	Not reversible	Not reversible	Not reversible	Not reversible	Not reversible	Not reversible	Not reversible
Type and quantity of residuals that will remain following treatment	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Metals, PCBs	Metals	Metals, PCBs	Not Applicable
Statutory preference for treatment	Does not satisfy	Somewhat satisfies	Somewhat satisfies	Somewhat satisfies	Mostly satisfies	Satisfies	Mostly satisfies	Somewhat satisfies
Short-Term Effectiveness								
Protection of workers during remedial action	Not Applicable	High	Moderate-High	Moderate	Moderate-High	Moderate	Moderate	High
Protection of the community during remedial action	Not Applicable	High	Moderate-High	Moderate-High	Moderate	Moderate-High	Moderate	Moderate-High
Potential environmental impacts of remedial action	Not Applicable	Low	Low	Low	Low-Moderate	Low	Low-Moderate	Low
Time until protection is achieved	Not achieved	Immediate	Immediate	Immediate	Immediate	Immediate	Immediate	Immediate
Implementability								
Technical feasibility	Not Applicable	Easy	Moderate	Easy-Moderate	Difficult	Moderate	Difficult	Easy
Reliability of technology	Not Applicable	Very Reliable	Very Reliable	Very Reliable	Somewhat Reliable	Very Reliable	Somewhat Reliable	Very Reliable
Administrative feasibility	Not Applicable	Very Difficult	Somewhat Difficult	Somewhat Difficult	Difficult	Somewhat Difficult	Difficult	Somewhat Feasible
Availability of services, equipment, and materials	Not Applicable	Readily Available	Readily Available	Readily Available	Limited	Available	Limited	Readily Available
Cost								
Total engineering and construction cost	$0	$1,205,986	$4,788,059	$4,080,784	$12,084,354	$10,774,243	$14,356,623	$1,314,509
Total institutional controls	$0	$21,000	$21,000	$21,000	$21,000	$21,000	$21,000	$21,000
Total present-worth O&M (TSCA Applicant to Cover Cost)	$0	$148,866	$148,866	$148,866	$148,866	$148,866	$148,866	$148,866
Contingency	$0	$343,963	$1,239,481	$1,062,662	$3,063,555	$2,736,027	$3,631,622	$371,094
Period of analysis (years) (30 years for cost purposes)	Not Applicable	30 years	30 years	30 years	30 years	30 years	30 years	30 years
Total cost, FS-level cost estimates (rounded)	$0	$1,720,000	$6,200,000	$5,310,000	$15,320,000	$13,680,000	$18,160,000	$1,860,000

TABLE 4-2
SUMMARY OF SHORT TERM EFFECTIVENESS CONSIDERATIONS

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Containment with Institutional Controls	Alternative 3A Hydraulic Dredging Off-site Disposal	Alternative 3B Mechanical Dredging Off-site Disposal	Alternative 4A Hydraulic Dredging Soil Washing	Alternative 4B Mechanical Dredging Incineration	Alternative 4C Mechanical Dredging Thermal Desorption	Alternative 5 Hydraulic Dredging IHC CDF Disposal
Total Area Addressed	No area addressed	0.5 acre	0.5 acre	0.5 acre	0.5 acre	0.5 acre	0.5 acre	0.5 acre
Total Volume of COC-Containing Sediment Removed and Disposed	No volume removed	No volume removed	18,569 cubic yards removed	18,569 cubic yards removed	18,569 cubic yards removed	18,569 cubic yards removed	18,569 cubic yards removed	18,569 cubic yards removed
Duration to Implement Construction Phase	No time period to implement	1 Month	2 Months	1 Month	4 Months	1 Month	6 Months	1 Month
Worker Risks	No worker risk since no action is taken	Minimal exposure to contaminated sediments. Divers may be required to assist with geotextile and aggregate placement.	Minimal exposure to contaminated sediments during dewatering and loadout to TSCA landfill. Chemical use for dewatering. Divers may be required to assist with geotextile and aggregate placement.	Some exposure to contaminated sediments off loading from barge and loading trucks for transport to TSCA landfill. Chemical use for dewatering. Divers may be required to assist with geotextile and aggregate placement.	Minimal exposure to contaminated sediments. Chemical use for dewatering. Divers may be required to assist with geotextile and aggregate placement. Potential for additional exposure if washing process is ineffective.	Some exposure to contaminated sediments off loading from barge and loading trucks for transport to incineration facility. Chemical use for dewatering. Divers may be required to assist with geotextile and aggregate placement.	Some exposure to contaminated sediments. Chemical use for dewatering. Divers may be required to assist with geotextile and aggregate placement. Potential for additional exposure if thermal desorption process is ineffective.	Minimal exposure to contaminated sediments. Divers may be required to assist with geotextile and aggregate placement.
Community Impacts	Continued risks from contaminated sediment to community	Trucking of clean cover material, noise, and dust creation	Increase in trucking of clean cover and waste material, noise, and dust creation	Increase in trucking of clean cover and waste material, noise, and dust creation	Increase in trucking of waste material and clean cover material, noise, and dust creation. Local treatment of TSCA material.	Increase in trucking of waste material and clean cover material, noise, and dust creation	Increase in trucking of waste material and clean cover material, noise, and dust creation. Local treatment of TSCA material.	Local disposal of TSCA sediment. Trucking of clean cover material, noise, and dust creation.

TABLE 4-3
ALTERNATIVE 2 - CONTAINMENT

CAPITAL COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Preparation					
1	Engineering Design/Agency Approvals/Access Agreements	1	Lump	$ 100,000.00	$ 75,000
	Preparation Subtotal				**$ 75,000**
Implementation					
2	Construction Contractor Mobilization, Site Preparation and Submittals	1	Lump	$ 131,040.00	$ 131,040
3	Geotextile Placement	3,360	SY	$ 60.00	$ 201,600
4	Articulated Mat Placement	3,360	SY	$ 200.00	$ 672,000
	Implementation Subtotal				**$ 1,004,640**
Site Restoration					
5	Site Restoration	1	Lump	$ 10,000.00	$ 10,000
6	Demobilization	1	Lump	$ 43,680.00	$ 43,680
	Site Restoration Subtotal				**$ 53,680**
Construction Subtotal					$ 1,133,320
7	Construction Contractor Bonds	2%			$ 22,666
8	Project Management and Construction Oversight				$ 50,000.00
Construction subtotal plus Contractor Bonds, Project Management, and Oversight					**$ 1,205,986**
CAPITAL COST SUBTOTAL					**$ 1,205,986**

INSTITUTIONAL CONTROLS COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Institutional Controls					
1	Prepare LUC Implementation Plan (mid-level staff with senior review)	100	hr	$ 110.00	$ 11,000
2	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000
Institutional Controls Subtotal					**$ 21,000**

O&M COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Annual Inspections					
1	Annual cap inspections (includes labor - 2 hours per site- and travel)	8.0	hr	$ 200.00	$ 1,600
2	Annual inspection report	1.0	ls	$ 5,000.00	$ 5,000
3	Project Management	4.0	hr	$ 200.00	$ 800
Annual Operation and Maintenance Subtotal					**$ 7,400**

ALTERNATIVE 2 CONTAINMENT		
Description		**Subtotal**
Construction		$ 1,205,986
Institutional Controls		$ 21,000
Operation and Maintenance (30-Year Present Value Analysis Costs)		$ 148,866
Contingency	25%	$ 343,963
Total (Rounded)		**$ 1,720,000**

TABLE 4-4
ALTERNATIVE 3A - HYDRAULIC DREDGING OFF-SITE DISPOSAL

CAPITAL COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Preparation					
1	Engineering Design/Agency Approvals/Access Agreements	1	Lump	$ 150,000.00	$ 150,000
	Preparation Subtotal				**$ 150,000**
Implementation					
2	Construction Contractor Mobilization, Site Preparation and Submittals	1	Lump	$ 249,126.45	$ 249,126
3	Hydraulic Dredging Overburden Material	13,168	CY	$ 15.00	$ 197,520
4	Hydraulic Dredging TSCA Material	5,401	CY	$ 20.00	$ 108,020
5	Geotextile Tube for Dewatering	2,653	LF	$ 40.00	$ 106,109
6	Dewater Sediment	18,569	CY	$ 1.25	$ 23,211
7	Waste Water Treatment	15,783,650	GAL	$ 0.05	$ 789,183
8	Geotextile Placement	1,680	SY	$ 60.00	$ 100,800
9	Articulated Mat Placement	1,680	SY	$ 200.00	$ 336,000
10	Transport and Dispose Overburden Material	19,752	TON	$ 45.00	$ 888,840
11	Transport and Dispose TSCA Material	8,102	TON	$ 190.00	$ 1,539,285
	Implementation Subtotal				**$ 4,338,094**
Site Restoration					
12	Site Restoration and Cleanup	1	Lump	$ 25,000.00	$ 25,000
13	Demobilization	1	Lump	$ 83,042.15	$ 83,042
	Site Restoration Subtotal				**$ 108,042**
Construction Subtotal					$ 4,596,136
14	Construction Contractor Bonds	2%			$ 91,923
15	Project Management and Construction Oversight				$ 100,000
Construction subtotal plus Contractor Bonds, Project Management, and Oversight					**$ 4,788,059**
CAPITAL COST SUBTOTAL					**$ 4,788,059**

INSTITUTIONAL CONTROLS COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Institutional Controls					
1	Prepare LUC Implementation Plan (mid-level staff with senior review)	100	hr	$ 110.00	$ 11,000
2	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000
Institutional Controls Subtotal					**$ 21,000**

O&M COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Annual Inspections					
1	Annual cap inspections (includes labor - 2 hours per site- and travel)	8.0	hr	$ 200.00	$ 1,600
2	Annual inspection report	1.0	ls	$ 5,000.00	$ 5,000
3	Project Management	4.0	hr	$ 200.00	$ 800
Annual Operation and Maintenance Subtotal					**$ 7,400**

ALTERNATIVE 3A -HYDRAULIC DREDGE & OFF-SITE DISPOSAL	
Description	**Subtotal**
Construction	$ 4,788,059
Institutional Controls	$ 21,000
Operation and Maintenance (30-Year Present Value Analysis Costs)	$ 148,866

Contingency	25%	$ 1,239,481
Total (Rounded)		**$ 6,200,000**

TABLE 4-5
ALTERNATIVE 3B - MECHANICAL DREDGING OFF-SITE DISPOSAL

CAPITAL COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Preparation					
1	Engineering Design/Agency Approvals/Access Agreements	1	Lump	$ 150,000.00	$ 150,000
	Preparation Subtotal				**$ 150,000**
Implementation					
2	Construction Contractor Mobilization, Site Preparation and Submittals	1	Lump	$ 168,577.95	$ 168,578
3	Mechanical Dredging Overburden Material	13,168	CY	$ 30.00	$ 395,040
4	Mechanical Dredging TSCA Material	5,401	CY	$ 30.00	$ 162,030
5	Dewater Sediment	18,569	CY	$ 5.00	$ 92,845
6	Waste Water Treatment	371,380	GAL	$ 0.10	$ 37,138
7	Geotextile Placement	1,680	SY	$ 60.00	$ 100,800
8	Articulated Mat Placement	1,680	SY	$ 200.00	$ 336,000
9	Transport and Dispose Overburden Material	19,752	TON	$ 45.00	$ 888,840
10	Transport and Dispose TSCA Material	8,102	TON	$ 190.00	$ 1,539,285
	Implementation Subtotal				**$ 3,720,556**
Site Restoration					
11	Site Restoration and Cleanup	1	Lump	$ 25,000.00	$ 25,000
12	Demobilization	1	Lump	$ 56,192.65	$ 56,193
	Site Restoration Subtotal				**$ 81,193**
Construction Subtotal					$ 3,951,749
13	Construction Contractor Bonds	2%			$ 79,035
14	Project Management and Construction Oversight				$ 50,000.00
Construction subtotal plus Contractor Bonds, Project Management, and Oversight					**$ 4,080,784**
CAPITAL COST SUBTOTAL					**$ 4,080,784**

INSTITUTIONAL CONTROLS COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Institutional Controls					
1	Prepare LUC Implementation Plan (mid-level staff with senior review)	100	hr	$ 110.00	$ 11,000
2	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000
Institutional Controls Subtotal					**$ 21,000**
O&M COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Annual Inspections					
2	Annual cap inspections (includes labor - 2 hours per site- and travel)	8.0	hr	$ 200.00	$ 1,600
3	Annual inspection report	1.0	ls	$ 5,000.00	$ 5,000
4	Project Management	4.0	hr	$ 200.00	$ 800
Annual Operation and Maintenance Subtotal					**$ 7,400**

ALTERNATIVE 3B - MECHANICAL DREDGING & OFF-SITE DISPOSAL	
Description	**Subtotal**
Construction	$ 4,080,784
Institutional Controls	$ 21,000
Operation and Maintenance (30-Year Present Value Analysis Costs)	$ 148,866

Contingency	25%	$ 1,062,662
Total (Rounded)		**$ 5,310,000**

TABLE 4-6
ALTERNATIVE 4A - HYDRAULIC DREDGING, SOIL WASHING, OFF-SITE DISPOSAL

CAPITAL COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Preparation					
1	Engineering Design/Agency Approvals/Access Agreements	1	Lump	$ 250,000.00	$ 250,000
	Preparation Subtotal				**$ 250,000**
Implementation					
2	Construction Contractor Mobilization, Site Preparation and Submittals	1	Lump	$ 1,221,313.05	$ 1,221,313
3	Hydraulic Dredging Overburden Material	13,168	CY	$ 15.00	$ 197,520
4	Hydraulic Dredging TSCA Material	5,401	CY	$ 20.00	$ 108,020
5	Soil Washing Chemical Treatment	27,854	TON	$ 234.00	$ 6,517,719
6	Dewater Sediment	18,569	CY	$ 5.00	$ 92,845
7	Waste Water Treatment	15,783,650	GAL	$ 0.05	$ 789,183
8	Geotextile Placement	1,680	SY	$ 60.00	$ 100,800
9	Articulated Mat Placement	1,680	SY	$ 200.00	$ 336,000
10	Transport and Dispose Overburden Material and Treated Sediment	25,423	TON	$ 45.00	$ 1,144,037
11	Transport and Dispose TSCA Material	2,430	TON	$ 190.00	$ 461,786
	Implementation Subtotal				**$ 10,969,223**
Site Restoration					
12	Site Restoration and Cleanup	1	Lump	$ 25,000.00	$ 25,000
13	Demobilization	1	Lump	$ 407,104.35	$ 407,104
	Site Restoration Subtotal				**$ 432,104**
Construction Subtotal					$ 11,651,327
14	Construction Contractor Bonds	2%			$ 233,027
15	Project Management and Construction Oversight				$ 200,000.00
Construction subtotal plus Contractor Bonds, Project Management, and Oversight					**$ 12,084,354**
CAPITAL COST SUBTOTAL					**$ 12,084,354**

INSTITUTIONAL CONTROLS COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Institutional Controls					
1	Prepare LUC Implementation Plan (mid-level staff with senior review)	100	hr	$ 110.00	$ 11,000
2	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000
Institutional Controls Subtotal					**$ 21,000**
O&M COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Annual Inspections					
2	Annual cap inspections (includes labor - 2 hours per site- and travel)	8.0	hr	$ 200.00	$ 1,600
3	Annual inspection report	1.0	ls	$ 5,000.00	$ 5,000
4	Project Management	4.0	hr	$ 200.00	$ 800
Annual Operation and Maintenance Subtotal					**$ 7,400**

ALTERNATIVE 4A - DREDGING & SOIL WASHING	
Description	**Subtotal**
Construction	$ 12,084,354
Institutional Controls	$ 21,000
Operation and Maintenance (30-Year Present Value Analysis Costs)	$ 148,866

Contingency	25%	$ 3,063,555
Total (Rounded)		**$ 15,320,000**

TABLE 4-7
ALTERNATIVE 4B - MECHANICAL DREDGING, INCINERATION, OFF-SITE DISPOSAL

CAPITAL COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Preparation					
1	Engineering Design/Agency Approvals/Access Agreements	1	Lump	$ 150,000.00	$ 150,000
	Preparation Subtotal				**$ 150,000**
Implementation					
2	Construction Contractor Mobilization, Site Preparation and Submittals	1	Lump	$ 168,577.95	$ 168,578
3	Mechanical Dredging Overburden Material	13,168	CY	$ 30.00	$ 395,040
4	Mechanical Dredging TSCA Material	5,401	CY	$ 30.00	$ 162,030
5	Dewater Sediment	18,569	CY	$ 5.00	$ 92,845
6	Waste Water Treatment	371,380	GAL	$ 0.10	$ 37,138
7	Geotextile Placement	1,680	SY	$ 60.00	$ 100,800
8	Articulated Mat Placement	1,680	SY	$ 200.00	$ 336,000
9	Transport and Dispose Overburden Material	19,752	TON	$ 45.00	$ 888,840
10	Transport to Incineration Facility (Treatment and Disposal)	8,102	TON	$ 1,000.00	$ 8,101,500
	Implementation Subtotal				**$ 10,282,771**
Site Restoration					
11	Site Restoration and Cleanup	1	Lump	$ 25,000.00	$ 25,000
12	Demobilization	1	Lump	$ 56,192.65	$ 56,193
	Site Restoration Subtotal				**$ 81,193**
Construction Subtotal					$ 10,513,964
13	Construction Contractor Bonds	2%			$ 210,279
14	Project Management and Construction Oversight				$ 50,000.00
Construction subtotal plus Contractor Bonds, Project Management, and Oversight					**$ 10,774,243**
CAPITAL COST SUBTOTAL					**$ 10,774,243**

INSTITUTIONAL CONTROLS COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Institutional Controls					
1	Prepare LUC Implementation Plan (mid-level staff with senior review)	100	hr	$ 110.00	$ 11,000
2	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000
Institutional Controls Subtotal					**$ 21,000**
O&M COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Annual Inspections					
2	Annual cap inspections (includes labor - 2 hours per site- and travel)	8.0	hr	$ 200.00	$ 1,600
3	Annual inspection report	1.0	ls	$ 5,000.00	$ 5,000
4	Project Management	4.0	hr	$ 200.00	$ 800
Annual Operation and Maintenance Subtotal					**$ 7,400**

ALTERNATIVE 4B- DREDGING, INCINERATION, & OFF-SITE DISPOSAL	
Description	**Subtotal**
Construction	$ 10,774,243
Institutional Controls	$ 21,000
Operation and Maintenance (30-Year Present Value Analysis Costs)	$ 148,866

Contingency	25%	$ 2,736,027
Total (Rounded)		**$ 13,680,000**

TABLE 4-8
ALTERNATIVE 4C - MECHANICAL DREDGING, THERMAL DESORPTION, OFF-SITE DISPOSAL

CAPITAL COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Preparation					
1	Engineering Design/Agency Approvals/Access Agreements	1	Lump	$ 250,000.00	$ 250,000
	Preparation Subtotal				**$ 250,000**
Implementation					
2	Construction Contractor Mobilization, Site Preparation and Submittals	1	Lump	$ 1,516,890.45	$ 1,516,890
3	Mechanical Dredging Overburden Material	13,168	CY	$ 30.00	$ 395,040
4	Mechanical Dredging TSCA Material	5,401	CY	$ 30.00	$ 162,030
5	Dewater Sediment	18,569	CY	$ 5.00	$ 92,845
6	Waste Water Treatment	371,380	GAL	$ 0.10	$ 37,138
7	Thermal Desorption	35,955	TON	$ 250.00	$ 8,988,750
8	Geotextile Placement	1,680	SY	$ 60.00	$ 100,800
9	Articulated Mat Placement	1,680	SY	$ 200.00	$ 336,000
10	Transport and Dispose Overburden Material and Treated Sediment	27,043	TON	$ 45.00	$ 1,216,951
11	Transport and Dispose TSCA Sediment and Treatment Residuals	810	TON	$ 190.00	$ 153,929
	Implementation Subtotal				**$ 13,000,373**
Site Restoration					
12	Site Restoration and Cleanup	1	Lump	$ 25,000.00	$ 25,000
13	Demobilization	1	Lump	$ 505,630.15	$ 505,630
	Site Restoration Subtotal				**$ 530,630**
Construction Subtotal					$ 13,781,003
14	Construction Contractor Bonds	2%			$ 275,620
15	Project Management and Construction Oversight				$ 300,000.00
Construction subtotal plus Contractor Bonds, Project Management, and Oversight					**$ 14,356,623**
CAPITAL COST SUBTOTAL					**$ 14,356,623**

INSTITUTIONAL CONTROLS COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Institutional Controls					
1	Prepare LUC Implementation Plan (mid-level staff with senior review)	100	hr	$ 110.00	$ 11,000
2	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000
Institutional Controls Subtotal					**$ 21,000**
O&M COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Annual Inspections					
2	Annual cap inspections (includes labor - 2 hours per site- and travel)	8.0	hr	$ 200.00	$ 1,600
3	Annual inspection report	1.0	ls	$ 5,000.00	$ 5,000
4	Project Management	4.0	hr	$ 200.00	$ 800
Annual Operation and Maintenance Subtotal					**$ 7,400**

ALTERNATIVE 4C- DREDGING, THERMAL DESORPTION, OFF-SITE DISPOSAL	
Description	**Subtotal**
Construction	$ 14,356,623
Institutional Controls	$ 21,000
Operation and Maintenance (30-Year Present Value Analysis Costs)	$ 148,866

Contingency	25%	$ 3,631,622
Total (Rounded)		**$ 18,160,000**

TABLE 4-9
ALTERNATIVE 5 - MECHANICAL DREDGING AND IHC CDF DISPOSAL

CAPITAL COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Preparation					
1	Engineering Design/Agency Approvals/Access Agreements	1	Lump	$ 100,000.00	$ 100,000
	Preparation Subtotal				**$ 100,000**
Implementation					
2	Construction Contractor Mobilization, Site Preparation and Submittals	1	Lump	$ 25,000.00	$ 25,000
3	Mechanical Dredging Overburden Material	14,900	CY	$ 35.00	$ 521,500
4	Mechanical Dredging TSCA Material	3,669	CY	$ 35.00	$ 128,415
5	Geotextile Placement	1,680	SY	$ 60.00	$ 100,800
6	Articulated Mat Placement	1,680	SY	$ 200.00	$ 336,000
7	Transport and Dispose Overburden Material	14,900	CY	$ -	$ -
8	Transport and Dispose TSCA Material	3,669	CY	$ -	$ -
	Implementation Subtotal				**$ 1,111,715**
Site Restoration					
9	Site Restoration and Cleanup	1	Lump	$ 3,000.00	$ 3,000
10	Demobilization	1	Lump	$ 25,000.00	$ 25,000
	Site Restoration Subtotal				**$ 28,000**
Construction Subtotal					$ 1,239,715
11	Construction Contractor Bonds	2%			$ 24,794
12	Project Management and Construction Oversight				$ 50,000.00
Construction subtotal plus Contractor Bonds, Project Management, and Oversight					**$ 1,314,509**
CAPITAL COST SUBTOTAL					**$ 1,314,509**

INSTITUTIONAL CONTROLS COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Institutional Controls					
1	Prepare LUC Implementation Plan (mid-level staff with senior review	100	hr	$ 110.00	$ 11,000
2	Meetings with agencies (senior staff and attorneys)	40	hr	$ 250.00	$ 10,000
Institutional Controls Subtotal					**$ 21,000**
O&M COSTS					
Item	**Description**	**Quantity**	**Unit**	**Unit Price (Incl. O&P)**	**Total Cost**
Annual Inspections					
2	Annual cap inspections (includes labor - 2 hours per site- and travel)	8.0	hr	$ 200.00	$ 1,600
3	Annual inspection report	1.0	ls	$ 5,000.00	$ 5,000
4	Project Management	4.0	hr	$ 200.00	$ 800
Annual Operation and Maintenance Subtotal					**$ 7,400**

ALTERNATIVE 5 - MECHANICAL DREDGING & IHC CDF DISPOSAL	
Description	**Subtotal**
Construction	$ 1,314,509
Institutional Controls	$ 21,000
Operation and Maintenance (30-Year Present Value Analysis Costs)	$ 148,866

Contingency	25%	$ 371,094
Total (Rounded)		**$ 1,860,000**

5.0 COMPARATIVE EVALUATION OF REMEDIAL ALTERNATIVES

This section compares the remedial alternatives for the IHC TSCA material. The remedial alternatives are detailed above in Section 3.2, and include seven active alternatives: Alternative 2 (Containment), Alternative 3A (hydraulic dredging and off-site disposal), Alternative 3B (mechanical dredging and off-site disposal), Alternative 4A (hydraulic dredging, soil washing, and off-site disposal), Alternative 4B (mechanical dredging, off-site incineration and off-site disposal), Alternative 4C (mechanical dredging, thermal desorption, and off-site disposal) and Alternative 5 (mechanical dredging and disposal in the IHC CDF). In accordance with FS guidance, Alternative 1 (no action) is also evaluated in this section. As described in FS guidance (EPA 1998), "The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs the decision maker must balance can be identified."

The comparative analysis of remedial alternatives and total costs associated with each alternative is described below and summarized in Table 5-1 at the end of this section. A more detailed cost analysis of each alternative is presented in Tables 4-3 through 4-9. The RAOs (allow full use and unrestricted dredging in navigation channel and reducing human health risks through exposure to contaminated sediments through ingestion, direct contact, or inhalation to acceptable levels) would be achieved by each of the active alternatives, except for Alternative 2. ARARs would be met for six alternatives and the remaining two alternatives would meet ARARs if administrative changes were made to the regulatory depth of the federal navigation channel.

5.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

This criterion assesses how well the alternatives achieve and maintain protection of human health and the environment. Alternative 1 (no action) would provide no improvement over current conditions, no risk reduction, and would not be protective of human health or the environment. Because Alternative 1 does not meet this threshold criterion, it is not discussed further in this section.

The remaining active alternatives are expected to be effective remedies for IHC TSCA sediment and should be protective of human health and the environment by addressing potential pathways of the TSCA sediment. The exposure pathways are ingestion, direct contact, and inhalation.

All active remedial options are considered effective at preventing exposure by limiting direct contact with the sediment. This would be accomplished by using a reactive cap in all active alternatives and by removing TSCA sediment in the navigation channel for all alternatives, except Alternative 2.

5.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This criterion assesses how the alternatives comply with regulatory requirements. Federal and state regulatory requirements that are either applicable or relevant and appropriate are known as ARARs. Only state requirements that are more stringent than federal requirements are considered ARARs. The potential ARARs include chemical-specific ARARs, action-specific ARARs, and location-specific ARARs, as shown in Table 2-1. All active remedial alternatives could achieve the identified ARARs. Alternative 2 would require congressional action to change the authorized navigation depth, which would impact commercial navigation within the channel and would potentially have a detrimental economic impact on commercial operations in the area. Alternatives 2, 3A, 3B, 4A, 4B and 4C would require approval to allow capping of the TSCA sediment remaining below the navigation channel depth. Alternative 5 requires approval for disposal of TSCA sediment in the IHC CDF.

5.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

This criterion evaluates the effectiveness of the alternatives in protecting human health and the environment when the cleanup is complete. It also considers the effectiveness of the cleanup over the long term.

Each of the active alternatives would meet the RAOs and provide long-term effectiveness and permanence once the RAO is met. The active alternatives are combinations of proven and reliable remedial processes, and the potential for failure of any individual component is low.

- Alternative 2 would achieve long-term effectiveness through capping the TSCA sediment with activated carbon imbedded in a layer of geotextile and covering the geotextile with an articulated concrete mat, followed by O&M and institutional controls to ensure and verify the ongoing effectiveness of the remedy.
- All remaining active alternatives would achieve long-term effectiveness by removing TSCA sediment in the navigation channel and covering residual TSCA sediment below the navigation channel depth with a cap described above.

All alternatives are proven technologies that meet the requirements for effectiveness and permanence. Compared to Alternative 2, the remaining active alternatives provide an additional level of protectiveness because a significant volume of TSCA sediment is removed from the channel and the federal navigation channel can be maintained at the required elevation.

5.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TRETAMENT

This criterion addresses the preference for selecting remedial actions that use treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible encapsulation, or reduction of total volume of contaminated media.

Active remedies including Alternatives 2, 3A, 3B, 4A, 4B, and 4C would employ a cap containing activated carbon to adsorb residual PCBs as groundwater flows though the sediment into the IHC. The activated carbon in the cap would sequester the PCBs from the water and reduce the mobility of PCBs.

Alternatives 4A, 4B, and 4C would provide additional treatment to sediment removed from the IHC. Alternative 4A requires washing all sediment with chemical additives to separate PCBs for the sediment particles. Soil washing is less effective on clay and silt particles, which comprise a portion of the TSCA sediment. The expected percent reduction in toxicity and volume would be approximately 70%. Alternatives 4B achieve 100% destruction of PCBs by incineration. Alternative 4C would reduce PCB toxicity and volume by over 90%.

5.5 SHORT-TERM EFFECTIVENESS

This criterion examines the effectiveness of the alternatives in protecting human health and the environment during the cleanup until the cleanup is complete. It also considers protection of the community, workers, and the environment during the cleanup. Short-term effectiveness of each remedial alternative is summarized in Table 4-2.

Each of the active alternatives would have short-term impacts including increased potential for exposure of workers and residents to TSCA sediment and construction-related risks. Truck traffic may increase temporarily to import material for the cap, and for off-site disposal options additional trucks would be required to haul sediment to designated landfills or off-site treatment facilities.

Alternatives 2 and 5 would require the least disturbance and shortest construction time. All other active alternatives would create only minimal impacts to workers and the community. Capping and sediment removal would all be done in wet conditions, limiting the potential for air and dust emissions. Sediment handling and treatment would occur on industrial property remote from residential areas. The longest duration is 6 months with completion of most alternatives in less than half that time, however additional time may be required for mobilization, demobilization and also coordination and scheduling around other work in the IHC.

5.6 IMPLEMENTABILITY

This criterion assesses the technical and administrative feasibility of an alternative and the availability of required goods and services. Technical feasibility considers the ability to construct and operate a technology and its reliability, the ease of undertaking remedial actions, and the ability to monitor the effectiveness of a remedy. Administrative feasibility considers the ability to obtain approvals from other parties or agencies and the extent of required coordination with other parties or agencies.

Alternative 5 is technically implementable as similar dredging has been performed by USACE in the IHC since 2012. The application submitted by USACE in 2014 for disposal of the removed TSCA sediment would need to be approved. Alternative 5 is considered implementable.

Alternatives 3A, 3B, and 4B are technically implementable because very similar work has occurred in the IHC in the last 5 years. Off-site treatment and disposal options are already permitted. However, each of these alternatives requires an application for removal, capping, and long-term management of TSCA sediment. These alternatives are considered difficult to implement because of the absence of an applicant for TSCA disposal and capping of residual sediment.

Alternative 2, 4A, and 4C would be very difficult to implement. Alternative 2 would require a change in the authorized depth of the federal navigation channel and would potentially impact local commerce. This action would require an act of Congress. For Alternative 4A, soil washing is not common in sediment treatment. Only one or two vendors with soil washing capability are available in the United States. Physical characteristics of the sediment and waste water treatment requirements may also present an implementation challenge and on-site treatment using soil washing would require a permit. Alternative 4C would employ a technology not typically used for sediment and is a technology that may increase community exposure due to air emissions. The operating parameters may be difficult to achieve with the IHC TSCA sediment. On-site treatment would also require permits to operate. In addition, these three alternatives also require an applicant for the TSCA dredging and capping of residual sediment, and no applicants have been identified.

5.7 COST

This criterion evaluates the capital, and operation and maintenance costs of each alternative. Present-worth costs are provided to help compare costs among alternatives with different implementation times.

The present-worth costs for the alternatives are included in Table 5-1. The detailed estimates and associated assumptions are presented in Tables 4-3 through 4-9. The cost estimates are consistent with the level of estimation required in the FS phase, with an accuracy of +50 to -30 percent. A final cost estimate would be developed and refined during the remedial design process after the selection of a recommended remedy.

Alternative 1 has no associated capital or O&M costs since no action would be taken. The remaining seven alternatives are progressively more expensive, with options requiring ex-situ treatment the most expensive. Alternative 2 is the least costly active alternative ($1.72 million) and Alternative 5 is the second least costly option ($1.86 million). Alternative 3B is the third costliest option ($5.31 million) and Alternative 3A is fourth ($6.20 million). Alternative 4B is fifth ($13.60 million), 4A sixth ($15.32 million), and 4C seventh ($18.16 million).

5.8 STATE AND COMMUNITY ACCEPTANCE

IDEM and IDNR are project partners on this GLLA FS and were involved in all aspects of alternative evaluation and the recommendation of a preferred alternative. Although the state could support Alternatives 2, 3A, 3B, 4A, 4B and 4C, the state also recognizes the lack of a willing applicant for TSCA approval of capping remaining sediments which is a required component of these alternatives. The state has expressed support for Alternative 5 and believes it is protective of human health and the environment.

This GLLA FS was conducted in response to concerns raised by community members. Some community members had expressed concerns regarding placement of TSCA sediments in the CDF. In the course of conducting this FS, alternatives were evaluated in an effort to identify a viable option that would not include CDF disposal. Various treatment options were also evaluated in response to community concerns. The FS evaluation determined that implementation of off-site disposal as part of a GLNPO GLLA partner-based project would require a willing applicant for approval of capping remaining TSCA sediment. No applicant has been identified, rendering a GLLA partner-based alternative infeasible.

5.9 SUMMARY

The purpose of the comparative analysis is to identify the relative advantages and/or disadvantages of each remedial action alternative. Table 5-1 summarizes the advantages and disadvantages described above. Threshold criteria were assigned Pass or Fail. All active alternatives meet the threshold criteria, although Alternative 2 would require an act of Congress to change the federal navigation depth in sections of the IHC. Alternative 1, No Action, failed to meet the threshold criteria and, therefore, this alternative was not considered further for the primary balancing criteria or sustainability.

Relative numerical scores for each balancing criteria were assigned to the alternatives using the scoring matrix in the notes section at the end of Table 5-1. Higher scores reflect greater feasibility for each balancing category. The scores for each balancing criteria were summed to compare the relative alternatives.

Alternative 5 has the highest score at 16. This alternative is effective, low cost, and implementable. Alternatives 2, 3A, 3B and 4B all score three points behind 5 at 14. Each of these alternatives have different strengths and weaknesses. For example, Alternative 4B would be technically implementable and would destroy almost all the PCBs in the TSCA sediment, but it would be a very expensive alternative. Alternative 3B is strong in all categories and would be slightly less expensive and less difficult to implement than Alternative 3A. Alternative 2 is the least expensive alternative but would be very difficult to implement. However, Alternatives 2, 3A, 3B, 4A, 4B and 4C require an applicant for the TSCA dredging and capping of residential sediment, and no applicants have been identified.

Alternatives 4A and 4C are the lowest ranking remedial options with a score of 11 and 12, respectively. Their low scores are attributed primarily to their high cost and very difficult implementation. Alternatives 4A and 4C also require an applicant for the TSCA dredging and capping of residual sediment, and no applicants have been identified.

The major constraint for implementing any GLLA remedial alternative is the requirement for long-term maintenance of a cap. Neither EPA nor the State of Indiana have the authority to take on the long-term requirements needed to maintain a cap. No other local entity has committed to taking on the long-term cap maintenance responsibilities. In the absence of an entity who can act as a TSCA applicant for capping ≥50 ppm PCB sediment, a GLLA-based alternative for remediating the canal is not feasible. Therefore, IHC Feasibility Study Alternatives 2, 3A, 3B, 4A, 4B and 4C were determined to be not feasible.

Alternative 5 was determined to be a viable option for addressing the ≥50 ppm PCB sediment in the canal: EPA Region 5 LCD TSCA and IDEM would need to approve USACE placement of the TSCA sediment in the CDF.

5.10 RECOMMENDED ALTERNATIVE

The objective of the IHC GLLA FS project was to explore options for offsite disposal of ≥50 ppm PCB material and identify a feasible alternative that is protective of human health and the environment. Given the lack of an entity who can act as an applicant for capping ≥50 ppm PCB sediment, the only remaining viable alternative for remediating the ≥50 ppm PCB sediment is to proceed with the USACE CDF approval process. Based on the evaluation and findings of this FS the recommended alternative is Alternative 5.

TABLE 5-1
COMPARATIVE EVALUATION OF REMEDIAL ALTERNATIVES

EVALUATION CRITERIA	Alternative 1 No Action	Alternative 2 Containment	Alternative 3A Hydraulic Dredging & Off-Site Disposal	Alternative 3B Mechanical Dredging & Off-Site Disposal	Alternative 4A Dredging, Soil Washing, Off-Site Disposal	Alternative 4B Dredging, Off-Site Incineration and Disposal	Alternative 4C Dredging, Thermal Desorption, Off-Site Disposal	Alternative 6 Mechanical Dredging & Disposal at IHC CDF
THRESHOLD CRITERIA								
Overall Protection to Human Health and the Environment	Not protective. No action would be taken.	Protective. TSCA sediment would be covered and contained	Protective. TSCA sediment would be removed and disposed off-site	Protective. TSCA sediment would be removed and disposed off-site	Protective. TSCA sediment would be removed, treated on-site to reduce PCBs, and disposed off-site	Protective. TSCA sediment would be removed, treated off-site to reduce PCBs, and disposed off-site	Protective. TSCA sediment would be removed, treated on-site to reduce PCBs, and disposed off-site	Protective. TSCA sediment would be removed and disposed at IHC CDF
Criteria Score	**Fail**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**
Compliance with ARARs	Would not meet ARARs	Would meet ARARs	Would meet ARARs	Would meet ARARs	Would meet ARARs	Would meet ARARs	Would meet ARARs	Would meet ARARs
Criteria Score	**Fail**	**Pass with Channel Modification**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**
PRIMARY BALANCING CRITERIA								
Long-Term Effectiveness and Permanence	Ineffective and temporary	Somewhat Effective	Effective	Effective	Effective	Effective	Effective	Effective
	Site Conditions would remain the same	All TSCA sediment is capped.	All TSCA sediment within the navigation channel is removed. Residual TSCA sediment remaining below the maximum dredge limit is capped.	All TSCA sediment within the navigation channel is removed. Residual TSCA sediment remaining below the maximum dredge limit is capped.	All TSCA sediment within the navigation channel is removed. Residual TSCA sediment remaining below the maximum dredge limit is capped.	All TSCA sediment within the navigation channel is removed. Residual TSCA sediment remaining below the maximum dredge limit is capped.	All TSCA sediment within the navigation channel is removed. Residual TSCA sediment remaining below the maximum dredge limit is capped.	All TSCA sediment within the navigation channel is removed. Residual TSCA sediment remaining below the maximum dredge limit is capped.
Criteria Score	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
Reduction of Toxicity, Mobility, or Volume through Treatment	Does not reduce toxicity, mobility, or volume.	Somewhat effective at reducing toxicity, mobility, or volume.	Somewhat effective at reducing toxicity, mobility, or volume.	Somewhat effective at reducing toxicity, mobility, or volume.	Effective at reducing toxicity, mobility, or volume.	Highly effective at reducing toxicity, mobility, or volume.	Highly effective at reducing toxicity, mobility, or volume.	Does not reduce toxicity, mobility, or volume.
	No treatment applied.	Limited treatment using activated carbon to reduce mobility of PCBs left in place.	Limited treatment using activated carbon to reduce mobility of PCBs left in place.	Limited treatment using activated carbon to reduce mobility of PCBs left in place.	Soil washing reduces volume of PCB waste by removing contaminants from sediment particles. High silt/clay content limits effectiveness to 70%. Limited treatment using activated carbon to reduce mobility of PCBs left in place..	Incineration of TSCA sediment reduces PCB concentration by up to 99%. Limited treatment using activated carbon to reduce mobility of PCBs left in place. Non-TSCA sediment not treated.	Thermal desorption of TSCA sediment reduces PCB concentration by 90 to 99%. Limited treatment using activated carbon to reduce mobility of PCBs left in place. Non-TSCA sediment not treated.	No treatment applied
Criteria Score	**1**	**2**	**2**	**2**	**3**	**4**	**4**	**1**
Short-term Effectiveness	No impacts during implementation	Slight impacts during implementation	Minimal impacts during implementation	Minimal impacts during implementation	Minimal impacts during implementation	Minimal impacts during implementation	Minimal impacts during implementation	Slight impacts during implementation
	No worker risks as no action is taken.	Implementation over 1 month period. Worker risk associated with cap placement. Limited contact with sediment by divers during placement of cap material. Risks are controllable. Truck traffic limits to delivery of cap materials.	Implementation over 2 month period. Worker risk associated with minimal dermal contact, inhalation, and ingestion. Risks are controllable. Direct contact with sediment limited to dewtaering and load out for disposal. Truck traffic for delivery of cap materials as well as disposal of sediment.	Implementation over 1 month period. Worker risk associated with minimal dermal contact, inhalation, and ingestion. Risks are controllable. Direct contact with sediment limited to dewtaering and load out for disposal. Truck traffic for delivery of cap materials as well as disposal of sediment.	Implementation over 4 month period. Worker risk associated with some dermal contact, inhalation, and ingestion. Risks are controllable. Direct contact with sediment during treatment, dewatering, and load out for disposal. Potential for handling sediment multiple times depending on treatment effectiveness. Truck traffic for delivery of cap materials as well as disposal of sediment. Potential for additional waste water emissions from treatment process.	Implementation over 1 month period. Worker risk associated with minimal dermal contact, inhalation, and ingestion. Risks are controllable. Truck traffic for delivery of cap materials as well as disposal of sediment.	Implementation over 6 month period. Worker risk associated with minimal dermal contact, inhalation, and ingestion. Risks are controllable. Truck traffic for delivery of cap materials as well as disposal of sediment. Potential for air emissions from treatment process.	Implementation over 1 month period. Worker risk associated with minimal dermal contact, inhalation, and ingestion. Risks are controllable. Sediment transported by barge to CDF and pumped directly into facility. Truck traffic limits to delivery of cap materials.
Criteria Score	**5**	**4**	**3**	**3**	**3**	**3**	**3**	**4**

TABLE 5-1
COMPARATIVE EVALUATION OF REMEDIAL ALTERNATIVES

EVALUATION CRITERIA	Alternative 1 No Action	Alternative 2 Containment	Alternative 3A Hydraulic Dredging & Off-Site Disposal	Alternative 3B Mechanical Dredging & Off-Site Disposal	Alternative 4A Dredging, Soil Washing, Off-Site Disposal	Alternative 4B Dredging, Off-Site Incineration and Disposal	Alternative 4C Dredging, Thermal Desorption, Off-Site Disposal	Alternative 5 Mechanical Dredging & Disposal at IHC CDF
Implementability	Easily Implementable	Very Difficult to Implement	Difficult to Implement	Difficult to Implement	Very Difficult to Implement	Difficult to Implement	Very Difficult to Implement	Implementable
	No worker risks as no action is taken.	Readily available technology. Materials are available in the local area. Technically easy to implement. Administrative change to authorized navigation depth may to very difficult to implement as change requires Congressional action. Permit applicant required for TSCA removal, cap placement, and long-term management.	Readily available technology. Used in last 5 years on Grand Calumet River and at the ArcelorMittal property in the past. Requires larger dewatering area and high volume of waste water treatment. Two off-site disposal options in Michigan and Indiana. Permit applicant required for TSCA removal, cap placement, and long-term management of remaining PCB residuals in sediment..	Readily available technology. Mechanical dredging completed annually in IHC. Similar work completed at ArcelorMittal property in last 5 years. Two off-site disposal options in Michigan and Indiana. Permit applicant required for TSCA removal, cap placement, and long-term management of remaining PCB residuals in sediment.	Dredging is easily implementable. Soil washing technically feasible, but not typically used for sediment. Limited number of vendors offering this treatment option. High silt/clay content in sediment limits effectiveness of chemical washing. Large waste water volume with high contaminant loading. Permits required for operation may be difficult to obtain. Permit applicant required for TSCA removal, cap placement, and long-term management.	Dredging is easily implementable. Incineration options available in Ohio and Kansas. Sediment drying required for incineration may be more difficult than direct disposal. Permit applicant required for TSCA removal, cap placement, and long-term management of remaining PCB residuals in sediment.	Dredging is easily implementable. Thermal desorption technically feasible, but not typically used for sediment. Sediment drying required for thermal desorption more difficult and required more time. Permits required for operation may be difficult to obtain. Permit applicant required for TSCA removal, cap placement, and long-term management of remaining PCB residuals in sediment.	Readily available technology. Mechanical dredging and placement in IHC CDF completed annually in IHC. The IHC CDF does not currently accept TSCA sediment and would require approval of a TSCA permit application to accept the TSCA sediment.
Criteria Score	**5**	**1**	**2**	**2**	**1**	**2**	**1**	**3**
Cost (relative to other alternatives)	$0	$1,720,000	$6,200,000	$5,310,000	$15,320,000	$13,680,000	$18,160,000	$1,860,000
Criteria Score	**5**	**5**	**4**	**4**	**1**	**2**	**1**	**5**
Alternative Total Score not including Modifying Criteria	**Not Acceptable**	**14**	**14**	**14**	**11**	**14**	**12**	**16**

Notes:

1. The Threshold Criteria have been evaluated on a pass/fail basis. An Alternative must pass both threshold criteria in order to be considered as a remedial action. Alternatives that fail either threshold criteria are marked as not applicable (NA) for the Alternative total score.
2. The Primary Balancing Criteria have been evaluated on a scale of 1-5. Details on each scale criterion are listed below.

Long-Term Effectiveness and Permanence
- 1 = Ineffective and temporary
- 2 = Somewhat effective
- 3 = Effective
- 4 = Highly Effective
- 5 = Highly Effective and Permanent

Reduction of Toxicity, Mobility, or Volume through Treatment
- 1 = Does not reduce toxicity, mobility, or volume
- 2 = Somewhat effective at reducing toxicity, mobility, or volume
- 3 = Effective at reducing toxicity, mobility, or volume
- 4 = Highly Effective at reducing toxicity, mobility, or volume
- 5 = Complete reduction of toxicity, mobility, or volume

Short-term Effectiveness
- 1 = Detrimental impacts during implementation
- 2 = Significant impacts during implementation
- 3 = Minimal impacts during implementation
- 4 = Slight impacts during implementation
- 5 = No impacts during implementation

Implementability
- 1 = Very difficult to implement
- 2 = Difficult to implement
- 3 = Implementable
- 4 = Readily implementable
- 5 = Easily implementable

Cost
- 1 = Over $15 Million
- 2 = $10 Million to $15 Million
- 3 = $7 Million to $10 Million
- 4 = $3.5 Million to $7 Million
- 5 = Zero to $3.5 Million

3 A full presentation of alternative costs can be found in Section 4 of the FS report.
4 The two Modifying Criteria, State Acceptance and Community Acceptance, will be evaluated following public comment on the FS report and the proposed plan.

6.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1989. Risk Assessment Guidance for Superfund (RAGS). Volume I. Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response. EPA/540/1-89/002. December.

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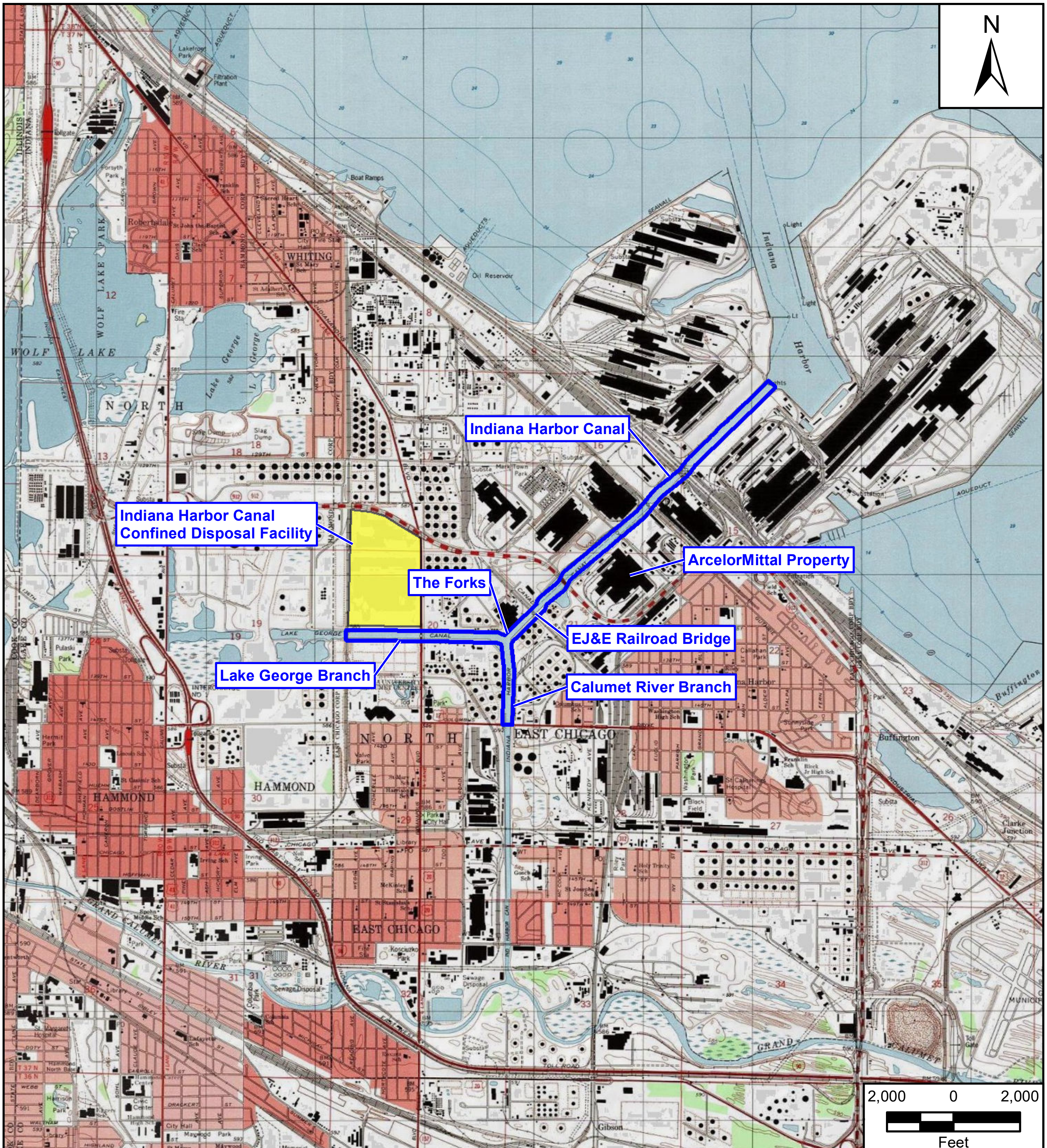
FIGURES



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Indiana Harbor Canal Confined Disposal Facility

Site Location

Source: USGS 7.5-Minute Topographic Quadrangle Map: East Chicago, IN 1988.

Indiana Harbor Canal TSCA Material
East Chicago, Lake County, Indiana

Figure 1-1
Site Location Map

TETRA TECH

Prepared For: USEPA

Prepared By: Tetra Tech Inc.

File Path: G:\G\G9026-START IV\Indiana\IHC TSCA Material\mxd\2018-07\Fig1-1-SiteLocation.mxd

Date Saved: 11/15/2018

EPA Contract No.: EP-S5-13-01

TDD No.: S05-0021-1710-002

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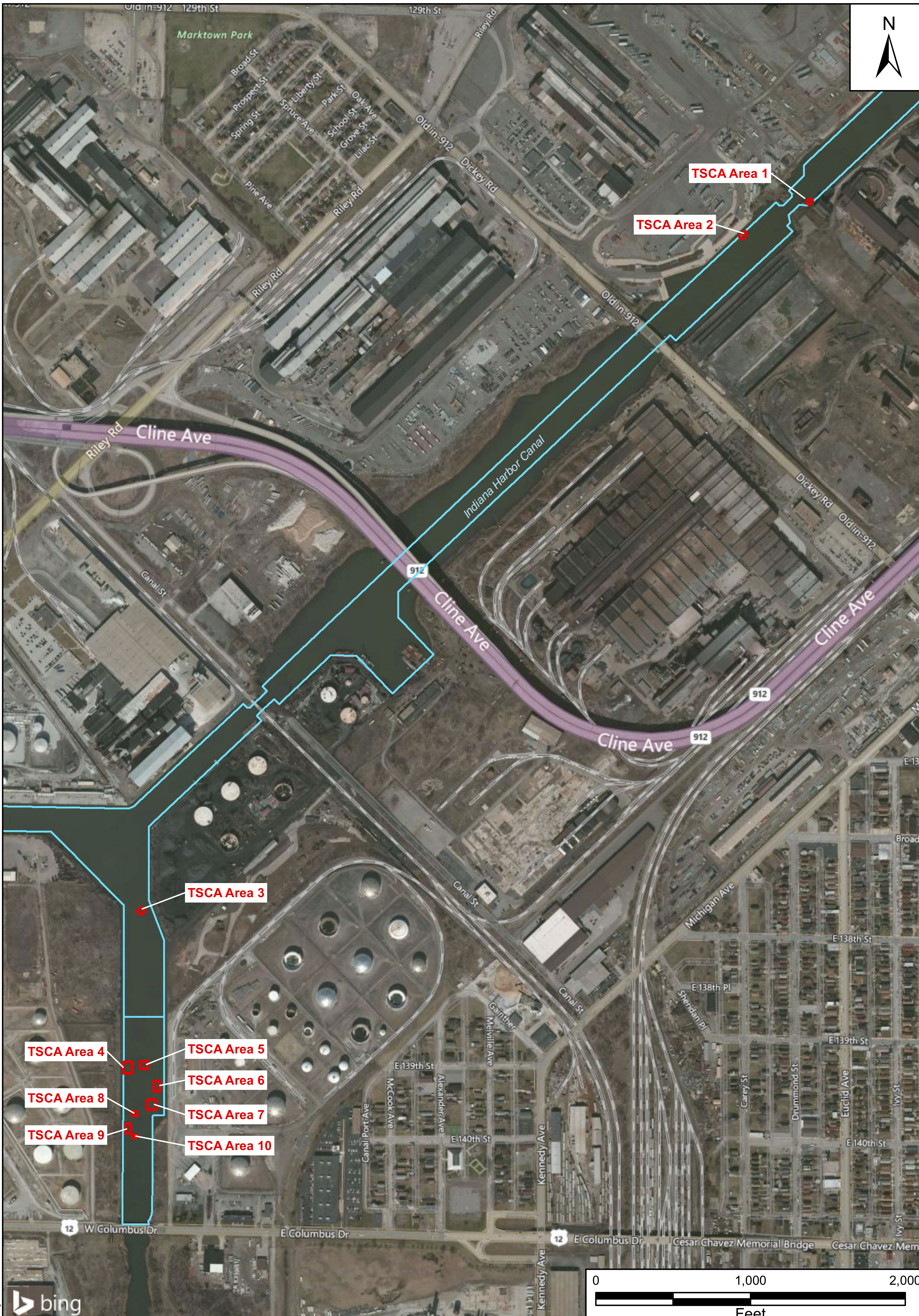

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Legend

TSCA Sediment Area

Navigation Channel

Source: Bing Maps Hybrid 2013

Indiana Harbor Canal TSCA Material
East Chicago, Lake County, Indiana

Figure 1-2
TSCA Sediment Locations

TETRA TECH

Prepared For: EPA | Prepared By: Tetra Tech, Inc.

Date Saved: 11/6/2018

EPA Contract No.: EP-S5-13-01

TDD No.: S05-0021-1710-002

Coordinate System: NAD 1983 StatePlane Indiana West FIPS 1302 Feet
Projection: Transverse Mercator
Datum: North American 1983

Bottom Excavation Boundary

Surface sediment contour - 5 feet interval

Surface sediment contour - 1 foor interval

Navigation Channel

Sediment Sample Results - 2018

Total PCBs < 50 mg/kg

Total PCBs > 50 mg/kg

Sediment Sample Results - 2006

Total PCBs < 50 mg/kg

Total PCBs > 50 mg/kg

Indiana Harbor Canal TSCA Material
East Chicago, Lake County, Indiana

Figure 2-1
TSCA Area 1 and 2 Excavation Limits

TETRA TECH

Source: Bing Maps Hybrid 2013

Prepared For: EPA | Prepared By: Tetra Tech, Inc.

Date Saved: 11/6/2018

EPA Contract No.: EP-S5-13-01

TDD No.: S05-0021-1710-002

Coordinate System: NAD 1983 StatePlane Indiana West FIPS 1302 Feet
Projection: Transverse Mercator
Datum: North American 1983

Bottom Excavation Boundary

Surface sediment contour - 5 feet interval

Surface sediment contour - 6 inches interval

Navigation Channel

Sediment Sample Results - 2018

Total PCBs < 50 mg/kg

Total PCBs > 50 mg/kg

Sediment Sample Results - 2006

Total PCBs < 50 mg/kg

Total PCBs > 50 mg/kg

Source: Bing Maps Hybrid 2013

Indiana Harbor Canal TSCA Material
East Chicago, Lake County, Indiana

Figure 2-2
TSCA Area 3 Excavation Limits

TETRA TECH

Prepared For: EPA

Prepared By: Tetra Tech, Inc.

File Path: G:\G\G9026-START IV\Indiana\IHC TSCA Material\mxd\2018-10\Fig2-2-SedimentLocations 46.mxd

Date Saved: 10/18/2018

EPA Contract No.: EP-S5-13-01

TDD No.: S05-0021-1710-002

Coordinate System: NAD 1983 StatePlane Indiana West FIPS 1302 Feet
Projection: Transverse Mercator
Datum: North American 1983

Bottom Excavation Boundary
Surface sediment contour - 5 feet interval
Surface sediment contour - 6 inches interval
Navigation Channel

Sediment Sample Results - 2018

Total PCBs < 50 mg/kg

Total PCBs > 50 mg/kg

Sediment Sample Results - 2006

Total PCBs < 50 mg/kg

Total PCBs > 50 mg/kg

Source: Bing Maps Hybrid 2013

Indiana Harbor Canal TSCA Material
East Chicago, Lake County, Indiana

Figure 2-3
TSCA Area 4 - 10 Excavation Limits

TETRA TECH

Prepared For: EPA | Prepared By: Tetra Tech, Inc.

Coordinate System: NAD 1983 StatePlane Indiana West FIPS 1302 Feet
Projection: Transverse Mercator
Datum: North American 1983

File Path: G:\G\G9026-START IV\Indiana\IHC TSCA Material\mxd\2018-10\Fig2-3-SedimentLocations 32-38.mxd

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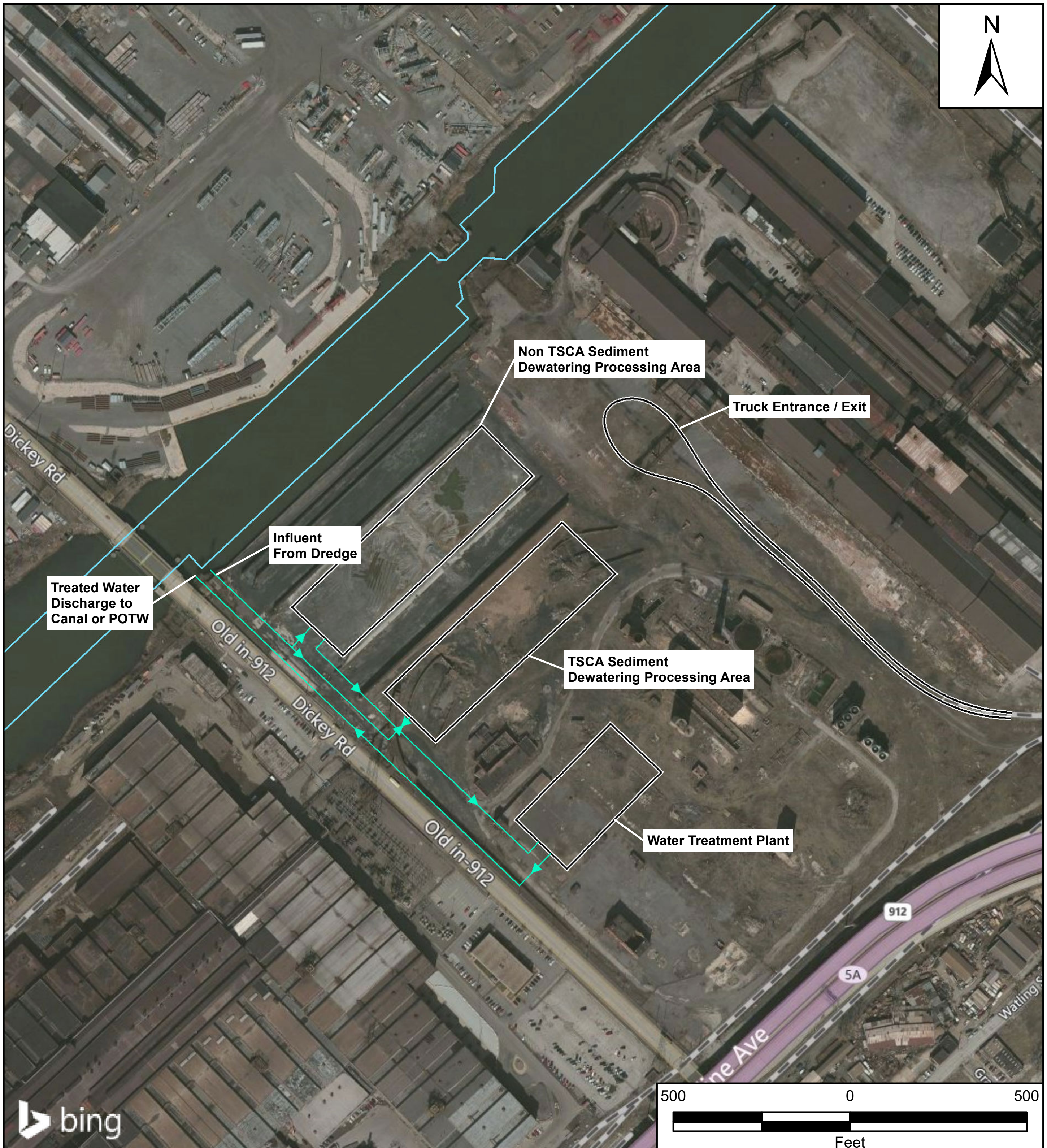
EPA Contract No.: EP-S5-13-01

TDD No.: S05-0021-1710-002



Legend

- Navigation Channel
- Pipeline

Indiana Harbor Canal TSCA Material
East Chicago, Lake County, Indiana

Figure 4-1
TSCA Sediment Remediation Alternative 3A Hydraulic Dredging

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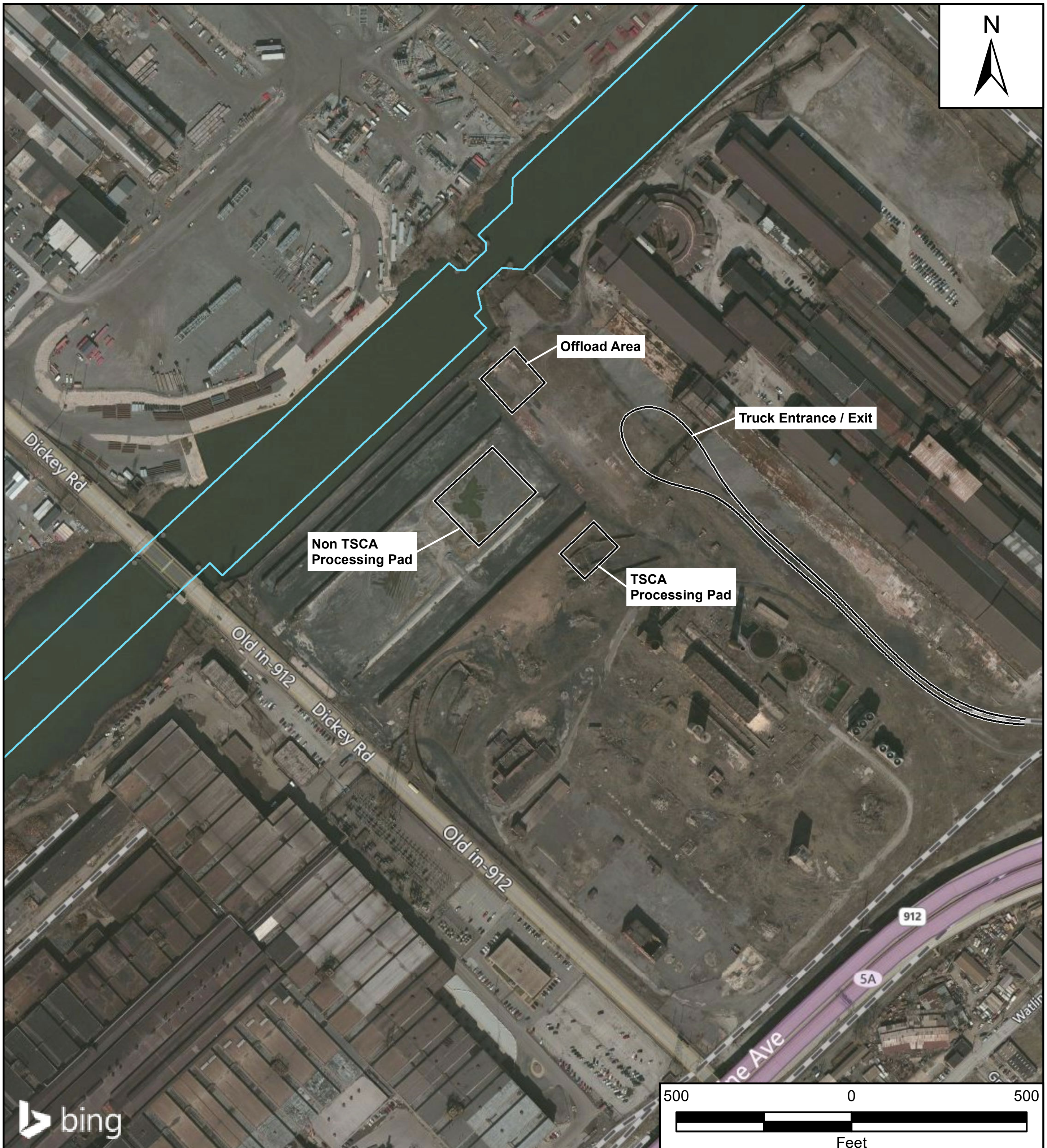
File Path: G:\G\G9026-START IV\Indiana\IHC TSCA Material\mxd\2018-07\Fig4-1-Alteanative4A.mxd

Date Saved: 8/8/2018 EPA Contract No.: EP-S5-13-01 TDD No.: S05-0021-1710-002

Coordinate System: NAD 1983 StatePlane Indiana West FIPS 1302 Feet
Projection: Transverse Mercator
Datum: North American 1983



Legend

Navigation Channel

Indiana Harbor Canal TSCA Material
East Chicago, Lake County, Indiana

Figure 4-2
TSCA Sediment Remediation
Alternative 3B
Mechanical Dredging

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Projection: Transverse Mercator
Datum: North American 1983

Legend

Navigation Channel

Pipeline

Indiana Harbor Canal TSCA Material
East Chicago, Lake County, Indiana

Figure 4-3
TSCA Sediment Remediation
Alternative 4A
Hydraulic Dredging - Soil Washing

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Datum: North American 1983

Legend

Navigation Channel

Indiana Harbor Canal TSCA Material
East Chicago, Lake County, Indiana

Figure 4-4
TSCA Sediment Remediation
Alternative 4C
Mechanical Dredging - Thermal Desorption

TETRA TECH

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Datum: North American 1983