Feasibility Study Report

Koppers Pond
Kentucky Avenue
Wellfield Superfund
Site,
Operable Unit 4
Horseheads, New York

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LIST OF ACRONYMS

µg/kg	Microgram per kilogram
µg/l	Microgram per liter
A&P	Great Atlantic & Pacific Tea Company, Inc.
ARAR	Applicable or relevant and appropriate requirement
AWL	Average water level (*i.e.*, Pond elevation of approximately 886 ft-msl)
AWQC	Ambient Water Quality Criteria
BHHRA	Baseline Human Health Risk Assessment
BSAF	Biota-sediment accumulation factor
CEC	Civil and Environmental Consultants, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
COPC	Chemical of potential concern
COPEC	Chemical of potential ecological concern
CSM	Conceptual site model
CTE	Central tendency exposure
cy	Cubic yard
ECL	(New York State) Environmental Conservation Law
EPC	Exposure point concentration
EWB	Elmira Water Board
FEMA	Federal Emergency Management Agency
FS	Feasibility Study
ft-msl	Feet above mean sea level
gpm	Gallons per minute
HI	Hazard index
HQ	Hazard quotient
HSWA	Hazardous and Solid Waste Amendments of 1984
HWL	High water level (*i.e.*, Pond elevation of approximately 887 to 888 ft-msl)
LDR	Land disposal restriction
LOAEL	Lowest observable adverse effects level
LWL	Low water level (*i.e.*, Pond elevation of approximately 883 to 884 ft-msl)
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goal
mg/kg	Milligram per kilogram
mg/l	Milligram per liter

MNR	Monitored Natural Recovery
NA	Not analyzed
NAAQS	National Ambient Air Quality Standards
NC	Not calculated
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	Not detected
NESHAPS	National Emissions Standards for Hazardous Air Pollutants
NOAA	U.S. Department of Commerce, National Oceanic and Atmospheric Administration
NOAEL	No observable adverse effects level
NPDES	National Pollutant Discharge Elimination System
NPV	Net present value
NS	No standard
NYCRR	New York Code, Rules, and Regulations
NYNHP	New York Natural Heritage Program
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSEG	New York State Electric and Gas
OM&M	Operation, maintenance, and monitoring
OU-1	Operable Unit 1
OU-2	Operable Unit 2
OU-3	Operable Unit 3
OU-4	Operable Unit 4
OSHA	U.S. Department of Labor, Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
ppm	Part per million
PRG	Preliminary remediation goal
RAO	Remedial Action Objective
RBC	Risk-based concentration
RCM	Reactive core mat
RCRA	Resource Conservation and Recovery Act of 1976
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
RL	Reporting limit
RME	Reasonable maximum exposure
ROD	Record of Decision
RTE	Rare, threatened, or endangered

SARA	Superfund Amendments and Reauthorization Act of 1986
sBERA	Supplemental Baseline Ecological Risk Assessment
SPDES	State Pollutant Discharge Elimination System
TBC	To be considered (guidance)
TCLP	Toxicity Characteristic Leaching Procedure
TMV	Toxicity, mobility, or volume
TOC	Total organic carbon
TSCA	Toxic Substances Control Act of 1976
UCL	Upper confidence level
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Department of the Interior, Fish and Wildlife Service
UTS	Universal Treatment Standards

1. INTRODUCTION

The Koppers Pond RI/FS Group (the Group) retained Woodard & Curran, Inc.[1] and Integral Consulting, Inc. (Integral)[2] to conduct a Remedial Investigation (RI) and Feasibility Study (FS) for Koppers Pond (the Site) as part of Operable Unit 4 (OU-4) of the Kentucky Avenue Wellfield Superfund Site in Horseheads, New York. The RI/FS has been conducted in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund"), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), as codified at 40 Code of Federal Regulation (CFR) 300; and, more specifically, the Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study, Index No. CERCLA-02-2006-2025 (Settlement Agreement), entered between the Group and the U.S. Environmental Protection Agency (USEPA) on September 29, 2006. This FS Report has been prepared to meet the requirements of Task IX of the Statement of Work appended to the Settlement Agreement.

The Group originally submitted a draft FS Report to USEPA in January 2013. USEPA reviewed and provided comments on that draft, and as an outcome of that review, USEPA and the Group agreed that additional pond sediment data (subsequently collected in May 2013) were needed to refine the scope of remedial alternatives. In April 2014, suspension of the discharges from the groundwater recovery and treatment system at the former Westinghouse Electric Corporation (Westinghouse) Horseheads plant site led to a significant reduction in surface water inflow to Koppers Pond and a corresponding drop of several feet in the pond water level. Koppers Pond became much shallower and smaller in open-water area than it was when the January 2013 draft FS was prepared, and USEPA and the Group agreed that revisions to the FS Report were necessary to address the changing hydrologic conditions. In 2015 and early 2016, the FS Report went through several rounds of USEPA review and revision, culminating in this report.

1.1 PURPOSE AND ORGANIZATION OF FS REPORT

In accordance with the requirements of CERCLA and the NCP, the FS involves a process of identifying and screening available response actions and technologies to develop remedial alternatives that meet the Superfund program goal [40 CFR 300.430(a)(1)(i)] and achieve, to the extent practicable, the Superfund program expectations for identifying and selecting remedial alternatives [40 CFR 300.430(a)(1)(iii)]. The FS is primarily based on the results of the RI (Cummings/Riter and Integral, 2012), which provided the physical, chemical, and biological data to characterize surface water, sediment, and biota in Koppers Pond. These data were used in the Baseline Human Health Risk Assessment (BHHRA) (Integral, 2012a) and the Supplemental Baseline Ecological Risk Assessment (sBERA) (Integral, 2012b)[3] to evaluate potential human health and ecological risks posed by exposure to chemicals of potential concern (COPCs)

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[1] Effective January 1, 2015, Cummings/Riter Consultants, Inc., the Group's selected RI/FS contractor, was integrated into Woodard & Curran, Inc. For the purposes of this report, the name Cummings/Riter is retained in reference to work conducted by the contractor prior to 2015.

[2] The Group had originally contracted with AMEC Earth & Environmental, Inc. (AMEC) to perform the human health and ecological risk assessments in support of the Koppers Pond RI/FS, and AMEC personnel conducted the risk assessment tasks over the 2007 through 2009 timeframe. In late 2009 and early 2010, however, several project team members moved from AMEC to other consulting firms, including Integral and Arcadis US, Inc. (Arcadis). To maintain technical continuity on the project, the Group retained Integral, with support from Arcadis, to complete the risk assessments and support the RI/FS for Koppers Pond.

[3] The current baseline ecological risk assessment, dated March 2012, is identified as the "sBERA" to minimize confusion with the draft baseline ecological risk assessment prepared for Koppers Pond by CDM Federal Programs, Inc. in 1999.

associated with Koppers Pond.[4] This FS is also based on the results of the supplemental sediment sampling completed in May 2013 and the more-recent evaluations of changes in pond hydrology.

The format and content of this FS Report are in accordance with the USEPA "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (1988b). Following this introductory chapter, Section 2 provides the evaluation of potential applicable or relevant and appropriate requirements (ARARs), to be considered (TBC) guidance, and other relevant regulatory guidance. Section 3 develops remedial action objectives (RAOs) and, where applicable, derives preliminary remediation goals (PRGs) to satisfy these objectives. Section 4 identifies general response actions and the locations and quantities of affected media to which the general response actions apply. Section 5 identifies and screens remedial technologies and process options. Section 6 identifies the assembled remedial action alternatives, and Section 7 evaluates these alternatives using the criteria and methodology specified in the NCP.

This FS Report is written with the recognition that future Koppers Pond water levels are not certain. Although there may be occasional and temporary higher water levels associated with significant precipitation events, the predominant condition of Koppers Pond in the future is expected to be closer to a low-water level (LWL) condition than previous higher water levels, including what are referred to as average water level (AWL) and high water level (HWL) conditions. A return to higher water levels could potentially occur if discharges from the groundwater recovery and treatment system at the former Westinghouse Horseheads plant site were resumed, thus supplementing the natural flow of surface water to Koppers Pond. As of this writing, USEPA has not formally approved the permanent shutdown of that groundwater recovery and treatment system, and future water level conditions in the pond are not known. To address this uncertainty, the FS discusses the effects of changed pond conditions on the assessments of potential human health and ecological risks and the derivation of RAOs and PRGs. Consistent with Superfund guidance to consider both current and future conditions, each of the action alternatives presented in this FS has been assembled and evaluated taking into consideration the range of hydrologic conditions observed during the RI/FS process and the potential for future pond conditions to vary. During the remedial design phase, specifications for the construction of the response action would be developed taking into consideration potential variations in water levels and the hydraulics of the pond, including the capacity needs for flood management.

1.2 SITE BACKGROUND

The Kentucky Avenue Wellfield Superfund Site is located in the Village of Horseheads and the Town of Horseheads in Chemung County, New York (Figure 1). The Kentucky Avenue Well is a former municipal water supply well owned by the Elmira Water Board (EWB) that was used as part of the EWB system to furnish potable water to local communities. The Kentucky Avenue Well was closed in 1980 when it was found that the groundwater produced from this well contained trichloroethylene. In 1983, USEPA included the Kentucky Avenue Wellfield Site on the National Priorities List for response actions under CERCLA.

Since the mid-1980s, several CERCLA response actions have been conducted with respect to the Kentucky Avenue Wellfield Superfund Site, as follows:

- Operable Unit 1 (OU-1) involved initial investigations, identification of potentially impacted private wells, and connection of potentially affected residents to the public water supply system.

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[4] The BHHRA identifies chemicals of potential concern (COPCs) to human receptors, whereas the sBERA identifies chemicals of potential ecological concern (COPECs). For simplicity in this FS Report, except where specifically discussing the results of the ecological risk assessment, the acronym "COPCs" is used to identify chemicals of potential concern to either human health or ecological receptors.

- Operable Unit 2 (OU-2) included supplemental investigations of the degree and extent of groundwater impacts and the installation of barrier wells and a groundwater treatment system to intercept and treat groundwater at the downgradient limits of the former Westinghouse Horseheads plant site. Treated groundwater was discharged to a waterway *(i.e.,* the "Industrial Drainageway") that then conveyed the water to Koppers Pond. OU-2 also included installation of a water treatment (*i.e.*, air stripper) system at the Kentucky Avenue Well.
- Operable Unit 3 (OU-3) involved the investigation and remediation of identified source areas at the former Westinghouse Horseheads plant site, the investigation of the Industrial Drainageway that conveys surface water to Koppers Pond, and the remediation of the Industrial Drainageway.

The RI/FS for Koppers Pond has been conducted under OU-4.

Response actions under OU-1 and OU-3 have been completed. Operation of the barrier wells and groundwater treatment system installed at the former Westinghouse plant site as part of OU-2 was suspended in April 2014. USEPA has not formally approved the permanent shutdown of the OU-2 groundwater recovery and treatment system, and post-shutdown groundwater monitoring is ongoing. Following the OU-2 installation, the EWB elected not to use the Kentucky Avenue Well and removed some parts and equipment from the treatment system. At this time, the Kentucky Avenue Well remains out of service, and it is unknown whether the installed treatment system is still operational.

1.2.1 Site Setting

Figure 2 is an aerial photograph showing Koppers Pond and nearby features.[5] The pond is surrounded by both vacant and active industrial and governmental properties that are zoned "M-1 Industrial" within the Village of Horseheads and "Manufacturing" in the Town of Horseheads. Koppers Pond is situated on property owned by the Village of Horseheads; Hardinge, Inc. (Hardinge); and EWB. To the north is the Old Horseheads Landfill that forms much of the northern bank of the pond. To the south is the Kentucky Avenue Well facility, to the southeast is the Hardinge facility, to the east is Ferrell Spring Company (formerly known as Fairway Spring Company), and to the west is a Norfolk-Southern Corporation (Norfolk-Southern) railroad right-of-way with active tracks.

Access to Koppers Pond is impeded by the railroad tracks and by the adjacent industrial and governmental properties, which are partially fenced. No recreational or other use of the pond is authorized by any of the property owners. "No Trespassing" signs have been posted at the Hardinge property, and the Village and Town of Horseheads have periodically undertaken more aggressive efforts to discourage trespassing. Such measures have included posting additional "No Trespassing" signs and increased police patrols. Nevertheless, the presence of litter and off-road vehicle tracks indicate that periodic trespassing has occurred in the area, and individuals were occasionally observed bank fishing in Koppers Pond when pond water levels were higher. Absent the implementation of additional measures, access to Koppers Pond is possible under current and reasonably anticipated future land use conditions, and these exposure pathways were evaluated in the BHHRA.

1.2.2 Pond Hydrology

Koppers Pond is situated in a previously low-lying, wet area that apparently began to fill with water with the onset of discharges from the former Westinghouse plant, which commenced operations in 1952.[6] Discharges, including treated

[5] This photograph was taken prior to the suspension of discharges from the OU-2 groundwater recovery and treatment system.

[6] As described in the RI Report, several companies, including Westinghouse, Toshiba America, Inc. (Toshiba), and the Cutler-Hammer Division of Eaton Corporation (Eaton), have conducted manufacturing operation at the former Westinghouse Horseheads plant site.

process wastewater, cooling water, and storm water runoff from former Westinghouse and Toshiba operations at the plant, as well as from Eaton, were eliminated over the years and supplanted by discharges from the OU-2 groundwater recovery and treatment system. Koppers Pond is presently a shallow, flow-through water body fed by surface water inflows. As shown in the pond hydrology studies conducted as part of the RI, due to a low-permeability clay layer underlying most of pond, the surface water level at that time was several feet higher than the local groundwater table, and although there is some exfiltration, the pond does not significantly interact with groundwater. Under natural conditions, much of the pond area would be expected to return to wetlands, but because of filling that has occurred around the pond and development in the contributory watershed, the future extent and depth of the pond are not known.

Because of the relatively flat topography, the open water area of Koppers Pond is highly dependent on the surface water elevation. At a pond surface water elevation of approximately 886 feet above mean sea level (ft-msl), as was observed during RI field sampling in May 2008, the open-water area of the pond covered about 8.9 acres and water depths were approximately 1.5 to 4 feet. During the initial RI fieldwork in 2007 and during supplemental field investigations conducted in 2009 and 2010, the pond surface elevation was approximately 887 to 888 ft-msl, and the pond surface area was estimated to be about 10 to 12 acres. At that time, water depths were typically 2.5 to 6 feet. These variations in water level were due to climatic and hydrologic conditions, as well as beaver dams that were at times built in the outlet channels of the pond. Additionally, at that time, the OU-2 groundwater recovery and treatment system was operating at the former Westinghouse plant site and discharging about 1,400 gallons per minute (2 million gallons per day) to Koppers Pond through the Industrial Drainageway. This discharge supplemented the water that would be present in the pond under natural conditions.

More recently, following the April 2014 suspension of the OU-2 groundwater recovery and treatment system operation, the pond surface elevation was lowered. Observations made in October 2014, following a long dry period, indicated a pond surface elevation of approximately 884.5 ft-msl with a corresponding surface area estimated at 7 acres. Observations from January 2015 indicate that the pond level had continued to decrease as the Site region experienced a prolonged dry period with monthly rainfalls measuring approximately half of average amounts since September 2014. The water level in January 2015 was estimated to be approximately 882 to 883 ft-msl, with a corresponding surface area of less than 2 acres. Observations of the pond in spring and early summer 2015 indicated some recovery in pond levels following a moderately wet spring, however the pond elevation remained 2 to 4 feet below levels observed prior to April 2014. By late 2015 and early 2016, the pond level had again receded with an estimated open water area, primarily in the former southwest corner, of about 2.5 to 3 acres.[7]

For clarity and consistency in this FS Report, three water level conditions are defined to index the range of hydrologic conditions observed (Figure 3):

- High Water Level (HWL) – Pond water elevation of approximately 887 to 888 feet ft-msl, with water depths of 2.5 to 6 feet over a pond surface (open-water) area of about 10 to 12 acres;
- Average Water Level (AWL) – Pond water elevation of approximately 886 ft-msl, with water depths of 1.5 to 4 feet over a pond surface (open-water) area of about at 8 to 10 acres; and
- Low Water Level (LWL) – Pond water elevation of approximately 883 to 884 ft-msl, with water depths of 0.5 to 2 feet over a pond surface (open-water) area of about 2.5 to 3 acres.[8]

[7] Just prior to final publication of this FS report, an inspection of the pond revealed that the pond did not have any open water.

[8] For the purposes of this FS Report, LWL conditions are considered “current” conditions although, as described above, water levels just prior to publication of this report have receded further, and no open water remains in the pond. This circumstance is thought to be due to lower than average rainfall in March through June 2016.

For the purposes of evaluating technologies and response actions in this FS, the term "mudflats" means the low-lying areas along the perimeter of the pond (particularly on the western side) that are inundated under HWL conditions but exposed under AWL conditions.

The term "exposed sediments or soils" means the areas formerly submerged during the RI under AWL conditions and due to subsequent low water elevations are no longer submerged. These exposed sediments or soils are not considered mudflats as that term is defined in this FS report. Upland soils lying beyond the mudflats are not addressed in this FS.

These "high," "average," and "low" designations refer only to observations made through early 2016 and do not necessarily define the entire range of pond water levels that may occur in the future. Recent observations indicate that the pond would not be naturally restored to AWL or HWL conditions. In the future, however, those AWL or HWL conditions could potentially recur under certain circumstances, but the duration of those increases is uncertain. For example, resuming the discharge of treated groundwater through the Industrial Drainageway from the former Westinghouse plant or the permitting of the discharge of water from a new or existing facility through the Industrial Drainageway would impact water levels in the pond.

At the northern end of its western leg, the pond receives inflow from the Industrial Drainageway, which in turn originates approximately 2,300 feet to the north-northwest of Koppers Pond at the outlet of the "Chemung Street Outfall" (Figure 2). This drainageway conveys most of the surface water runoff from an approximate 1,350-acre watershed comprised of industrial, commercial, and residential properties as well as discharges from the former Westinghouse Horseheads plant site (Figure 4). At various times historically, such discharges included treated process wastewater, cooling water, storm water runoff, and the effluent from the OU-2 groundwater treatment system. Total flows were approximately 1,400 gallons per minute (gpm) and provided the base flow for the Industrial Drainageway. At this time, however, discharges from the former Westinghouse site are limited to storm water runoff.

Calculated on an annual average basis, storm water runoff from the 1,350-acre watershed, including the former Westinghouse site, contributes approximately 600 gpm to the flow in the Industrial Drainageway. Recent observations indicate runoff to the pond is only generated at times of significant rainfall (*e.g.,* at least 0.2 inches in a rain event), so this flow is irregularly distributed. There are extended periods in which the Industrial Drainageway is not flowing and there is no appreciable surface water inflow to the pond.

When water levels are sufficiently high, the overflow from Koppers Pond discharges to two outlet streams located at the southern end of the pond, which combine to form a single outlet channel (Figure 2). The invert elevations of the two outlet streams where they exit Koppers Pond are estimated at 885.0 to 885.5 ft-msl; no discharge from the pond occurs when the pond surface is lower than these elevations (*i.e.*, LWL conditions). The outlet channel flows into Halderman Hollow Creek and then winds through residential and commercial areas before discharging to Newtown Creek approximately 1.5 miles downstream of Koppers Pond.

Federal Emergency Management Agency (FEMA) flood mapping shows the 100-year flood elevation at 894 ft-msl throughout the area of Koppers Pond and its outlet channels down to the confluence of Halderman Hollow Creek (FEMA, 1996). High water in the area during flood events appears to be primarily associated with backwater flooding. The pond and surrounding area act as a retention basin during flood events providing storage of floodwaters and reducing flooding in downstream residential and commercial areas.

1.3 CONCEPTUAL SITE MODEL

The following sections outline the conceptual site model (CSM) that was developed through Site characterization studies completed as part of the RI as well as the BHHRA and sBERA. Figure 5 presents the CSM used in the BHHRA, and Figures 6 and 7 provide the CSM developed in the sBERA for AWL and HWL conditions, respectively.[9] Figure 8 provides the CSM for the outlet channels.

As discussed in Section 1.2.2, lower water levels than those evaluated in the BHHRA or in either the AWL or HWL cases evaluated in the sBERA have recently been seen at Koppers Pond and are likely to persist under natural conditions lacking the supplemental influx of water from the OU-2 groundwater recovery and treatment system at the former Westinghouse plant site or other manmade sources. In many instances, the LWL condition exposure pathways are similar to those under AWL conditions, but some potential exposure pathways (*e.g.*, human health exposure from fish consumption) would be different under current conditions. Most notably, under the recently observed LWL conditions, the pond will not support the level of fishery assumed in evaluating the fish consumption pathway in the BHHRA. For other pathways for both the BHHRA and sBERA, differences would primarily relate to the potential frequency of exposure and the areal extent of the various exposure areas. With sustained LWL conditions, some areas around the pond may become permanent vegetated uplands that are not inundated except under severe storm events. Potential ecological receptors in these upland areas could include terrestrial species that were not considered in the sBERA.

The BHHRA evaluated current and future exposures consistent with USEPA guidance (USEPA, 1989b). Under the July 2016 conditions at Koppers Pond, no fishery is present due to limited open water area and water depth.[10] If AWL or HWL conditions would be returned, a fishery could be possible if higher water levels are sustained for a sufficient period of time to allow for fish populations to rebound or possibly recolonize the pond. While the specific height of water required to support such a situation has not been established, for the purposes of this report, it is assumed that water levels would need to meet or exceed the AWL condition. Under such a scenario, fish consumption from Koppers Pond could be possible in the future.

1.3.1 COPCs

In the sBERA, the COPECs selected for evaluation differed by media. No COPECs were retained for surface water. The sediment COPECs included 4-methylphenol, polycyclic aromatic hydrocarbons (PAHs) (plus total PAHs), polychlorinated biphenyls (PCBs), metals, and total cyanide[11]. PCBs were the only COPEC retained for evaluation of potential effects on forage fish based on the screening of the observed results. COPCs identified in the BHHRA included arsenic (in fish) and PCBs (in sediment and fish). The pathway of concern is fish consumption under a future scenario in the pond if the pond was returned to AWL or HWL conditions for a sufficient period of time to allow for a viable fishery. Aroclor 1254 was the main driver, and PCBs with lower concentrations were Aroclors 1248 and 1260.

Although the set of COPCs generally does not change under the range of hydrologic conditions observed in the pond, the relative significance of constituents varies considerably. For example, under HWL or AWL conditions, PCBs (via fish consumption) dominated the estimated cancer risks and non-cancer hazards in the BHHRA. Under the current LWL conditions, the remnant pond does not support a significant fishery, and PCBs pose a much lower level of potential

[9] Between the 2008 and 2010 field investigations, the typical water elevation of Koppers Pond increased due to the presence of a beaver dam in the West Outlet. The Mudflat Area located between the outlet channels was dry in 2008 but was submerged in 2010. Therefore, the AWL and HWL scenarios represented the Site conditions observed in 2008 and 2010, respectively.

[10] As of publication of the FS, no fishery was present as no open water remained in the Pond.

[11] Total cyanide was retained as a COPEC in the sBERA because one or more observed Site concentrations exceeded screening values. The ecological risk characterization indicated, however, that none of the calculated risks associated with cyanide was greater than 1.0 using a conservative (*i.e.*, No Observed Adverse Effects Level [NOAEL]) based on a Toxicity Reference Value, and there was no need to evaluate cyanide as part of the FS process.

human health risk and hazard associated with direct contact. PCBs could pose a future cancer risk and non-cancer hazard above the NCP risk range and the goal of protection of a HI = 1 if the pond were returned to the conditions assumed in the BHHRA and fish populations rebounded. Metals in sediments that have become exposed sediments or soils are the primary COPCs under LWL conditions for ecological receptors.

1.3.2 Sources of COPCs

1.3.2.1 Metals

Historical sources of metals to Koppers Pond included industrial discharges from the former Westinghouse Horseheads plant site, as well as from urban and industrial runoff. Ongoing sources of metals may include urban and industrial runoff, as industrial discharges to the Industrial Drainageway have been terminated. Treated process discharges from the former Westinghouse Horseheads plant site to the Industrial Drainageway are no longer a source of COPCs to Koppers Pond. Table 1 provides the OU-4 metals concentration data in sediments found in drainage structures upstream of and draining to Koppers Pond.

When Westinghouse began operations at the Horseheads plant site in 1952, wastewater discharges were not regulated. In 1957, Westinghouse submitted a permit application to the New York State Department of Health (NYSDOH) and received a permit to operate a wastewater treatment facility at the Site. With passage of the Federal Water Pollution Control Act Amendments of 1972, the National Pollutant Discharge Elimination System (NPDES) permitting process was initiated. Under the NPDES program, effluent limitations were established for specific types of wastewater discharges. New York State Department of Environmental Conservation (NYSDEC) was granted primacy for permitting and began issuing State Pollution Discharge Elimination System (SPDES) permits under Federal Water Pollution Control Act authority. Westinghouse applied for an SPDES permit, which was received in March 1973.

After 1973, the treated wastewater discharges from the various entities operating at the former Westinghouse plant site were regulated by SPDES permits issued by NYSDEC. In various discharge permits, effluent limitations were set for metals (*e.g.*, cadmium, chromium, copper, lead, nickel, silver, and zinc) and other parameters that are not COPCs. To some extent, the metals concentrations in Koppers Pond sediment and mudflat soils result from these permitted discharges.

1.3.2.2 PCBs

The source of the PCBs found in Koppers Pond sediment has not been determined. Sampling conducted as part of the OU-3 RI did not find elevated PCB concentrations in soils or sediments in surface water drains at the former Westinghouse plant site. The maximum concentration of total PCBs detected in any soil sampled from the former Westinghouse plant site as part of the OU-3 RI (Philip Environmental Services Corporation [Philip], 1996) was 3,190 micrograms per kilogram (µg/kg).[12] In this soil sample, Aroclor 1254 and 1260 concentrations were reported at 790 and 2,400 µg/kg, respectively. By comparison, OU-3 remedial design sampling found total PCBs in Industrial Drainageway sediments at concentrations ranging to greater than 50,000 µg/kg in (Cummings/Riter, 2001). Nearly all of the PCBs in Industrial Drainageway sediments were reported as Aroclor 1254.

Pursuant to USEPA's September 1996 Record of Decision (ROD), Industrial Drainageway sediments were remediated in 2003 as part of OU-3, with a remediation goal of 1,000 µg/kg of total PCBs. Post-remedial sampling of residual sediments and bank soils, conducted in accordance with the USEPA-approved remedial design (Cummings/Riter, 2001), indicated an arithmetic average PCB concentration of 307 µg/kg (Cummings/Riter, 2004). After sediment

[12] In this report (including data tables and figures), COPC concentrations in sediment and soil are reported on a dry-weight basis, and COPC concentrations in fish tissue are reported on a wet-weight basis.

removal, clean soils were used to replace sediments and bank soils as needed to reshape the channel. No additional maintenance activities in the Industrial Drainageway are known to have occurred since remediation was completed in 2003.

Soil sampling at the Old Horseheads Landfill conducted as part of the OU-2 RI (Ebasco Services, Incorporated [Ebasco], 1990) showed PCB concentrations in subsurface soils ranging to 300,000 µg/kg. Surface soil concentrations were much lower, and the elevated PCB concentrations detected in Industrial Drainageway sediments included locations upstream of the Old Horseheads Landfill. Also, field inspections conducted as part of the OU-4 RI show no evidence of active or former seeps from the Old Horseheads Landfill that would have the potential to affect Koppers Pond.

In OU-4 RI sampling, trace levels of PCBs (*i.e.*, 8.2 to 34 µg/kg) were found in manhole sediments upstream of the former Westinghouse plant site, and 73 µg/kg PCBs were found in sediment at a culvert from the Norfolk-Southern right-of-way. Sediment at the Chemung Street Outfall exhibited 130 µg/kg PCBs (Table 1). These concentrations are below the 1,000 µg/kg remediation goal established for the Industrial Drainageway in the 1996 ROD.

An investigation by the Group identified a past PCB release to soil at the nearby former Great Atlantic & Pacific Tea Company, Inc. (A&P)/Southern Tier Crossing site, and noted past PCB transformer handling at the New York State Electric and Gas (NYSEG) Elmira Service Center. Both of these facilities are located in the Koppers Pond watershed (Figure 4), but the extent to which PCBs from the A&P or NYSEG facilities were transported to the Industrial Drainageway and Koppers Pond is not known.

Finally, although historical (deeper) sediments in the western leg of the pond show the highest PCB concentrations found in pond sediments, the highest PCB levels in surface sediments in the 2008 RI sampling occurred in the upper eastern leg of the pond. The reason for this distribution is not known with certainty, but may be the result of lower PCB concentrations in more recently deposited materials from the Industrial Drainageway in the western leg of the pond or may reflect a source of the PCBs in surface sediments in the eastern portion of Koppers Pond that is not related to the Industrial Drainageway. Surface sediments were collected from all of the original 2008 sampling locations in May 2013. In the May 2013 sampling, PCB concentrations were 140 to 640 µg/kg, with higher concentrations generally observed in the upper western leg of the pond.

1.3.2.3 PAHs

No specific industrial source has been identified for the PAHs found in Koppers Pond sediments. These constituents appear to originate from various urban sources, including, but not limited to, runoff from streets and parking lots.

1.3.2.4 Current Sources

The past known sources that introduced COPCs to Koppers Pond have been substantially abated, and PCB concentrations associated with sediments in the Industrial Drainageway were substantially reduced following the OU-3 remediation. Ongoing sources appear to be limited to runoff from local industrial and commercial facilities and local roadways. There remains no source material constituting a principal threat as that concept is defined by USEPA (1991a).

1.3.3 Fate and Transport

As discussed in Section 1.3.2, historical sources of COPCs to Koppers Pond included discharges to the Industrial Drainageway, runoff from industrial and commercial facilities, and runoff from streets and parking lots. Given their water-solid partitioning coefficients, the COPCs conveyed in these flows were primarily transported as particulates, although some metals were likely transported in the dissolved phase as well. The particulate phase included both suspended solids within the water column discharging to the pond and the sediment bed load transported along the bottom of the Industrial Drainageway and other drainage channels.

Under the full range of hydrologic conditions observed at the pond, Koppers Pond acts as a detention basin that provides quiescent conditions for settling and for the accumulation of sediment. Because the Industrial Drainageway enters the western leg of the pond, sediments that historically entered the pond from the Industrial Drainageway were more likely to accumulate in the western portion of the pond, rather than the eastern portion. The eastern portion of the pond would likely accumulate solids associated with runoff from local adjoining properties, as described in Section 1.3.2, above.

The metals, PCBs, and PAHs that comprise the COPCs associated with Koppers Pond are generally persistent and long-lived constituents in freshwater aquatic environments that accumulate in sediment. There can be significant variability among the half-lives of PCBs and PAHs in pond sediment depending on the specific chemical form of the constituent and a wide variety of site-specific factors related to the physical characteristics of the sediment and the overlying water column. Similar variability in PCB and PAH half-lives is also observed in surface soil. Temporal changes in total metals concentrations are typically most affected by physical processes, although bioavailability can be affected by chemical and biological processes. Information regarding bioavailability for the metals in the pond is not being presented in this report.

The settled solids that comprise the pond sediments represent a potential ongoing source of COPCs within Koppers Pond. Transfer of chemicals via uptake by emergent vegetation and bioturbation by benthic aquatic organisms and food-web transfer to higher trophic-level organisms represent the principal mechanisms that COPCs may move among environmental media within Koppers Pond. As less-impacted sediment (*e.g.*, bed load from the Industrial Drainageway) is transported to and deposited in the pond, the COPC concentrations in the upper surface of the pond sediments is expected to be reduced in areas where those incoming sediments are deposited.

Table 2 summarizes PCB data for Koppers Pond sediments collected between 1995 and 2013. The data indicate PCB concentrations in surface sediments were trending downward over that time span, as might be expected following the Industrial Drainageway remediation. More pronounced decreases were observed in comparing the data from the 2008 versus 2010 and 2008 versus 2013 data sets. In addition, all of the surface sediment samples collected in 2010 (5 sample locations) and 2013 (14 sample locations) exhibited PCB concentrations less than 1,000 µg/kg (the remediation goal established for the Industrial Drainageway in the 1996 ROD).

The quiescent settling conditions in Koppers Pond result in very limited transport of chemicals out of Koppers Pond into the outlet channels. As discussed in Section 1.3.4.2, the sediment samples collected from the outlet channels and intermittently inundated areas around the pond (mudflats) generally showed much lower COPC concentrations compared to Koppers Pond sediments. The discharge is even more limited at LWL conditions. With current inflows to the pond only from surface water runoff, the pond water level has dropped, and discharges from the pond to the outlet channels, if any, would only be associated with short-duration, high intensity runoff events. In many areas, what had been pond sediment is now exposed sediments or soils.

1.3.4 Affected Environmental Media

1.3.4.1 Surface Water

The OU-4 RI data indicated that surface water in Koppers Pond and its outlet channel was not degraded and met ambient water quality standards. Using USEPA *SW-846* methods (USEPA, 2008b) as described in the USEPA-approved RI/FS Work Plan (Cummings/Riter and AMEC, 2007), the OU-4 RI sampling showed no exceedances of New York State surface water standards given at New York Code, Rules, and Regulations (NYCRR) Title 6, Part 703 (Table 3). Evaluations conducted in the BHHRA and sBERA further showed that exposure to COPCs in surface water did not comprise a significant source of potential exposure to either human or ecological receptors. In addition, no significantly impacted surface water was found in samples upstream of Koppers Pond, suggesting that surface water inflows at that time did not pose a significant ongoing threat to pond water quality.[13]

The OU-2 RI (Ebasco, 1990) concluded that there was no significant communication between surface water in Koppers Pond and local groundwater. Hydrologic evaluations conducted as part of the OU-4 RI reached the same conclusion. Those evaluations were conducted at times when the baseline inflow to Koppers Pond was provided from discharges from the former Westinghouse plant site. Without that baseline flow and resultant lowered water levels, the limited exfiltration from the pond is more apparent. Monitoring conducted as part of OU-2 has not shown the COPCs associated with Koppers Pond sediment at elevated concentrations in groundwater.

1.3.4.2 Sediment

The bottom of Koppers Pond, including the more-recently exposed sediments or soil, is generally comprised of soft silty sediments overlying a hard clay layer. In a portion of the eastern leg of the pond, the pond bottom was identified as sand and gravel, and silty sediments in this area are either absent or present in a very thin (less than 6-inch) layer.

Grain-size determinations for three sediment samples collected in 2008 showed the silt and clay content of the sediment ranging from 85 to 97 percent. In the 2008 sampling, the solids content of subaqueous sediments ranged from 25 to 59 percent in upper (0- to 6-inch) sediment and 34 to 67 percent in deeper (greater than 6-inch) sediment. Sampling in 2010 and 2013 indicated solids contents in the range of 21 to 32 percent in the upper (0- to 6-inch) sediments. In the 2008 sampling (all depths), the total organic carbon (TOC) content ranged from 4 to 18 percent with an average TOC of 6 percent across all depths. In surface sediments (2008, 2010, and 2013 sampling), the TOC content ranged from 2 to 14 percent with an average TOC of about 7 percent.

Figure 9 provides an isopach map of sediment thickness based on probing conducted in May 2008 (*i.e.*, AWL conditions). As shown in this figure, accumulated sediments above the native underlying clay layer ranged in thickness from 0 to 38 inches, with greater thicknesses associated with the upper western leg of the pond where the Industrial Drainageway discharges to the pond. The total volume of pond sediments calculated from the May 2008 probing data is 21,400 cubic yards (cy), which is equivalent to an average sediment thickness of 1.5 feet (18 inches) over the 8.9-acre pond surface area defined by the May 2008 surveying.

Metals, PCBs, and PAHs have been detected in pond sediments at concentrations above screening levels applied in both the BHHRA and sBERA[14]. Screening levels were compared to the maximum detected concentrations. Those chemicals exceeding the screening levels were used to identify areas, COPCs, and conditions where further evaluation in the BHHRA and sBERA was needed. Elevated concentrations of these COPCs occur throughout the pond sediments, although concentrations generally tend to be higher in the western leg of the pond as compared to the central portion and eastern leg of the pond.

Table 4 summarizes metals and PCB data from the surface (0- to 6-inch) sediments in Koppers Pond and its outlet channels. The 0- to 6-inch layer represents the biologically active zone of the sediments and a depth where human receptors, *e.g.*, adolescent trespassers may be exposed. Figures 10 through 12 graphically present the depth-specific metals and PCB data from the OU-4 RI and 2013 supplemental sediment sampling.

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[13] Based on the investigations described in the OU-4 RI Report, the previously observed "floc" in the Industrial Drainageway, which was identified as a potential source of metals in Koppers Pond (NYSDOH, 1997), is no longer present, and suspected accumulations of such floc in the aboveground piping leading to the Chemung Street Outfall were not observed during any of the field studies conducted between 2008 and 2013.

[14] Refer to the sBERA, dated March 2012 and the 2012 BHHRA for more information regarding screening levels.

Surface sediment metals concentrations were not markedly different in historical data (1995 and 1998) versus samples collected in 2008 as part of the OU-4 RI (Table 4). In four of five locations sampled in both 2008 and 2010, the metals levels in the 2010 samples were generally lower. Comparisons of the paired data from the four locations where surface sediment samples collected in both 2008 and 2013 were analyzed for metals shows that, between the 2008 and 2013 sampling, concentrations of several key metals (*i.e.*, cadmium, copper, lead, mercury, nickel, and zinc) are lower on average by about 20 to 50 percent. Chromium concentrations are virtually unchanged between the 2008 and 2013 sampling. Likewise, barium and silver concentrations vary somewhat between sampling events, but overall the concentrations observed in the 2013 sampling remain unchanged from historical data.

PCB concentrations in surface sediment appear to have decreased somewhat between the 1995/1998 data and the 2008 data, and the 2010 and 2013 PCB data show a continuing and more pronounced decreasing concentration trend (Table 4). The decrease in PCB concentrations may at least in part be due to the reduction of input of PCBs from the Industrial Drainageway sediment that was achieved by the remediation completed in 2003. Except where the 2008 sampling showed very low PCB levels (*i.e.*, less than 100 µg/kg), the PCBs levels in all co-located 2010 and 2013 samples were lower than in 2008, and all of the surface sediment samples collected in 2010 and 2013 exhibited total PCB concentrations less than 1,000 µg/kg. As indicated previously, the 1996 USEPA ROD selected a remedial goal of 1,000 µg/kg for PCBs in sediments in the Industrial Drainageway.

As indicated in Figures 10 through 12, the 2008 vertical profiling sampling did not reveal consistent patterns of concentrations with the depth interval of the sediment. Metals concentrations are highly variable with depth, with patterns depending on the specific metal and the location within the pond. The pattern of PCB distribution is more consistent with concentrations generally higher in deeper sediments.

Sediment accumulations atop the clay layer are much thinner in the outlet channels, and no soft sediments were found at Sample Locations SD10-18 and SD10-19. Most metals and PCB concentrations are generally lower in the outlet channel samples than in the pond sediment samples. Similarly, surface soils samples collected in the periodically inundated low-lying areas around the pond all showed metals concentrations lower than corresponding average values for pond sediments. Total PCB concentrations in mudflat soil sampled ranged from non-detect to 43 µg/kg and these concentrations are less than 1,000 µg/kg.

In the 2008 data, PAH concentrations tended to be higher in the surface (0- to 6-inch) sediments, and PAH concentrations are not markedly different in historical sediment data (1995 and 1998) from 2008 and 2010 concentrations. The supplemental sediment sampling conducted in 2013 did not include PAH analyses. PAH levels in the outlet channel samples are similar to those in the pond, but these results appear to be skewed by the effects of one outlet channel sample (SD08-15) with a suspected local source of PAHs (*i.e.*, railroad ties used as a low-water crossing).

Table 5 summarizes the calculated exposure point concentrations (EPCs) for COPCs in surface sediment. Listed metals are those for which the EPC exceeds the New York State Soil Cleanup Objectives (SCOs) (6 NYCRR Subpart 375-6) for protection of ecological resources. The BHHRA did not identify arsenic as a COPC in soil, and the arsenic EPC did not exceed the SCO. However, PCBs were identified as a COPC in fish based on consumption. The calculated EPCs are the 95-percent upper confidence level (UCL)[15] of the mean concentrations calculated from the 2008 and 2010 OU-4 RI data. For comparison, the 95-percent UCL values are also shown with the addition of the 2013 supplemental sediment sampling. The cadmium, mercury, nickel, silver, zinc, and total PCB UCL values were lower

[15] The updated EPCs shown in this table were calculated using ProUCL version 4, which was the same version of this software that was used in the BHHRA.

when data from all three years were combined.[16] The calculated UCLs increased when all three years were combined for barium, chromium[17], copper, and lead. The statistics for the metals data from the four sediment samples collected in 2013 were biased because all four samples were collected from the western arm of Koppers Pond, which has higher metal concentrations than other portions of the pond.

1.3.4.3 Biota

In sampling conducted in 1988, NYSDEC reported the detection of PCBs in largemouth bass and carp collected from Koppers Pond. These findings led to the issuance of a fish consumption advisory for Koppers Pond by NYSDOH. The NYSDOH advisory currently in effect is for women under 50 years and children under 15 years not to eat any fish from Koppers Pond. For all others, the recommendation is to eat no more than one meal of carp from Koppers Pond per month and up to four meals per month of all other fish species from Koppers Pond (NYSDOH, 2014). NYSDOH has not revised its fish advisory to reflect recent changes to the hydrology of Koppers Pond.

Sampling and analysis of fish tissue were conducted in 1995 as part of the OU-3 RI (Philip, 1996) and again in 2003 to follow-up the Industrial Drainageway remediation (Civil & Environmental Consultants, Inc. [CEC], 2003). For the OU-4 RI, fish were collected from Koppers Pond in May 2008 using electroshocking techniques, resulting in a total of 20 individual gamefish samples and 6 forage fish samples for analysis. A forage fish sample was also collected from the outlet channels in October 2010. Collected species included both bottom-feeding species (*e.g.*, common carp and white sucker) and pelagic species (*e.g.*, largemouth bass, pumpkinseed, black crappie, and green sunfish). The samples of larger fish for potential human consumption were prepared as skin-on fillets with the belly flap included; smaller fish species for ecological evaluation were analyzed as whole-body samples. Fish samples were analyzed for metals and PCBs. PAHs are generally metabolized by fish and were not analyzed in the fish tissue samples collected for OU-4 or in the 2003 samples collected following the Industrial Drainageway remediation (CEC, 2003). Table 6 summarizes the OU-4 RI fish analytical data, and calculated EPCs from the BHHRA are presented in Table 7.

Metals concentrations in fish samples collected in 2003 and 2008 showed that copper, lead, nickel, and zinc average concentrations appear to have decreased in fish tissue from the 2003 sample set to the 2008 samples, whereas the chromium and average mercury concentrations appear to have increased. Although the average chromium concentrations were higher in 2008 compared to 2003, the ranges of the results show extensive overlap so the differences in the average concentrations may not indicate a temporal pattern.

As discussed in the RI, PCB concentrations found in the OU-4 fish tissue were related to the size and species of the type and species of fish samples, as follows:

Species	Length (millimeters)	Weight (grams)	Average Total PCB Concentration (µg/kg)
Common carp	517 to 621	1,909 to 3,818	1,123
White sucker	342 to 412	373 to 666	288
Largemouth bass	380 to 407	651 to 843	246
Black crappie	218 to 292	110 to 285	505

[16] The total PCB UCL that was calculated using the 2013 data alone was 411 µg/kg.

[17] Analysis of water, sediment, and fish tissue samples was conducted for total chromium, and speciation analyses (*i.e.*, trivalent versus hexavalent) were not conducted during the RI. The RI assumed that the chromium detected in these environmental media was predominantly in the trivalent form.

The overall EPC for total PCBs in fish tissue, calculated as the 95 percent UCL value, was 827 µg/kg (wet-weight basis) and the EPC for arsenic was 0.08 milligram per kilogram (mg/kg) and for mercury was 0.2 mg/kg (Table 7). EPCs were not calculated for the other COPC metals because they did not cause or contribute to unacceptable human health or ecological risk.

As described in Section 4.3.3.2 of the RI Report, on a lipid-normalized basis, PCB concentrations in fish samples collected in 2003 and 2008 showed decreasing concentrations in the bottom-feeding species (*i.e.*, common carp and white sucker), but increases in pelagic species (*i.e.*, black crappie and largemouth bass). The limited open water area and shallow water depth no longer support a meaningful gamefish population, and consequently, the PCB concentrations in the tissues of gamefish is not important under the LWL conditions currently present at Koppers Pond.

1.3.5 Potential Receptors

1.3.5.1 BHHRA

The BHHRA evaluated the following exposure scenarios:

- Dermal contact with and incidental ingestion of surface water and sediment from the pond during wading events related to teenage trespassing activities; and
- Consumption of game fish taken from Koppers Pond by a young child (assumed to consume fish provided by an adult/adolescent angler), adolescent, and adult.

These routes of potential exposure are shown in the BHHRA CSM provided as Figure 5.

The BHHRA evaluated cancer risks and non-cancer hazards under current and future conditions. Since the BHHRA was completed in 2012 (Integral Consulting, Inc., 2012a) conditions at Koppers Pond have changed, and the conditions assumed under the BHHRA current scenario were no longer present in 2015 and 2016, during the development of this FS Report. However, consistent with USEPA Guidance (USEPA, 1989b), the USEPA Superfund Program considers both current and future conditions to support decisions. The future conditions assumed in the BHHRA remain as a potential future condition at Koppers Pond as described previously.

Under the LWL conditions observed more recently and expected in the future lacking the supplemental influx of water from other sources, the pond would not support a fishery that would produce the numbers and sizes of fish that would make Koppers Pond a source of fish for human consumption. That potential exposure pathway only applies if surface water inflows to the pond and water levels like those observed during the RI were returned to Koppers Pond (*i.e.*, AWL or HWL conditions) in the future and those water levels sustained for sufficient time for a viable fishery to be established. Under LWL conditions, potential direct contact exposure scenarios would include both pond sediment and surface water and former sediments that become exposed sediments or soils.

1.3.5.2 SBERA

The sBERA included food web modeling as well as evaluations of direct-contact exposures to assess potential ecological risks of the following potential ecological receptors:

- Benthic invertebrates,
- Amphibians and reptiles,
- Forage fish,
- Herbivorous birds,
- Piscivorous birds,

- Herbivorous mammals, and
- Piscivorous mammals.

Potential routes of exposure and receptors associated with Koppers Pond are shown on Figures 6 and 7 as the CSM for AWL and HWL conditions, respectively. Figure 8 shows the potential routes of exposure and receptors associated with the outlet channels. A qualitative evaluation of human health and ecological risks associated with the current LWL conditions has been conducted, as noted in Sections 1.4.1 and 1.5.1, respectively.

1.4 SUMMARY OF BHHRA

The BHHRA evaluated exposures to the young child, adolescent, and adult who may contact COPCs in Koppers Pond. Examples of exposure pathways evaluated include direct contact (incidental ingestion and dermal contact with impacted sediment) and ingestion of fish. Exposure factors including ingestion rates, body weight, exposure frequency, and duration varied with age group. The exposure factors provide a "reasonable maximum exposure" (RME) which represents the highest level of human exposure that could reasonably be expected to occur. The exposure information, combined with chemical-specific toxicity information, is used to estimate cancer risks and non-cancer hazards to support risk management decisions. In addition, USEPA estimated cancer risks and non-cancer hazards to the Central Tendency Exposed (CTE) individual, which represents average exposure, to provide additional information for risk management purposes.

The results of the BHHRA, which considered AWL conditions now regarded as a potential future condition, indicated that exposures to COPCs in sediment and surface water for both the outlet channels and Koppers Pond do not pose a significant health concern based on direct contact, *e.g.*, ingestion and dermal contact. The calculated excess lifetime cancer risk to the identified receptor (*i.e.,* teenage trespasser) from direct contact with Koppers Pond sediments and surface water was 9.6×10^{-7} under RME conditions. Under these conditions, the hazard index (HI) for non-cancer hazards was estimated as 0.03 for this receptor. The excess lifetime cancer risk is less than the target risk range given in the NCP (*i.e.*, 10^{-6} to 10^{-4}), and the non-cancer hazard is below the goal of protection of an HI = 1 (USEPA, 1991b).

Under a potential future AWL scenario as was considered in the BHHRA, the risks to the RME individual from ingestion of fish is a total carcinogenic risk of 3.1×10^{-4} developed by combining risks to the young child (7.3×10^{-5}), adolescent (7×10^{-5}), and adult (1.6×10^{-4}) (Table 8). The non-cancer HI for the young child was 21, for the adolescent 20, and for the adult 16, exceeding the goal of protection of an HI = 1. Total PCBs was the main contributor. The assumed consumption rate was 25 grams per day for the adult or approximately 40 half pound meals per year, 8 grams for the young child (1 to 6 years) or approximately 13 half pound meals per year, and 16 grams for the adolescent (7 to 13 years of age) or approximately 26 half pound meals per year.

The future risks under a potential AWL scenario to the CTE or average individual from consumption of fish was a total cancer risk of 2.6×10^{-5} with risks to the young child (9.1×10^{-6}), adolescent (8.8×10^{-6}), and adult (2.4×10^{-5}). The non-cancer hazards for the CTE individual were HI = 5.7 for the young child, HI = 5.5 for the adolescent, and HI = 4.0 for the adult for whom the HI remains above the goal of protection of an HI = 1. The main contributor to both the cancer risks and non-cancer hazards was PCBs. The consumption rates used in this assessment were 8 grams per day for the adult or approximately 13 half-pound meals per year, 3 grams per day for the young child or approximately 5 half-pound meals per year, and 5 grams per day for the adolescent or approximately 8 half-pound meals per year.

In both cases, the cancer risks and non-cancer health hazards to the RME and CTE individuals under AWL conditions assumed in the BHHRA are expected to be higher than those for the current RME and CTE individuals under an LWL (or lower) scenario. If pond water levels remain low, the pond will not support a significant or possibly any game fish or larger forage fish population. However, as described above (Section 1.2.2), there is a potential for the future conditions assumed in the BHHRA, which indicate cancer risks and non-cancer hazards above the risk range and goal of protection of an HI = 1 for the RME individual.

1.4.1 Assessment of Human Health Risks under Low Water Conditions

As discussed in Section 1.2.2, the recent suspension of treated groundwater discharges to the Industrial Drainageway and below average precipitation for an extended period of time have resulted in a substantial decrease in the water depth and the open water area from those considered "current conditions" in the BHHRA for Koppers Pond. The potential impacts of this reduced input, some of which are already observable at Koppers Pond, include the following:

- An increased potential for sediment exposure by trespassers that were previously inaccessible; and
- A decrease in the quality or elimination of the pond fishery due to reduced pond area and water depth, wider temperature fluctuations, and decreased dissolved oxygen from lower pond turnover under current conditions.

These changes, which are not captured in the 2012 BHHRA, are evaluated qualitatively below.

***Increased Accessibility by Adolescent Trespassers*:** For the BHHRA, all of the sediment and mudflat results were assumed under the RME scenario to be accessible and were included in the EPC UCL calculations. Therefore, a decrease in the water depth would not affect the media that were evaluated for this exposure pathway, but would affect accessibility.

As discussed in Section 1.3.4.2 and shown in Table 5, the collection of additional sediment samples in May 2013 resulted in changes in the calculated EPCs for this exposure pathway. As shown in Table 9, the changes in the EPCs result in only a slight change in the calculated cancer risks and non-cancer hazards, and the updated risks do not change the overall conclusions that there are no calculated cancer risks or non-cancer hazards exceeding the cancer risk range of 10^{-4} to 10^{-6} and the goal of protection of a non-cancer HI = 1 under LWL conditions for this receptor and exposure pathway.

***Changes in the Koppers Pond Fishery under Low Water Conditions*:** With the decrease in surface water inflows to the pond, the open-water area of the pond and water depths have been significantly reduced. Under these current LWL conditions, the viability of the Koppers Pond fishery has been severely affected or possibly eliminated. Koppers Pond cannot sustain a fishery that would produce the numbers and sizes of fish that would make the pond a viable source of fish for human consumption, and the calculated risks as presented in the BHHRA would not occur under current conditions. However, consistent with USEPA guidance, the BHHRA evaluated cancer risks and non-cancer hazards under potential future conditions (USEPA, 1989b). As discussed previously, if Koppers Pond was returned to AWL or HWL conditions, AWL and HWL scenarios could be a future condition. Under the AWL condition in the BHHRA, the cancer risk range and goal of protection of an HI = 1 were exceeded under such potential future conditions.

1.5 SUMMARY OF SBERA

The results of the sBERA indicate that exposures to COPECs in the environmental media of Koppers Pond and its outlet channels under HWL and AWL conditions do not pose a significant ecological concern for any of the evaluated receptors, except for cadmium in the muskrat. Under highly conservative modeled assumptions (*e.g.*, the NOAEL toxicity benchmark, modeled prey organism tissue concentrations), the hazard quotient (HQ) for the muskrat is greater than 1. This estimate may not be reliable, however, because the estimated exposure results from consumption of aquatic invertebrates, for which there are no empirical data. Instead, the concentrations in these invertebrates were conservatively modeled to support this exposure pathway. When more realistic assumptions about the likely availability of cadmium to muskrats are employed, muskrats are not predicted to be at potential risk under HWL and AWL conditions based on the lowest-observable adverse-effects level (LOAEL) toxicity benchmark.

In the RI Site characterization conduct under AWL and HWL conditions, the benthic community in Koppers Pond was found to be depressed, but its species density and diversity were generally consistent with what would be expected in a warm-water, shallow pond with a mucky bottom. Benthic community conditions at a nearby reference pond were found to be similar.

1.5.1 Assessment of Ecological Risk under Low Water Conditions

The decrease in the Koppers Pond water depth has resulted in the conversion of sediments in the shallow portions of Koppers Pond to exposed sediments or soils and allowed access to sediments that were previously inaccessible to certain potential receptors. Under LWL conditions, which were not assessed in the 2012 sBERA, larger areas of exposed sediments or soils are present. Observations over the past several months indicate that these exposed sediment areas are becoming revegetated with forbs and grasses. The presence of forbs and grasses could be indicative of a terrestrial environment and the presence of additional terrestrial receptors that were not evaluated in the sBERA.

***Effect of Decreasing Water Levels on Muskrat Risk*:** This receptor was re-evaluated in this report because it was the only receptor that showed a significant ecological concern under HWL and AWL conditions, which was based on exposure to cadmium. Sediment EPCs were also updated to include the May 2013 sediment sample results. The sBERA calculations are complex because the tissue levels in one of the prey items (aquatic invertebrates) is calculated as the product of the sediment concentration and the biota transfer factors. The empirical data for the remaining forage item (plants) was used as reported. Table 10 compares the sediment EPCs and calculated cadmium HQs from the 2012 sBERA for the AWL and HWL conditions compared those to the updated 2015 values. The changes in the EPCs result in a slight change in the calculated NOAEL and LOAEL based HQs for cadmium. The updated risks do not change the overall conclusions that cadmium was the primary risk driver for the muskrat using modeled prey data.

Table 10 also shows the HQ results using the measured forage fish results as a surrogate for the aquatic invertebrate concentrations (which was evaluated as part of the uncertainty assessment in the 2012 sBERA). The measured forage fish results were considered to be more representative of the exposure to muskrats compared to the modelled aquatic invertebrate concentrations. Use of measured COPEC concentrations in forage fish species as a surrogate for the aquatic invertebrates reduced the calculated HQ values for cadmium to values only slightly greater than one.

***Effect of Decreasing Water Levels on Wading Birds*:** The potential for contact of sediments by wading birds is a function of the water column depth. Deeper sediments are unlikely to be contacted when the water depth is greater than the length of the wading birds legs. For the development of the sediment exposure to wading birds (*i.e.*, the Great blue heron) in the sBERA, sediments that were present at water depths less than 2 feet were included in the sediment EPC calculation. For the AWL scenario evaluated in the sBERA, this included samples at eight locations: SD-1, SD-2, SD-3, SD-4, SD-5, SD-7, SD-8, and SD-9. To assess the potential impact on the calculated risks for LWL conditions, all shallow sediment samples regardless of water depth were included in the sediment EPC calculation, along with the 2013 sediment sample results. None of the individual COPECs had HQ values greater than one.

Table 11 compares the cadmium HQs for the AWL condition for wading birds that were evaluated in the 2012 sBERA to the updated 2015 values reflecting LWL conditions. The cadmium results are shown in the table to provide comparisons to the muskrat results. The changes in the EPCs result in a slight change in the calculated NOAEL- and LOAEL-based HQs, but none were greater than one. Therefore, the updated EPCs related to the decreased water levels do not change the overall conclusions of the risk results from the sBERA for this species.

2. ARARs, TBCs, AND OTHER GUIDANCE EVALUATION

Under Section 121(d) of CERCLA, as amended by SARA, remedial actions when completed must achieve a level of cleanup consistent with Federal and State environmental laws, statutes, and regulations that are ARARs. Section 2.1 provides an overview of ARARs as they are applied to CERCLA site remediation, and Section 2.2 discusses other Federal and State advisories and standards that comprise guidance for formulating and evaluating remedial action alternatives. Sections 2.3 through 2.5 identify and discuss ARARs and guidance specific to remedial action for Koppers Pond. Consistent with USEPA guidance, the final ARARs will be included in the ROD and will be chosen based on the selected remedial action.

Please note that certain ARARs may be specific to only AWL and HWL conditions, and some may be specific only to the current LWL conditions. ARARs that apply only to certain hydraulic conditions of the pond are identified as such in the following discussions.

2.1 OVERVIEW OF ARARs

ARARs consist of two distinct types of environmental laws and regulations that affect what remediation may be required and how that remediation is executed: “Applicable Requirements” and “Relevant and Appropriate Requirements.” The NCP (40 CFR 300.5) and USEPA (1988a) guidance define these concepts as follows:

“Applicable” requirements mean those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

“Relevant and appropriate” requirements mean those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

If a particular requirement is found not to be applicable, it may be found relevant and appropriate. The NCP [40 CFR 300.400(g)] lists factors to be examined for relevance and appropriateness to determine whether a requirement addresses problems or situations sufficiently similar to circumstances of the release or remedial action contemplated and whether the requirement is well-suited to the site. The determination that a requirement is relevant and appropriate is a two-step process: (1) determination if a requirement is relevant; and (2) determination if a requirement is appropriate. A requirement may be relevant, but not appropriate given the circumstances of a particular site.

The NCP and USEPA guidance further defines three specific types of ARARs, as follows:

- Chemical-specific,
- Location-specific, and
- Action-specific.

Chemical-specific ARARs include those laws and requirements that regulate the amounts or concentrations of hazardous substances that may be found in, or discharged to, the environment. These requirements are usually health- or risk-based concentration (RBC) limits or discharge limitations for specific hazardous substances. Chemical-specific ARARs are important in determining the extent to which the environmental media at a site are impacted and in determining the residual levels of constituents allowable after site remediation. Based on this information, remedial action alternatives can be selected to achieve the remedial action cleanup goals.

Location-specific ARARs apply to the area in which a site is located. Identified regulations that are potential ARARs may require actions to preserve or protect aspects of the environment or cultural resources of the area that may be threatened by the site or by the remedial actions to be undertaken at the site.

Action-specific ARARs are regulations that apply to specific technologies or types of technologies to be used for site remediation. For each remedial action component, a number of potential action-specific ARARs may be identified. The action-specific requirements do not in themselves determine the remedial action alternatives; rather they may modify how or to what degree the component activities will be implemented.

In addition to the legally binding requirements established as ARARs, many Federal and State programs have developed criteria, advisories, guidelines, or proposed standards that may provide useful information or recommended procedures if no ARARs address a particular situation or existing ARARs do not provide protection. In such situations, these TBC criteria or guidelines can be applied.

While it is necessary to meet (or waive) the substantive provisions of permitting regulations that are ARARs, under CERCLA Section 121(e)(1) response actions are exempt from administrative requirements and the need to obtain Federal, State, or local permits related to on-site activities. In addition, USEPA policy is that on-site response actions are exempt from any "permit equivalency" process that might attach non-ARAR conditions or require approval of a permitting authority before a CERCLA action may proceed (USEPA, 1992).

2.2 TBC GUIDANCE

USEPA and NYSDEC have published guidance regarding the interpretation and application of their respective regulatory programs. Guidance documents used in the preparation of the RI, BHHRA, and sBERA were cited in those reports. Most notably, USEPA, NYSDEC, NOAA, and other guidance on the effects and concentrations of COPECs in sediment was used in the COPEC screening and Site-specific evaluations presented in the sBERA. Similarly, USEPA and NYSDEC and others have published guidance on recommended concentrations of PCBs and other COPCs in fish tissue, primarily based on the protection of wildlife and food-web effects.

USEPA and NYSDEC guidance documents used in the preparation of this FS Report are cited in the text and tables. A list of references, including cited guidance documents, follows the text.

2.3 CHEMICAL-SPECIFIC ARARS, TBCS, AND OTHER GUIDANCE

This section discusses potential chemical-specific ARARs, TBCs, and other guidance for Koppers Pond. These potential requirements are summarized in Table 12. The final designation of ARARs will be provided in the ROD.

2.3.1 Sediment

No Federal or State of New York cleanup criteria have been promulgated that define allowable concentrations of hazardous substances in sediments. TBC guidance is available from USEPA; NYSDEC; the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA); and other sources. Such TBC guidance was used in screening and evaluating concentrations of COPECs as part of the sBERA.

2.3.2 Soils

For sediments that have become exposed as soils under the current LWL conditions, the New York State SCOs (6 NYCRR Subpart 375-6) establish target cleanup levels for protection of human health and ecological resources. SCOs have been developed for human health protection by direct-contact pathways address various land uses ranging from residential to industrial. SCOs are also defined for protection of ecological resources and for protection of groundwater.

The SCOs for protection of ecological resources will be evaluated as chemical-specific ARARs, TBCs, or other guidance for the development of RAOs for Koppers Pond sediments that have become exposed as soils. For purposes of the FS, these SCOs for protection of ecological resources are considered protective of potential human health based on direct contact and ecological risks associated with the exposed sediments or soils.

2.3.3 Surface Water

2.3.3.1 Federal Water Pollution Control Act

The Federal Water Pollution Control Act, as amended by the Clean Water Act (33 United States Code [USC] §1251 *et seq.*), provides the authority for USEPA to establish water quality criteria for surface water bodies. Federal Ambient Water Quality Criteria (AWQC) developed under the Clean Water Act set forth criteria for protection of freshwater aquatic life and for protection of human health from the ingestion of water and aquatic organisms. These criteria also specify the analytical testing methods to be used in comparing surface water quality to criteria (40 CFR 136.3).

Federal AWQC are non-enforceable guidelines used by states to set water quality standards for surface water. The New York State ambient water quality standards (Section 2.2.3.3) are the applicable requirements for Koppers Pond.

2.3.3.2 Safe Drinking Water Act

Regulations promulgated under the Safe Drinking Water Act (42 USC §300f *et seq.*) establish enforceable maximum contaminant levels (MCLs) and non-enforceable maximum contaminant level goals (MCLGs) for finished water provided to consumers (40 CFR 141). MCLs and non-zero MCLGs must be attained for groundwater or surface waters that are potential sources of drinking water [40 CFR 300.430(e)(2)(I)(5)(B)]. Koppers Pond is not used for drinking water supply and is not a potential drinking water source. MCLs and MCLGs are not ARARs for Koppers Pond.

2.3.3.3 New York Environmental Conservation Law, Article 15, Title 3 and Article 17, Titles 3 and 8

Water quality standards are established under various sections of the New York State Environmental Conservation Law (ECL), including Article 15 (ECL §15-0313) and Article 17 (ECL §§17-0301, 17-0303, and 17-0809). New York State surface water quality standards are established at NYCRR Title 6 Part 703 and are also published in the NYSDEC Technical and Operational Guidance Series Memo 1.1.1 (NYSDEC, 1998). The New York State ambient water quality standards for total PCBs and other COPCs are chemical-specific ARARs for Koppers Pond.

The New York State ambient water quality standards specify stringent limits on PCBs, mercury, and other COPCs (*e.g.*, PAHs) in surface waters. With respect to PCBs, New York has established four different ambient water quality standards as follows:

- 0.09 micrograms per liter (µg/l) for potable water sources;
- 0.014 µg/l for the protection of benthic aquatic life;
- 1.2×10^{-4} µg/l for the protection of wildlife bioaccumulation; and
- 1×10^{-6} µg/l for protection of human health based on fish consumption.

Koppers Pond is not a potable water source and has no reasonable potential to be a source in the future.

The ambient water quality standard for the protection of benthic aquatic life is applicable to pore water of subaqueous sediment. Section 3.2.3.1 discusses the relationship between concentrations of PCBs in sediment and pore water and the estimated PCB level in sediment that is protective of this criterion.

The remaining two New York State ambient water quality standards for PCBs (*i.e.,* 1.2×10^{-4} µg/l for the protection of wildlife bioaccumulation and 1×10^{-6} µg/l for protection of human health based on fish consumption) are based on modeling the bioaccumulation of PCBs in fish tissue and the uptake of PCBs by higher trophic level receptors. The analytical methods from 40 CFR 136.3 designated for measuring PCBs in surface water can achieve reliable quantitation only at concentrations two to four orders of magnitude higher than these values, so the standard, in effect, becomes the practical quantitation limit for the analysis.

2.3.4 Air Quality

Under the Federal Clean Air Act, USEPA requires attainment and maintenance of primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR 50) to protect public health and public welfare, respectively. These standards are not source-specific. They define acceptable nationwide airborne concentrations of conventional air pollutants (*e.g*., particulates, sulfur dioxide) and are relevant and appropriate as chemical-specific ARARs for any remedial action associated with Koppers Pond.

States are responsible for assuring compliance with NAAQS. NYSDEC Air Quality Standards are provided at 6 NYCRR Part 257 and New York State Regulations for Prevention and Control of Air Contamination and Air Pollution are given at 6 NYCRR Part 200. The New York State requirements for implementing, maintaining, and enforcing NAAQS are relevant and appropriate chemical-specific ARARs.

2.3.5 Fish Tissue

No Federal or State of New York cleanup standards have been promulgated that define allowable concentrations of hazardous substances in fish tissue. TBC guidance for ecological risks is available from USEPA, NYSDEC, and NOAA, and from the International Joint Commission, United States and Canada, Great Lakes Water Quality Agreement of 1978, as amended (Section 2.5). Such TBC guidance was used in screening and evaluating concentrations of COPECs as part of the sBERA, but these guidance values are not cleanup standards. In any case, it is noted that under the current LWL conditions, Koppers Pond will not support a fish population that would serve as a source of edible fish. Under such conditions, these guidance documents are not relevant.

2.4 LOCATION-SPECIFIC ARARS, TBCS, AND OTHER GUIDANCE

Location-specific ARARs are restrictions placed on concentrations of hazardous substances or the conduct of activities solely because they are in a specific location. Such locations to which these types of regulations apply include floodplains, wetlands, sensitive ecosystems or habitats, and historic places. The following sections discuss potential location-specific ARARs, TBC, and other guidance for Koppers Pond, and Table 13 summarizes these potential ARARs, TBCs, and other guidance. Location-specific ARARs, TBCs, and other guidance will be finalized in the ROD.

2.4.1 Floodplains and Wetlands

2.4.1.1 Section 404 of the Clean Water Act

Section 404 of the Clean Water Act (Federal Water Pollution Control Act, as amended) (33 USC §1344) and the implementing regulations at 33 CFR 320 *et seq.* establish requirements for issuing permits for the discharge of dredged or fill material into navigable waters of the United States, including jurisdictional wetlands, navigable streams (including floodplains), and certain lakes. These regulations, which are primarily administered by the U.S. Army Corps of Engineers (USACE), define special policies, practices, and procedures to be followed, and USACE has established a

Nationwide Permit Program (33 CFR 330) designed to streamline the permitting process for certain types of activities, including environmental remediation (*i.e.*, Nationwide Permit 38).

The USACE regulations also provide for the enhancement, restoration, or creation of alternate wetlands. The regulations at 33 CFR 230 specifically state that no activity which adversely affects an aquatic ecosystem (including wetlands) shall be permitted if there is a practical alternative available that has less adverse impact. If there is no practicable alternative, the adverse impacts of the activity must be minimized.

The USACE regulations under the Clean Water Act would be applicable to remediation activities at Koppers Pond that impact open water areas of the pond and outlet channels, associated floodplain areas, or adjacent jurisdictional wetlands. USACE Section 404 permitting requirements are location-specific ARARs for a possible Koppers Pond remediation.

2.4.1.2 Statement of Procedures on Floodplain Management and Wetlands Protection

The procedures set forth at 40 CFR 6, Appendix A, define USEPA policy and guidance for implementation of Executive Orders 11988 and 11990. Executive Order 11988, Floodplain Management [40 CFR 6.302(b)], requires Federal agencies carrying out their responsibilities to take action to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains. Executive Order 11990, Protection of Wetlands (40 CFR 6, Appendix A), establishes a Federal policy requiring government agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance their natural and beneficial values.

Remediation of Koppers Pond could affect the 100-year floodplain and associated wetlands. Executive Orders 11988 and 11990 and the associated regulations are location-specific ARARs for a possible Koppers Pond remediation.

2.4.1.3 New York ECL Article 24 Title 7, Freshwater Wetlands

Freshwater wetlands of New York State are protected under Article 24 of the ECL, commonly known as the Freshwater Wetlands Act. Wetlands protected under Article 24 are known as New York State regulated wetlands. The regulated area includes the wetlands themselves and a protective buffer or adjacent area that extends 100 feet landward of the wetland boundary. Regulated activities include dredging, draining, excavation, and removal of aggregate from any freshwater wetland [ECL §24- 0701(2)]. Regulations on activities are provided in 6 NYCRR Part 665; procedural requirements are specified in 6 NYCRR Part 663. The Freshwater Wetlands Act and its associated regulations are location-specific ARARs for a possible Koppers Pond remediation.

2.4.2 Sensitive Ecosystems and Habitats

2.4.2.1 Endangered Species Act

The Endangered Species Act of 1978 (16 USC §531 *et seq.*) (50 CFRs 17 Subpart I and 50 CFR 402) and subsequent amendments provide for the conservation of threatened and endangered species of animals and plants, and the habitats in which they are found. The act requires Federal agencies, in consultation with the Secretary of the Interior, to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat of such species. Exemptions may be granted by the Endangered Species Committee.

The New York Natural Heritage Program (NYNHP), under authority of NYSDEC (Section 2.3.2.4), provides information on the locations and identities of rare species to enable fully informed decision-making while protecting these sensitive resources. Appendix A of the Koppers Pond Screening-Level Ecological Risk Assessment (AMEC, 2009) compiled the correspondence with NYNHP and NYSDEC concerning whether there were reported observations of rare, threatened, or endangered (RTE) species at or near Koppers Pond. The NYNHP response letter dated November 19, 2008 stated that it had no records of known occurrences of rare or state-listed animals or plants, significant natural communities, or other significant habitats on or near the Site. In December 2008, NYNHP updated the RTE summary to include the potential presence of slender pondweed (*Stuckenia filiformis alpinus*) at or near Koppers Pond. This inclusion was based on a historical record from 1943 that this species was reported “in cold brook, Chemung Street, Horseheads.”

In September 2009, an investigation was conducted to assess the potential presence of an RTE plant, the slender pondweed, *Stuckenia filiformis alpinus* (Integral, 2010a). The sBERA concluded that the identified RTE species are not likely present at Koppers Pond. Accordingly, the endangered species regulations are not location-specific ARARs.

2.4.2.2 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 USC §662) requires consideration of the effects of a proposed action on wetlands and areas affecting streams (including floodplains), as well as other protected habitats. Federal agencies must consult with the U.S. Department of the Interior, Fish and Wildlife Service (USFWS), and the appropriate State agency with jurisdiction over wildlife resources prior to issuing permits or undertaking actions involving the modification of any body of water (including impoundment, diversion, deepening, or otherwise controlled or modified for any purpose). The requirements of this act are location-specific ARARs for possible remediation activities at Koppers Pond.

2.4.2.3 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 USC 703 *et seq.*) prohibits Federal agencies from taking or funding actions that result in the killing, hunting, taking, or capturing of any migratory birds, nests, or eggs. Koppers Pond is used incidentally by migratory birds, and this act may be an ARAR for possible remediation of Koppers Pond.

2.4.2.4 New York State ECL Article 11, Title 5 - Endangered and Threatened Species of Fish and Wildlife - Species of Special Concern

The New York State endangered species legislation enacted in 1970 was designed to complement the Federal Endangered Species Act. This act authorized NYSDEC to adopt the Federal endangered species list so that prohibitions of possession or sale of federally listed species and products could be enforced by State enforcement agents and to develop a State-specific list. The State list includes species which, while plentiful elsewhere, are endangered in New York. The law was amended in 1981 to authorize the adoption of a list of threatened species that would receive protection similar to endangered species. In addition to the threatened species list, NYSDEC also adopted a list of species of special concern for which a risk of endangerment has been documented by NYSDEC. The law and regulations restrict activities in areas inhabited by endangered species.

The sBERA review included State-listed endangered or threatened species potentially associated with Koppers Pond and concluded that such species are not likely present (Section 2.3.2.1). Accordingly, the New York State endangered species regulations are not location-specific ARARs for Koppers Pond.

2.4.3 Historic Places

Section 106 of the National Historic Preservation Act (16 USC §470 *et seq.*) requires that Federal agencies take into account the effects of their actions on any district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places. Implementing regulations for Section 106 established by the Advisory Council on Historic Preservation (36 CFR 800) provide specific criteria for identifying adverse effects of Federal undertakings on historic properties. Effects to cultural resources listed, or eligible for listing, on the National Register of Historic Places are evaluated. If the undertaking results in adverse effects, the agency must consult with the State Historic Preservation Office and other parties to develop ways to avoid, reduce, minimize, or mitigate the impact of the undertaking on historic properties.

A Stage I Cultural Resource Survey was conducted in conjunction with pre-design investigations for OU-2 of the Kentucky Avenue Wellfield Site. A recent review of those findings and other file information led USEPA to conclude that a possible remediation of Koppers Pond has a low potential to affect cultural resources and to recommend that no additional cultural resource investigations be required at this time. On this basis, the requirements of Section 106 of the National Historic Preservation Act are not location-specific ARARs for Koppers Pond remediation.

2.5 ACTION-SPECIFIC ARARS

Action-specific ARARs are technology- or activity-based requirements or limitations on remedial actions at a site. These requirements are triggered by the specific activities selected to accomplish a remedy. Because there are usually several alternative remedial actions for any site, very different requirements can come into play. These action-specific requirements do not determine the remedial alternative; rather, they indicate how a selected alternative must be applied, as well as the performance criteria.

The following sections discuss the Federal and State action-specific requirements likely to apply to the remedial alternatives for Koppers Pond. These potential action-specific ARARs are summarized in Table 14.

2.5.1 Non-Hazardous and Hazardous Waste Management

Regulations promulgated under the Resource Conservation and Recovery Act of 1976 (RCRA) (42 USC §6924) at 40 CFR 260 through 268 establish acceptable practices and minimum national standards for managing both non-hazardous and hazardous waste. RCRA regulations are a complex compendium of requirements that address the management of these wastes, as well as the siting, design, operation, and closure of facilities used to manage these materials.

Subtitle C of RCRA establishes the national hazardous waste program under which USEPA has promulgated regulations identifying hazardous wastes and setting standards for handling, transporting, and treating hazardous wastes (40 CFR 260 through 265). These requirements are applicable to alternatives that involve the on-site management or off-site transportation and disposal of materials generated after the effective date of the RCRA regulations and determined to be RCRA hazardous wastes under the source evaluation, characterization, and testing requirements for waste generators given in 40 CFR 261. None of the impacted materials associated with Koppers Pond is a listed hazardous waste, but experience from the OU-3 remediation of the Industrial Drainageway (Cummings/Riter, 2001, 2004) suggests that some sediment could exhibit the characteristic of a hazardous waste due to cadmium or other metals concentrations above their corresponding regulatory thresholds in the toxicity characteristic leaching procedure (TCLP) test. Sampling and analysis would be incorporated into remedial alternatives involving sediment removal from Koppers Pond to identify potentially characteristic hazardous wastes and determine waste treatment and off-site disposal requirements.

RCRA Subtitle D establishes minimum national criteria for management of non-hazardous waste. The regulations promulgated under RCRA Subtitle D (40 CFR 258) are applicable to remedial alternatives that involve the generation, management, or disposal of non-hazardous waste. Non-hazardous waste must be transported and disposed of in accordance with these requirements. State of New York regulations implement RCRA Subtitle D and provide additional requirements for solid waste management that are potentially applicable or relevant and appropriate to remedial actions.

The Hazardous and Solid Waste Amendments of 1984 (HSWA) set prohibitions on the land disposal of hazardous wastes (40 CFR 286 Subpart C) with the intent of reducing the toxicity and mobility of hazardous constituents in a hazardous waste prior to land disposal. HWSA banned liquid hazardous wastes and hazardous wastes containing free liquids from placement in landfills. HSWA also set treatment standards for other types of hazardous waste that must be met prior to land disposal (40 CFR 268 Subpart D). RCRA/HWSA land disposal restrictions (LDRs) and universal treatment standards (UTS) would be applicable to remedial alternatives encompassing Koppers Pond sediment removal to the extent that such sediment, if any, was determined to be a RCRA characteristic hazardous waste due to cadmium or other metals concentrations above corresponding TCLP regulatory thresholds.

Federal regulations provide for delegation of RCRA authority to states, and New York has been delegated such authority. Under ECL Article 27, New York has promulgated hazardous and solid waste management regulations that generally mirror the Federal requirements, as follows:

- 6 NYCRR Part 360 - Solid Waste Management Facilities;
- 6 NYCRR Part 361 - Siting of Industrial Hazardous Waste Facilities;
- 6 NYCRR Part 364 - Standards for Waste Transportation;
- 6 NYCRR Parts 370 and 371 - Standards for Hazardous Waste Management;
- 6 NYCRR Part 372 - Hazardous Waste Manifest System and Related Standards;
- 6 NYCRR Part 373 - Hazardous Waste Management Facilities; and
- 6 NYCRR Part 376 - LDRs.

RCRA and New York State waste regulations are potential action-specific ARARs for response actions at Koppers Pond, but which of this broad spectrum of regulations is applicable depends on the specific remedial approach and whether any materials generated in the remediation are determined to be RCRA hazardous. If not specifically applicable, certain RCRA regulations may be relevant and appropriate requirements for the various alternative response actions. In accordance with USEPA policy, the authorized portions of the New York State RCRA program, rather than the Federal regulations, constitute ARARs. Only those Federal RCRA regulations that have not been fully authorized in New York State are potential Federal ARARs.

2.5.2Toxic Substances Control Act

The Toxic Substances Control Act of 1976 (TSCA) (15 USC §2605) gives USEPA authority to require testing of both new and existing chemical substances entering the environment, including PCBs, and to regulate them where necessary. TSCA requirements (40 CFR 761.50 through 761.79) generally do not apply to PCBs at concentrations less than 50 parts per million (ppm), however, and USEPA guidance provides that the form and concentration of the PCB contamination be determined on an "as found" basis, rather than on the original form and concentration of PCB materials prior to their release. NYSDEC regulates materials with PCB concentrations greater than 50 ppm as a hazardous waste (Section 2.4.1).

OU-4 RI data, as well as data from OU-3 and other prior investigations, all show PCB concentrations in Koppers Pond sediments and other affected environmental media at concentrations much lower than 50 ppm. On this basis, TSCA regulations are not an action-specific ARAR for response actions at Koppers Pond. Sampling and analysis would be incorporated into remedial alternatives involving sediment removal to confirm PCB concentrations in all removed materials are less than 50 ppm.

2.5.3Clean Water Regulations

The Federal Water Pollution Control Act established the NPDES program (40 CFR 122) to regulate discharges to navigable waters of the United States. Permits are required for such discharges, including discharges of storm water from industrial activities and waste disposal operations. The NPDES permitting process is used to define the allowable constituent concentrations and loadings in the effluent.

New York has been delegated NPDES authority pursuant to the Federal program, and New York has developed State effluent regulations. New York State regulations set forth effluent limitations for constituents contained in point-source discharges to surface water as follows:

- New York State ECL Article 15, Title 5, and Article 17, Title 3; 6 NYCRR Part 608 - Use and Protection of Waters: These regulations cover excavation and fill of the navigable waters of the state. No person, local public corporation, or interstate authority may excavate from or place fill, either directly or indirectly, in any of the navigable waters of the state or in marshes, estuaries, tidal marshes, and wetlands that are adjacent to and contiguous at any point to any of the navigable waters of the state, and that are inundated at mean high water or tide, without a permit.
- New York ECL Article 17, Title 8; 6 NYCRR Part 750-758 - Water Resources Law: These regulations provide standards for storm water runoff, surface water, and groundwater discharges. In general, they prohibit discharge of any pollutant to the waters of New York without a SPDES permit.
- New York ECL Article 17, Title 5: These provisions make it unlawful for any person, directly or indirectly, to throw, drain, run, or otherwise discharge into such waters organic or inorganic matter that causes or contributes to a condition in contravention of an applicable standard as identified at 6 NYCRR 701.1.
- New York ECL Article 11, Title 5 - Fish and Wildlife Law: This law provides that no deleterious or poisonous substances shall be thrown or allowed to run into any public or private waters in quantities injurious to fish life, protected wildlife, or waterfowl inhabiting those waters or injurious to the propagation of fish, protected wildlife, or waterfowl.

The Federal and State discharge limitations for point source discharges associated with Koppers Pond are potential action-specific ARARs.

2.5.4 Clean Air Regulations

2.5.4.1 Clean Air Act

Clean Air Act NAAQS requirements are described in Section 2.2.4 as potential chemical-specific ARARs. The Federal Clean Air Act also establishes National Emission Standards for Hazardous Air Pollutants (NESHAPs) for source types (*i.e.*, industrial categories) that have the potential to emit hazardous air pollutants. Site remediation at facilities that are major sources of hazardous air pollutants is also regulated under NESHAPS. Section 112(a)(1) of the Clean Air Act defines major sources as those that have the potential to emit greater than 10 tons per year of any one hazardous air pollutant or 25 tons per year of any combination of hazardous air pollutants.

Koppers Pond would not be covered by any designated source type (industrial category) under NESHAPs regulations or be a major source of hazardous air pollutants. NESHAPs regulations are not likely applicable to any remedial alternatives at Koppers Pond and, based on the types and potential quantities of hazardous substances in affected environmental media, would not be relevant and appropriate requirements.

2.5.4.2 New York State ECL, Article 19, Title 3 - Air Pollution Control Law

NYSDEC regulations that pertain to air emissions are 6 NYCRR Parts 200, 202, 211, 212, 219, and 257. The emission of air contaminants that jeopardize human, plant, or animal life, are ruinous to property, or cause a level of discomfort is strictly prohibited (6 NYCRR 211). These regulations were adopted pursuant to New York State's Air Pollution Control Law and submitted to and approved by USEPA pursuant to Section 110 of Federal Clean Air Act (42 USC §7401). The USEPA-approved New York State regulations are listed at 40 CFR 52.1679.

2.5.5 Occupational Safety and Health Act

Under the authority of the Occupational Safety and Health Act of 1970, the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), has developed regulations designed to protect worker health and safety. OSHA coverage includes employers and employees in manufacturing, construction, and other fields and addresses hazards from toxic substances, harmful physical agents, trenching hazards, fires and explosions, and other workplace hazards.

OSHA regulations at 29 CFR 1910.120 set specific employee protection requirements for workers engaged in hazardous waste operations and emergency response, including CERCLA response actions. These regulations also incorporate by reference OSHA regulations for related operations. For example, OSHA defines requirements for worker respiratory protection at 29 CFR 1910.134, and the OSHA Safety and Health Regulations for Construction (29 CFR 1926) specify general safety and health requirements for the construction industry, including earthwork activities associated with remediation. OSHA regulations are applicable to possible remediation performed at Koppers Pond.

OSHA regulations at 29 CFR 1910.1200, Subpart Z, Hazard Communication, are intended to ensure employees are apprised of hazards in their workplace through a program of hazard communication (commonly referred to as "right-to-know"). The standards require each employer to establish and implement an information program, including mandated container labeling, safety data sheet distribution, and employee training. OSHA standards and employee right-to-know regulations under 29 CFR 1910.1200 are applicable and require that on-site workers be informed as to the hazardous nature of the chemicals with which they work.

2.5.6 Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act, as amended (49 USC §5101 *et seq.*), provides for the regulation of the interstate transport of hazardous materials. Under this authority, the U.S. Department of Transportation (USDOT) has promulgated Rules for Hazardous Materials Transport (49 CFR 107 and 171 through 179) to regulate the transport of hazardous materials, including packaging, transport equipment, and placarding. These USDOT rules apply to wastes shipped off-site for laboratory analysis, treatment, or disposal. Transportation of hazardous wastes from the Site would also be subject to New York regulations at 6 NYCRR Parts 364, 370, and 371.

3. REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIATION GOALS

This section describes the objectives for remedial action at Koppers Pond and the PRGs to accomplish those objectives.

3.1 REMEDIAL ACTION OBJECTIVES

RAOs describe in general terms the overall purpose of the remedial action and what the remedial action is intended to accomplish. The development of RAOs for Koppers Pond has relied on the following information, requirements, and guidance:

- Terms and conditions of the Settlement Agreement entered between the Group and USEPA on September 29, 2006;
- Results of environmental media sampling and other investigations conducted as part of the OU-4 RI and prior studies;
- Results of the supplemental (May 2013) surface sediment sampling;
- Evaluations of potential human health and ecological risks presented in the BHHRA and sBERA, respectively, and the further evaluation of risks under LWL conditions as presented in this FS Report;
- Evaluation of potential chemical-specific and location-specific ARARs and TBC guidance;
- Assessment of the range of hydrologic conditions observed in Koppers Pond and the likely effects of those changes on potential human health and ecological risks; and
- Procedures for evaluating potential RAOs as provided in the NCP and in USEPA and NYSDEC guidance.

The examination of RAOs begins with the potential objectives that might be appropriate to address impacted surface water, sediment, soils, and biota and then refining these generic objectives to Site-specific circumstances. Such potential RAOs for Koppers Pond are as follows:

- Reduce the potential for human exposure from direct contact with and ingestion of COPCs in pond sediment and exposed sediments or soils that becomes exposed under LWL conditions;
- Reduce the potential risk to human health from exposure to COPCs from fish consumption if the pond returns to AWL or HWL conditions that could support a fishery in the future;
- Maintain water quality standards in surface water; and
- Prevent potential unacceptable risks to biota from direct contact with or ingestion of COPECs in either pond sediment or sediment that is exposed under LWL conditions or in food items that become exposed to COPECs in exposed sediments or soils under LWL condition.

With respect to the first potential RAO (reduce the potential risk to human health from direct contact and ingestion of COPCs in pond sediment and mudflat soil), the BHHRA indicated that under AWL and HWL conditions the calculated excess lifetime cancer risk to the RME individual (teenage trespasser) from direct contact with Koppers Pond sediments and surface water was 9.6×10^{-7}, and the HI for non-cancer hazards was calculated as 0.03 for this receptor. Evaluation of this receptor under recently observed LWL conditions yields similar results (Table 9). The cancer risk is lower than the risk range given in the NCP (*i.e.*, 10^{-6} to 10^{-4}), and the non-cancer HI is well below the HI = 1 under all observed hydraulic conditions. At these levels, and in accordance with the NCP and USEPA guidance (1991b, 1997), remedial action is not needed to reduce the potential risk to human health from direct contact and ingestion of COPCs. Under LWL conditions, however, concentrations of cadmium in exposed sediments would exceed New York State industrial SCOs for the protection of human health (Table 5). The industrial SCOs are based on more frequent and more extensive direct contact with COPCs than would likely be associated with an infrequent trespasser, thereby indicating potential risks even though an assessment based on Site-specific factors does not show unacceptable cancer risks or non-cancer hazards. Table 5 also includes New York State SCOs for the protection of groundwater. Data collected as part of the RI did not reveal Site-related impacts to groundwater at Koppers Pond.

With respect to the second potential RAO (reduce the potential risk to human health from exposure to COPCs from fish consumption), the BHHRA indicated that, using USEPA default assumptions, the estimated excess lifetime cancer risk to the RME individual from fish consumption under HWL and AWL conditions was 3.1×10^{-4} and the non-cancer HI was calculated as 21 for the young child, 20 for the adolescent, and 16 for the adult (Table 8). The Uncertainty Section of the BHHRA discussed sustainable yields of fish and concluded the estimated RME excess lifetime cancer risk was 7.4×10^{-5} and the non-cancer HI for the child was 5.3, the adolescent HI = 5.1 and the adult HI = 3.7 (Table 8). The non-cancer HI is above the target of 1 in either case. In all cases, the cancer risk and non-cancer hazard are contributed almost entirely (*i.e.*, more than 90 percent) by PCBs (Aroclor 1254). Consistent with the NCP and USEPA guidance (1991b, 1997), and based on the assumptions described in the BHHRA, these potential health risks and hazards are a basis for possible remedial action at Koppers Pond to reduce the potential exposure to COPCs from fish consumption under potential future AWL or HWL conditions.

With respect to the third potential RAO (maintain water quality standards in surface water), the results of surface water sampling as part of the OU-4 RI indicated that COPC concentrations in pond surface water did not exceed NYCRR Title 6 Part 703 water quality standards (Table 3) under HWL or AWL conditions, and evaluations conducted in the BHHRA and sBERA showed that exposure to COPCs in surface water does not comprise a significant source of potential exposure to either the human or ecological receptors. No chemical-specific ARARs are exceeded, and the RAO is to maintain surface water quality in open water areas of Koppers Pond.

With respect to the fourth potential RAO (prevent potential unacceptable risks to biota from direct contact with or ingestion of COPCs in either pond sediment or sediment that becomes exposed sediments or soils under LWL conditions), the sBERA did not identify actionable ecological risks associated with impacted environmental media at Koppers Pond under AWL and HWL conditions. With respect to sediment that becomes exposed sediments or soils under LWL conditions or food items that become exposed to constituents in exposed sediments or soils under LWL conditions, certain COPC concentrations exceed New York State SCOs for the protection of ecological resources (Table 5).

In summary, USEPA considers both current and future conditions at sites to inform decisions. The RAOs for Koppers Pond vary depending on the hydrologic conditions in the pond. Under possible future AWL or HWL conditions, the RAOs are to reduce the potential for exposure of human receptors to PCBs from consuming fish taken from the pond. In contrast, under current LWL conditions, the fish consumption pathway is not operative, and the RAOs would be to reduce the potential exposure for human and ecological receptors from direct contact with exposed sediments with COPC concentrations exceeding the New York State SCOs for the protection of public health and to reduce potential exposure of ecological receptors from direct contact with and ingestion of exposed sediments or soils with COPC concentrations exceeding the New York State SCOs for the protection of ecological resources, as well as contaminated food items and the protection of surface water quality. These objectives provide the basis for PRGs and for establishing and evaluating a range of remedial alternatives for Koppers Pond. The RAOs can be achieved through a wide spectrum of remedial alternatives that reduce potential access to the pond for fishing, directly or indirectly reduce PCB concentrations in fish tissue, and/or reduce COPC concentrations in near-surface exposed sediments or soils. The RAOs emphasize the need to be adaptive during the remedial design phase to the hydrologic conditions evident at the pond.

USEPA (1991b, 1995) guidance requires evaluation of RAOs in consideration of both current and potential future receptors. With respect to Koppers Pond, based on current zoning, the presence of the adjacent Old Horseheads Landfill, and the lack of economic development pressure, the current use of properties surrounding Koppers Pond is not expected to change in the foreseeable future. As such, the identified RAOs address both current and future Site land use conditions (at Koppers Pond), satisfying USEPA (1995) guidance regarding potential future land use. Changes in pond hydrology are not expected to affect potential future land use.

As a result, the following RAOs have been established for OU-4 (Koppers Pond):

- Minimize exposure to ecological receptors to contaminants in exposed sediments or soils; and
- Reduce the future health risks and hazards associated with the potential future consumption of fish from Koppers Pond if AWL or HWL by reducing the concentration of contaminants in fish.

3.2 EVALUATION OF PRGS

PRGs flow from RAOs but are more-specific statements of the desired endpoint concentrations or risk levels that provide adequate protection of human health and the environment. USEPA guidance provides that, to the extent possible, chemical-specific ARARs should be used to define PRGs and that compliance with ARARs is generally considered protective (USEPA, 1997). USEPA policy is that compliance with a chemical-specific ARAR generally will be considered protective even if it is outside the acceptable cancer risk range (*i.e.*, 10^{-4} to 10^{-6}) unless there are extenuating circumstances such as exposure to multiple COPCs or multiple pathways of exposure (USEPA, 1991b).

3.2.1 Chemical-Specific ARARs, TBCs, and Other Guidance

As described in Sections 2.2.1 and 2.2.4, respectively, there are no chemical-specific ARARs that prescribe chemical constituent concentrations in sediments or fish tissue. The results of the Site-specific risk assessments are used as the basis for PRGs associated with these media. New York State water quality standards at NYCRR Title 6 Part 703 are the chemical-specific ARARs for surface water (Section 2.2.3.3).

For exposed sediments or soils under LWL conditions, the New York State SCOs for the protection of human health, groundwater, and ecological receptors are presented in Table 5. For purposes of the FS, USEPA has determined that the New York State SCOs for protection of ecological resources are protective of potential human health and ecological risks associated with soils at Koppers Pond.

3.2.2 Risk-Based Concentrations

In the absence of chemical-specific ARARs, USEPA guidance states that, for chemicals which pose cancer risks, PRGs should generally be established at concentrations that achieve a 10^{-6} excess lifetime cancer risk as the "point of departure" for remedial planning. Similarly, for individual chemicals that pose non-cancer hazards, PRGs should be established at concentrations that achieve an HQ = 1, in consideration of the cumulative effect of chemicals with the same toxic endpoint or mechanism (USEPA, 1991b, 1991c, and 1997).

Table 8 summarizes the BHHRA, which addressed human health risks associated with AWL conditions. Under those conditions, risks above the acceptable risk range were calculated based on consumption of fish taken from Koppers Pond. As shown in Table 8, of the three COPCs that contribute to the non-cancer HI under such conditions, only PCBs exhibit an HQ greater than 1. The two COPCs that contribute to cancer risks are PCBs, which contribute more than 90 percent of the total risk, and arsenic.

RBCs for Koppers Pond fish tissue and sediment were calculated by linearly proportioning current COPC concentrations in fish and sediment using the ratio of target cancer risks and non-cancer hazards to current calculated cancer risks and non-cancer hazards, as follows:

$$RBC_c = COPC_u \times \left(\frac{10^{-6}}{ELCR} \right)$$

and

$$RBC_n = COPC_u \times \left(\frac{1.0}{HQ} \right)$$

where,

RBC_c	=	Calculated RBC based on cancer risk, µg/kg;
RBC_n	=	Calculated RBC based on non-cancer hazard, µg/kg;
$COPC_u$	=	COPC concentration in current (unremediated) condition, µg/kg;
ELCR	=	Estimated excess lifetime cancer risk, dimensionless; and
HQ	=	Hazard quotient, dimensionless.

The COPC concentrations used in these calculations are the EPCs used in the BHHRA, which were calculated as 95 percent UCL values.

Tables 15 and 16 present the calculated RBCs for the RME individual for Koppers Pond fish tissue and sediment, respectively, based on the above proportioning equations. The sediment RBC calculation is based on the assumption that changes in PCB concentrations in sediment will result in linearly proportional changes to PCB concentrations in fish tissue.

A PRG of 1,000 µg/kg for total PCBs in sediments is consistent with remediation goals established by USEPA at other Superfund sites in New York State waterbodies.

3.2.3PRGs for Koppers Pond Remediation

Chemical-specific ARARs and calculated RBCs were then evaluated. AWL and HWL conditions are discussed in the following Sections 3.2.3.1 and 3.2.3.2, respectively. Under AWL and HWL conditions, Koppers Pond sediment was defined as the target of remediation, and sediment remediation, driven by PCB concentrations, provided the principal basis for developing and evaluating remedial alternatives. Under LWL conditions, metals in exposed sediments or soils drive the development and evaluation of remedial alternatives as discussed in Section 3.2.3.3.

3.2.3.1 Sediment

As discussed in Section 1.3.2.2 and shown in Table 1, PCB concentrations were detected in sediment samples taken from various locations upstream of Koppers Pond during the OU-4 RI. In some instances, the maximum detected PCB concentrations are higher than RBCs calculated to achieve a non-cancer HI = 1.0 or an excess lifetime cancer risk of 10^{-6}. In addition, some PCB contribution to Koppers Pond is likely associated with the Industrial Drainageway, albeit substantially reduced from pre-remedial conditions. In the ROD for OU-3, USEPA specified a goal for the Industrial Drainageway sediment remediation of 1,000 µg/kg total PCBs to mitigate human health risks from fish consumption and direct contact with sediments (USEPA, 1996). The achieved residual PCB concentration in post-remedial soil and sediment samples averaged 307 µg/kg (Cummings/Riter, 2004).

These data suggest that the very low RBCs calculated for Koppers Pond sediment may not be feasible as long-term PRGs. To be sustainable, sediment PRGs for Koppers Pond, which acts as a sediment trap for inflows from the Industrial Drainageway and other runoff, would need to take into consideration the potential impacts of upstream sediment concentrations.

For this reason, a PRG of 1,000 µg/kg total PCBs in Koppers Pond sediment will be used in the evaluation of remedial alternatives in the FS. This PRG is the same as that determined by USEPA to be protective of human health in the OU-3 ROD and applied to the remediation of Industrial Drainageway sediment. Because the sediment PRG is based on reducing PCB concentrations in fish tissue, attainment of this PRG is primarily evaluated for surface (0-to 6-inch) sediments in Koppers Pond. The 0- to 6-inch sediment layer is the biologically active zone, and attainment of the PRG in this layer should achieve the RAO of reducing exposures to PCBs in fish tissue. Attainment of the PRG in all pond sediments, regardless of depth, is also considered in the evaluation of remedial technologies and alternatives and is assessed in the individual and comparative detailed analysis of remedial alternatives (Section 7). A PRG of 1,000 µg/kg for total PCBs in sediments is consistent with remediation goals established by USEPA at other Superfund sites in New York State waterbodies.

As discussed in Section 2.2.3.3, the New York State water quality standard for the protection of benthic aquatic life (0.014 µg/l) is applicable to the pore water of the sediment, and USEPA (1990) guidance on remedy selection for PCB-impacted Superfund sites provides an approach for determining PRGs for PCBs in freshwater sediment based on pore water concentration and equilibrium partitioning. The governing equation is as follows:

$$C_s = C_w \times K_{oc} \times f_{oc}$$

where,

C_s	=	calculated PCB concentration in sediment, µg/kg;
C_w	=	applicable surface water quality standard, µg/l;
K_{oc}	=	water-organic carbon partitioning coefficient, liters per kilogram; and
f_{oc}	=	fraction of organic carbon in sediment, dimensionless.

In this calculation, C_w is the New York State water quality standard for protection of benthic aquatic life (0.014 µg/l). Using an average TOC of 7 percent in Koppers Pond sediment and a log K_{oc} of 6.14 per the USEPA (1990) guidance, the corresponding PCB concentration in sediment protective of benthic aquatic life and consistent with the New York State water quality standard is 1,400 µg/kg.[18] Accordingly, a PRG of 1,000 µg/kg total PCBs in sediment is protective of pore water quality.

To determine whether there is the potential to exceed the remaining two New York State water quality standards for PCBs (*i.e.,* 1.2 x 10^{-4} µg/l for the protection of wildlife bioaccumulation and 1 x 10^{-6} µg/l for protection of human health based on fish consumption), pond water PCB concentrations were estimated based on the passive diffusion of PCBs from pore water to pond water.[19] Based on a calculated pore water concentration of 0.065 µg/l, the hydrologic characteristics of Koppers Pond, and the diffusivity of PCB in water, the estimated pond water PCB concentration (6.1 x 10^{-11} µg/l) is several orders of magnitude less than the most conservative NYSDEC surface water criterion. These calculations are provided in Appendix A. On this basis, a PRG of 1,000 µg/kg total PCBs in sediment is protective of pond water quality.

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18 The USEPA guidance document is based on Aroclor 1242. Although Aroclor 1254, which is characteristic of the PCBs present in Koppers Pond sediment, is much less soluble and would partition more strongly to solids (resulting in a much higher C_s), the K_{oc} value used by USEPA (1990) for Aroclor 1242 is approximately equal to what would be calculated for Aroclor 1254 using the equations provided in Lyman, *et al*. (1982). On that basis, the calculation of C_s for Aroclor 1254 applied the same chemical properties as were used by USEPA (1990) for Aroclor 1242.

19 The calculations were performed for water-level conditions between defined AWL and LWL conditions.

3.2.3.2 Fish Tissue

For the AWL or HWL scenario, the calculated RBCs for fish tissue can be useful as metrics for evaluating the progress of remediation, but such calculated values need to be applied with caution. While remedial technologies for fishery management will be evaluated, there are few options for actions that can be taken to directly reduce PCB or other COPC concentrations in fish tissue.

Rather, remediation addresses calculated human health risks by reducing potential consumption or by reducing total or bioavailable concentrations in sediment that, in turn, leads to reductions in concentrations in fish tissue. The underlying assumption is that reductions in total or bioavailable concentrations in sediment will result in a corresponding reduction of concentration in fish tissue, but that quantitative relationship, both in terms of degree and timing, cannot be defined prior to remediation and development of Site-specific empirical data. USEPA has determined that active remediation of PCB-impacted sediments to 1,000 µg/kg, continuation of the existing fish consumption advisory, followed by long-term monitored natural recovery are expected to reach the remediation goal for sediments to address possible future human consumption of fish tissue and ecological endpoints.

The 2008 fish and sediment data were evaluated to determine whether the calculation of a Site-specific biota-sediment accumulation factor (BSAF) for PCBs would be useful to support the development of a PRG. There are two major limitations with such calculations. First, the biota and sediment samples were not paired spatially, which results in greater uncertainty of the calculation value since the average sediment concentrations are used to derive the BSAFs. Second, the calculated BSAFs for the gamefish and larger forage fish were highly variable, even when the fish concentrations were normalized to lipid content and sediment concentrations were normalized to organic carbon content, which would reduce the predictive power of the BSAFs. Therefore, there was little utility in applying a site-specific BSAF to develop fish tissue PRGs.

Therefore, the RBCs for fish tissue will not be set as PRGs but used as guidance in evaluating the rate at which attenuation of PCB concentrations in the pond is occurring. The evaluation of remedial technologies specifically examines approaches designed to reduce PCB and other COPC concentrations in fish tissue to their lowest practical levels and alternatives using such approaches are addressed in both the individual and comparative detailed analysis of remedial alternatives (Section 7).

3.2.3.3 Soils

Under the current LWL conditions, certain former pond sediments are exposed and considered to be soils, subject to the New York State SCOs as potential chemical-specific ARARs, TBCs, or other guidance for the protection of human health, groundwater, and ecological resources. With respect to SCOs for the protection of public health, the industrial values in soils are presented based on current and anticipated future land use. The SCOs for metals and PCBs for protection of ecological resources are lower than those for protection of human health or groundwater. For PAHs, the controlling objectives vary.

A comparison of 95-percent upper confidence limit of mean shallow sediment concentrations with the SCOs listed in Table 5 shows that the SCOs for ecological resources are exceeded for barium, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc, with cadmium concentrations also exceeding industrial SCOs. As such, these SCOs for the protection of ecological resources are used as PRGs for exposed soils.[20] It is noted that concentrations of these

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[20] Table 5 shows the EPCs for certain PAHs exceed the corresponding SCO for sediments in the outlet channel. As described in Section 1.3.4.2, however, this situation results from the PAH concentrations in one outlet channel sample (SD08-15) which was collected near where railroad ties had been placed by others across the channel for use as a low-water crossing. Other outlet

metals in some sediment samples collected upstream of Koppers Pond also exceed the SCOs for ecological resources (Table 1). Table 5 identifies the PRGs for OU-4.

channel samples exhibit very low PAH concentrations, and PAH concentrations in these samples as well as pond sediment samples do not exceed SCOs.

4. GENERAL RESPONSE ACTIONS AND AFFECTED SITE AREAS

This section describes the general response actions and the affected environmental media at Koppers Pond. These media are primarily described under the AWL condition corresponding to the 2008 field studies for the RI. Effects of hydrologic changes on these media are also addressed.

4.1 GENERAL RESPONSE ACTIONS

Based on the established RAOs, PRGs, and RBCs, general response actions would be needed to address potential exposure to COPCs. Sediment remediation, driven by exposure to PCBs through the consumption of fish under potential future AWL/HWL conditions and soil (exposed sediment resulting from lower levels of water in the pond) remediation driven by metals concentrations under water level conditions that are below AWL conditions, provide the principal basis for developing and evaluating response actions.

Under the range of hydrologic conditions observed during the RI/FS process, potential general response actions encompass a wide spectrum of institutional and engineering controls, containment, removal, and treatment options that are protective of human health and the environment and are compliant with ARARs. In accordance with the NCP, the No Action alternative is carried through the evaluation process for comparison.

4.2 AFFECTED SITE AREAS

Under OU-4, affected environmental media are limited to Koppers Pond and its outlet channels. As described in Section 1.2.2, this area comprises an area of approximately 12 acres which Koppers Pond formerly occupied under HWL conditions, defined by a corresponding pond water elevation of approximately 887 to 888 ft-msl (Figure 3). While the size of the water body referred to as the Pond has reduced in recent years because of changes in the nature and volume of discharges to the Industrial Drainageway, among other things, the full 12-acre area of the former Pond area is addressed by OU-4. The 12 acres are generally bounded by the Old Horseheads Landfill to the north and northeast, the Conrail tracks to the west, and an area of the Kentucky Avenue Wellfield property to the south. Waters from Koppers Pond historically have discharged via an outlet stream to its south, which ultimately drains to Newtown Creek.

In the 2008 RI sampling, the pond bottom was found to be comprised of soft sediments that ranged in thickness from 0 to 38 inches. A native, hard clay layer generally underlies the soft sediments except for an area in the eastern leg of the pond where the underlying soils are sand and gravel. The solids content of the sediments ranged from 21 to 59 percent for the surface (0- to 6-inch) sediment and from 34 to 67 percent for deeper sediments. On this basis, the total quantity of pond sediments on a dry-weight basis (defined by AWL conditions) is estimated to be approximately 12,000 tons. This total does not include the approximate 3 acres of mudflats that are exposed at AWL conditions but inundated at HWL conditions.

Based on the 2008 RI data, approximately 11,700 cy of the total sediment quantity (54 percent) exceeded the 1,000 µg/kg PRG for PCBs, and about 2,100 cy of surface (0- to 6-inch) sediment (29 percent) exceeded this value. However, none of the surface sediment collected in the 2010 sampling (5 locations) or 2013 sampling (14 locations) exceeded the 1,000 µg/kg PRG for PCBs. None of the outlet channel or mudflat soil samples exceeded this PRG.

In the case of LWL conditions, default New York SCOs for the protection of ecological resources are exceeded by metals concentrations in some former pond sediment samples. OU-4 sediment sampling locations from 2008, 2010, and 2013, along with corresponding metals concentrations, are shown in Figures 10 through 12. As indicated in these figures, outlet channel and mudflat samples collected in 2008 and 2010 generally did not show exceedances of the default New York SCOs for the protection of ecological resources.

Under HWL and AWL conditions, impacted gamefish and larger forage fish are generally confined to Koppers Pond with limited movement upstream in the Industrial Drainageway or downstream in the outlet channels. No fishery of gamefish or larger forage fish is supported under current LWL conditions.

Figure 3 generally depicts the areas in Koppers Pond corresponding to HWL, AWL, LWL conditions and the areas identified as mudflats. [21]

[21] Even more recent observations of the pond show that no open water remains, which is thought to be due to dry conditions during the spring and early summer of 2016.

5. IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

Based on the RAOs, PRGs, and RBCs described in Section 3, this section identifies remedial technologies and process options applicable to each general response action for Koppers Pond. In accordance with the NCP and USEPA guidance, the identified remedial technologies and process options are then evaluated on the basis of effectiveness, implementability, and cost to select and retain one or more representative processes for each general response action and, if practicable, remedial technology. Technologies are evaluated for the range of hydrologic conditions that have been observed at the pond over the course of the RI. Remedial technologies may need to be revisited in designing and implementing any selected remedy, depending on conditions evident in the future.

Table 17 provides a compendium of general response actions, remedial technologies, and process options potentially applicable to Koppers Pond. The following subsections discuss these technologies and their potential applicability (*i.e.*, effectiveness, implementability, and cost). The evaluations are summarized in Table 18. Tables 17 and 18 are structured to describe components that can be assembled in various combinations to comprise comprehensive remedial alternatives. Capital costs are presented for specific process options, whereas operation, maintenance, and monitoring (OM&M) activities and costs are listed separately.

Estimated and assumed quantities applicable to various remedial action components (*e.g.*, surface areas, volumes) that were used as the basis of the preliminary cost evaluations are presented in Section 4.2. Unit costs, derived from USEPA guidance, published construction cost estimating references, and remediation experience, were applied to the estimated quantities to assess these relative costs.

For the summary evaluations of remedial technologies and process options presented in Table 17, relative costs are generally categorized as follows:

- Low - less than $100,000;
- Mid-Range - $100,000 to $500,000;
- High - $500,000 to $1,000,000; and
- Very High - greater than $1,000,000.

From these evaluations, wherever feasible, one or more representative processes were selected and retained for each general response action, including feasible containment, removal, and treatment options. No principal threat wastes are associated with Koppers Pond, and USEPA guidance regarding treatment of principal threat waste (USEPA, 1991a) is not applicable.

USEPA's policy is that there is no presumptive remedy for impacted sediment sites, regardless of the COPC or level of risk (USEPA, 2002; 2005), and USEPA guidance further cautions that the remedy selection process for sediment sites should include a clear analysis of the uncertainties involved, including uncertainties concerning the predicted effectiveness of various alternatives and the timeframes for achieving RAOs. For any response action to be successful, any continuing sources of COPCs to Koppers Pond must be abated, and to this end, known sources have indeed been addressed. Treated industrial wastewater discharges from the former Westinghouse Horseheads plant site have been eliminated, and remediation of the Industrial Drainageway was completed in 2003. As indicated in Section 3.2.3.1, however, the potential exists for the influx of low-level concentrations of PCBs (or metals and PAHs) to Koppers Pond from storm water run-off in the watershed and the Industrial Drainageway. The PRGs for COPCs in Koppers Pond sediment were established consistent with USEPA guidance.

5.1 NO ACTION

The No Action alternative serves as a baseline against which overall effectiveness of the active alternatives can be compared, as required under CERCLA and the NCP. Under the No Action alternative, no activities would be implemented to remove, contain, or treat sediment or soils. As the baseline condition, existing deterrents to trespassing (*e.g.*, partial fencing, no trespassing signs) and the current NYSDOH fish consumption advisory would remain in place, but are assumed to be no more (or no less) effective than they are currently. In addition, no additional action would be taken to reduce potential exposures from consuming fish taken from Koppers Pond, and no action would be taken to protect human health and ecological receptors from risks associated with contact with exposed sediments or soils. Although revegetation is occurring naturally which may provide some isolation of COPCs from human health receptors, the no action alternative would not include any long-term monitoring to assess the extent of or effectiveness provided by revegetation. The No Action alternative does not achieve the RAOs of reducing potential human health or ecological risks in the short term. Natural processes (*e.g.*, sedimentation) would be expected to continue and similarly, with time, a layer of dead and decaying vegetation would accumulate atop newly exposed sediments providing a degree of natural cover. No monitoring would be conducted to assess progress or provide the basis for future decision-making regarding changes to institutional controls (*e.g.*, deed notices, fish consumption advisories).

The No Action alternative is easily implemented, and it involves no cost. In accordance with the NCP and USEPA guidance, the No Action alternative is carried through the alternatives evaluation process to provide a baseline from which the performance of action alternatives can be assessed.

5.2 ENGINEERING AND INSTITUTIONAL CONTROLS

Engineering and institutional controls comprise a wide variety of possible response actions, including access restrictions, fencing, fish consumption advisories, monitoring and maintenance, deed notices, restrictive covenants, and fishery management. These controls can serve as effective remedial components in combination with other technologies or, in some instances, as stand-alone response actions.

5.2.1 Access Restrictions

At Koppers Pond, if AWL or HWL conditions were returned, potential human health risks are associated with the consumption of fish taken during recreational fishing. The pond is primarily located on private industrial property, and the remainder is on property owned by local governmental bodies, including the Village of Horseheads (Old Horseheads Landfill property) and the EWB (Kentucky Avenue Well property). At present, access to Koppers Pond is not permitted, and the pond is partially fenced and posted "No Trespassing." Anglers who use the pond are trespassing. Under the current LWL conditions, the pond does not support a substantial fishery, and risks are primarily associated with trespassers contacting exposed sediments.

Additional measures to control access to Koppers Pond as a means to discourage recreational fishing and trespassing are considered implementable. Access controls can take the form of physical controls, including expanding the existing fencing to completely enclose the pond, posting of additional signage, and security inspections.

5.2.1.1 Fencing and Security

Fencing and security are effective in minimizing inadvertent access, but require active and routine inspection and maintenance to remain effective in the longer term. Fencing and security could reduce potential exposure associated with consuming fish from Koppers Pond under AWL or HWL condition or from contacting exposed sediments under LWL conditions. These process options could achieve certain RAOs in the short term. Fencing and security are readily implementable in the short term and have low to mid-range capital and annual costs. Total life-cycle costs for extending these restrictions in the long term can become mid-range to high. These options are retained for further evaluation as a component of remedial action alternatives. Deed Notices and Restrictive Covenants

Institutional controls in the form of deed notices and restrictive covenants are frequently used at Superfund sites to reduce potential future risks at locations where residual impacted environmental media contain COPCs at concentrations that are not protective for all uses. A deed notice notifies future Site owners at the time of property transfer of environmental conditions at the site. Restrictive covenants (or deed restrictions) are designed to limit future Site activities.

At Koppers Pond, deed notices and restrictive covenants could have applicability associated with changes in land use and certain types of intrusive activities. Deed notices and restrictions on the properties on which Koppers Pond is located, as well as a surrounding buffer area, could be employed to prohibit changes in land use or activity that could potentially lead to increased pond access (*e.g.*, residential land use), and specific restrictions could be used to limit the types of activities that could be performed in the pond if affected sediments or soils remain in place, with or without containment (*e.g.*, capping). These institutional controls would be relatively easy to put in place at the Site.

Deed notices and restrictive covenants are considered implementable at this Site, as certain members of the Group own most of the property on which Koppers Pond is located.[22] Placing a deed notice or restrictive covenant involves low cost, although such instruments can, at times, impact the value of the affected as well as adjacent properties. The options of deed notices and restrictive covenants are retained for further evaluation as a component of remedial action alternatives.

5.2.1.2 Fish Consumption Advisory

NYSDOH first issued a fish consumption advisory for Koppers Pond in 1988 under AWL/HWL pond conditions when the pond could sustain a fish population, and a consumption advisory has been in effect for Koppers Pond continuously since that time. The current NYSDOH fish consumption advisory is for women under 50 years and children under 15 years not to eat any fish from Koppers Pond. For all others, the recommendation is to eat no more than one meal per month of carp and four meals per month of other species of fish from Koppers Pond (NYSDOH, 2014).

USEPA does not consider a fish consumption advisory to represent a final remedy, but such advisories can be a useful risk-management tool for reducing potential exposure to COPCs in fish taken for human consumption. In evaluating remedial alternatives for Koppers Pond, including the No Action alternative, it is assumed that the existing fish consumption advisory will remain and be updated by NYSDOH. The existing fish consumption advisory will remain in effect until NYSDOH concludes that the consumption advisory can be removed. NYSDOH periodically reviews fish data to ensure the advisories are up to date and considers whether the fish consumption advisories need modification.

5.2.2 Monitoring and Maintenance

5.2.2.1 Physical Monitoring

If impacted environmental media are left in place, with or without containment, long-term physical monitoring could reduce the potential for contact with and exposure to these materials. Specific physical monitoring activities might include routine inspections of access controls for indications of trespassing and activities that could lead to exposure. Physical monitoring could also be performed to enforce deed restrictions and other institutional controls. It could also protect against encroachment into the Site or established buffer zones by development activity. For some alternatives (*e.g.,* capping), physical monitoring could involve periodic surveys and probing of the cover layer to assess cap stability and thickness.

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[22] EWB owns a portion of the property on which Koppers Pond is situated but has not participated in the RI/FS process.

Physical monitoring is considered an essential component of any remedy in which access is restricted or affected materials are left in place. Physical monitoring is easily implemented in the short term and involves low annual costs. Implementation over long timeframes requires commitment and communication of requirements in the future, and implementability (*i.e.*, reliability) decreases with time. Total life-cycle costs for extending such monitoring in the long term could become mid-range. This process option is retained for further evaluation as a component of remedial action alternatives.

5.2.2.2 Chemical Monitoring

For sediment remediation projects, as may be associated with Koppers Pond under AWL or HWL conditions, whether sediments are removed or left in place, monitoring would typically include chemical monitoring to provide an ongoing assessment of the progress of remediation. Specific monitoring activities could include surface water monitoring, fish surveys, fish sampling and tissue analysis, benthic community studies, sediment toxicity testing, sediment chemical and physical analysis, and soil invertebrate and small mammal tissue analysis. Such monitoring is readily implemented and involves low cost in the short term. Long-term implementation requires commitment and communication of requirements. Total life-cycle costs for continuing monitoring in the long term could become mid-range to high, depending on the scope and required duration of the chemical monitoring. This process option is retained for further evaluation as a component of remedial action alternatives. Post-remedial chemical monitoring is not typically associated with soil remediation projects, as may be associated with Koppers Pond under LWL conditions, unless there is a potential ongoing or future contribution of COPCs.

5.2.2.3 Maintenance

Maintenance is an essential component of any remedy involving the use of physical controls for materials left on-site, including access controls (*e.g.*, fencing) or containment systems (*e.g.*, capping). Such maintenance activities are considered implementable and generally involve low annual costs in the short term. If such maintenance is required in the long term, however, total life-cycle costs could become mid-range to high, and implementability (*i.e.*, reliability) could decrease over long timeframes. Maintenance is retained for further evaluation as a component of remedial action alternatives.

5.2.2.4 Fishery Management

If AWL or HWL conditions in Koppers Pond returned for a sufficient period of time to establish a viable fishery, fishery management could be an effective component in the overall management of potential risks associated with consumption of fish taken from Koppers Pond. Fishery management could involve periodically harvesting portions of the fish population, especially older, larger fish (*e.g*., carp) or target gamefish (*e.g*., largemouth bass) in which PCBs are likely to be present at greater concentration than in other fish. As long as doing so would not increase risk or create an attractive nuisance, the removed fish could be replaced by stocking similar or alternate species tolerant of the warm water conditions of the pond. This fish replacement could effectively reduce the EPCs of PCBs and other COPCs available to potential human receptors (*i.e*., anglers) and higher trophic level ecological receptors.

A one-time event would likely not achieve RBCs in fish tissue, but an ongoing program of fish harvesting and restocking could be an effective risk-management tool for reducing COPC concentrations with the goal of achieving RBCs. Fish harvesting would not materially affect the overall mass of PCBs in Koppers Pond but would reduce the human exposure potential.

Fishery management through harvesting and restocking is implementable for Koppers Pond under AWL or HWL conditions. Based on an assessment of the inlets and outlets to the pond and observation made during the OU-4 RI field studies of the pond, Koppers Pond represents a closed system in which the gamefish and larger forage fish are essentially confined to the pond, and these fish do not migrate into or escape the pond from connecting streams or channels.

The cost of a fishery management program is expected to be low to mid-range depending on the frequency and duration of harvesting and stocking cycles and the scope of attendant chemical monitoring. The process option of fishery management is retained for further evaluation as a component of remedial action alternatives if AWL or HWL conditions were returned.

5.3 CONTAINMENT

In inundated areas at Koppers Pond (*i.e.*, the pond under AWL and HWL conditions or the residual open water areas under LWL conditions), containment response actions involve the in-place, subaqueous covering of impacted sediments, and a soil cover for exposed sediments/soils under LWL conditions.

5.3.1 Subaqueous Capping

Subaqueous capping refers to the placement of a covering or cap of clean material over impacted sediments that remain submerged in place. Depending on the COPCs and sediment conditions present, an isolation cap is generally designed to reduce risk through the following functions (USEPA, 2005):

- Physical isolation of the impacted sediments to reduce exposure due to direct contact and to reduce the ability of burrowing organisms to move COPCs to the cap surface;
- Stabilization and erosion protection of impacted sediments to reduce resuspension and transport of COPCs into the water column; and
- Chemical isolation of impacted sediments to reduce exposure from dissolved COPCs that may be transported into the water column.

In addition, subaqueous caps enhance natural processes by providing a substrate that can be repopulated to develop a biologically active zone of sediments with reduced concentrations of COPCs. Reactive subaqueous caps that provide a degree of *in-situ* treatment by removing COPCs from advective flow or diffusion from underlying sediments are discussed in Section 5.6.2.1.

Subaqueous caps are generally constructed of inert materials (*i.e.*, clean sediment, sand, or gravel) and may also incorporate geotextile stabilization fabrics or low-permeability liners. Various innovative isolation capping materials have also been undergoing performance evaluation and are becoming commercially available. Cap thicknesses depend on design objectives and Site-specific factors, especially the hydrodynamic environment of the water body where the cap is being placed. The capping material is introduced and spread in thin layers using barge-mounted cranes and clamshells or by multiple passes of barge and hopper systems. Sand cannons and other broadcast methods may also have some applicability, especially in areas of very shallow water.

Impacted sediments are left in place in the aquatic environment where COPCs could be exposed or dispersed if the cap is significantly disturbed or if COPCs move through the cap in sufficient quantities. The capping material provides the substrate for benthic recolonization.

The initial assessment of the following key factors indicates that a subaqueous capping system would be technically feasible, effective, and implementable at Koppers Pond:

- Koppers Pond is not used in navigation, and maintenance of a minimum water depth for navigation is not a concern;
- With proper design, hydrodynamic conditions (*e.g.*, floods, ice scour) are not likely to compromise the cap; and
- Interaction between the pond and groundwater is not significant, and rates of advective flow are not likely to create unacceptable COPC releases.

Technical issues that would need to be resolved to confirm technical feasibility and applicability include the following:

- Short-term habitat destruction caused by cap placement weighed against long-term risk reduction;
- Impacts of fill placement in Koppers Pond, including potential effects on downstream flood protection; and
- Geotechnical properties of the sediment, especially the compressive strength needed to support a cap and maintain long-term integrity without excessive settlement.

Subaqueous capping would not be applicable to areas of the pond that are no longer submerged due to the decrease in water levels following cessation of the OU-2 groundwater discharges. Section 5.3.2 discusses containment technologies for exposed sediments/soils.

The pond and its surrounding area are entirely within the 100-year floodplain (FEMA, 1996). To avoid filling a large portion of the pond entirely and to comply with the location-specific ARARs established by USACE regulations under Section 404 of the Clean Water Act (Section 2.3.1.1) and corresponding State of New York regulations (Section 2.3.1.3), the cap thickness would need to be kept to the minimum practicable (*i.e.*, 6 inches) and the pond outlet structure may need to be modified to maintain the pond water level above the cap. In addition, the pond may need to be deepened by sediment removal to accommodate the cap, but this potential is mitigated somewhat because, in environments like Koppers Pond with low-density sediments, placement of a subaqueous cap can result in appreciable consolidation of the underlying sediments, offsetting, at least in part, the thickness of the placed materials.

In this case, sediment removal to accommodate the placement of capping materials would be counterproductive. The surface (0- to 6-inch) sediments in Koppers Pond exhibit lower PCB concentrations than deeper sediments. Based on the May 2008 data set,[23] the arithmetic mean PCB concentration in the 0- to 6-inch sediments is 840 µg/kg versus 2,000 µg/kg in the 6- to 18-inch depth interval, and 2,400 µg/kg in the 18- to 30-inch depth interval. Furthermore, all 14 locations sampled as part of the 2013 supplemental (2013) sampling showed PCB concentrations less than the 1,000 µg/kg PRG.

Subaqueous capping systems require periodic monitoring to evaluate the long-term integrity of the cap. A well-designed subaqueous capping system should require little to no maintenance in a relatively quiescent pond environment.

The cost of subaqueous capping is comprised of material and placement costs and can vary widely depending on the cap thickness and materials employed. Depending on the open-water area to be addressed, subaqueous capping at Koppers Pond could involve mid-range to very high capital costs. These costs are in addition to the costs of any required pre-removal (Section 5.4.1) to accommodate the cap.

The process option of subaqueous capping is retained as a containment response action for assembling and evaluating remedial alternatives. Based on the geometry and hydrodynamics of the pond, the cap thickness would be kept to the practical minimum (*i.e.,* 6 inches), and the design objectives would focus on providing a biologically active zone of the pond bottom with reduced COPC concentrations.

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[23] The data set from 2008 is used in this comparison because vertical profiling of concentrations in sediment was only performed in the 2008 sampling. As noted in Section 1.3.3 and shown in Table 2, however, surface sediments exhibited lower PCB concentrations where co-located samples were collected in 2010, and none of the five surface sediment samples collected in 2010 exhibited a PCB concentration in excess of the 1,000 µg/kg PRG. Furthermore, all 14 locations sampled as part of the 2013 supplemental sampling showed PCB concentrations less than the 1,000 µg/kg PRG.

5.3.2 Soil Cover

Under LWL conditions, exposed sediments/soil could be covered by clean soil material using traditional soil capping methods to isolate these materials and interrupt the direct-contact pathway for both human and ecological potential receptors. Construction materials would consist of clean soil that has been tested from an off-site source and may also include one or more geotextile fabrics as needed to facilitate placement of the soil. The soil cover would be revegetated with a seed mix appropriate for site-specific conditions (*e.g.*, wetlands, transition zone, uplands). The thickness would depend on design objectives and site-specific factors (*e.g.,* minimizing placement of fill in a floodway), and the cover soil would be placed using conventional construction equipment. Technical issues would be similar to those identified for subaqueous caps, including floodplain considerations and habitat destruction.

Soil cover systems require periodic physical monitoring to evaluate the long-term integrity of the cap. A well-designed soil and vegetative cover system should require little to no maintenance in an undisturbed environment.

The cost of a soil cover is comprised of material and placement costs and can vary depending on the cap thickness and materials employed. Placement of a soil cover at Koppers Pond would be expected to involve mid-range capital costs.

The process option of a soil cover is retained as a containment response action for assembling and evaluating remedial alternatives. Based on the geometry and hydrodynamics of the pond, the cap thickness would be kept to the practical minimum, and the design objectives would focus on interrupting direct-contact pathways and providing a suitable vegetative cover and positive drainage.

5.4 SEDIMENT AND SOIL REMOVAL AND DISPOSAL

Localized or pond-wide removal of impacted sediments can be accomplished by excavation (*i.e.*, removal conducted after the surface water is diverted and the pond is drained) (Section 5.4.1.1) or by dredging (*i.e.*, removal conducted under water) (Section 5.4.1.2) as a direct means of eliminating COPCs from the aquatic environment. An excavation or dredging alternative involves multiple steps of materials handling, including removal, staging, dewatering, water treatment, sediment transport, and sediment disposal. Soil removal is accomplished using standard excavation practices (Section 5.4.1.4).

The following sections discuss removal, materials handling, and disposal process options. Remedial technologies and process options for physical treatment of removed sediments and soils (*e.g.*, dewatering, stabilization) are discussed in Section 5.6.1.

5.4.1 Sediment and Soil Removal

Removal of impacted sediments and soils could allow for the attainment of RAOs for Koppers Pond. The principal limitations of sediment removal are that it is usually more complex and costly than *in-situ* management, it is highly disruptive to the existing environment, and the achieved results (*e.g.*, reductions in COPC concentrations in fish tissue) may not be commensurate with the level of effort. Similar to subaqueous capping, sediment removal involves at least a temporary destruction of the aquatic community and habitat within the remediation area. Localized sediment removal can be effective in removing “hot spots” where COPCs exceed PRGs for PCBs. Because in most areas of the pond PCB concentrations in sediments increase with depth, removing the surface (0- to 6-inch) sediments and leaving underlying sediments would not be beneficial.

The following factors indicate that sediment removal, by either excavation or dredging, would be technically implementable at Koppers Pond:

- Most of the existing shoreline areas, except for the steeper slopes on the north side associated with the Old Horseheads Landfill, allow for access to the pond as needed to support excavation or dredging operations, and maneuverability and access are not unduly impeded by piers, buried cables, or other structures; and

- Impacted sediment overlies a well-defined pond bottom.

Similar considerations apply to excavating impacted soil, and soil excavation is technically implementable at Koppers Pond. The PRGs for soils include metals and PCBs.

Expected costs for sediment or soil removal from Koppers Pond would be moderate to very high depending on the quantity to be addressed.

5.4.1.1 Sediment Excavation

Excavation of sediment is a straightforward process option that can facilitate subsequent *ex-situ* treatment and disposal. Excavation is conducted "in-the-dry" and requires removal of standing water from the excavation area. For localized hot-spot removal, temporary structures (*e.g.*, cofferdams constructed using sheet piling or soil dikes) can be used as needed to isolate the excavation area so that the surface water within the containment can be pumped out. Pond-wide sediment excavation would require that surface water inflow to the pond, primarily associated with the Industrial Drainageway, be intercepted and diverted to the outlet channels downstream of the pond. This surface water diversion would involve constructing dams at the downstream end of the Industrial Drainageway and at the outlet channel entrances and bypass pumping around the pond. Accumulated water from within the pool formed by the dams would also need to be removed by pumping. Temporary dewatering of the pond would allow improved control of the removal process and less potential for resuspension of constituents in the water, and working "in-the-dry" can also provide the opportunity for sediments to be dewatered in stockpiling and handling excavated materials.

Basic unit costs to excavate and stockpile excavated sediments are typically in the range of $10 to $20 per cy, but costs for surface water diversion can add significantly to these costs. Subsequent handling of stockpiled materials is not included in these costs and would depend on the degree of drying that needed to be achieved.

5.4.1.2 Sediment Dredging

Removal of the sediments from Koppers Pond could also be accomplished by dredging, thereby avoiding the need for diverting surface water inflows. Dredging would only be applicable to submerged sediments overlain by at least several feet of water. Dredging is not applicable to sediments in very shallow water areas or to sediments that are no longer inundated due to lowered pond water levels.

Dredges are typically mounted on a barge or similar vessel, and dredging is accomplished either mechanically (*e.g.*, clamshells, hydraulic excavators) or hydraulically. Given the generally quiescent conditions of the pond and the relatively thin sediment layer, use of a floating, barge-mounted dredge would appear feasible and practicable for deeper open-water areas observed under AWL or HWL conditions. Even under AWL or HWL conditions, however, the shallow surface water (*i.e.*, less than 1 to 5 feet) would provide some design and construction challenges, and a specialty shallow-draft mini-dredge would likely be required. Also, depending on the pond water level at the time of dredging, the pond outlet channel entrances would possibly need to be reconfigured to ensure sufficient water depth to allow the dredge access to the upper portions of the western leg of the pond.

For a small hydraulic dredge operating in relatively shallow water, dredging costs are typically $15 to $30 per cy of sediment. These costs do not include the $50 to $100 per cy in costs associated with sediment handling and mechanical dewatering.

5.4.1.3 Retained Sediment Removal Process Options

The remedial technology of sediment removal is retained for further evaluation as a component of remedial alternatives involving *ex-situ* treatment and disposal technologies. Excavation and dredging are both effective and implementable, and the selection between these two process options relates primarily to cost and implementability. For pond-wide sediment removal, excavation in the dry may be more practical than dredging, especially where the overlying water depth is shallow. Temporary dewatering of the pond would allow improved control of the removal process and less potential for resuspension of constituents in the water column. Based on its broader applicability and flexibility, sediment excavation is retained as a process option for development of remedial alternatives.

5.4.1.4 Soil Excavation

Soil excavation is a straightforward process using heavy construction equipment that is used in advance of subsequent *ex-situ* treatment or disposal. Soft and wet soil conditions could require special (*i.e.*, low ground-pressure) equipment or other means for achieving access to all soils to be excavated. Excavated soils will have a high water content and may need to be stockpiled to drain or dry before further handling. Surface water management when excavating near the pond shore would also require special planning and design. Basic unit costs to excavate and stockpile excavated soils are typically in the range of $10 to $20 per cy. Solidification of stockpiled materials is not included in these costs and would depend on the degree of drying that needed to be achieved.

5.4.2 Land Disposal

Disposal of removed sediments or soils is a long-term technology for achieving RAOs.

5.4.2.1 Off-Site Landfill

Off-site disposal of impacted sediments or soils in a properly designed and permitted landfill would eliminate on-site risks associated with these materials. Permitted commercial facilities exist for such off-site disposal; available disposal options depend on the characteristics of the material.

With permitted commercial landfills available to accept dewatered sediment or soils as solid or hazardous waste, the process option of off-site disposal is considered implementable. Unit rates for transportation and disposal would likely range from approximately $80 per ton for non-hazardous waste to $250 per ton for hazardous waste. As a result, this option would involve a high to very high capital cost depending on the volume of wastes generated and the material characteristics. Off-site disposal in a landfill is retained as a process option in further evaluation of remedial action alternatives.

5.4.2.2 On-Site Landfill

Removed impacted sediment or soil could also be relocated to a newly designed and constructed on-site landfill. An on-site disposal facility is technically implementable, and use of an on-site facility would reduce short-term risks associated with transportation of waste materials to off-site facilities. While effective and technically implementable, institutional and long-term management issues make construction of an on-site landfill appear to be administratively challenging to implement, especially if any of the removed sediments or soil exhibited the characteristics of an RCRA hazardous waste. The process option of an on-site landfill is not retained for further evaluation.

5.4.2.3 On-Site Consolidation

As an alternative to a new on-site landfill, removed impacted sediment from a portion of the pond or exposed sediments or soils could also be consolidated into a smaller "waste management area" within the pond footprint to reduce costs and short-term risks associated with transportation of waste materials to off-site disposal facilities. The waste management area would be constructed for long-term containment with a soil cap. This option can be technically effective, but could adversely impact the aquatic habitat and storm water retention provided by the pond. Other institutional (*i.e.*, permitting) would need to be addressed in remedial design. The process option of on-site consolidation is retained for further evaluation.

5.5 MONITORED NATURAL RECOVERY

Monitored natural recovery (MNR) relies on natural physical, chemical, and biological processes to achieve RAOs and is viable remedy option at many impacted sediment sites, including this one under AWL or HWL conditions. MNR is not applicable to soils under LWL conditions. Per USEPA (2005) guidance, MNR is an approved remedial technology that may be considered.

An MNR remedy takes advantage of ongoing, naturally occurring processes to contain, detoxify, degrade, or reduce the bioavailability of COPCs in sediment. Burial or dilution by deposition of clean sediment is often the dominant process relied upon for natural recovery, but other physical, biological, and chemical mechanisms can also reduce the potential for exposure to certain COPCs. Under anaerobic conditions, the primary metabolic pathway for PCBs is reductive dechlorination in which chlorine removal and substitution with hydrogen by bacteria can result in a form of PCBs with fewer chlorine molecules that are potentially less toxic (USEPA, 2008a).

The two key advantages of MNR are its relatively low implementation cost and its non-invasive nature. Key limitations of MNR are that it leaves COPCs in place without engineered containment and that it can be slow in reducing potential exposures in comparison to more-active remedies. As with any risk reduction approach that takes a period of time to reach remediation goals, remedies that include MNR frequently rely on institutional and engineering controls, such as access controls and fish advisories, to control human exposure during the recovery period.

To be effective and implementable in any given setting, multiple lines of evidence are needed to confirm that MNR is occurring or can be made to occur. Site conditions at Koppers Pond that are especially conducive to MNR (USEPA, 2005) under AWL or HWL conditions and the lines of evidence that MNR can be successful in this setting include the following:

- Current and anticipated future land uses are compatible with natural recovery (*i.e.*, no substantive development of the immediate area around the pond is expected in the foreseeable future);
- Based on the elimination of COPC sources and the observed changes in sediment COPC concentrations as discussed in Section 1.3.3, natural recovery processes have a reasonable degree of certainty to continue at rates that will contain, destroy, or reduce the bioavailability or toxicity of some of the COPCs over time;
- Expected human exposure is low and, until such time as exposures are reduced to acceptable levels, can be reasonably controlled by engineering and institutional controls;
- The surface water setting is generally quiescent, and under storm flow conditions, the pond is principally subjected to backwater flooding;
- COPC concentrations are low and cover diffuse areas;
- The most-recent (2013) data show PCB concentrations in the biologically active sediment zone are decreasing and are below the PRG;
- In their aquatic environment, the metals present in sediments do not cause or contribute to unacceptable human health or ecological risks;
- Sediment core data demonstrate generally indicate higher PCB concentrations in sediment at depth rather than in surface sediments; and

- COPCs were not detected in the surface water column above New York State ambient water quality standards.

Site conditions at Koppers Pond that present challenges to implementing an MNR remedy are the following (USEPA, 2005):

- Although the most recent (2013) sampling data show PCB concentrations in the biologically active zone of sediment meeting the PRG, data are inconclusive and somewhat inconsistent on whether PCB concentrations in higher trophic level receptors (*i.e.,* fish tissue) are moving towards RBCs;
- PCBs do not readily biodegrade or otherwise transform to lower toxicity forms; and
- PCBs bioaccumulate in fish tissue.

MNR is retained as a remediation technology under AWL and HWL conditions. Enhancements to make MNR more effective for the specific conditions at Koppers Pond will also be considered in the assemblage and evaluation of remedial alternatives.

5.6 TREATMENT

Treatment options evaluated in this FS include options for treatment of removed sediments and soils and innovative *in-situ* treatment technologies that may be available to destroy or reduce the bioavailability of COPCs in sediment.

5.6.1 Treatment of Removed Sediments

Sediments in Koppers Pond are silty and clayey materials with water contents typically greater than 50 percent by weight (*i.e.*, solids content typically 30 to 40 percent by weight). If removed by in-the-dry excavation methods (particularly under the current LWL conditions) or mechanical dredging, air drying may be sufficient to eliminate excess (free) water as needed in advance of land disposal.[24] Air drying would also likely be sufficient for excavated exposed sediments or soils. In addition, if any removed sediments exhibit the characteristic of a hazardous waste, treatment of such materials would be needed in advance of land disposal.

5.6.1.1 Sediment and Soil Dewatering

Sediment and soil dewatering can be accomplished by air drying or adding amendments. Amendments are discussed in Section 5.6.1.2 (Stabilization/Solidification).

Air drying of excavated sediment and soil typically requires large land areas for materials laydown and stockpiling and extended timeframes. Moreover, for sediments, the degree of dewatering and drying achieved by air drying is typically lower than can be achieved by mechanical means. Because the initial sediment water contents are much lower, air drying is typically used when sediments are excavated in the dry or by mechanical dredging. Enhancements to air drying (*e.g.*, filter socks or Geotubes®) can be used to address these issues when the sediments are free draining. With such enhancements, the process is often referred to as passive or gravity dewatering.

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[24] Sediments removed by hydraulic dredging typically require mechanical dewatering before further processing. In this case, dredging has not been retained as a process option for sediment removal (Section 5.4.1.3), and mechanical dewatering is not considered further.

Costs for handling and air drying sediments or soils are typically in the range of $5 to $30 per cy. The savings in transportation and disposal costs (*i.e.*, from removal of the weight of the free water) partially offset the costs of drying and dewatering.

Air drying for excavated sediments and soils is retained as a treatment process option for alternatives involving the removal of sediments and soils from Koppers Pond.

5.6.1.2 Stabilization/Solidification

As described in USEPA guidance, stabilization/solidification refers to a class of treatment processes designed to accomplish one or more of the following (USEPA, 1989a):

- Decrease the surface area of the waste mass across which transfer of COPCs could occur;
- Limit the solubility of COPCs in the waste; and
- Improve the handling and physical characteristics of the waste (*e.g.*, eliminate free liquids).

Stabilization/solidification treatment could be used to eliminate free liquids associated with sediments removed from Koppers Pond in lieu of, or in addition to, dewatering. Stabilization/solidification, which adds weight to the material destined for off-site disposal, is typically not preferable to dewatering, which removes the weight of the free water. Stabilization/solidification is typically employed only when the material exhibits the characteristic of a hazardous waste and treatment is needed to either render the material non-hazardous or to meet LDRs and UTS.

Stabilization/solidification is implementable and would employ available and proven technology. The cost of stabilization/solidification would depend on the final mix design (*i.e.*, reagents and dosages) but is typically in the range of $25 to $100 per ton of material treated, which equates to about $30 to $120 per cy. Depending on the quantity of waste that requires treatment, this process option involves a mid-range to high capital cost. Solidification to address free liquids adds volume and weight to materials being disposed of, adding to transportation and disposal costs.

This process option is retained for further evaluation in the assembly of remedial action alternatives for treatment of removed sediments or soils exhibiting the characteristics of a hazardous waste as needed to meet LDRs in advance of off-site disposal.

5.6.1.3 Thermal Treatment

Incineration would be an effective process option for the destruction of PCBs, PAHs, and other organic constituents in removed sediments or soils, but incineration does not treat metals. Permitted commercial waste incinerators are available, but throughput is quite limited, transportation distances are long, and unit costs are very high, often in excess of $1,000 per cy. Depending on the quantity of material that requires treatment, this process option involves a very high capital cost.

On-site incineration is also an effective remedial technology to treat PCB-containing sediments, but licensing and permitting of an on-site incinerator would be very difficult, and significant community objection would be expected. Costs to install and operate an on-site incinerator would be very high.

From a practical perspective, incineration is not reasonably implementable and costs are disproportionate to the risk reductions achieved as compared to land disposal. The PCB concentrations in the sediments at Koppers Pond are much below levels that would render this material PCB remediation waste under TSCA regulations or hazardous under New York State regulations, and these sediments are not hazardous as a result of other organic constituents. Treatment prior to disposal is not needed to meet LDRs for organic constituents. Accordingly, incineration is not well suited for the treatment of Koppers Pond sediments or soils, and this process option has been eliminated from further consideration.

Thermal desorption, which involves heating the solid materials sufficiently to promote volatilization of PCBs and other organics is a proven technology for treatment of sediments and soils (Interstate Technology and Regulatory Cooperation Work Group, 1997). The bed temperature and residence time are designed to volatilize the target organic compounds, but not oxidize or destroy them and the process does not generally treat metals. Off-gases from the heated solids are routed to a secondary combustion chamber where the gases are incinerated. Air pollution controls are provided for particulates and acid gases (formed in the incineration of halogenated compounds) as needed. Residual organic compounds in the off-gas are removed through condensation followed by carbon adsorption or they are destroyed in a secondary combustion chamber or a catalytic oxidizer.

Thermal desorption is typically conducted in transportable units specifically permitted for remediation purposes. Trial (test) burns are usually needed to prove the effectiveness of treatment and to fine-tune operating parameters (*e.g.*, residence time and temperature in both primary and secondary chambers).

Thermal desorption is an effective means of removing organic compounds from a solid material and is less costly and more easily controlled than higher temperature incineration processes. Thermal desorption does not generally treat metals in the solid waste stream. Unit costs are typically in the range of $200 to $400 per cy. Depending on the quantity of material that requires treatment, this process option involves a high to very high capital cost. The processing rate (and cost) is often controlled by the water content of the waste, as wet materials require longer residence times and fuel consumption to maintain adequate temperatures. As a result, such materials can be more costly to process via thermal desorption.

The same factors that rule out incineration as a viable process option are likewise applicable to thermal desorption. The PCB concentrations in the sediments and soils at Koppers Pond are below levels that would render this material PCB remediation waste under TSCA regulations or hazardous under New York State regulations, and these sediments and soils are not hazardous as a result of other organic constituents. Treatment prior to disposal is not needed to meet LDRs for organic constituents. Accordingly, thermal desorption is not well suited for the treatment of Koppers Pond sediments, and this process option has been eliminated from further consideration.

5.6.2 *In-Situ* Treatment

In-situ remediation of sediments and soils has been the focus of considerable research, but proven, effective technologies are limited. Thus, this remedial technology is not carried forward.

5.6.2.1 Reactive Subaqueous Capping

Reactive or adsorptive materials have been used in combination with subaqueous capping to reduce the potential flux of organic constituents from the capped sediment to the water column overlying the cap. In a basic design, the cap consists of an inert material (*e.g.*, sand) used in conjunction with reactive amendments (*e.g.*, activated carbon, Sedimite™). The cap mixed material is spread using barge systems, sand cannons, or other broadcast means and then worked into the underlying sediment through bioturbation or manual methods.

An alternative design is a reactive-core mat (RCM), which is basically two sheets of geotextile sewn together to create a sandwich containing activated carbon. A clean sand cover is placed atop the RCM to serve as the substrate for benthic recolonization. It is reported to be effective in addressing organic chemical flux through the cap and has a long design life.

As described in Section 1.3, there is limited interaction between the pond and groundwater, and advective transport of COPCs upward through the pond bottom is not a significant pathway for introducing COPCs to the pond. Reactive capping is not typically used with soil covers in upland areas. On this basis, reactive capping is not an effective technology and is not retained in assembling remedial action alternatives in the FS.

5.6.2.2 Biological Treatment of Sediment

Bioremediation of sediments with PCBs, PAHs, and other organics has been proven effective in laboratory and pilot-scale testing, although advancements in full-scale applications are limited. Depending on the constituents present, treatment can be directed toward aerobic or anaerobic degradation. In general, this technology treats the pore water associated with the sediments; aqueous dissolution of the target COPCs is generally required before they are bioavailable and amenable to treatment.

In the research conducted in preparing this FS for Koppers Pond, no commercially available and proven *in-situ* biological or biochemical treatment process for sediments was identified. Likewise, biological treatment is not effective at treating metals in soils. This process option will not be considered further.

5.6.2.3 Phytoremediation of Soils

Phytoremediation is the direct use of plants and their associated microorganisms to stabilize or reduce COPC concentrations in soils, sediments, surface water, or groundwater. Plant species are selected for use based on factors such as ability to extract or degrade the COPCs, adaptation to local climates, high biomass, depth root structure, compatibility with soils, growth rate, ease of planting and maintenance, and ability to take up large quantities of water through the roots.

In the case of metals, which under LWL conditions are the primary risk drivers for Koppers Pond, the most common phytoremediation mechanism is phytoextraction, wherein COPCs in soils, sediments, or water are transferred into harvestable plant biomass. The plants absorb the constituents through the root system and store them in the root biomass or transport them up into the stems or leaves. The uptake into plants and translocation into the aboveground tissues depends on a number of site-specific and plant-specific factors. At the time of disposal, constituents are typically concentrated in the much smaller volume of the plant matter than in the initially impacted soil or sediment. The growth and harvest cycle must usually be repeated over multiple years to achieve a significant cleanup.

Phytoremediation requires significant maintenance to ensure root establishment and vegetative growth, and the plants must be routinely harvested and properly disposed of. The rate of constituent uptake, and therefore the duration of the remediation, is uncertain and will depend on many site-specific and plant-specific factors. Moreover, there can be concerns with concentration of COPCs in edible plant tissue, and steps need to be taken to avoid introducing COPC to the food chain by wildlife consuming the plant material.

The effectiveness of a phytoremediation technology for Koppers Pond would require further study and evaluation. A pilot-scale study would be needed to determine the plant species to be employed, rates of constituent uptake, the final COPC concentrations achievable in soils, and proper means to avoid introducing COPCs to the food chain through plant consumption. Such study and evaluation has not been conducted as part of the FS. Phytoremediation is not retained for further consideration as a remedial alternative.

6. DESCRIPTION OF REMEDIAL ACTION ALTERNATIVES

This section assembles remedial action alternatives that employ various combinations of the remedial technologies and process options that survived the screening presented in Section 5. The assembled alternatives represent a range of MNR, containment, removal, and treatment combinations. As noted above, identification and selection of any remedial alternative at this time are complicated by the uncertainty of future hydrologic conditions in the pond, and alternatives need to be adaptive to a range of such conditions.

6.1 RETAINED TECHNOLOGIES AND PROCESS OPTIONS

From the evaluations present in Section 5, the retained remedial technologies and process options include the following:

- No Action
- Institutional and Engineering Controls
  - Access Restrictions
    - Fencing and Security
    - Deed Notices and Restrictions
    - Fish Consumption Advisory
  - Monitoring and Maintenance
    - Physical Monitoring
    - Chemical Monitoring
    - Maintenance
  - Fishery Management
- Monitored Natural Recovery
- Containment
  - Subaqueous Capping
  - Soil Cover
- Sediment and Soil Removal and Disposal
  - Sediment Removal
    - Excavation
  - Soil Removal
  - Land Disposal
    - Off-Site Disposal
    - On-Site Consolidation
- Treatment
  - Treatment of Removed Sediments and Soil
    - Dewatering
    - Stabilization/Solidification

Based on the screening evaluation, these remedial technologies and process options are more implementable than those remedial technologies and process options deleted from further consideration. These retained remedial technologies and process options have been assembled into remedial action alternatives as described in the following section.

6.2 IDENTIFICATION OF REMEDIAL ACTION ALTERNATIVES

Five remedial action alternatives have been assembled for detailed evaluation in the FS. These alternatives are presented in the general order of the least intrusive (starting with No Action) through the most intrusive remedial approach. As described in the following sections, in some instances, alternatives are "built-up" with the more extensive alternatives incorporating components of less-extensive approaches and then adding additional components.

These discussions focus on the remedial components and how these components will achieve RAOs for Koppers Pond. Due to uncertainty in future pond water levels, the alternatives have been developed with the flexibility to address the range of observed hydrologic conditions. For remedial planning and cost estimating purposes, it is estimated that Koppers Pond, as defined in Section 4.2 above, comprises of two areas. The area containing sediments and exposed soils, is an area of approximately 8 to 10 acres with a corresponding elevation of approximately 886 ft-msl and consists of a combination of sediments and exposed soils depending on the water elevation. The mudflats comprise an area of approximately 3 acres with a corresponding elevation of approximately 887 to 888 feet ft-msl (Figure 3).

Included are conceptual remedial designs and brief descriptions of possible methods for remedial construction. This level of detail provides the basis for cost estimates and evaluations of short-term impacts associated with remedy implementation. It must be recognized, however, that for any alternative, design details and construction techniques will be established in during remedial design and remedial action, and changes in design and implementation methods and techniques can be expected.

6.2.1 Alternative 1 – No Action

In accordance with the NCP, the No Action alternative is carried through the detailed evaluation and comparison of alternatives to provide the baseline for assessing the performance of other alternatives. The No Action alternative would allow current conditions at Koppers Pond to remain unchanged except for natural processes (*e.g.*, pond levels reaching equilibrium, natural re-vegetation, *etc.*). Existing deterrents to trespassing and the current NYSDOH fish consumption advisory would remain in place, but presumed to be no more (or no less) effective than they are currently. No additional action would be taken to reduce potential exposures from consuming fish taken from Koppers Pond (to the extent that pond water levels would allow for the presence of a significant fish population) or from contact with exposed sediments by human or ecological receptors. No monitoring would be conducted to document reductions in concentrations or provide the basis for future decision-making regarding changes in institutional controls (*e.g.*, fish consumption advisory).

6.2.2 Alternative 2 – Access Restrictions, Institutional Controls, and Monitored Natural Recovery

Alternative 2 provides an MNR remedy in which natural processes, including deposition of new sediment atop the current pond bottom, would be expected to cause COPC concentrations in fish tissue to gradually decrease and is based on a potential future AWL/HWL scenario. In addition, this alternative includes access restrictions, institutional controls, and a fishery management program. In order for an MNR remedy based on COPCs in fish to be applicable, Koppers Pond would need to return to AWL or HWL conditions and be sustained for a sufficient period of time for a sustainable fish population to be established. If AWL/HWL return but are so temporary as to not allow for a sustainable fish population to be established, then there is no exposure due to the consumption of fish. MNR is not applicable to exposed soils. For the exposed soils, revegetation processes could, with time, act to isolate COPCs in exposed sediments or soils.

Alternative 2 includes the following combination of remedial technologies and process options to address conditions at Koppers Pond and achieve the RAOs:

- Installing, maintaining, and monitoring a security fence around the perimeter of Koppers Pond to deter trespassing and reduce potential exposures associated with consumption of fish taken from the pond to the extent that the pond is returned to AWL or HWL conditions for a sufficient period of time for fish populations to return to the pond;

- Monitoring PCB and other selected COPC or indicator concentrations in the biologically active zone of sediments and in fish tissue to confirm continuing concentration reductions;
- Conducting additional, complementary monitoring to provide a continuing evaluation of pond and fishery conditions (*e.g.*, sediment toxicity, metals bioavailability in sediment); and
- Instituting a fishery management program providing chemical monitoring and other assessments of the fish population and perhaps periodic harvesting and restocking of fish in an effort to lower PCB and other COPC concentrations in fish that could potentially be consumed by human receptors.

These active remedial measures would be supported by placement of deed notices and restrictive covenants on the affected properties that prohibit activities which could interfere with ongoing MNR. A review of Site conditions would be conducted no less often than once every five years until RAOs are achieved.

Table 19 lists the primary remedial action components for Alternative 2 and provides a preliminary cost estimate. This table shows estimated capital and OM&M costs and calculates total estimated life-cycle costs presented on the basis of net present value (NPV). The cost estimates shown in Table 19, as well as the component and cost tables for Alternatives 3 through 5, were developed using estimated quantities and applying unit pricing derived from USEPA guidance, published construction cost estimating references, and the remediation experience of the project team. Consistent with USEPA guidance, these estimates, which include contingencies, are believed to be within the accuracy range of +50 to -30 percent. NPV calculations are based on a 5-percent discount rate, net of inflation, over a maximum timeframe of 30 years. The estimates do not include costs of remedial design or associated predesign investigations.

6.2.2.1 Fencing

Under Alternative 2, chain-link security fencing would be installed around the perimeter of Koppers Pond to supplement the existing fencing and provide an effective deterrent to trespassing. The fencing would provide for lockable vehicle gates at access points, and no trespassing and other warning signs would be posted at regular intervals along this fence. Fencing is designed to deter trespassing and fishing at Koppers Pond, thereby reducing potential human health risks associated with fish consumption (if AWL/HWL conditions return and are sustained) until such time as natural processes reduce RBCs in fish tissue to levels that do not pose potential human health risks.

For the purpose of this FS, it assumed that new fencing would be installed around the entire perimeter of the pond. Figure 13 shows the conceptual alignment of this fencing, which extends a total length of 4,300 feet, and is aligned to reduce impacts to wetlands, especially on the northwestern end of the pond near the confluence of the Industrial Drainageway. Access for fence installation would need to be obtained from the property owners (*i.e.,* the Village of Horseheads, Hardinge, and EWB). The final fencing plan would be developed in remedial design in consideration of topography, ground conditions (*e.g.*, wetlands), and vegetation.

6.2.2.2 Institutional Controls

Institutional controls would include deed notices and environmental restrictive covenants that prohibit activities in Koppers Pond which could cause or contribute to the spread of COPCs or interfere with remedial efforts. Such restrictive covenants would prohibit the use of the pond as a water supply for any purpose or uses that could expose deeper, more-impacted sediments. Dredging, excavating, or otherwise modifying the pond would be prohibited without pre-review and approval from USEPA. These covenants would be designed to avoid potential additional human health exposure pathways and to ensure that potentially impacted sediments would be properly managed if disturbed.

6.2.2.3 Monitoring

Following fence installation, inspections would be conducted on a routine basis to confirm the integrity of the fence and to identify any needed repairs. Such monitoring would be designed to ensure the fencing remains a deterrent to trespassing and fishing at Koppers Pond, thereby reducing potential human health risks associated with fish consumption throughout the design life of these physical controls.

Chemical monitoring would also be conducted on an appropriate schedule to assess COPCs in the biologically active zone of sediments and in fish tissue under AWL or HWL conditions. The monitoring program would be developed as part of the remedial design, but would be expected to include some of the following:

- Monitoring of fish for PCB concentrations;
- Monitoring of sediments for concentrations of PCBs and inorganics in the biologically active zone; and
- Sediment toxicity testing, pore water testing, and acid volatile sulfide/simultaneously extract metals testing of sediments to monitor COPC bioavailability.

For purposes of evaluating alternatives in this FS, select monitoring of surface sediment and fish tissue COPC concentrations is assumed to be conducted between five-year reviews with more-expansive sampling events corresponding to five-year reviews. Monitoring data would be evaluated using appropriate statistical methods. Under AWL or HWL conditions, chemical monitoring would continue until RBCs in fish tissue were achieved and sustained COPC concentrations in fish have declined to a constant level, greater than RBCs, that is caused by sources other than sediments in Koppers Pond. At that time, the NYSDOH would be expected to evaluate any changes to its fish advisory; any changes would solely be the responsibility of NYSDOH. Deed notices and environmental restrictive covenants prohibiting uses of the pond that could create new exposure pathways (*e.g.*, use of the pond for a water supply) or disturb deeper sediments would remain in place.

6.2.2.4 Fishery Management

To complement measures designed to deter trespassing and consumption of fish taken from Koppers Pond and longer-term MNR processes, Alternative 2 also includes the provision for a fishery management program under AWL or HWL conditions. To the extent such a program is warranted based on Site conditions once they have stabilized, it would involve chemical monitoring and other assessments of the fish population and, if deemed appropriate based on continuing Site evaluations, periodic harvesting and possible restocking of fish in an effort to lower PCB and other bioaccumulative COPC concentrations in fish that could potentially be consumed by human receptors. Available literature indicates that the species of the warm water game fish found in Koppers Pond under AWL or HWL conditions have typical average life spans that range from 11 to 15 years for largemouth bass (*Micropterus salmoides*) and 10 to 20 years for common carp *(Cyprinus carpio)*. A summary of the literature search on the life histories of these species is provided as Appendix B.

Harvesting older adult fish, to the extent that it is possible given that the fishery would first need to be established, especially the bottom-feeding carp, and restocking the pond with juvenile fish of species tolerant of the pond conditions existing at that time, could help to reduce the average PCB concentrations in the overall fish population, and some reduction would likely be sustained. Repeated harvesting and restocking would be expected to reduce bioaccumulative PCB concentrations in fish tissue in a step-wise fashion. Active fishery management would continue until RBCs in fish tissue are achieved and sustained or are shown to be unachievable because of the presence of other sources of PCBs to Koppers Pond. It is recognized that harvesting and restocking fish would present challenges in interpreting fish tissue concentrations. These challenges would be addressed in the remedial design and are considered minor in comparison to the benefits of reducing fish tissue concentrations and the corresponding human health risk.

6.2.3 Alternative 3 – Access Restrictions, Institutional Controls, and Capping

Alternative 3 provides containment of sediments and exposed sediments or soils exceeding the PRGs associated with Koppers Pond to achieve RAOs. A 6-inch thick subaqueous cap, including a geotextile membrane, would be placed throughout the open-water area of the pond to provide a uniform and continuous bottom surface. A soil cap would extend over the area of exposed sediments and exposed soils. This alternative includes sediment removal and consolidation within the footprint of Koppers Pond needed to accommodate the placement of capping material without negatively affecting the role of the pond in controlling downstream flooding. As part of the remedial design, pre-design investigations would be undertaken to refine the limits of capping and to evaluate the need for modifications of the pond outlet structure to help maintain the design pond surface water elevation.

This alternative includes the following:

- Placing deed notices and restrictive covenants on the affected properties to prohibit activities that could interfere with long-term containment; and
- Monitoring the stability of the subaqueous cap and soil cover.

A review of Site conditions would be conducted no less often than once every five years.

Under AWL or HWL conditions, this alternative also includes long-term monitoring and testing of sediment and fish to monitor and confirm that reduction of COPC concentrations is occurring and that the reduction is achieving RAOs.

Table 20 lists the primary remedial action components for Alternative 3, and provides corresponding preliminary cost estimate. This table show the estimated capital and OM&M costs and calculate total estimated life-cycle costs presented on the basis of NPV.

6.2.3.1 Fencing

Chain-link security fencing, as described in Section 6.2.2.1 for Alternative 2 and shown in Figure 13, is also a component of Alternative 3. Under this alternative, fencing is designed to deter trespassing and fishing at Koppers Pond. Under LWL conditions, fencing would reduce the potential for trespassers to be in direct contact with soil containing constituents in exceedance of PRGs. Under AWL/HWL conditions, fencing would reduce the potential human health risks associated with fish consumption until such time as RBCs are achieved and sustained in fish tissue. During the remedial design, the installation of additional fencing and/or modifications to the existing fencing to supplement the existing fencing would be evaluated

6.2.3.2 Institutional Controls

Institutional controls, as described in Section 6.2.2.2 for Alternative 2, are also a component of Alternative 3. Deed notices and environmental restrictive covenants prohibiting uses of the pond that could create new exposure pathways (*e.g.*, use of the pond for a water supply) or disturb the subaqueous cap, underlying sediments, or soil cover would remain in place. NYSDOH periodically reviews fish data to ensure the advisories are up to date and considers whether the fish consumption advisories need modification. Any such changes would solely be the responsibility of NYSDOH.

6.2.3.3 Capping

The subaqueous cap would consist of a woven geotextile overlain with a 6-inch thick medium sand layer. Construction options would be evaluated in remedial design. Because the total capping system is thin (*i.e.,* 6 inches), it is assumed that sediments would not need to be removed to accommodate the subaqueous cap. Further evaluations would be conducted in remedial design, but the expectation is that the placement of the sand layer would result in consolidation of the soft underlying sediment that would offset most or all of the 6-inch thickness. The subaqueous cap would extend throughout the open-water areas of the pond, and for cost-estimating and planning purposes, an area of 3 acres has been assumed.

In addition, a soil cover would be placed over newly exposed sediment soils. For cost-estimating and planning purposes, an area of 6 acres has been assumed for the soil cap. The soil cover would consist of a woven geotextile overlain with an appropriately thick soil cover *(e.g., 6 to 12-inch common fill and topsoil)* with an appropriate vegetative seed mix. Due to the variability in observed water elevations, during the remedial design, further evaluation would be conducted to define the areas requiring a subaqueous cap versus a soil cap in order to maximize the long-term effectiveness of the cap. Under this alternative, a cap (comprising of some combination of subaqueous and soil) would cover the approximately 9 acres of sediments and exposed soils (Figure 3). Installation would utilize conventional construction equipment, although some specialty equipment may be needed to accommodate expected soft ground conditions. Some regrading would be required to ensure positive drainage. Appropriate sediment control measures would be utilized during construction to protect the pond outlet channels.

Measures would be evaluated to maintain the function of the pond to the extent practicable considering the expected variability in water elevations over time. Measures could include modification of the pond outlet structure to help maintain the necessary pond surface water elevation and excavation and consolidation of a limited volume of sediments to ensure proper flow of water into the pond.

During the remedial design, additional soil sampling would be conducted to define the lateral extent of the area comprising sediments and exposed soils versus the area comprising mudflat soils. Based on this sampling, areas of mudflat soils with exceedances of the PRGs would be addressed in a manner consistent with the provisions of this alternative.

6.2.3.4 Monitoring

Physical monitoring of the fence would be conducted on a routine basis as described in Section 6.2.2.3. Physical monitoring of the subaqueous cap would entail periodic probing to confirm that the cap integrity (*i.e.*, thickness and uniformity) is being maintained. Physical monitoring of the soil cover would entail periodic inspections.

If determined necessary based on pond water levels, chemical monitoring would also be conducted on a routine schedule to assess COPC concentrations in fish tissue. For purposes of evaluating alternatives in this FS, monitoring of fish tissue PCBs and other selected COPC concentrations is assumed to be conducted between five-year reviews with more-expansive sampling events corresponding to five-year reviews. Monitoring data would be evaluated using appropriate statistical methods, and such chemical monitoring would continue until RBCs in fish tissue are achieved if fish are present. The existing fish consumption advisory would remain in effect until NYSDOH concluded that available fish contamination data and source information indicate that the advisory can be removed; any such changes would solely be the responsibility of NYSDOH. Environmental restrictive covenants would remain in place.

6.2.4Alternative 4 – Sediment/Soil Consolidation and On-Site Containment

This remedial alternative involves removing the pond and permanently replacing the aquatic habitat with a combination of wetland and upland habitat by the following:

- Lowering the elevation of the two outlet channels and allowing the pond to drain to the extent practicable;
- Constructing temporary earthen dams at the upper western end of the pond (*i.e.*, at the mouth of the Industrial Drainageway) and across the pond to separate the eastern and western lobes;
- Installing and operating a bypass piping and pumping system as needed to divert the flow of the Industrial Drainageway around the pond, discharging downstream in the western outlet channel;

- Excavating and drying the sediment such that the sediments do not contain free liquids;
- Relocating the sediments from a portion of the pond into another portion;
- Constructing a drainage ditch connecting the Industrial Drainageway to the western outlet channel and eliminating the eastern outlet channel; and
- Installing an appropriately thick (*e.g.*, 12-inch) clean soil cover atop the consolidated sediments.

Two sub-alternatives are evaluated:

- Alternative 4A - Relocating the sediments from the western portion of the pond into the eastern portion; and
- Alternative 4B - Relocating the sediments from the eastern portion of the pond into the western portion.

Differences between these two approaches primarily relate to cost and constructability.

Figures 14A and 14B provide conceptual design sketches of Alternatives 4A and 4B, respectively. The lateral limits of sediment removal in the eastern or western portion of the pond would be consistent with the lateral extent of the pond with an elevation of approximately 886 ft-msl (under AWL conditions). In addition, areas of mudflat soils with exceedances of the PRGs would also be delineated and addressed in a manner consistent with the provisions of this alternative.

Under either Alternative 4A or 4B, a portion of the pond would be restored as a low-lying, wetland area (assuming future water conditions will support a wetland environment) and the remainder as upland habitat. An evaluation would be conducted during the remedial design to determine how to meet this objective and if achieving a wetland area is possible under natural (*i.e.*, no supplemental discharge flow) conditions. Engineering and institutional controls would be used to ensure the long-term integrity of the containment area. Detailed analysis of this approach is provided in Section 7.

Tables 21A and 21B list the primary remedial action components for Alternatives 4A and 4B and provides preliminary cost estimates. These tables show the estimated capital and OM&M costs and calculate total estimated life-cycle costs presented on the basis of NPV.

6.2.4.1 Sediment and Soil Excavation

Because of the generally shallow water depth and limited flow through the pond even under HWL conditions, it is envisioned that sediment/soil removal would be most efficiently accomplished “in-the-dry.” The basic concept would be to use temporary dams at the upper western end of the pond (*i.e.*, at the mouth of the Industrial Drainageway), and across the entrances to the two outlet channels. A soil dike would also be constructed at the south end of the pond, dividing the two legs. A bypass piping and pumping system would then be installed to divert the flow of the Industrial Drainageway around the pond, discharging downstream of the temporary dams on the outlet channels. The water in the pond between the upstream and downstream dams would similarly be pumped out to discharge downstream in the outlet channels. The lateral limits of excavation would be consistent with the lateral extent of the pond under AWL conditions.

6.2.4.2 Sediment/Soil Handling

After allowing the sediments/soils to initially air dry, the designated material from the excavation side would be removed and transferred to the containment side. Depending on the water content of the materials, it may be necessary to first windrow the materials to air in drying before consolidating. Once sufficiently dried, stockpiled sediments/soils would be loaded into dump trucks and transported to the containment area. Materials would be placed in lifts, graded, and compacted. Once all designated materials are compacted, an appropriately thick soil cover (*i.e*., common fill and topsoil) would be placed atop the consolidation area.

6.2.4.3 Restoration

As the containment area is being completed, a channel would be constructed to direct surface water flow, and the temporary upstream dam would be removed to restore water flow into Koppers Pond. The temporary downstream dams would be removed once a minimum water depth and velocity of flow were established. At the same time, a thick layer of topsoil (*i.e*., 4 inches) would be placed in the sediment/soil excavation area and then seeded with appropriate vegetative seed mix (*i.e*., wetland, transitional, upland).

Because of the extensive scale of remedial action under Alternative 4, other Site restoration activities (*e.g.*, revegetation of work areas, fish stocking if conditions permit) would also be conducted.

6.2.5Alternative 5 – Sediment or Soil Removal and Off-Site Disposal

Alternative 5 involves the removal of all sediment from Koppers Pond, whether the sediment remains inundated or is exposed under LWL conditions. No institutional or ongoing engineering controls are required for Alternative 5, and no post-remedial monitoring would be conducted.

Alternative 5 is an applicable remediation approach irrespective of water level conditions in the pond, as the primary difference between removal under various hydrologic conditions relates to the amount of dewatering/water management needed during implementation. Table 22 lists the primary remedial action components for Alternative 5 and provides the corresponding preliminary cost estimate. This table shows the estimated capital and OM&M costs and calculates total estimated life-cycle costs presented on the basis of NPV.

6.2.5.1 Sediment and Soil Excavation

Because of the generally shallow water depth and limited flow through the pond even under HWL conditions, it is envisioned that complete sediment removal would be most efficiently accomplished “in-the-dry.” The basic concept would be to use temporary dams at the upper western end of the pond (*i.e.*, at the mouth of the Industrial Drainageway), and across the entrances to the two outlet channels. A bypass piping and pumping system would then be installed to divert the flow of the Industrial Drainageway around the pond, discharging downstream of the temporary dams on the outlet channels. The water in the pond between the upstream and downstream dams would similarly be pumped out to discharge downstream in the outlet channels. The lateral limits of excavation would be consistent with the lateral extent of the pond under AWL conditions. In addition, areas of mudflat soils with exceedances of the PRGs would also be delineated and addressed in a manner consistent with the provisions of this alternative.

6.2.5.2 Sediment/Soil Handling

After allowing the sediments/soils to initially dry, the designated material would be excavated and stockpiled for further air drying. Filter socks or other enhancements for air-drying could also be employed as needed to accelerate this process. Stockpiled sediments would be sampled for TCLP metals and PCBs. Any materials found to exhibit the characteristics of a RCRA hazardous waste, which for planning purposes is assumed to be 10 percent of the total volume of material removed, would be segregated and then treated to render the material non-hazardous and compliant with LDRs prior to off-site disposal. Such treatment would involve stabilization using appropriate reagents to reduce metals solubility (*e.g.,* buffered phosphates or silicates).

6.2.5.3 Off-Site Disposal

Once sufficiently dried, sediments/soils would be loaded into dump trailers and transported off-site to a permitted industrial (non-hazardous) waste landfill for disposal. Under Alternative 5, an estimated 28,600 tons of material would be sent off-site for disposal.

6.2.5.4 Site Restoration

Once the impacted sediments/soils are removed, the temporary upstream dam would be removed to restore water flow into Koppers Pond. The temporary downstream dams would be removed once a minimum water depth and velocity of flow were established. Because of the extensive scale of remedial action under Alternative 5, other Site restoration activities (*e.g.*, revegetation, fish stocking in the case of AWL of HWL conditions) would also be conducted.

7. DETAILED ANALYSIS OF ALTERNATIVES

In this section, the detailed analysis criteria developed by USEPA in the NCP [40 CFR 300.430(e)(9)(iii)] are used to evaluate the assembled remedial action alternatives. These NCP criteria provide a systematic method for conducting an evaluation leading to the selection of an appropriate remedial action alternative and are applied both in the detailed analyses of the individual alternatives (Section 7.2) and in the comparative analysis among alternatives (Section 7.3).

7.1 EVALUATION FACTORS

The following sections summarize the nine evaluation criteria applied in the detailed analysis of remedial alternatives.

7.1.1 Threshold Criteria

Under the NCP, the threshold factors that remedial action alternatives need to achieve are the following:

- Overall protection of human health and the environment; and
- Compliance with ARARs.

All of the action alternatives were assembled and developed to meet the threshold NCP evaluation criteria.

7.1.1.1 Protection of Human Health and the Environment

The BHHRA addressed the excess lifetime cancer risk and non-cancer hazards associated with exposure to affected environmental media at Koppers Pond under AWL conditions. Table 8 summarizes these risks and hazards. As described in Section 1.4.1, potential human health risks presented in the BHHRA are substantially reduced under the current LWL conditions because under these hydrologic conditions, Koppers Pond does not support a fishery that would serve as a source of risks through consumption of fish taken from the pond. The sBERA identified no unacceptable ecological risk associated with exposure to affected environmental media at Koppers Pond under AWL or HWL conditions. For purposes of the FS, USEPA has determined that the New York State SCOs for protection of ecological resources are protective of potential human health and ecological risks associated with the exposed sediments or soils at Koppers Pond under LWL condition.

7.1.1.2 Compliance with ARARs

At Koppers Pond under AWL or HWL conditions, chemical ARARs do not define remedial objectives for the following reasons:

- ***Sediments:*** No Federal or State of New York cleanup standards have been promulgated that define allowable concentrations of chemical hazardous substances in sediments. TBC guidance available from USEPA, NYSDEC, NOAA, and other sources was used in screening and evaluating concentrations of COPECs as part of the sBERA, but such TBC guidance does not define cleanup standards.
- ***Soils:*** Under AWL conditions, there are no soils present that would be subject to ARARs.
- ***Surface Water:*** The OU-4 data indicate that surface water in Koppers Pond and its outlet channel is not degraded, and sampling showed no exceedances of New York State surface water standards given at NYCRR Title 6, Part 703.
- ***Air:*** Conditions at Koppers Pond do not cause or contribute to any significant air pollution or contravention of NAAQS or New York air quality standards.
- ***Fish Tissue:*** No Federal or State of New York cleanup standards have been promulgated that define allowable concentrations of hazardous substances in fish tissue. Guidance is available from USEPA,

NYSDEC, and NOAA, and from the International Joint Commission, United States and Canada, Great Lakes Water Quality Agreement of 1978, as amended with respect to ecological values. Such guidance was used in screening and evaluating concentrations of COPECs as part of the sBERA.

Under AWL or HWL conditions, chemical-specific ARARs are currently being met, and all of the alternatives, including the No Action alternative, satisfy the threshold criterion of meeting chemical-specific ARARs. Compliance with chemical-specific ARARs is not a discriminator among the alternatives.

Under LWL conditions, the New York State SCOs are ARARs, TBCs, or other guidance for exposed sediments or soils. As noted in Section 3.2.3.3, concentrations of various constituents in the exposed sediments under these conditions exceed the SCOs for the protection of ecological resources. Alternatives 3 through 5 are designed to achieve the PRGs for exposed sediments and soils. Alternatives 1 and 2 do not achieve PRGs for exposed sediments and soils.

Location-specific ARARs, particularly those dealing with construction in floodways and protection of wetlands, and action-specific ARARs define how remedial alternatives can be implemented. For those alternatives that involve removal of materials from environmentally sensitive areas (*e.g.*, wetlands, floodplain), removal would need to be conducted in a manner that minimizes long-term impacts. For alternatives that involve placement of fill (*i.e.*, capping), the containment would need to be situated and designed to address issues associated with potential downstream flooding. It appears that all of the alternatives could be implemented to achieve such ARARs, TBC, and other guidance, but further evaluation would be required during the remedial design for Alternative 3 or 4, which involve placement of fill in the floodway.

7.1.2Balancing Criteria

As discussed in Section 7.1.1, the only alternatives surviving the screening process (except for the No Action alternative) are those that have a reasonable expectation of meeting the NCP threshold criteria. Accordingly, the detailed analysis and comparison of alternatives focuses on the five balancing criteria identified in the NCP:

- Long-Term Effectiveness and Permanence;
- Reduction of Toxicity, Mobility, or Volume (TMV);
- Short-Term Effectiveness;
- Implementability; and
- Cost.

These balancing criteria are discussed in the following sections.

7.1.2.1 Long-Term Effectiveness and Permanence

The criterion of long-term effectiveness and permanence addresses a remedial action alternative in terms of the risk remaining at the Site after RAOs have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals or untreated wastes. The potential for residual risk may be measured by numerical standards such as cancer risk levels or non-cancer hazards or the volume or concentration of COPCs in residuals remaining on-site once cleanup levels have been met. The characteristics of the residuals are considered to the degree that they remain hazardous taking into account their TMV and propensity to bioaccumulate. The adequacy and reliability of controls used to manage treatment residuals or untreated waste that remain at the Site are also evaluated. This assessment may need to examine containment systems and institutional controls to determine if they are sufficient to ensure that any exposure to human and environmental receptors is within the acceptable risk range. This factor also addresses the long-term reliability of management controls for providing continued protection from residuals. It includes the assessment of the potential need to replace technical components of an alternative and the potential exposure pathway and risk posed should the remedial action need replacement.

7.1.2.2 Reduction of TMV

The criterion for reduction of TMV through treatment addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce TMV of the hazardous substances. This preference is satisfied when treatment is used to reduce the contaminant at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. As discussed in Section 1.3.2.4, there remains no source material associated with Koppers Pond that would constitute a principal threat as that concept is defined by USEPA (1991a).

7.1.2.3 Short-Term Effectiveness

The short-term effectiveness evaluation criterion addresses the impacts of the alternative during the construction and implementation phase until RAOs are met. Under this criterion, alternatives are evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The following factors are addressed as appropriate for each alternative:

- Protection of the Community during Remedial Actions - This aspect of short-term effectiveness addresses any risk that results from implementation of the proposed remedial action, such as dust from excavation, transportation of hazardous materials, or air quality impacts that may affect human health.
- Protection of Workers during Remedial Actions - This factor assesses threats that may be posed to workers and the effectiveness and reliability of protective measures that would be taken.
- Environmental Impacts - This factor addresses the potential adverse environmental impacts that may result from the construction and implementation of an alternative and evaluates the reliability of the available mitigation measures in preventing or reducing the potential impacts.

The short-term effectiveness factor also assesses the time until remedial response objectives are achieved.

7.1.2.4 Implementability

The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. This criterion involves analysis of the following:

- Technical Feasibility:
    - Technical difficulties and unknowns associated with employing a remedial technology;
    - Reliability of the technology to achieve and maintain remedial objectives;
    - Ease of undertaking subsequent or supplemental remedial action if needed to maintain RAOs; and
    - Ability to monitor the effectiveness of the remedy.
- Administrative Feasibility and Feasibility of Obtaining Goods and Services:
    - Activities needed to coordinate and obtain necessary access and off-site permits;
    - Availability of necessary equipment and trained personnel for Site work; and
    - Availability of adequate off-site disposal services and capacity.

7.1.2.5 Cost

The cost criterion is primarily focused on the relative cost of each feasible alternative and the evaluation of how well alternatives achieve balancing criteria at what cost. The NCP provides no clear directive or definition of cost-effectiveness but only identifies the costs to be considered (40 CFR 300.430[e][9][G]).

7.1.3 Modifying Factors

The remaining two (modifying) evaluation criteria from the NCP (*i.e.*, State acceptance and community acceptance) are not addressed in the FS. USEPA will address State and community acceptance in the ROD after the FS and the proposed remedial action plan are subjected to public review.

7.2 ANALYSIS OF INDIVIDUAL ALTERNATIVES

This section provides the detailed analysis of remedial alternatives using the NCP criteria discussed in Section 7.1.

7.2.1 Alternative 1 – No Action

7.2.1.1 Threshold Criteria

Under the No Action alternative, conditions at the Koppers Pond Site remain unchanged. Existing deterrents to trespassing and the current NYSODH fish advisory would remain in place, but are assumed to be no more (or no less) effective than they are currently. No additional action would be taken to reduce potential exposures from individuals consuming fish taken from Koppers Pond if the pond returned to AWL/HWL conditions that support a fish population. The No Action alternative would not achieve the RAO for reducing potential human health risks or minimize exposure to ecological receptors to contaminated soils and sediments or food items that become exposed to COPCs in exposed sediments or soils. Although natural processes would be expected to continue that may result in decreased PCB concentrations in surface sediments and fish tissue, the no action alternative would not include any long-term monitoring to assess the extent of or the effectiveness provided. No decrease in metals concentrations in exposed sediment would be expected, but overtime a layer of dead and decaying vegetation would be expected to provide a degree of cover over these materials. Likewise, no monitoring would be conducted to assess progress or provide the basis of these processes for future decision-making regarding changes institutional controls (*e.g.*, fish consumption advisory). Alternative 1 does not meet the substantive requirements of the ARARs, as no work would be done to address the contamination. This alternative would not address the New York State SCOs for soils. This remedy would not meet the criteria of protection of human health.

7.2.1.2 Balancing Criteria

Long-Term Effectiveness and Permanence: Natural processes would be expected to result in some cover for exposed sediments and decreased PCB concentrations in fish tissue if AWL/HWL return and a fish population is established, but monitoring would not be conducted for Alternative 1. There would not be confirmation that long-term effectiveness was achieved. There is the potential for sediment-disturbing activities to occur under Alternative 1, so permanence is not achieved. No action is taken to address COPC concentrations in exposed sediment, while a layer of dead and decaying vegetation would be expected to provide a degree of cover over these materials over time. However, permanence is not assured.

Reduction in TMV: The No Action alternative does not reduce the TMV of COPCs through treatment.

Short-Term Effectiveness: The No Action alternative does not achieve RAOs in the short term. This alternative involves no short-term increased impacts to the community, workers, or the environment from remediation, and no greenhouse gas emissions are associated with Alternative 1.

Implementability: Alternative 1 is technically and administratively implementable.

Cost: Alternative 1 involves no cost.

7.2.2 Alternative 2 – Access Restrictions, Institutional Controls, and Monitored Natural Recovery

7.2.2.1 Threshold Criteria

Under Alternative 2, natural processes are expected to result in decreased COPC concentrations in surface sediments and fish tissue under an AWL/HWL scenario. Monitoring would be conducted to allow ongoing assessment of remediation progress and potential risks. In the interim (*i.e.*, until such time as RBCs are achieved and sustained in fish tissue if a fish population is present), the existing deterrents to trespassing would be supplemented and the current NYSDOH fish consumption advisory retained. Under AWL/HWL conditions, an active fisheries management program could be employed in addition to access restrictions and institutional controls to address potential risks in the short-term. Institutional controls would not address risk to ecological receptors, and Alternative 2 does not address potential exposures to exposed sediments and soils. Alternative 2 would be implemented in manner to achieve location- and action-specific ARARs.

7.2.2.2 Balancing Criteria

Long-Term Effectiveness and Permanence: Alternative 2 provides for attainment of RBCs in fish tissue through an MNR approach. The PRG for PCBs in surface sediments was already shown to be met in the most-recent (May 2013) sediment sampling, but the timeframe to meet the RBCs in fish tissue is uncertain. The monitoring program would allow for ongoing assessment of progress. The principal residual risk is associated with PCB concentrations in underlying sediments and the potential for such sediments to be disturbed in a manner that allows these sediments to be introduced into the biologically active zone. Under Alternative 2, long-term risks with eating fish from Koppers Pond are managed and long-term effectiveness and permanence are achieved through institutional controls that prohibit activities in the pond that could result in deeper sediments becoming exposed. Alternative 2 would not provide long-term effectiveness and permanence for soils as certain metals concentrations in exposed sediments and soils would likely remain above the PRGs.

Reduction in TMV: For the PCBs at Koppers Pond, the primary MNR fate processes are covering or dilution of surface sediment with clean sediment. Alternative 2 achieves reduction in TMV primarily through the natural processes that provide containment (*i.e.*, sedimentation), thereby reducing the mobility of PCBs and their communication with the active biological zone of sediments or pond water. Alternative 2 does not provide a reduction in TMV for contaminated exposed sediment and soils.

Short-Term Effectiveness: The timeframe for the MNR processes that provide remediation for sediments under Alternative 2 is uncertain. Available data indicate PCB concentrations in surface sediments were decreasing following source abatement (Table 2), and the May 2013 sediment sampling data met the PRG for PCBs. Trends in fish tissue data were not evident, but current water levels no longer support a fish population and one is not believed to be present. Until such time as RBCs in fish tissue are achieved, Alternative 2 manages short-term risks through access and institutional controls.

Under Alternative 2, remedial construction activities are limited to fence installation, and impacts to the community and workers are minimal. Adverse environmental impacts are not expected, and Alternative 2 is considered "green remediation." Greenhouse gas emissions associated with Alternative 2 are negligible.

The final fence alignment would be selected and the clearing associated with fence construction would be conducted to minimize impacts to wetlands. If necessary, the fishery management program would involve periodically harvesting a select portion of the fish population from the pond. The removed fish could be replaced by stocking similar or alternatively selected species that could tolerate the pond conditions existing at that time.

Implementability: Alternative 2 is technically implementable. The equipment and personnel resources needed for the engineering controls and monitoring are readily available. While it is recognized that there is uncertainty related to the rates and ultimate effectiveness of natural recovery processes in the sediments, Alternative 2 can be implemented in an adaptive management strategy. Depending on Site monitoring data, the MNR processes could be enhanced in a step-wise fashion if needed to mitigate unacceptable recovery or risks in the future. Administratively, Alternative 2 is implementable with no significant issues associated with access, or the availability of equipment and workers. No off-site permitting is associated with Alternative 2.

Cost: As shown in Table 19, the capital cost of Alternative 2 is estimated to be $270,000. The NPV of monitoring, inspection, and maintenance costs over a 30-year post-remedial period is estimated to be $640,000. Accordingly, the total life-cycle cost of Alternative 2 is estimated to be $910,000.

7.2.3 Alternative 3 – Access Restrictions, Institutional Controls, and Capping

7.2.3.1 Threshold Criteria

Alternative 3 involves isolating sediments in Koppers Pond with a combination of subaqueous capping for open-water areas and soil cover for areas where sediments have become exposed sediments or soils. Alternatives 3 is presented to address the range from HWL to LWL hydrologic conditions. As long as the integrity of the containment system is maintained, potential exposure to underlying impacted sediments/soils would be managed. Alternative 3 would meet RAOs.

Remedial design would address issues regarding construction and filling in a floodway, but the volume of fill added to the pond by subaqueous capping or soil cover, particularly when accounting for the expected consolidation of underlying soft sediments, would not be expected to significantly affect the pond level or potential downstream flooding. During remedial design, measures to address the necessary mitigation will be evaluated and developed, as determined appropriate. A restoration plan may be required to address impacts to wetlands. The plan would include a description of the current wetland community, backfill, topsoil, plantings, and post-restoration monitoring.

Alternative 3 can be completed in a manner that achieves ARARs. Alternative 3 meets the threshold criteria for remedial action. Alternative 3 relies on effective cap placement and maintenance to isolate contaminated sediments and soils. This alternative would also provide reduced PCB concentrations in fish. Alternative 3 can be implemented to comply with chemical-, location-, and action-specific ARARs.

7.2.3.2 Balancing Criteria

Long-Term Effectiveness and Permanence: Alternative 3 addresses the PCBs and metals in sediments and soils by containment. The PRGs for PCBs and metals in sediment and soils would be achieved at the end of remedial construction. Post-remedial monitoring and institutional and access controls would be needed to maintain the long-term integrity of the cap and/or cover.

Alternative 3 provides for attainment of RBCs in fish tissue through a containment approach. Under current conditions PCB concentrations in fish tissue is not a concern because water levels do not support a fish population. If AWL/HWL conditions were to return and be sustained for a sufficient period of time to establish a fish population, the timeframe to meet these RBCs is uncertain, but an active monitoring program would allow for ongoing assessment of progress. The principal remaining risk is associated with PCB concentrations in sediments beneath the containment and the potential for such sediments to be disturbed in a manner that allows such sediments to be in the biologically active zone.

Under Alternative 3, long-term risks are managed by containment for either sediments or soils. Long-term effectiveness and permanence are achieved through the containment and the accompanying institutional controls that prohibit activities that could result in impacted sediments/soils becoming exposed.

Reduction in TMV: Alternative 3 achieves reduction in TMV through containment of impacted sediments and soils.

Short-Term Effectiveness: Alternative 3 is considered effective in the short-term and results in modest adverse short-term impacts.

Under Alternative 3, on-site remedial construction activities include fence installation and subaqueous capping/soil cover, and involve little to no removal or handling of impacted sediments. For this reason, potential impacts to workers are limited to physical construction hazards and risks to the community from on-site activities are minimal. These potential short-term risks would be addressed through on-site controls, safe work practices, and monitoring during remediation.

Additional short-term risks associated with Alternative 3 relate to the transportation of the estimated 10,800 to 19,300 tons of borrow soil needed for construction. Such off-site transportation would require approximately 500 to 890 truckloads, resulting in short-term risks associated with potential motor vehicle accidents and air emissions. Greenhouse gas and other air pollutant emissions would be associated with truck transportation. Appropriate transportation safety measures could help limit impacts and risks to the community, but may not eliminate them.

Placing the sand for subaqueous capping would adversely impact the aquatic environment throughout the pond in the short-term. The environmental impacts would be mitigated with time as the new pond bottom is repopulated with benthic organisms and the habitat restored by natural processes. The final fence alignment would be selected and the clearing associated with fence construction would be conducted to minimize impacts to wetlands.

Placing the soil cover would temporarily disturb the vegetative growth that has begun on the exposed sediment. The environmental impacts would be mitigated by including an appropriate seed mixture in the soil cover to promote revegetation.

Alternative 3 involves filling in the floodplain and, if not designed properly, the potential for resultant downstream flooding impact. The pond and surrounding area provide water storage during flood events that can lessen the impacts of downstream flooding, including possible flooding in the residential neighborhood just south of the Hardinge plant. The remedial design would take into consideration the hydraulics of the pond, including capacity needs for flood management. As described in Section 6.2.3.2, the expectation is that the placement of the capping material would result in consolidation of the soft underlying sediment that would offset most or all of the thickness of a cap.

Implementability: Alternative 3 is technically implementable as both subaqueous and upland capping are proven technologies. The cap would provide a uniform and continuous pond bottom or soil cover. The degree and timing of PCB reductions in fish tissue if fish a fish population returns are not known with certainty, but chemical monitoring would be part of the ongoing assessment of achieving RAOs.

Depending on chemical Site monitoring data and cap integrity monitoring observations, the cap could be modified to mitigate unacceptable recovery or risks in the future, if needed. Administratively, Alternative 3 is implementable with no significant issues associated with off-site permitting or the availability of needed equipment and workers.

Cost: As shown in Table 20, the capital cost of Alternative 3 is estimated to be $1,659,000. The NPV of monitoring, inspection, and maintenance costs over a 30-year post-remedial period is estimated to be $262,000. Accordingly, the total life-cycle cost of Alternative 3 is estimated to be $1,921,000. For cost-estimating and planning purposes, this alternative assumes an area of 3 acres would be addressed by a subaqueous cap, and 6 acres by a soil cap.

7.2.4 Alternative 4 – Sediment/Soil Consolidation and Containment

7.2.4.1 Threshold Criteria

Alternative 4 involves removing sediments from a portion of the pond and consolidating these into a containment area constructed in the other leg of the pond. Alternatives 4A and 4B present the two options for the containment area, *i.e.,* the eastern and western leg, respectively. Differences between these two sub-alternatives relate to constructability and cost.

In either case, Alternative 4 replaces the existing habitat with wetlands and upland habitat. This alternative meets the RAO but potential downstream impacts would need to be quantified during the remedial design before it could be determined how this approach could be implemented in compliance with location-specific ARARs, *i.e.*, substantive requirements of USACE regulations under Section 404 of the Clean Water Act and corresponding State of New York regulations. During remedial design, measures to address the necessary mitigation will be evaluated and developed, as appropriate. A restoration plan may be required to address impacts to wetlands. The plan would include a description of the current wetland community, backfill, topsoil, plantings, and post-restoration monitoring. Alternative 4 relies on a combination of technologies (excavation, consolidation, and capping) to isolate impacted sediments and soils.

7.2.4.2 Balancing Criteria

Long-Term Effectiveness and Permanence: Alternative 4 addresses the PCBs and metals in sediment/soils by removal, consolidation, and on-site containment. The PRGs for PCBs and metals in sediment/soils would be achieved at the end of remedial construction. The aquatic habitat would be eliminated (although a portion of the pond would be restored as wetlands), and attainment of RBCs in fish tissue is not relevant to Alternative 4. Post-remedial monitoring and institutional and access controls would be needed to maintain the long-term integrity of the on-site containment area.

Reduction in TMV: Alternative 4 achieves on-site reduction in TMV through removal and consolidation of PCB- and metal-impacted sediments/soils into an on-site containment area.

Short-Term Effectiveness: Alternative 4 provides for attainment of the PRGs at the completion of remedial construction. The remedial construction schedule is expected to be about six months. Alternative 4 eliminates the aquatic habitat provided in Koppers Pond, and RBCs in fish tissue are not relevant. Alternative 4 is considered effective in the short-term.

Under Alternative 4, potential short-term risks to on-site workers include both chemical and physical hazards associated with excavating, handling, transporting, and consolidating impacted sediments/soils. Community risks from on-site activities would be related to potential exposure to air emissions or impacted runoff from Site work areas. These worker and community risks would be addressed through on-site controls, safe work practices, and monitoring during remediation.

Additional short-term risks associated with Alternative 4 relate to the transportation of the estimated 10,000 to 11,000 cy (16,500 to 18,000 tons) of borrow soil needed for construction. Such off-site transportation would require approximately 760 to 830 truckloads, resulting in short-term risks associated with potential motor vehicle accidents. Greenhouse gas and other air pollutant emissions would be associated with truck transportation. Appropriate transportation safety measures could help limit impacts and risks to the community, but may not eliminate them.

Environmental impacts would be expected from implementation of Alternative 4, due to the elimination of the aquatic habitat provided by Koppers Pond and replacement with wetlands and uplands habitat. It is noted that under the current LWL conditions, much of these environmental impacts are presently occurring.

Alternative 4 involves filling in the floodplain and the potential for resultant downstream flooding impact. The pond and surrounding area provide water storage during flood events that can lessen the impacts of downstream flooding. Eliminating the pond would increase the potential for downstream flooding including possible flooding in the residential neighborhood just south of the Hardinge plant.

Implementability: Alternative 4 relies on proven remediation technologies and is technically implementable. PCB and metals concentrations in sediment/soil would be directly addressed through consolidation and cover. The aquatic habitat would be eliminated, so the RAO would be met. Monitoring would be performed to confirm the integrity of the cover. Administratively, Alternative 4 is implementable with no significant issues associated with the availability of needed workers and equipment, but permitting issues may be significant with respect to downstream flooding. Replacement wetlands may be required to compensate for the net loss of aquatic habitat.

Cost: As shown in Table 21A, the capital cost of Alternative 4A is estimated to be $3,203,000. The NPV of monitoring, inspection, and maintenance costs over a 30-year post-remedial period is estimated to be $195,000. Accordingly, the total life-cycle cost of Alternative 4A is estimated to be $3,398,000. As shown in Table 21B, the capital cost of Alternative 4B is estimated to be $2,929,000. The NPV of monitoring, inspection, and maintenance costs over a 30-year post-remedial period is estimated to be $195,000. Accordingly, the total life-cycle cost of Alternative 4B is estimated to be $3,124,000.

7.2.5 Alternative 5 – Sediment/Soil Removal and Off-Site Disposal

7.2.5.1 Threshold Criteria

Alternative 5 involves the removal of all sediment, including sediment that has become exposed sediments or soils from Koppers Pond, thereby providing a permanent remedy. Under Alternative 5, protection of human health and the environment would be effected by removing all sediments from the pond and currently exposed sediment/soil. Alternative 5 meets the RAO and can be completed in a manner that achieves ARARs. Alternative 5 meets the threshold criteria for remedial action. Under this alternative, the removal of all sediment, including soils at Koppers Pond, is expected to result in the elimination of the remaining existing fish in the pond.

7.2.5.2 Balancing Criteria

Long-Term Effectiveness and Permanence: Alternative 5 is a permanent remedy that is effective in the long term. The PRG for PCBs and metals in sediment/soil and RBCs in fish tissue, if fish are present, would be achieved at the completion of remedial construction. Impacted sediments exhibiting PCB or metals concentrations exceeding the PRGs would not remain at the pond, and no post-remedial monitoring or long-term institutional controls would be required.

Reduction in TMV: Alternative 5 achieves on-site reduction in TMV through removal of PCB- and metals-impacted sediments/soils. The mobility of COPCs would be eliminated through disposal in permitted commercial facilities.

Short-Term Effectiveness: Alternative 5 provides for attainment of the PRGs for PCBs and metals in sediment/soil and RBCs in fish tissue, if fish are present, at the completion of remedial construction. The remedial construction schedule is expected to be about six to eight months.

Under Alternative 5, potential short-term risks to on-site workers include both chemical and physical hazards associated with excavating and handling impacted sediments/soils. Community risks would be related to potential exposure to air emissions or impacted runoff from Site work areas. These worker and community risks would be addressed through on-site controls, safe work practices, and monitoring during remediation.

Additional short-term risks associated with Alternative 5 relate to the off-site transportation of the 28,600 tons of dried sediment wastes. Such off-site transportation would require approximately 1,300 truckloads, resulting in short-term risks associated with potential motor vehicle accidents. Greenhouse gas and other air pollutant emissions would be associated with truck transportation. Appropriate transportation safety measures could help limit impacts and risks to the community, but may not eliminate them.

Alternative 5 involves removal of sediments from the pond, and implementation of this alternative would provide for increased surface water storage during flood events.

Removal of pond sediments and exposed soil would adversely impact the aquatic and wetland environment in the short-term. The environmental impacts would be mitigated with time as the pond is repopulated with benthic organisms, the habitat restored by natural processes, and the pond restocked with warm water fish, if AWL or HWL conditions return.

Implementability: Alternative 5 relies on proven remediation technologies and is technically implementable. Sediment/soil removal, drying, and handling techniques would be optimized in remedial design. PCB and metals concentrations in sediment/soil would be directly addressed through removal. This alternative involves removing all PCB- and metal-impacted sediment and exposed sediments or soils above cleanup goals, and post-remedial monitoring would not be needed.

Administratively, Alternative 5 is considered implementable with no significant issues associated with off-site permitting or the availability of needed goods and services. Permitted off-site disposal facilities are available to accept the wastes to be generated in remediation, but the volume of waste associated with this alternative may strain the capacity of local facilities. Multiple (and more-distant) facilities may need to be used.

Cost: As shown in Table 22, the capital cost of Alternative 5 is estimated to be $4,824,000. There is no post-remedial monitoring, inspection, or maintenance associated with Alternative 5, so the total life-cycle cost estimate for Alternative 5 is also $4,824,000.

7.3 COMPARATIVE ANALYSIS

This section presents a comparative analysis among the five remedial action alternatives by comparing each alternative against the others using the two threshold and five balancing evaluation criteria as a basis of comparison. Table 23 summarizes this comparative analysis using a quantitative scale by which alternatives are rated on a relative basis on how well that alternative achieves each criterion based on the individual and comparative analyses. If the criterion is not met, the score is 0. If the criterion is met, a relative score from 1 (lowest acceptable attainment) to 5 (highest degree of attainment) is assigned. An aggregated score is calculated as the sum of the ranks for each of the seven comparative criteria under each alternative.

7.3.1 Threshold Criteria

Alternatives 3, 4, and 5 satisfy the threshold criterion of overall protectiveness of human health and the environment. These alternatives address potential human health risks through various remedial technologies supported by institutional controls, where needed. Variations among the action alternatives primarily relate to the timeframes needed to achieve a protective RBC in fish tissue if AWL or HWL conditions and fish return and the reliability of meeting this RBC in a reasonable timeframe. Accordingly, the comparative analysis of alternatives focuses on the five balancing criteria identified in the NCP. The No Action alternative (*i.e.*, Alternative 1) is not protective of human health and the environment.

Alternative 2 would not meet New York State SCOs for the protection of ecological resources for the exposed sediments (soils).

Under all water level conditions, further evaluation during remedial design would be needed to confirm how Alternatives 3 and 4 could be implemented in compliance with location-specific ARARs for USACE regulations under Section 404 of the Clean Water Act.

7.3.2 Balancing Criteria

7.3.2.1 Long-Term Effectiveness and Permanence

Alternative 1, No Action, does not meet the criterion of long-term effectiveness and permanence. No monitoring would be conducted, and no physical or institutional controls would be emplaced to address residual PCB or metal concentrations.

Alternatives 2 focuses remedial measures on the biologically active zone (0- to 6-inch) of sediments but does not address metals in soils. Alternative 3 provides in-place containment of sediments and soils using a combination of subaqueous capping and soil cover as appropriate. Alternative 4 eliminates the pond in its current configuration, consolidating impacted sediments/soils into an on-site containment area, and replacing the aquatic and upland habitat with a combination of wetlands and upland habitat. Alternative 5 calls for removal of all impacted pond sediments/soils.

Alternative 5 best achieves the balancing criterion of long-term effectiveness and permanence. The isolation of impacted materials effected through Alternatives 3 and 4 relies on the maintenance of institutional and Site controls.

7.3.2.2 Reduction of Toxicity, Mobility, and Volume

None of the alternatives relies on treatment as the principal remedial technology. Alternative 2 MNR involves naturally occurring processes (*e.g.*, sedimentation) that can reduce the toxicity or mobility of COPCs in sediments. Alternatives 3 and 4 primarily rely on containment to effect reductions in bioavailable COPCs. Alternatives 4 and 5 provide for treatment only to the extent needed to handle removed sediments efficiently and, for Alternative 5, if needed to address identified hazardous waste, achieve UTS and LDRs. Alternative 5 involves reduction in the volume of on-site COPCs through removal and containment in permitted off-site land disposal facilities.

7.3.2.3 Short-Term Effectiveness

Under Alternative 1, No Action, short-term risks to human and ecological receptors are those defined under current use conditions and measures are not taken to address the current potential human health or ecological exposure. Alternative 2 addresses short-term risks through access and institutional control, monitoring, and fishery management. The most-recent Site data show that the PRG for PCBs is already achieved in surface sediment, but the timeframe to meet RBCs in fish tissue if AWL orHWL conditions return and a fish population is established is uncertain.

Alternative 3 provides for short-term effectiveness by isolating existing pond sediments/soils beneath a subaqueous cap or soil cover, as appropriate, thereby achieving PRGs. Remedial construction for this alternative could be completed in one construction season. Again, however, the timeframe for attaining the RBC for PCB concentrations in fish tissue, if relevant, remains uncertain. Alternative 4 eliminates the pond, and attainment of RBCs in fish tissue is not relevant to Alternative 4, and the PRG in soils would be achieved by the time remedial construction is complete. Alternative 5 provides for attainment of the PRG in sediment and soils and the RBC in fish tissue (the pond would be completely restocked) by the time remedial construction is completed. Alternatives 4 and 5 could also be completed in one construction season.

For all of the action alternatives, potential short-term risks to Site workers and the community would be addressed through on-site controls and monitoring during remediation. In avoiding removal and handling of impacted sediments, or importing large quantities of soil, Alternative 2 has lower levels of short-term risks to workers and the community.

Remedial construction and off-site transportation under Alternatives 3, 4, and 5 would result in short-term impacts to the environment (*e.g.*, diesel fuel consumption and emissions) and public safety (*e.g.*, motor vehicle accidents, noise).

Alternatives 3 through 5 all result in varying levels of impacts to the aquatic habitat in Koppers Pond, including complete elimination of the aquatic habitat associated with the pond and replacing this habitat with a combination of wetlands and uplands habitat under Alterative 4. The aquatic habitat impacts under Alternatives 3 and 5 would eventually be restored by natural processes. Under Alternative 4, the replacement of aquatic and upland habitat with wetlands and uplands habitat would be permanent.

7.3.2.4 Implementability

All of the alternatives are considered technically and institutionally implementable. Further evaluation during remedial design would be necessary to confirm how Alternatives 3 and 4 could be implemented in compliance with USACE and corresponding State of New York regulations regarding filling in a floodplain.

Alternative 2 provides an MNR approach with the necessary monitoring and institutional controls and can be implemented for the sediments. Alternative 2 uses an adaptive management strategy in which enhancements to MNR for the sediments could be added as needed if the degree or rate of recovery is not deemed adequate. MNR would not address the exposed sediments (soils).

7.3.2.5 Cost

The near-term capital costs associated with the action alternatives range from $270,000 for Alternative 2 to $4,824,000 for Alternative 5. The NPV of monitoring, inspection, and maintenance costs over a 30-year post-remedial period range from $0 for Alternative 5 to $640,000 for Alternative 2. Total life-cycle costs range from $910,000 for Alternative 2 to $4,824,000 for Alternative 5.

The achieved degree of protection of human health and the environment are relatively proportionate with the cost of implementation. On the other hand, the cost of Alternative 5 is disproportionately high to the risk involved and the benefits that might be achieved, relative to the other alternatives. Alternative 4 is midway between Alternatives 3 and 5 in cost-effectiveness. Alternative 1 (no action) involves no cost but is not necessarily effective.

7.3.3 Quantitative Comparison

As shown in quantitative comparison provided in Table 23, Alternatives 3, 4, and 5 protect human health and the environment. Alternative 2 would not address exposed sediments (soils) and would not be protective of human health and the environment.

Under Alternative 3, a layer of imported sand would cover the underlying sediment, and exposed sediments(soil) would be covered by an appropriately thick layer of clean imported soil. The time to achieve PRGs for these alternatives is dependent on the pond hydrology. Under Alternatives 2 and 3, long-term institutional controls are designed to minimize pond disturbance that could reintroduce PCBs or metals from deeper layers into the biologically active zone of sediments/soils. Under Alternative 4, all pond sediments would be consolidated into an on-site disposal facility for which long-term maintenance and institutional controls would be required. Under Alternative 5 all pond sediments would be removed, obviating the need for long-term institutional controls. Alternatives 4 and 5 could also be implemented in one construction season.

With respect to the balancing criteria used for comparative analysis, there are variations among the alternatives. Alternative 2, which relies principally on MNR for sediments, scores well on implementability, cost effectiveness, and reduced short-term impacts, but timeframes to achieve RBCs in fish tissue are less certain and would not address exposed sediments (soils). On the other end of the spectrum, Alternatives 4 and 5 most quickly achieve a long-term remedy, but do so with potentially significant short-term impacts and risks to the community and at a much higher cost. Measures to mitigate the potential risks and impacts would be implemented including engineering controls, personnel protective equipment, safe work practices, appropriate transportation safety measures, and monitoring would be implemented. These measures could help limit impacts and risks to the community, but do not eliminate them.

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TABLES

Table 1
PCB and Metals Concentrations in Sediments Samples
Collected Upstream of Koppers Pond

Sample Location	Sample No.	Metals (mg/kg)								Total PCBs (µg/kg)
		Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	
Norfolk Southern Railroad Culvert	SED08-20	9.1 J	1.3 J	24.1	64 J	90	0.18	22	269	73
Chemung Street Outfall	SED08-21	2.5 J	20 J	32	148 J	104	0.45	18	626	130
Storm Sewer Leading to Chemung Street Outfall	SED08-24	6.0	1.0	69	87	148	0.088	31	993	61
Manhole Upstream of Former Westinghouse Plant Site	SED08-27	3.0	0.81	32	61	40	0.017 J	20	152	8.2
Retention Ponds at Southern Tier Shopping Center (downstream)	SED08-28	6.0	0.42	17	23	30	0.060	21	123	34
Retention Ponds at Southern Tier Shopping Center (upstream)	SED08-29	3.5	0.29	12	22	32	0.052	17	102	28
Drainage from Chemung County Department of Public Works Yard	SED08-41	2.8	0.86	9.5 J	20 J	9.2 J	0.015 J	13	52 J	43

Notes:
1. *For sample locations, see Figure 3.*
2. *Concentrations are reported on a dry-weight basis.*
3. *Samples collected in May 2008 as part of OU-4 RI.*
4. *J - associated result is quantitatively uncertain.*
5. *The PCB Remediation Goal for OU-3 remediation of Industrial Drainageway was 1,000 µg/kg. Arithmetic average of post-remediation samples = 307 µg/kg.*

Table 2
Temporal Changes in PCB Data Sets
Surface (0- to 6-Inch) Sediments in Koppers Pond

Comparison of 1995/1998 to 2008 PCB Data Concentrations in µg/kg			
Parameter	**1995/1998 Dataset**	**2008 Dataset**	**Percent Difference**
Mean	960	841	12
Median	665	580	13
Maximum	4,500	2,700	40
Comparison of 2008 to 2010 PCB Data (Five Common Sample Locations) Concentrations in µg/kg			
Parameter	**2008 Dataset**	**2010 Dataset**	**Percent Difference**
Mean	988	512	48
Median	1,300	520	60
Maximum	1,500	750	50
Comparison of 2008 to 2013 PCB Data Concentrations in µg/kg			
Parameter	**2008 Dataset**	**2013 Dataset**	**Percent Difference**
Mean	841	301	64
Median	580	290	50
Maximum	2,700	640	76

Notes :
1. *Concentrations are for total PCBs on a dry-weight basis.*
2. *1995 data collected as part of OU-3 RI.*
3. *1998 data collected to support draft BERA (CDM, 1999).*
4. *2008 and 2010 data collected as part of OU-4 RI.*
5. *2013 data collected to supplement OU-4 RI data.*

Table 3
Summary of May 2008 and September 2009 Surface Water Quality Data
Koppers Pond and Outlet Channels

Constituent	NYSDEC Class C Surface Water Standard	Detections	Units	Highest Reporting Limit	Mean of Detections	Median of Detections	Maximum Detection
Volatile Organic Compounds							
Chloroform	--	**2/10**	µg/L	1	**0.076 J**	**0.076 J**	**0.083 J**
Tetrachloroethene	--	**1/10**	µg/L	1	**0.22 J**	**0.22 J**	**0.22 J**
1,1,1-Trichloroethane	--	**2/10**	µg/L	1	**0.33 J**	**0.33 J**	**0.36 J**
Semi-Volatile Organic Compounds							
Benzaldehyde	--	**2/10**	µg/L	0.97	**0.094 J**	**0.094 J**	**0.13 J**
Benzo(a)anthracene	--	**1/10**	µg/L	0.19	**0.051 J**	**0.051 J**	**0.051 J**
Benzo(b)fluoranthene	--	**2/10**	µg/L	0.19	**0.26**	**0.26**	**0.27**
bis(2-Ethylhexyl) phthalate	0.6	0/10	µg/L	1.2	NC	NC	NC
Chrysene	--	**2/10**	µg/L	0.19	**0.056 J**	**0.056 J**	**0.061 J**
Dibenzofuran	--	**9/10**	µg/L	0.95	**0.17**	**0.17**	**0.17**
Di-n-butyl phthalate	--	**9/10**	µg/L	0.95	**0.42**	**0.39**	**0.61**
Fluoranthene	--	**6/10**	µg/L	0.19	**0.47**	**0.45**	**0.51**
Hexachlorobenzene	0.00003	0/10	µg/L	0.19	NC	NC	NC
Hexachlorobutadiene	0.01	0/10	µg/L	0.19	NC	NC	NC
Hexachlorocyclopentadiene	0.45	0/10	µg/L	0.97	NC	NC	NC
Hexachloroethane	0.6	0/10	µg/L	0.97	NC	NC	NC
Phenanthrene	--	**9/10**	µg/L	0.19	**0.20**	**0.18 J**	**0.26**
Pyrene	--	**3/10**	µg/L	0.19	**0.068 J**	**0.068 J**	**0.069 J**

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Table 3
Summary of May 2008 and September 2009 Surface Water Quality Data
Koppers Pond and Outlet Channels

Constituent	NYSDEC Class C Surface Water Standard	Detections	Units	Highest Reporting Limit	Mean of Detections	Median of Detections	Maximum Detection
Pesticides							
Aldrin	0.001	0/10	µg/L	0.048	NC	NC	NC
alpha-Chlordane	0.00002	0/10	µg/L	0.048	NC	NC	NC
4,4'-DDD	0.00008	0/10	µg/L	0.048	NC	NC	NC
4,4'-DDE	0.000007	0/10	µg/L	0.048	NC	NC	NC
4,4'-DDT	0.00001	0/10	µg/L	0.048	NC	NC	NC
Dieldrin	0.0000006	0/10	µg/L	0.048	NC	NC	NC
Endosulfan I	0.009	0/10	µg/L	0.048	NC	NC	NC
Endosulfan II	0.009	0/10	µg/L	0.048	NC	NC	NC
Endrin	0.002	0/10	µg/L	0.048	NC	NC	NC
Heptachlor	0.0002	0/10	µg/L	0.048	NC	NC	NC
Heptachlor epoxide	0.0003	0/10	µg/L	0.048	NC	NC	NC
Methoxychlor	0.03	0/10	µg/L	0.095	NC	NC	NC
Toxaphene	0.000006	0/10	µg/L	1.9	NC	NC	NC
PCBs							
Aroclor 1016	0.000001	0/10	µg/L	0.38	NC	NC	NC
Aroclor 1221	0.000001	0/10	µg/L	0.38	NC	NC	NC
Aroclor 1232	0.000001	0/10	µg/L	0.38	NC	NC	NC
Aroclor 1242	0.000001	0/10	µg/L	0.38	NC	NC	NC
Aroclor 1248	0.000001	0/10	µg/L	0.38	NC	NC	NC
Aroclor 1254	0.000001	0/10	µg/L	0.38	NC	NC	NC
Aroclor 1260	0.000001	0/10	µg/L	0.38	NC	NC	NC

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Table 3
Summary of May 2008 and September 2009 Surface Water Quality Data
Koppers Pond and Outlet Channels

Constituent	NYSDEC Class C Surface Water Standard	Detections	Units	Highest Reporting Limit	Mean of Detections	Median of Detections	Maximum Detection
Metals							
Antimony	--	**10/10**	µg/L	1	**0.63**	**0.60**	**0.99**
Barium	--	**10/10**	µg/L	50	**120**	**120**	**124**
Calcium	--	**10/10**	µg/L		**68,460**	**67,800**	**72,600**
Manganese	--	**10/10**	µg/L		**3.75**	**3.80**	**5.70**
Silver	0.1	0/10	µg/L	1	NC	NC	NC
Mercury	0.0007	0/10	µg/L	0.2	NC	NC	NC
Other Constituents							
Cyanide (total)	5.2	0/10	mg/L	10	NC	NC	NC
Hardness	--	**10/10**	mg/l		**249**	**251**	**262**
Total Suspended Solids	--	**10/10**	mg/l		**19.80**	**16.00**	**45.00**

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Table 3
Summary of May 2008 and September 2009 Surface Water Quality Data
Koppers Pond and Outlet Channels

<u>Notes</u> :

1. *Samples collected in May 2008 and September 2009 from Koppers Pond and the outlet channels as part of OU-4 RI.*
2. *Listed constituents are those detected in one or more laboratory samples or those for which an applicable surface water standard has been*
3. *Standard from NYCRR Title 6, Part 703: Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations (August 1999). Values based on average water pH = 8.0 and hardness = 250 milligrams per liter. "--" indicates that a corresponding water quality standard has not been promulgated.*
4. *Listed PCB criterion is the most restrictive value for all water uses and exposure pathways.*
5. *For clarity, all detections are shown in* ***bold-face*** *type.*
6. <u>*Data Legend*</u> *:*
   J - associated result is quantitatively uncertain.
7. *"NC" - not calculated.*
8. *Samples for metals analyses were field filtered (i.e., reported values are dissolved metals).*
9. *Constituents that were detected but the maximum detection was below the standard are not shown.*

Table 4
Summary of Select Metals and PCB Data for Koppers Pond and Outlet Channel Surface Sediments

Parameter	Metals (mg/kg)										Totals PCBs (µg/kg)
	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Silver	Zinc	
1995 through 1998 Data											
Pond Sediments											
Number of Samples	6	10	10	10	7	10	8	6	10	7	10
Mean	4.33	528	243	223	368	632	0.56	116	17	4,510	960
Median	4.55	516	109	218	354	443	0.39	116	13	2,120	665
25th Percentile	2.61	476	52.7	131.0	135	136.5	0.12	82.7	7.5	1,130	183
75th Percentile	5.78	563	514	333	544	911	0.97	155	23	6,820	1,100
Minimum	0.95	346	2.2	35.4	130	31.5	U	60.5	4.5	1,020	U
Maximum	7.8	739	583	357	694	2,210	1.53	156	40	12,500	4,500
Outlet Channel Sediments											
Number of Samples	4	4	7	7	4	7	7	6	4	4	7
Mean	4.9	267	20.5	64.3	65.8	148	0.10	36.0	2.1	393	U
Median	5.1	227	13.2	40.7	33.8	101	0.12	24.8	0.9	230	U
25th Percentile	4.6	172	7.0	34.9	22.8	91.6	0.040	21.7	0.6	130	U
75th Percentile	5.4	322	29.9	97.6	141	164	0.15	45.1	2.4	819	U
Minimum	3.6	77.9	1.3	22.7	19.5	31.2	U	18.5	0.14	101	U
Maximum	5.7	536	54.1	159	176	393	0.18	97.3	6.4	1,010	U
2008 OU-4 Data											
Pond Sediments											
Number of Samples	13	13	13	13	13	13	13	13	13	13	13
Mean	2.9	450	261	245	358	648	0.52	103	20	4,291	841
Median	2.7	483	117	230	298	348	0.40	117	9.4	1,720	580
25th Percentile	2.5	380	51.8	143	127	214	0.19	68.2	7.8	887	200
75th Percentile	3.6	552	540	390	657	1,245	0.86	129	35	9,055	1,400
Minimum	1.9	226	4.4	21.8	25.9	36.6	0.10	23.8	0.5	129	20.0
Maximum	4.8	596	739	462	820	1,620	1.40	180	53	12,500	2,700

Table 4
Summary of Select Metals and PCB Data for Koppers Pond and Outlet Channel Surface Sediments

Parameter	Metals (mg/kg)										Totals PCBs (µg/kg)
	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Silver	Zinc	
2008 OU-4 Data (cont'd)											
Outlet Channel Sediments											
Number of Samples	4	4	4	4	4	4	4	4	4	4	4
Mean	4.4	238	41.6	86.4	98.9	171	0.1	44.0	6.3	809	155
Median	3.7	236	35.7	85.9	97.8	181	0.13	45.4	5.1	711	160
25th Percentile	3.23	225	7.9	39.5	42.5	68.7	0.063	32.7	3.6	226	47.5
75th Percentile	4.88	249	81.1	134	157	263	0.22	54.0	7.8	1,490	258
Minimum	3	198	3.0	24.8	25.1	34.3	0.044	29.9	0.42	123	20.0
Maximum	7.2	282	91.9	149	175	288	0.25	55.5	14.5	1,690	280
2010 OU-4 Data											
Pond Sediments											
Number of Samples	5	5	5	5	5	5	5	5	5	5	5
Mean	2.78	393	273	282	395	847	0.69	97.4	23.8	4,763	512
Median	2.8	402	292	320	447	982	0.81	99.1	27.3	4,860	520
25th Percentile	2.7	365	268	232	370	654	0.62	89.8	20.8	4,705	480
75th Percentile	3.1	412	323	352	476	989	0.82	107	29	5,920	550
Minimum	2.1	363	115	151	185	339	0.35	75.4	9.4	1,950	260
Maximum	3.2	425	367	357	495	1,270	0.87	116	32	6,380	750
2013 OU-4 Supplemental Data											
Pond Sediments											
Number of Samples	4	4	4	4	4	4	4	4	4	4	14
Mean	2.78	485	333	425	550	1,163	0.71	108	21	5,700	301
Median	2.7	490	325	425	515	1,150	0.67	104	20	5,550	290
25th Percentile	2.58	433	303	378	475	963	0.63	96.3	18.8	5,250	180
75th Percentile	2.9	543	355	473	590	1,350	0.75	115	22	6,000	395
Minimum	2.5	380	250	370	430	850	0.61	94.0	18.0	4,500	140
Maximum	3.2	580	430	480	740	1,500	0.90	130	25	7,200	640

Table 4

Summary of Select Metals and PCB Data for Koppers Pond and Outlet Channel Surface Sediments

<u>*Notes:*</u>

1. Data are for sediment data collected from uppermost 0 to 6 inches.

2. Concentrations of metals given in units of mg/kg. Concentrations of PCBs given in units of µg/kg. Both are reported on a dry-weight basis.

3. Aroclor 1254 was the only PCB Aroclor detected in the 1995/1998 and OU-4 sediment samples used in the statistical analyses.

4. In statistical evaluations, non-detect values were taken as one-half of the corresponding reporting limit.

5. The values for duplicate samples SED10-01 and SED08-05 were taken as averages of the two results.

6. "U" indicates none detected. RLs range from 0.035 (estimated) to 0.12 mg/kg for mercury and 42 to 1,250 ug/kg for PCBs.

Table 5
New York State Soil Cleanup Objectives and Calculated EPCs for COPCs in Surface Sediments

Constituent of Potential Concern	New York State Soil Cleanup Objective (NYS SCO)			Calculated EPC		
	NYS SCO for Protection of Human Health (Industrial)	NYS SCO for Protection of Soil to Groundwater	NYS SCO for Protection of Ecological Resources	Koppers Pond (2008 and 2010 Data)	Koppers Pond (2008, 2010, and 2013 Data)	Outlet Channels
Metals (mg/kg):						
Barium	10,000	820	433	474	478	282
Cadmium	60	7.5	4	392	370	91.9
Chromium	6,800	NS	41	275	321	149
Copper	10,000	1,720	50	463	484	175
Lead	3,900	450	63	762	892	288
Mercury	5.7	0.73	0.18	0.73	0.72	0.25
Nickel	10,000	130	30	117	115	55.5
Silver	6,800	8.3	2	27.1	25.9	14.5
Zinc	10,000	2,480	109	5,976	5,928	1,690
PCBs (µg/kg):						
Total PCBs	25,000	3,200	1,000	1,338	981	280
PAHs (µg/kg):						
Benzo(a)anthracene	11,000	1,000	NS	867	867	2,200
Benzo(b)fluoranthene	11,000	1,700	NS	1,099	1,099	2,600

Notes :

1. *EPC concentrations are 95% UCL values calculated for surface (0 to 6") sediments calculated using ProUCL v4. Maximum values were used as EPCs in outlet channels due to limited sample size (n=4).*
2. *Concentrations of metals given in units of mg/kg. Concentrations of PCBs given in units of µg/kg. Both are dry-weight basis.*
3. *The 2013 samples were collected on May 21 and were analyzed for TAL metals, Aroclor PCBs and total organic carbon.*
4. *"NS" - not specified.*

Table 6
Summary of Select Metals and PCB Data for Koppers Pond Fish Samples

Chemical	June 2003 Data				May 2008 Data			
	Frequency Detected	ND Range	Mean	Detected Range	Frequency Detected	ND Range	Mean	Detected Range
Select Metals (mg/kg)								
Arsenic	1/24	1.2-1.5	NC	0.33-0.33	15/20	--	0.06	0.018-0.15
Cadmium	19/24	0.26-0.3	0.14	0.03-0.54	0/20	0.1 - 0.1	ND	--
Chromium	24/24	--	0.40	0.13-1	20/20	--	0.59	0.32-1.2
Copper	24/24	--	0.89	0.45-2.2	20/20	--	0.46	0.21-1
Lead	24/24	--	0.84	0.17-2.1	20/20	--	0.06	0.0065-0.17
Mercury	24/24	--	0.03	0.0041-0.1	20/20	--	0.14	0.011-0.37
Nickel	8/24	0.83-0.99	NC	0.2-0.38	20/20	--	0.04	0.012-0.1
Zinc	24/24	--	21.57	8-33	20/20	--	9.45	4.8-26.1
PCBs (ug/kg)								
Aroclor 1248	10/24	50-250	110	29-1,100	0/17	4.2 - 4.2	ND	--
Aroclor 1254	23/24	200-200	581	160-2,000	17/17	--	443	73-1,700
Aroclor 1260	24/24	--	135	34-400	13/17	4.2 - 4.2	83	17-360
Total PCBs	24/24	--	791	267-2,400	17/17	--	525	90-2,060
Other								
Percent Lipids	24/24	--	2.14	0.7-8.1	14/16	0.1 - 0.1	1.0	0.1-3.5
Species	Black Crappie, Common Carp, Green Sunfish, Largemouth Bass, Pumpkinseed, and White Sucker				Black Crappie, Common Carp, Largemouth Bass, and White Sucker			

Notes:

1. *Results are for individual fish, except for pumpkinseed samples collected in 2003, which were composited.*
2. *Concentrations are reported on a wet-weight basis.*
3. *Mean values calculated by setting non-detect results to one-half the reported detection limit.*
4. *"ND" indicates not detected.*
5. *"NC" indicates not calculated.*

Table 7
Calculated EPCs for COPCs in Koppers Pond Fish Samples

COPC	EPC	Arithmetic Mean
Total PCBs (µg/kg)	827	321
Arsenic (mg/kg)	0.08	0.06
Mercury (mg/kg)	0.20	0.08

Notes:
1. *Concentrations are on a wet-weight basis.*
2. *The calculated EPCs are the 95% UCL for each compound.*

Table 8
Summary of Baseline Human Health Risk Assessment Results

Fish Consumption

Human Health Risk of COPC	BHHRA Results	
	Reasonable Maximum Exposure	Central Tendency Exposure
Noncancer Hazard		
Arsenic	0.1	0.04
Mercury	1.0	0.3
Total PCBs	19.9	5.3
Total Noncancer Hazard	21	5.6
Cancer Risk		
Arsenic	2.0E-05	2.2E-06
Mercury	--[2]	--[2]
Total PCBs	2.9E-04	2.4E-05
Total Cancer Risk	3.1E-04	2.6E-05

Notes :

1. *Noncancer hazards are for child (0 to 6 years) receptor, which is the maximum values for all evaluated receptors (e.g., adolescent and adult).*
2. *"--" indicates COPC was not evaluated for carcinogenicity.*

Table 9

Comparison of Direct Contact Exposure Pathway Risk Results from BHHRA and Updated Risk Results for Low Water Level Conditions for the Teenage Trespasser

Medium	COPC	June 2012 BHHRA Results			2015 BHHRA Updated Risks		
		Sediment EPC	Noncancer Hazard	Cancer Risk	Sediment EPC	Noncancer Hazard	Cancer Risk
Sediment	Arsenic	3.20	7.16E-04	2.76E-08	3.12	6.99E-04	2.70E-08
	Benzo(a)anthracene	0.87	--	5.41E-09	0.87	--	5.41E-09
	Benzo(a)pyrene	0.75	--	4.69E-08	0.75	--	4.69E-08
	Benzo(b)fluoranthene	1.10	--	6.85E-09	1.10	--	6.85E-09
	Benzo(ghi)perylene	0.83	--	5.14E-09	0.83	--	5.14E-09
	Cadmium	392	3.14E-03	--	370	2.96E-03	--
	Chromium	275	1.56E-02	--	321	1.82E-02	--
	Dibenz(a,h)anthracene	0.16	--	1.02E-08	0.16	--	1.02E-08
	Indeno(1,2,3-cd)pyrene	0.69	--	4.33E-09	0.69	--	4.33E-09
	Lead	762	--	--	762	--	--
	Total PCBs (Aroclor 1254)	1.34	6.88E-03	2.36E-08	0.981	5.05E-03	1.73E-08
	Sediment and COPC Total		2.63E-02	1.30E-07	--	2.69E-02	1.23E-07
Surface Water	*Surface Water and COPC Total*		5.25E-05	2.98E-07	--	5.25E-05	2.98E-07
All Media Total			**2.6E-02**	**4.3E-07**	**--**	**2.7E-02**	**4.2E-07**

Notes:

1. *All EPCs have units of mg/kg.*
2. *The 2015 BHHRA Updated Risks reflect changes in the EPCs from the addition of the May 2013 sediment samples. Updated EPCs are shown in Table 5.*
3. *Surface water and sediment PAHs were not evaluated in the May 2013 sediment samples so their EPCs and risks are unchanged.*
4. *The updated risks were calculated by applying the ratio of the updated EPCs and BHHRA EPCs to the risks shown in Appendix Table A-9.1 of the BHHRA.*
5. *The acceptable regulatory thresholds are less than 1 for noncancer hazard and 10^{-4} to 10^{-6} or less for cancer risk, per the NCP.*
6. *"--" indicates not applicable.*

Table 10
Comparison of Cadmium Ecological Risk Results from sBERA and Updated NOAEL Risk Results for Low Water Level Conditions for the Muskrat

COPEC	Forage/Prey	March 2012 sBERA Results						2015 sBERA Updated Risks		
		HWL Scenario			AWL Scenario					
		Sediment EPC	HQ_{NOAEL}	HQ_{LOAEL}	Sediment EPC	HQ_{NOAEL}	HQ_{LOAEL}	Sediment EPC	HQ_{NOAEL}	HQ_{LOAEL}
Cadmium	Measured plant conc; Modelled aquatic invertebrate	189	5.8	2.2	253	7.8	3.0	266	8.2	3.1
	Measured plant conc; Forage fish as surrogate for aquatic invertebrate	189	NA	NA	253	1.4	0.1	266	1.4	0.5

Notes :

1. *All EPCs are in units of mg/kg.*
2. *The sBERA EPCs are the average of the media concentrations. The "2015 sBERA Updated Risks" reflect changes in the EPCs from the addition of the May 2013 sediment samples.*
3. *Koppers Pond AWL and HWL Muskrat sediment EPCs and HQ results from sBERA Table H1-3a and Table H1-3b, respectively.*
4. *The forage fish cadmium results (0.073 mg/kg) were used for both the 2012 and 2015 surrogate risk calculations.*
5. *Koppers Pond AWL Muskrat sediment EPCs and HQ results using forage fish as a surrogate from sBERA Table H4-3. The HWL scenario was not included in the uncertainty assessment in the 2012 sBERA.*
6. *"NA" indicates not assessed*

Table 11
Comparison of Cadmium Ecological Risk Results from sBERA and Updated NOAEL Risk Results for Low Water Level Conditions for the Great Blue Heron

COPEC	**Forage/Prey**	**March 2012 sBERA Results AWL Scenario**			**2015 sBERA Updated Risks**		
		Sediment EPC	**HQ_{NOAEL}**	**HQ_{LOAEL}**	**Sediment EPC**	**HQ_{NOAEL}**	**HQ_{LOAEL}**
Cadmium	Measured forage fish	330	4.5E-01	1.8E-01	266	3.7E-01	1.4E-01

<u>Notes</u> :

1. *All EPCs are in units of mg/kg.*
2. *The sBERA EPCs are the average of the media concentrations. The "2015 sBERA Updated Risks" reflect changes in the EPCs from the addition of the May 2013 sediment samples.*
3. *None of the individual COPECs had HQ values greater than one for any scenario. The cadmium results are provided to allow comparison to the muskrat results shown in Table 10.*
4. *Koppers Pond AWL Great Blue Heron HQ results from sBERA Table H1-2b, respectively.*

Table 12
Summary of Potential Chemical-Specific ARARs

Medium	Authority	Regulation	Requirement Synopsis
Surface Water	Clean Water Act (Federal Water Pollution Control Act, as amended), 33 USC 1251	40 CFR 129	Provides authority for USEPA to establish AWQC used by states to set standards.
	Safe Drinking Water Act, 42 USC 300	40 CFR 141	Establishes MCLs and MCLGs for finished water provided to consumers and sources of potable water. Koppers Pond is not a potential potable water source.
	New York ECL Article 15, Title 3 and Article 17, Titles 3 and 8	6 NYCRR 703	Establishes New York State water quality standards for surface water and groundwater.
Air	Clean Air Act, National Primary and Secondary Ambient Air Quality Standards	40 CFR 50	These standards are not source-specific, but rather are national limitations on ambient air intended to protect public health and welfare. They define acceptable airborne concentrations of conventional air pollutants.
	New York ECL Article 19, Title 3 Air Pollution Control Law	6 NYCRR 200 6 NYCRR 257	Provides New York State requirements for implementing, maintains, and enforcing NAAQS.
Soils	New York ECL Article 27, Titles 13 and 14, et al.	6 NYCRR 375	Established New York State soil cleanup objectives for protection of human health,groundwater, and ecological resources.

Table 13
Summary of Potential Location-Specific ARARs

Topic	Authority	Regulation	Requirement Synopsis
Floodplains and Wetlands	Clean Water Act Section 404	33 CFR 320	A permit is required to discharging dredged or other fill materials into waters of the United States, including jurisdictional wetlands, navigable streams (including the floodway), and certain lakes.
		33 CFR 230	Requires that impacts to aquatic ecosystems (including wetlands) be minimized.
	Executive Order 11988: Floodplain Management	40 CFR 6.302(b)	Any adverse impacts associated with direct or indirect development of a floodplain should be avoided to the maximum extent possible.
	Executive Order 11990: Protection of Wetlands	40 CFR 6 Appendix A	Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.
	New York ECL Article 24, Title 7 Freshwater Wetlands Act	6 NYCRR 663; 6 NYCRR 665	Identifies New York State regulated wetlands and regulated activities.
Sensitive Ecosystems and Habitats	Endangered Species Act, 16 USC 1531of 1978	50 CFR 17; 50 CFR 402	Requires Federal agencies take action to conserve rare, threatened, or endangered (RTE) species and ensure Federal actions do not destroy or adversely modify critical habitat. sBERA determined that RTE species or habitat would not be affected by remediation of Koppers Pond.
	Fish and Wildlife Coordination Act, 16 USC 661	40 CFR 6.302	Must consult with USFWS if actions impact fish and wildlife resources.

Table 13
Summary of Potential Location-Specific ARARs

Topic	Authority	Regulation	Requirement Synopsis
Sensitive Ecosystems and Habitats (cont'd)	Migratory Bird Treaty Act, 16 USC 703	50 CFR 21	Prohibits actions taken or funded by Federal agencies that result in the killing, hunting, taking, or capturing or any migratory birds. Koppers Pond used incidentally by migratory waterfowl.
	New York ECL Article 11, Title 5	6 NYCRR 182	Complements Federal RTE regulations and provides for New York State list of species of special concern. sBERA determined that state-listed RTE species or species of special concern, or their habitat, would not be affected by remediation of Koppers Pond.
Historic Places	National Historic Preservation Act, 16 USC 470	36 CFR 800	Requires Federal agencies take into account historic sites. A Stage I Cultural Research Survey did not identify historic sites associated with Koppers Pond.

Table 14
Summary of Potential Action-Specific ARARs

Topic	Authority	Regulation	Requirement Synopsis
Solid Waste Management	Resource Conservation and Recovery Act	40 CFR 258	RCRA Criteria for Municipal Solid Waste Landfills - Establishes minimum national criteria for management of non-hazardous waste. Applicable to remedial alternatives that generate non-hazardous waste.
	New York ECL Article 27	6 NYCRR 360	New York State standards for solid waste management facilities. Applicable to remedial alternatives that generate non-hazardous waste.
Hazardous Waste Management	Resource Conservation and Recovery Act	40 CFR 260	RCRA Hazardous Waste Management System - General. Defines terms and general standards. Applicable to remedial alternatives that generate hazardous waste.
		40 CFR 261	RCRA - Identification and Listing of Hazardous Waste. Identifies solid wastes subject to regulation as hazardous wastes.
		40 CFR 262	RCRA - Standards Applicable to Generators of Hazardous Waste. Establishes requirements for on-site management of any hazardous wastes generated in remedial action.
		40 CFR 263	RCRA - Standards Applicable to Transporters of Hazardous Waste. Establishes requirements for off-site transportation of any hazardous wastes generated in remedial action.
		40 CFR 264	RCRA - Standards Applicable to Owners and Operators of Treatment, Storage, and Disposal Facilities. Establishes national standards for hazardous waste management. Applicable to construction of on-site hazardous waste treatment/disposal facility and to any off-site treatment/disposal of hazardous waste.
		40 CFR 268	RCRA Land Disposal Restrictions. Set prohibitions on the land disposal of hazardous wastes and treatment standards that must be met prior to land disposal. Applicable to remedial alternatives that generate hazardous wastes.

Table 14
Summary of Potential Action-Specific ARARs

Topic	Authority	Regulation	Requirement Synopsis
Hazardous Waste Management	New York ECL Article 27	6 NYCRR 360	New York State requirements for solid waste management facilities. Applicable to remedial alternatives that generate non-hazardous waste.
		6 NYCRR 361	New York State requirements for siting industrial hazardous waste facilities. Applicable to construction of any on-site hazardous waste treatment/ disposal facility and to any off-site treatment/disposal of hazardous waste.
		6 NYCRR 364	New York State requirements for waste transportation. Establishes requirements for off-site transportation of any hazardous wastes generated in remedial action. Applicable to remedial alternatives that generate hazardous wastes.
		6 NYCRR 370 6 NYCRR 371	New York State requirements for hazardous waste management. Applicable to remedial alternatives that generate hazardous wastes.
		6 NYCRR 372	New York State requirements for hazardous waste manifest system and related standards.
PCBs	Toxic Substances Control Act	40 CFR 761	Established requirements for management of PCB wastes. Affected site media have not been found to contain PCBs > 50 ppm, and TSCA regulations are not an ARAR.
Clean Water Regulations	Clean Water Act (Federal Water Pollution Control Act, as amended), 33 USC 1251	40 CFR 122	Establishes NPDES program. Discharges to navigable waters are regulated by permit, with effluent limitations and monitoring requirements applied to specific constituents. Permitting is required for point-source discharges and for storm water discharges associated with industrial activity, including waste disposal areas.

Table 14
Summary of Potential Action-Specific ARARs

Topic	Authority	Regulation	Requirement Synopsis
Clean Water Regulations (cont'd)	New York State ECL Article 15, Title 5 Article 17, Title 3	6 NYCRR 608	Use and Protection of Waters. Prohibits excavation or fill placement in navigable waters of the State or adjacent wetlands without a permit.
	New York ECL Article 17, Title 8 Water Resources Law	6 NYCRR 750-758	Provides New York State standards for storm water runoff, surface water, and groundwater discharges. Generally prohibit discharge of any pollutant to the waters of New York without a SPDES permit.
	New York ECL Article 17, Title 5	6 NYCRR 701	Prohibit discharges that cause or contribute to a condition in contravention of applicable standards.
	New York ECL Article 11, Title 5 Fish and Wildlife Law	6 NYCRR 701	Prohibits discharge of substances in quantities injurious to fish life, protected wildlife, or waterfowl inhabiting those waters or injurious to the propagation of fish, protected wildlife, or waterfowl.
Clean Air Regulations	Clean Air Act National Emission Standards for Hazardous Air Pollutants	40 CFR 61 and 63	Establishes emission standards for source types that emit hazardous air pollutants. Based on type and quantities of hazardous substance present, NESHAPS is not an ARAR.
	New York ECL Article 19, Title 3 Air Pollution Control Law	6 NYCRR 200 6 NYCRR 257	Provides New York State requirements for emissions of hazardous air pollutants. Based on type and quantities of hazardous substance present, these requirements are not an ARAR.
Health and Safety	Occupational Safety and Health Act	29 CFR 191	Specify requirements for health and safety protection for workers potentially exposed to contaminants in hazardous waste site remediation. Also includes employee "Right-to-Know" regulations.
		29 CFR 1926	Specify the type of safety equipment and procedures to be followed during construction activities, including earthwork construction.

Table 14
Summary of Potential Action-Specific ARARs

Topic	Authority	Regulation	Requirement Synopsis
Hazardous Materials Transportation	Hazardous Materials Transportation Act 49 USC 5101	49 CFR 171-179	These regulation establish definitions and provisions for transporting hazardous materials; marking, labeling and placarding requirements; as well as general requirements for shipments rand packaging.

Note :

1. *The status of these potential action-specific ARARs as "applicable" or "relevant and appropriate" requirements depends on the specific remedial alternative.*
2. *USEPA policy is that authorized portions of the New York State RCRA program, rather than Federal regulations, constitute ARARs.*

Table 15
Calculated Preliminary Remediation Goals in Koppers Pond Gamefish Based on Reasonable Maximum Exposure

Potential Human Health Risks by Exposure Scenario[1]	Baseline Analysis
	RME
Noncancer Hazard	
Arsenic (mg/kg)[2]	--[3]
Mercury (mg/kg)[2]	--[3]
Total PCBs (µg/kg)[2]	42
Cancer Risk (1×10^{-6})	
Arsenic (mg/kg)[2]	0.0040
Total PCBs (µg/kg)[2]	2.9
Cancer Risk (1×10^{-5})	
Arsenic (mg/kg)[2]	0.040
Total PCBs (µg/kg)[2]	29
Cancer Risk (1×10^{-4})	
Arsenic (mg/kg)[2]	0.40
Total PCBs (µg/kg)[2]	290

Notes :

1. *Concentrations are on a wet-weight basis.*
2. *Units, mg/kg is milligrams per kilogram and µg/kg are micrograms per kilogram.*
3. *"--" indicates baseline risk does not exceed target value.*

Table 16
Calculated Preliminary Remediation Goals in Sediment at Koppers Pond Based on Preliminary Remediation Goals in Gamefish

Potential Human Health Risks by Exposure Scenario[1]	**Baseline Analysis**
	Reasonable Maximum Exposure
Noncancer Hazard	
Arsenic (mg/kg)[2]	--[3]
Mercury (mg/kg)[2]	--[3]
Total PCBs (µg/kg)[2]	67
Cancer Risk (1 x 10^{-6})	
Arsenic (mg/kg)[2]	0.16
Total PCBs (µg/kg)[2]	4.6
Cancer Risk (1 x 10^{-5})	
Arsenic (mg/kg)[2]	1.6
Total PCBs (µg/kg)[2]	46
Cancer Risk (1 x 10^{-4})	
Arsenic (mg/kg)[2]	--
Total PCBs (µg/kg)[2]	460

Notes :

1. *Concentrations are on a dry-weight basis.*
2. *Units, mg/kg is milligrams per kilogram and µg/kg are micrograms per kilogram.*
3. *"--" indicates baseline risk does not exceed target value.*

Table 17
Compendium of General Response Actions, Remedial Technologies, and Process Options

General Response Action	Remedial Technology	Process Option
No Action	None	None
Engineering and Institutional Controls	Access Restrictions	Fencing and Security
		Deed Notices and Restrictive Covenants
		Fish Advisory
	Monitoring and Maintenance	Physical Monitoring
		Chemical Monitoring
		Maintenance
		Fishery Management
Containment	Subaqueous Capping	Isolation Capping
	Soil Cover	Soil Cover
Sediment/Soil Removal and Disposal	Sediment/Soil Removal	Excavation
		Dredging
	Land Disposal	Off-Site Disposal
		On-Site Disposal
		On-Site Consolidation
Monitored Natural Recovery	Monitored Natural Recovery	Monitored Natural Recovery
Treatment	Treatment of Removed Sediments	Sediment Dewatering
		Stabilization
		Thermal Treatment
	In Situ Treatment	Reactive Capping
		Biological Treatment - Phytoremediation

Note:
1. *Shaded entries are those screened out in the evaluation process.*

Table 18
Summary of Remedial Technology and Process Options Evaluation

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost Factor	Status
No Action	None	None	Would not address risks in short term.	Easily implemented.	None.	Retained as baseline for comparison.
Engineering and Institutional Controls	Access Restrictions	Fencing and Security	Effective in reducing inadvertent access. Requires routine inspection and maintenance.	Easily implemented.	Low capital cost.	Retained as component of remedial action alternatives.
		Deed Notices and Restrictive Covenants	Effective in avoiding intrusive activities that could lead to unacceptable exposure. Controls must be enforced.	Easily implemented. May be complicated by multiple property owners.	Low capital cost.	Retained as component of remedial action alternatives.
		Fish Advisory	Effective in notifying public of potential hazards. Requires accompanying public education.	NYSDOH fish advisory already in place.	Low capital cost.	Retained as component of remedial action alternatives under AWL conditions.
	Monitoring and Maintenance	Physical Monitoring	Essential component of process options for access restrictions and on-site containment or disposal.	Easily implemented in the short-term; more difficult in long-term.	Low annual costs. Life-cycle cost can become mid-range.	Retained as component of remedial action alternatives.
		Chemical Monitoring	Essential component of process options until fish RBCs are achieved and maintained.	Easily implemented in the short-term; more difficult in long-term.	Low annual costs. Life-cycle cost can become mid-range to high depending on scope and duration.	Retained as component of remedial action alternatives.

Table 18
Summary of Remedial Technology and Process Options Evaluation

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost Factor	Status
Engineering and Institutional Controls (cont'd)	Monitoring and Maintenance (cont'd)	Maintenance	Essential component of process options for access restrictions and on-site containment or disposal.	Easily implemented in the short-term; more difficult in long-term.	Low annual costs. Life-cycle cost can become mid-range to high depending on scope and duration.	Retained as component of remedial action alternatives.
		Fishery Management	Can be effective in reducing potential exposures. Not effective for removing COPC mass from pond.	Easily implemented.	Low event costs. Life-cycle cost can become mid-range depending on frequency and duration.	Retained as component of remedial action alternatives.
Containment	Subaqueous Capping	Isolation Capping	(AWL) Isolates underlying sediment and provides new substrate for benthic community.	Cap must be thin to avoid filling large portion of pond or requiring removal of nearly all sediment.	High capital cost.	Retained as component of remedial action alternatives under AWL conditions.
	Soil Cover	Isolation Capping	(LWL) Isolates underlying sediment/soils and provides new vegetative cover.	Cap must be thin to avoid requiring removal of soils to maintain floodplain capacity.	High capital cost.	Retained as component of remedial action alternatives under LWL conditions.
Sediment/Soil Removal and Disposal	Sediment/Soil Removal	Excavation	Effective method of local or pond-wide sediment or soil removal.	Requires partial (in sections) or complete draining of pond.	High to very high capital cost. Volume dependent.	Retained as component of remedial action alternatives.
		Dredging	(AWL) Standard sediment removal method. More difficult to confirm completeness. Can be employed for "hot spot" removal.	Implementable. Outlets may need to be reworked for water depth to accommodate dredge.	High to very high capital cost. Volume dependent.	Not retained as component of remedial action alternatives based on comparison to excavation.

Table 18
Summary of Remedial Technology and Process Options Evaluation

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost Factor	Status
Sediment/Soil Removal and Disposal (cont'd)	Land Disposal	Off-Site Disposal	Effective method for sediment/soil disposal. May require treatment to render waste non-hazardous or to meet LDRs.	Commercial faculties available. Increases short-term risks associated with waste transport.	High to very high capital cost. Volume dependent.	Retained as component of remedial action alternatives.
		On-Site Disposal	Effective method for sediment/soil disposal.	Permitting and property issues make impractical compared to off-site option.	High capital cost.	Not retained as component of remedial action alternatives due to implementability issues.
		On-Site Consolidation	Effective method for sediment/soil disposal.	Implementable if permitting issues can be resolved.	Mid-range to high capital cost.	Retained as part of remedial approach involving pond removal.
Monitored Natural Recovery	Monitored Natural Recovery	Monitored Natural Recovery	Effectiveness depends on Site-specific factors. Not applicable to sediments exposed under LWL conditions.	Readily implementable.	Low to mid-range capital cost.	Retained as component of remedial action alternatives under AWL conditions.
Treatment	Treatment of Removed Sediments and Soils	Sediment/Soil Dewatering	Method to reduce waste volume and render materials suitable for land disposal.	Standard construction method for sediment/ soil handling from dredging.	High incremental cost. Partially off-set by reduced transportation and disposal costs.	Air drying retained as component of remedial action alternatives involving sediment or soil removal.
		Solidification/ Stabilization	Effective treatment if removed sediments test RCRA hazardous.	Standard technology for treating wet sediments/soils.	Mid-range incremental cost.	Retained as component of remedial action alternatives.

Table 18
Summary of Remedial Technology and Process Options Evaluation

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost Factor	Status
Treatment (cont'd)	Treatment of Removed Sediments and Soils (cont'd)	Thermal Treatment	Effective for destruction of PCBs as alternative to land disposal.	Off-site facilities implementable only for very small quantities. On-site facilities not administratively implementable.	Very high capital cost. Volume dependent.	Not retained as component of remedial action alternatives due to implementability issues.
	In Situ Treatment	Reactive Capping	(AWL) Innovative products and techniques for reducing potential flux of PCBs from sediment.	Limited full-scale application	Mid-range to high capital cost.	Not retained. Treatment is not necessary to meet remedial action objective under AWL conditions.
		Biological Treatment	Biological processes have been extensively tested for PCB, but generally with limited effectiveness. Phytoremediation for metals would require site-specific pilot study to determine viability.	No commercially viable process available. Implementability of phytoremediation not confirmed.	Expected to be mid-range to high capital cost.	Deleted from further consideration due to lack of effectiveness and implementability. If compatible with prmary remedy, phytormedation may be reviewed as a supplment duriing remedial design.

Notes:
1. *Shaded entries are those screened out in the evaluation process.*
2. *AWL = Average Water Levels; LWL = Low Water Levels.*

Table 19
Alternative 2 - Access Restrictions, Institutional Controls, and Monitored Natural Recovery
Primary Remedial Action Components and Preliminary Cost Estimate

Activity Description	Units	Quantity	Unit Cost ($)	Total Cost ($)
Remedial Construction				
Facility Fencing	LF	4,300	28	120,400
Subtotal - Remedial Construction				120,400
Other Remedial Action Costs				
Construction Oversight	Task	1	12,000	12,000
Institutional Controls	LS	1	75,000	75,000
Subtotal - Other Remedial Action Costs				87,000
Contingency (30 percent)				62,220
Total Remedial Action Capital Costs (Rounded)				**$ 270,000**
Post-Remedial Monitoring, Inspection, and Maintenance				NPV Factor
Monitoring	Year	30	25,000	15.37
Fish Harvesting/Restocking	Event	3	20,000	1.99
Site Inspection and Maintenance	Year	30	5,000	15.37
Five-Year Reviews	Event	6	50,000	2.78
NPV at 5% Discount Rate (Rounded)				**$ 640,000**
Total Life-Cycle Cost				**$ 910,000**

Table 20
Alternative 3 - Access Restrictions, Institutional Controls, and Capping
Primary Remedial Action Components and Preliminary Cost Estimate

Activity Description	Units	Quantity	Unit Cost ($)	Total Cost ($)
Remedial Construction				
Mobilization and Demobilization	LS	1	30,000	30,000
Site Preparation				
Site Utilities and Facilities	LS	1	15,000	15,000
Surface Water and Erosion Controls	LS	1	50,000	50,000
Stabilized Entrance and Site Access Road	LS	1	8,000	8,000
Facility Fencing	LF	4,300	28	120,400
Subaqueous Capping (assumed 3 acres)				
Geotextile	SY	14,520	12	174,240
Sand Cover	Ton	3,600	50	180,000
Soil Cover (assumed 6 acres)				
Grading	SY	29,040	2	58,080
Geotextile	SY	29,040	3	87,120
Soil Cover/Fill	CY	4,840	30	145,200
Topsoil	CY	4,840	38	183,920
Site Restoration	LS	1	40,000	40,000
Subtotal - Remedial Construction				1,091,960
Other Remedial Action Costs				
Construction Oversight	Task	1	109,200	109,200
Institutional Controls	LS	1	75,000	75,000
Subtotal - Other Remedial Action Costs				184,200
Contingency (30 percent)				383,000
Total Remedial Action Capital Costs (Rounded)				**$ 1,659,000**
Post-Remedial Monitoring, Inspection, and Maintenance				NPV Factor
Pond/Cover Monitoring	Year	30	7,500	15.37
Site Inspection and Maintenance	Year	30	5,000	15.37
Five-Year Reviews	Event	6	25,000	2.78
NPV at 5% Discount Rate (Rounded)				**$ 262,000**
Total Life-Cycle Cost				**$ 1,921,000**

Table 21A
Alternative 4A - Soil/Sediment Consolidation and On-Site Containment
Consolidation into Eastern Leg
Primary Remedial Action Components and Preliminary Cost Estimate

Activity Description	Units	Quantity	Unit Cost ($)	Total Cost ($)
Remedial Construction				
Mobilization and Demobilization	LS	1	40,000	40,000
Site Preparation				
Site Utilities and Facilities	LS	1	22,500	22,500
Surface Water and Erosion Controls	LS	1	20,000	20,000
Stabilized Entrance and Site Access Road	LS	1	8,000	8,000
Temporary Fencing	LF	4,300	3	12,900
Temporary Soil Dike				
Geotextile	SY	650	3	1,950
Soil Placement and Compaction	CY	850	30	25,500
Sediment Relocation				
By-Pass Pumping Setup and Operation	LS	1	50,000	50,000
Handling and Drying	CY	14,300	20	286,000
Stabilization Treatment	Ton	1,430	30	42,900
Sediment Excavation and Consolidation	CY	14,300	20	286,000
Sediment Placement and Compaction	CY	14,300	6	85,800
Channel Construction	LF	900	60	54,000
Removal Area Regrading/Restoration	Acre	5	50,000	250,000
Confirmation Sampling	Each	50	120	6,000
Wetland Area				
Topsoil	CY	2,700	38	102,600
Wetland Plantings	Acre	5	5,000	25,000
Sediment Management Area				
Geotextile	SY	19,400	3	58,200
Soil Cover Placement and Grading	CY	3,200	30	96,000
Topsoil	CY	3,200	38	121,600
Seeding and Mulching	Acre	4	5,000	20,000
Long-Term Surface Water/Erosion Controls	LS	1	25,000	25,000
Subtotal - Remedial Construction				1,639,950
Other Remedial Action Costs				
Construction Oversight	Task	1	164,000	164,000
Institutional Controls	LS	1	60,000	60,000
Compensatory Wetlands	Acre	8	75,000	600,000
Subtotal - Other Remedial Action Costs				824,000
Contingency (30 percent)				739,185
Total Remedial Action Capital Costs (Rounded)				**$ 3,203,000**
Post-Remedial Monitoring, Inspection, and Maintenance				NPV Factor
Site Inspection and Maintenance	Year	30	10,000	15.37
Five-Year Reviews	Event	6	15,000	2.78
NPV at 5% Discount Rate (Rounded)				**$ 195,000**
Total Life-Cycle Cost				**$ 3,398,000**

Table 21B
Alternative 4B - Soil/Sediment Consolidation and On-Site Containment
Consolidation into Western Leg
Primary Remedial Action Components and Preliminary Cost Estimate

Activity Description	Units	Quantity	Unit Cost ($)	Total Cost ($)
Remedial Construction				
Mobilization and Demobilization	LS	1	40,000	40,000
Site Preparation				
Site Utilities and Facilities	LS	1	22,500	22,500
Surface Water and Erosion Controls	LS	1	50,000	50,000
Stabilized Entrance and Site Access Road	LS	1	8,000	8,000
Temporary Fencing	LF	4,300	3	12,900
Temporary Soil Dike				
Geotextile	SY	650	3	1,950
Soil Placement and Compaction	CY	850	30	25,500
Sediment Relocation				
By-Pass Pumping Setup and Operation	LS	1	50,000	50,000
Handling and Drying	CY	7,100	20	142,000
Stabilization Treatment	Ton	710	30	21,300
Sediment Excavation and Consolidation	CY	7,100	20	142,000
Sediment Placement and Compaction	CY	7,100	6	42,600
Channel Construction	LF	900	60	54,000
Removal Area Regrading/Restoration	Acre	4	50,000	200,000
Confirmation Sampling	Each	40	120	4,800
Wetland Area				
Topsoil	CY	2,100	38	79,800
Wetland Plantings	Acre	4	5,000	20,000
Sediment Management Area				
Geotextile	SY	24,200	3	72,600
Soil Cover Placement and Grading	CY	4,000	30	120,000
Topsoil	CY	4,000	38	152,000
Seeding and Mulching	Acre	5	5,000	25,000
Long-Term Surface Water/Erosion Controls	LS	1	25,000	25,000
Subtotal - Remedial Construction				1,311,950
Other Remedial Action Costs				
Construction Oversight	Task	1	131,000	131,000
Institutional Controls	LS	1	60,000	60,000
Compensatory Wetlands	Acre	10	75,000	750,000
Subtotal - Other Remedial Action Costs				941,000
Contingency (30 percent)				675,885
Total Remedial Action Capital Costs (Rounded)				**$ 2,929,000**
Post-Remedial Monitoring, Inspection, and Maintenance				NPV Factor
Site Inspection and Maintenance	Year	30	10,000	15.37
Five-Year Reviews	Event	6	15,000	2.78
NPV at 5% Discount Rate (Rounded)				**$ 195,000**
Total Life-Cycle Cost				**$ 3,124,000**

Table 22
Alternative 5 - Sediment or Soil Removal and Off-Site Disposal
Primary Remedial Action Components and Preliminary Cost Estimate

Activity Description	**Units**	**Quantity**	**Unit Cost ($)**	**Total Cost ($)**
Remedial Construction				
Mobilization and Demobilization	LS	1	40,000	40,000
Site Preparation				
Site Utilities and Facilities	LS	1	22,500	22,500
Surface Water and Erosion Controls	LS	1	40,000	40,000
Stabilized Entrance and Site Access Road	LS	1	8,000	8,000
Temporary Fencing	LF	4,300	3	12,900
Sediment Removal				
By-Pass Pumping Setup and Operation	LS	1	50,000	50,000
Excavation, Handling, Drying, and Loadout	CY	21,400	35	749,000
Stabilization Treatment	Ton	2,600	30	78,000
Sediment Transportation and Disposal	Ton	28,600	80	2,288,000
Confirmation Sampling	Each	50	120	6,000
Site Restoration	LS	1	80,000	80,000
Subtotal - Remedial Construction				3,374,400
Other Remedial Action Costs				
Construction Oversight	Task	1	337,000	337,000
Subtotal - Other Remedial Action Costs				337,000
Contingency (30 percent)				1,113,000
Total Remedial Action Capital Costs (Rounded)				**$ 4,824,000**
Post-Remedial Monitoring, Inspection, and Maintenance				NPV Factor
Pond Monitoring	Year	0	-	7.92
Site Inspection and Maintenance	Year	0	-	7.92
NPV at 5% Discount Rate (Rounded)				**$ -**
Total Life-Cycle Cost				**$ 4,824,000**

Table 23
Comparative Analysis of Alternatives

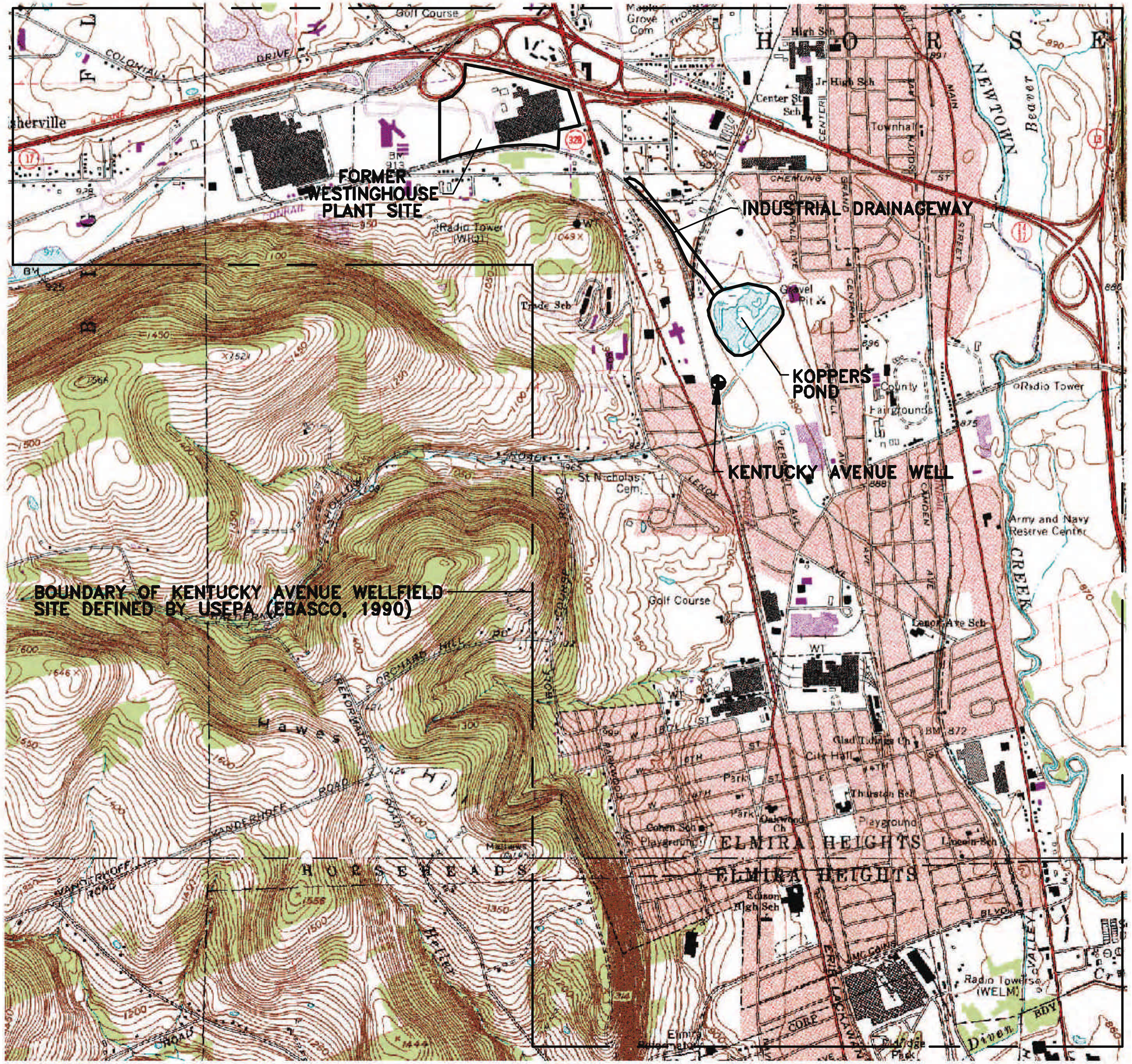
Evaluation Criteria	Alternative				
	1	2	3	4	5
	No Action	Access Restrictions, Institutional Controls, and Monitored Natural Recovery	Access Restrictions, Institutional Controls, and Capping	Sediment/Soil Consolidation and On-Site Containment	Sediment or Soil Removal and Off-Site Disposal
Threshold Criteria					
Overall protection of human health and the environment	**0**	**0**	**5**	**5**	**5**
Compliance with ARARs	**1**	**2**	**4**	**4**	**5**
Balancing Criteria					
Long-term effectiveness and permanence	**0**	**2**	**4**	**4**	**5**
Reduction of TMV	**0**	**2**	**4**	**4**	**5**
Short-term impact and effectiveness	**2**	**3**	**4**	**4**	**2**
Implementability	**5**	**4**	**5**	**5**	**5**
Cost effectiveness	**0**	**4**	**3**	**2**	**1**
Total Threshold and Balancing Score	**8**	**17**	**29**	**28**	**28**

<u>Note</u> :

1. *Alternatives are rated on a relative basis on how well that alternative achieves each criterion. If the criterion is not met, the score is 0. If the criterion is met, a relative score from 1 (lowest acceptable attainment) to 5 (highest degree of attainment) is assigned.*

FIGURES

DRAWING NUMBER 07502B1



SCALE
0 2000 4000 FEET

QUADRANGLE LOCATION

REFERENCE:

MODIFIED FROM U.S GEOLOGICAL SURVEY HORSEHEADS, NEW YORK, AND ELMIRA, NEW YORK–PENNSYLVANIA, QUADRANGLES, PHOTOREVISED 1978.

FIGURE 1

SITE LOCATION MAP

KENTUCKY AVENUE WELLFIELD SITE – OU4
HORSEHEADS, NEW YORK

PREPARED FOR

KOPPERS POND RI/FS GROUP

CUMMINGS RITER CONSULTANTS, INC.

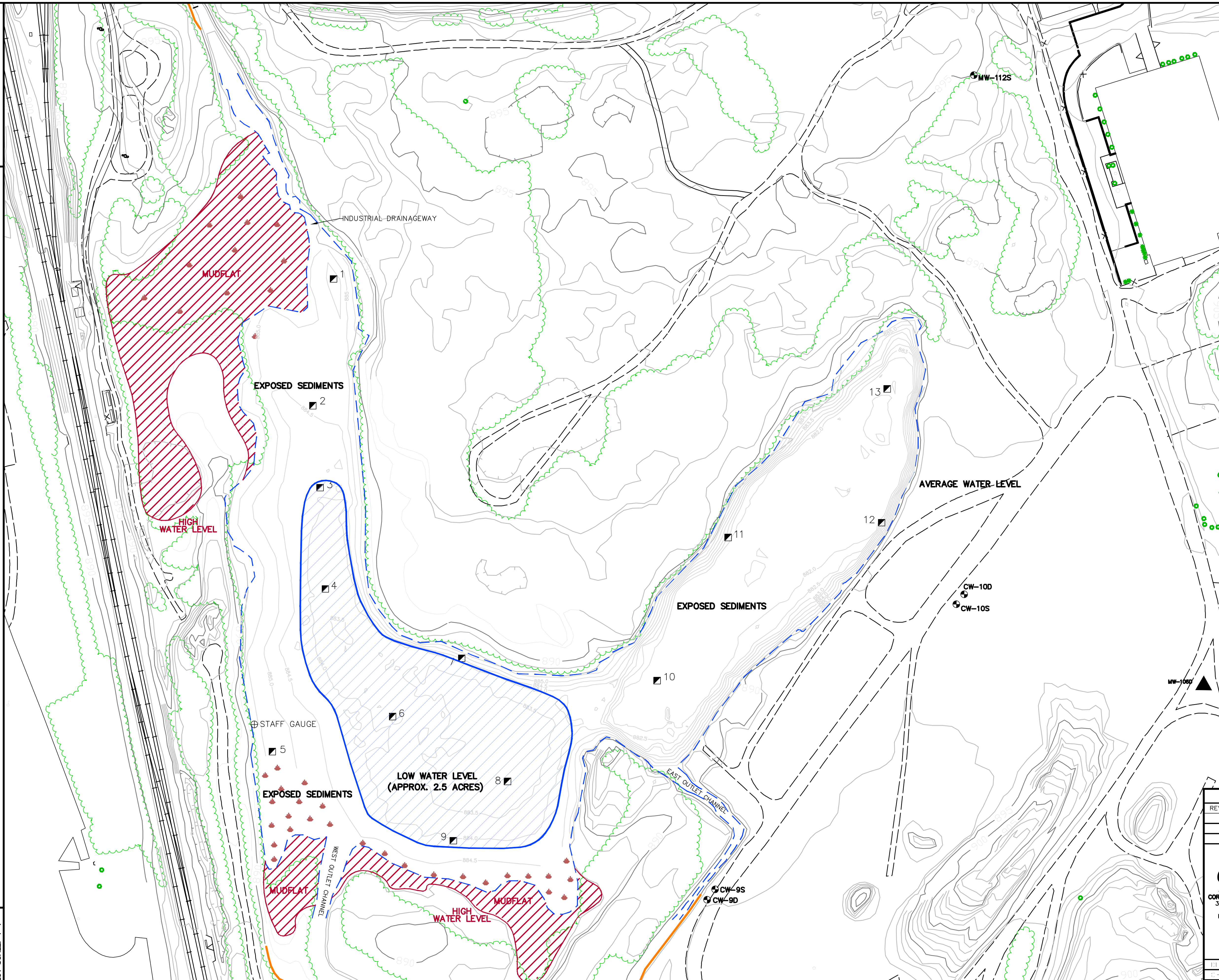
DRAWING NUMBER	
07502B1	
DRAWN BY: T.E. McKee	DATE: 1–31–07
CHECKED BY: W.C. Smith	DATE: 2–19–07
APPROVED BY: W.C. Smith	DATE: 2–19–07

PLOT SCALE: 1=1

FIGURE 2
SITE PLAN
KENTUCKY AVE. WELLFIELD SITE - OU4
HORSEHEADS, NEW YORK
Prepared For:
KOPPERS POND RI/FS GROUP

CUMMINGS RITER CONSULTANTS, INC.

hheads-9b.mxd



LEGEND

MW-112S	MONITORING WELL LOCATION
886	EXISTING ELEVATION CONTOUR
885.0	SEDIMENT ELEVATION CONTOUR
	UTILITY POLE
	TYPICAL LOW WATER CONDITIONS
	TYPICAL AVERAGE WATER CONDITIONS
	TYPICAL HIGH WATER CONDITIONS
12	SEDIMENT SAMPLE LOCATION
	STAFF GAUGE

NOTE

1. CONTOUR ELEVATIONS IN THE POND ARE BASED ON WATER ELEVATION OF 885.75', SURVEYED ON MAY 6, 2008.

REFERENCE:

1. MAPPING COMPLETED BY STEREOPHOTO GRAMMETRIC METHODS BY WEILER ASSOCIATES FROM 1:4800 SCALE AERIAL FLOWN 11-09-91.

SCALE

70 0 70 140 FEET

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED

CUMMINGS RITER CONSULTANTS, INC.
CORPORATE HEADQUARTERS
300 Penn Center Blvd.
Suite 800
Pittsburgh, PA 15235
(412) 241-4500
Fax: (412) 241-7500

FIGURE 3
WATER LEVEL CONDITIONS

KENTUCKY AVENUE WELLFIELD SITE – OU4
HORSEHEADS, NEW YORK

PREPARED FOR
KOPPERS POND RI/FS GROUP

SIZE E | SCALE: 1" = 50' | REV. –

DRAWN BY: D.J. Martino DATE: 04-01-16
CHECKED BY: B.R. Maurer DATE: 04-01-16
APPROVED BY: B.R. Maurer DATE: 04-01-16

DRAWING NUMBER 07502E3

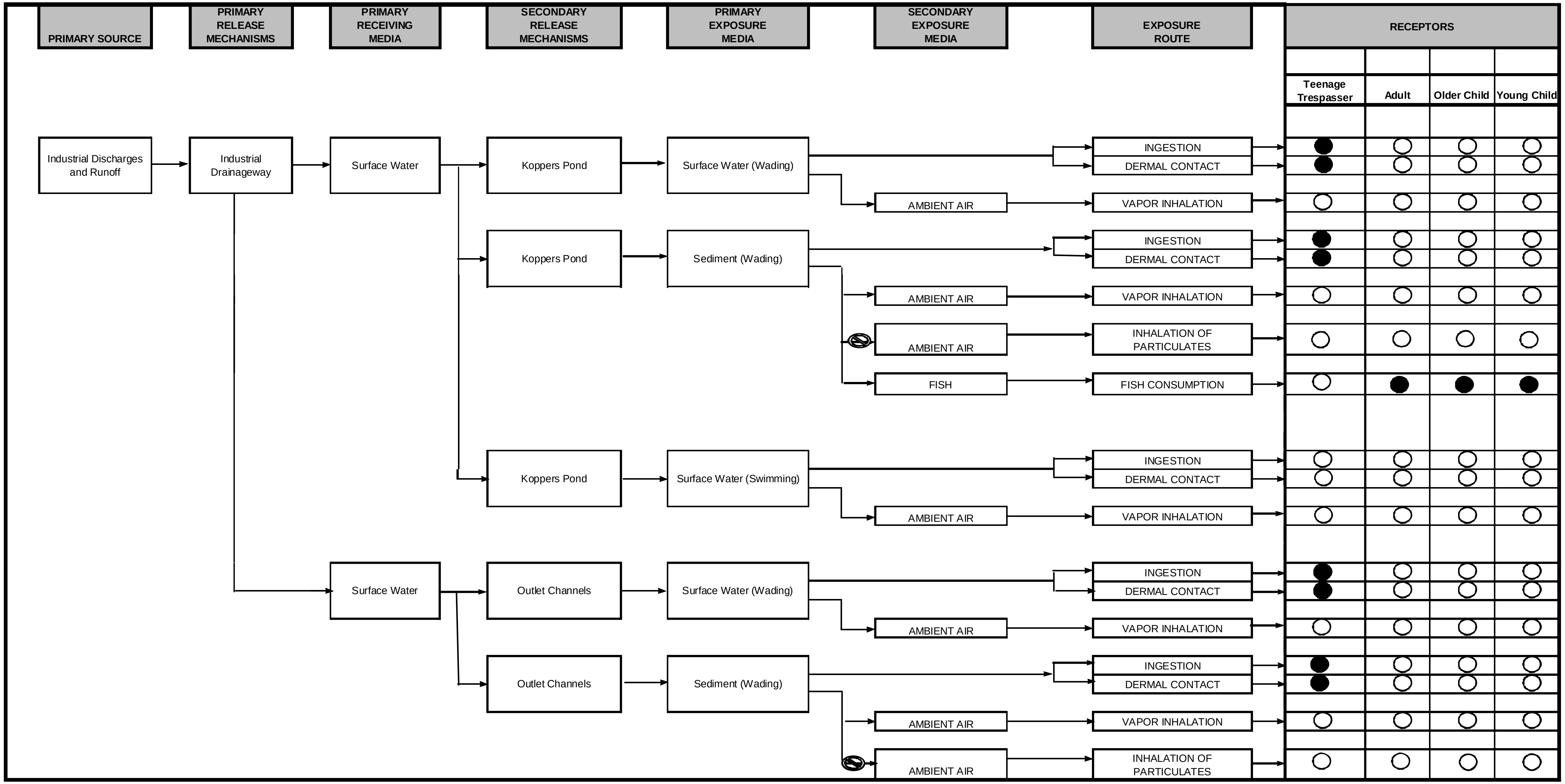
PLOT SCALE: 1=1

CUMMINGS RITER CONSULTANTS, INC.

hheads-9c.mxd

FIGURE 4 - WATERSHED MAP
KENTUCKY AVE. WELLFIELD SITE - OU4
HORSEHEADS, NEW YORK

Prepared For:
KOPPERS POND RI/FS GROUP

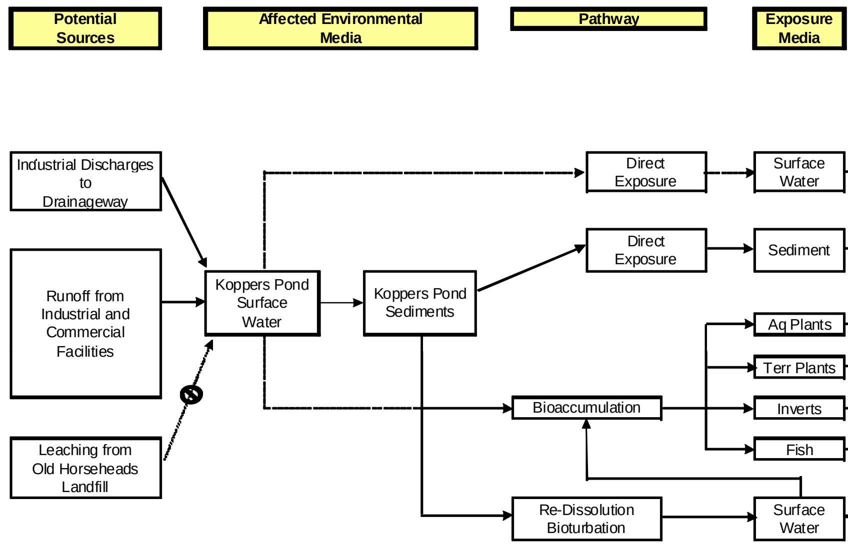


LEGEND

- ○ Exposure Pathway Evaluated and Incomplete
- ● Exposure Pathway Evaluated and Complete
- ⊘ Transport Pathway Incomplete

integral consulting inc.

Figure 5. Conceptual Site Model for the Baseline Human Health Risk Assessment Under the AWL and HWL Scenarios
Koppers Pond Kentucky Avenue Wellfield Site, Operable Unit 4, Horseheads, New York



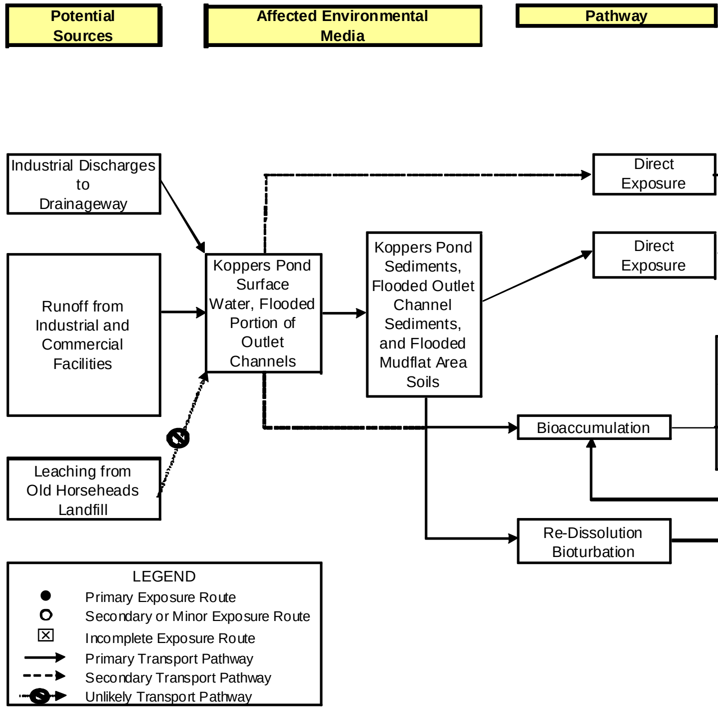
Exposure Route and Receptor Group

Exposure Media	Exposure Route	Aquatic Receptors: Benthic Inverts	Aquatic Receptors: Amphibians and Reptiles	Aquatic Receptors: Fish	Semi-Aquatic Receptors [a]: Aquatic Birds (Ducks)	Semi-Aquatic Receptors [a]: Semi-Aquatic Birds (Herons)	Semi-Aquatic Receptors [a]: Herbivorous Mammals (Muskrats)	Semi-Aquatic Receptors [a]: Omivorous Mammals (Raccoon)	Semi-Aquatic Receptors [a]: Piscivorous Mammals (Mink)
Surface Water	*Ingestion*	○	○	○	○	○	○	○	○
	Direct Contact	○	○	○	☒	☒	☒	☒	☒
Sediment	*Ingestion*	●	●	●	●	●	●	●	●
	Direct Contact	●	●	○	○	○	○	○	○
Aq Plants	*Ingestion*	●	●	●	●	●	●	●	●
Terr Plants	*Ingestion*	☒	☒	☒	○	○	●	●	○
Inverts	*Ingestion*	☒	●	●	●	●	○	○	○
Fish	*Ingestion*	☒	☒	○	●	●	○	○	●
Surface Water	*Ingestion*	○	○	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○	○	○

LEGEND
- ● Primary Exposure Route
- ○ Secondary or Minor Exposure Route
- ☒ Incomplete Exposure Route
- → Primary Transport Pathway
- - - → Secondary Transport Pathway
- ⊘→ Unlikely Transport Pathway

Notes:
This CSM addresses Koppers Pond under the AWL scenario and is also relevant to the assessment of the reference pond.
A dashed line indicates that this is likely a *de minimis* transport or exposure pathway under current conditions.
Surface water may be minor direct exposure source based on measured chemical concentrations (no COPECs were retained for this medium).
Modified from Figure 3-1 of the ERAGS Steps 3 through 5 Report (Integral, 2010b)
[a] Semi-aquatic receptors are those species that spend part or all of thier lives near or foraging from a waterbody.

Figure 6. Conceptual Site Model for the Supplemental Baseline Risk Assessment of Koppers Pond under the AWL Scenario
Kentucky Avenue Wellfield OU4 - Koppers Pond, Horseheads, New York

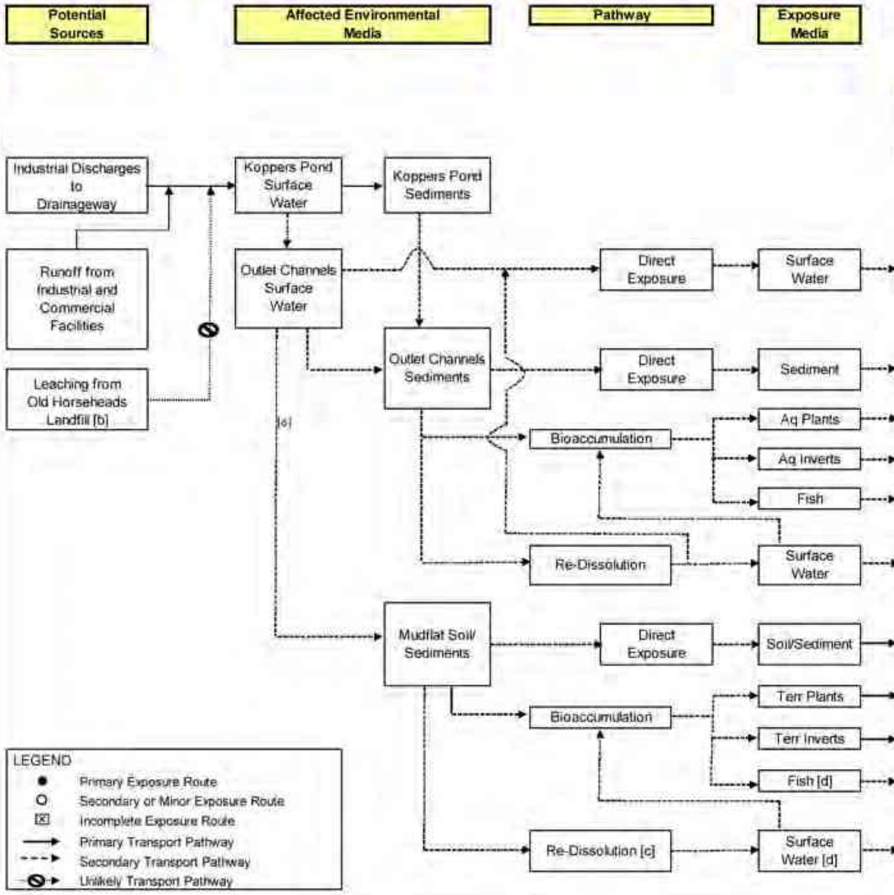


Exposure Route and Receptor Group

Exposure Media	Exposure Route	Aquatic Receptors: Benthic Inverts	Aquatic Receptors: Amphibians and Reptiles	Aquatic Receptors: Fish	Semi-Aquatic Receptors [a]: Aquatic Birds (Ducks)	Semi-Aquatic Receptors [a]: Semi-Aquatic Birds (Herons)	Semi-Aquatic Receptors [a]: Herbivorous Mammals (Muskrats)	Semi-Aquatic Receptors [a]: Omivorous Mammals (Raccoon)	Semi-Aquatic Receptors [a]: Piscivorous Mammals (Mink)
Surface Water	*Ingestion*	○	○	○	○	○	○	○	○
	Direct Contact	○	○	○	☒	☒	☒	☒	☒
Sediment, Flooded Soils	*Ingestion*	●	●	●	●	●	●	●	●
	Direct Contact	●	●	○	○	○	○	○	○
Aq Plants	*Ingestion*	●	●	●	●	●	○	○	●
Terr Plants	*Ingestion*	☒	☒	☒	○	○	●	●	○
Inverts	*Ingestion*	☒	●	●	●	●	○	○	○
Fish	*Ingestion*	☒	☒	○	●	●	○	○	●
Surface Water	*Ingestion*	○	○	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○	○	○

Notes:
This CSM addresses Koppers Pond under the HWL scenario. Under these conditions a portion of the mudflat/outlet area is inundated and continuous with the Koppers Pond water column.
A dashed line indicates that this is likely a *de minimis* transport or exposure pathway under current conditions.
Surface water may be minor direct exposure source based on measured chemical concentrations (no COPECs were retained for this medium).
Modified from Figure 3-1 of the ERAGS Steps 3 through 5 Report (Integral, 2010b)
[a] Semi-aquatic receptors are those species that spend part or all of thier lives near or foraging from a waterbody.

Figure 7. Conceptual Site Model for the Supplemental Baseline Risk Assessment of Koppers Pond under the HWL Scenario
Kentucky Avenue Wellfield OU4 - Koppers Pond, Horseheads, New York

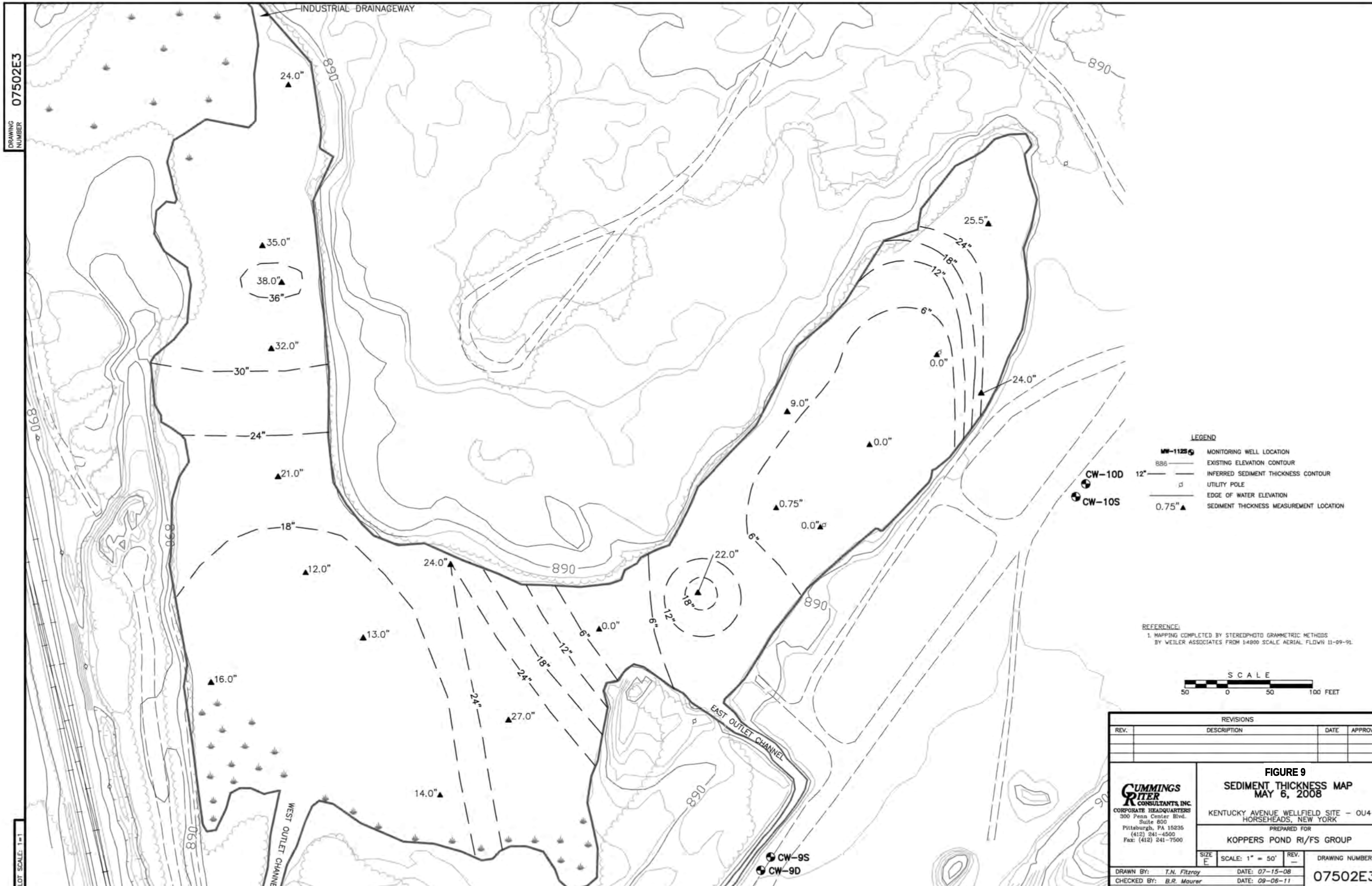


Exposure Route and Receptor Group

Exposure Media	Exposure Route	Aquatic Receptors: Benthic Inverts	Aquatic Receptors: Amphibians and Reptiles	Aquatic Receptors: Fish	Semi-Aquatic Receptors [a]: Aquatic Birds (Ducks)	Semi-Aquatic Receptors [a]: Semi-Aquatic Birds (Herons)	Semi-Aquatic Receptors [a]: Herbivorous Mammals (Muskrats)	Semi-Aquatic Receptors [a]: Omivorous Mammals (Raccoon)	Semi-Aquatic Receptors [a]: Piscivorous Mammals (Mink)
Surface Water	*Ingestion*	○	○	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○	○	○
Sediment	*Ingestion*	●	●	○	○	○	●	●	●
	Direct Contact	●	●	○	○	○	○	○	○
Aq Plants	*Ingestion*	●	●	○	○	●	●	●	●
Aq Inverts	*Ingestion*	☒	○	○	○	●	○	○	●
Fish	*Ingestion*	○	○	○	○	○	☒	☒	●
Surface Water	*Ingestion*	○	○	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○	○	○
Soil/Sediment	*Ingestion*	☒	☒	☒	○	●	●	●	●
	Direct Contact	☒	☒	☒	○	○	○	○	○
Terr Plants	*Ingestion*	☒	☒	☒	○	○	●	●	●
Terr Inverts	*Ingestion*	☒	☒	☒	☒	☒	●	●	○
Fish [d]	*Ingestion*	☒	☒	☒	☒	☒	☒	☒	○
Surface Water [d]	*Ingestion*	○	○	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○	○	○

Notes:
Potential transport from Koppers Pond to the outlet channels (and mudflat area) was likely more significant in the past when the Industrial Drainageway was at peak use.
The areal extent of the outlet channels and mudflat soils/sediments is much less under the HWL scenario relative to the AWL scenario. Much of the mudflat area was inundated under the HWL scenario due to the presence of a beaver dam in the west outlet.
A dashed line indicates that this is likely a *de minimis* transport or exposure pathway under current conditions. Surface water may be minor direct exposure source based on measured chemical concentrations, although no COPECs were retained from this media.
Modified from Figure 3-1 of the ERAGS Steps 3 through 5 Report (Integral 2010b).
[a] Semi-aquatic receptors are those species that spend part or all of their lives near or foraging from a waterbody. They are unlikely to use the mudflat area except when it is inundated.
[b] Based on observations made during the 2008 field sampling effort there was no apparent leachate seeps near the Old Horseheads Landfill. Therefore this exposure pathway is considered to be incomplete.
[c] Re-dissolution of COPECs may occur *only* when the mudflat area is flooded (HWL scenario).
[d] Represents a potential transport pathway or exposure media only when mudflat area is flooded (HWL scenario).

Figure **8** Conceptual Site Model for the Outlet Channels and Mudflat Area under the AWL and HWL Scenarios
Kentucky Avenue Wellfield OU4 - Koppers Pond, Horseheads, New York



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED

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CORPORATE HEADQUARTERS
300 Penn Center Blvd.
Suite 800
Pittsburgh, PA 15235
(412) 241-4500
Fax: (412) 241-7500

FIGURE 9

SEDIMENT THICKNESS MAP
MAY 6, 2008

KENTUCKY AVENUE WELLFIELD SITE – OU4
HORSEHEADS, NEW YORK

PREPARED FOR

KOPPERS POND RI/FS GROUP

SIZE E | SCALE: 1" = 50' | REV. –

DRAWING NUMBER 07502E3

DRAWN BY: T.N. Fitzroy DATE: 07-15-08
CHECKED BY: B.R. Maurer DATE: 09-06-11
APPROVED BY: B.R. Maurer DATE: 09-06-11

SD-01	2008	2010	2013
Cadmium	739 J	283 J	250 J
Chromium	462 J	370 J	370 J
Copper	820 J	467 J	430 J
Lead	1,480 J	1,030 J	850 J
Nickel	180 J	121 J	97 J
Zinc	12,500 J	5,020 J	4,500 J
Aroclor-1254	1,400 J	700 J	380 J

SD-02	2008	2013
Cadmium	544	430 J
Chromium	379	480 J
Copper	669	740 J
Lead	1,620	1,500 J
Nickel	117	130 J
Zinc	9,830	7,200 J
Aroclor-1254	1,400	640 J

SD-11	2008
Cadmium	57.1
Chromium	154
Copper	164
Lead	348
Nickel	84.3
Zinc	981
Aroclor-1254	220

SD-13	2008	2013
Cadmium	72.1 J	--
Chromium	195 J	--
Copper	246 J	--
Lead	267 J	--
Nickel	124 J	--
Zinc	1,190 J	--
Aroclor-1254	2,700 J	180 J

SD-40	2008
Cadmium	2
Chromium	17.5
Copper	36.2
Lead	79
Nickel	16.3
Zinc	101
Aroclor-1254	43

SD-03	2008	2010	2013
Cadmium	535 J	323 J	320 J
Chromium	441 J	367 J	470 J
Copper	657 J	476 J	540 J
Lead	1,580 J	1,270 J	1,300 J
Nickel	122 J	89.8 J	110 J
Zinc	9,330 J	5,920 J	5,600 J
Aroclor-1254	1,300 J	480 J	400 J

SD-51	2013
Aroclor-1254	200 J

SD-52	2013
Aroclor-1254	150 J

SD-12	2008
Cadmium	46.5 J
Chromium	130 J
Copper	133 J
Lead	312 J
Nickel	46.3 J
Zinc	882 J
Aroclor-1254	180 J

SD-04	2008	2010	2013
Cadmium	553 J	367 J	330 J
Chromium	400 J	320 J	380 J
Copper	657 J	495 J	490 J
Lead	1,010 J	989 J	1,000 J
Nickel	157 J	107 J	94 J
Zinc	8,780 J	6,380 J	5,500 J
Aroclor-1254	1,500 J	550 J	440 J

SD-07	2008	2013
Cadmium	287 J	--
Chromium	258 J	--
Copper	352 J	--
Lead	664 J	--
Nickel	88.5 J	--
Zinc	4,120 J	--
Aroclor-1254	580 J	180 J

SD-53	2013
Aroclor-1254	300 J

SD-10	2008	2013
Cadmium	117	--
Chromium	230	--
Copper	298	--
Lead	273	--
Nickel	119	--
Zinc	1,720	--
Aroclor-1254	460	170 J

SD-05	2008	2013
Cadmium	23.2 J	--
Chromium	136 J	--
Copper	107 J	--
Lead	146 J	--
Nickel	76.3 J	--
Zinc	449 J	--
Aroclor-1254	410 J	140 J

SD-08	2008	2010	2013
Cadmium	356 J	292 J	--
Chromium	274 J	232 J	--
Copper	412 J	370 J	--
Lead	562 J	654 J	--
Nickel	133 J	99.1 J	--
Zinc	4,930 J	4,860 J	--
Aroclor-1254	670 J	520 J	420 J

SD-06	2008	2010	2013
Cadmium	61	115 J	--
Chromium	80.5	151 J	--
Copper	94.7	185 J	--
Lead	116	339 J	--
Nickel	52.1	75.4 J	--
Zinc	892	1,950 J	--
Aroclor-1254	72	260 J	280 J

(2010)	SD-31	SD-32	SD-33
Cadmium	3.4 J	4.2	5.1 J
Chromium	41.6 J	42.2	51.2 J
Copper	35.1 J	41.8	46.8 J
Lead	114 J	126	157 J
Nickel	35.4 J	34.7	40.1 J
Zinc	202 J	227	263 J
Aroclor-1260	20 J	27 J	20 J

SD-09	2008	2013
Cadmium	4.4	--
Chromium	21.8	--
Copper	25.9	--
Lead	37	--
Nickel	23.8	--
Zinc	129	--
Aroclor-1254	20	330 J

SD-30	2008
Cadmium	1.3
Chromium	21.4
Copper	21.2
Lead	29
Nickel	21.4
Zinc	95
Aroclor-1254	ND

SD-15 (0-3)	2008
Cadmium	22.7 J
Chromium	83.4 J
Copper	94.6 J
Lead	189 J
Nickel	41.1 J
Zinc	534 J
Aroclor-1254	190 J

SD-16 (0-4)	2008
Cadmium	48.7
Chromium	88.3
Copper	101
Lead	172
Nickel	49.6
Zinc	888
Aroclor-1254	130

SD-14 (0-5)	2008
Cadmium	3
Chromium	24.8
Copper	25.1
Lead	34
Nickel	29.9
Zinc	123
Aroclor-1254	20

SD-17 (0-6)	2008
Cadmium	91.9
Chromium	149
Copper	175
Lead	288
Nickel	55.5
Zinc	1,690
Aroclor-1254	280

SD-18 (0-3)	2010
Cadmium	7
Chromium	25
Copper	29.2
Lead	45
Nickel	27.2
Zinc	192
Aroclor-1254	28

SD-19 (0-3)	2010
Cadmium	0.7
Chromium	18.7
Copper	18.6
Lead	19
Nickel	25.4
Zinc	95
Aroclor-1254	2.9

Notes:
1. Metals data is in mg/kg (ppm).
PCB data is in ug/kg (ppb).
2. All PCBs were quantified as Aroclor 1254 or 1260. Thus, the Aroclor 1254/1260 concentrations shown on this figure are the total PCB concentrations.
3. Depth intervals were 0-6" unless otherwise indicated.

Pond Sample Location
Outlet Channel Sample Location
Mud Flat Sample Location

Prepared For:
KOPPERS POND RI/FS GROUP
CUMMINGS RITER CONSULTANTS, INC.

FIGURE 10
SEDIMENT SAMPLE RESULTS
0 - 6 INCHES DEEP
KENTUCKY AVE. WELLFIELD SITE - OU4
HORSEHEADS, NEW YORK

hheads-10a.mxd

SD08-01 (6-18)	
Cadmium	759
Chromium	329
Copper	752
Lead	829
Nickel	194
Zinc	12,100
Aroclor 1254	2,200

SD08-02 (6-18)	
Cadmium	931
Chromium	454
Copper	961
Lead	645
Nickel	308
Zinc	11,500
Aroclor 1254	5,100 J

SD08-13 (6-18)	
Cadmium	94.4
Chromium	432
Copper	517
Lead	227
Nickel	254
Zinc	1,280
Aroclor 1254	410

SD08-03 (6-18)	
Cadmium	1,080
Chromium	418
Copper	965
Lead	776
Nickel	274
Zinc	13,800
Aroclor 1254	4,900

SD08-11 (6-9)	
Cadmium	49.2
Chromium	211
Copper	233
Lead	140
Nickel	157
Zinc	726
Aroclor 1254	690

SD08-04 (6-18)	
Cadmium	72.4
Chromium	101
Copper	164
Lead	65
Nickel	106
Zinc	580
Aroclor 1254	4,300

SD08-07 (6-18)	
Cadmium	56.5
Chromium	64.6
Copper	99.5 J
Lead	64.1
Nickel	56 J
Zinc	742 J
Aroclor 1254	1,300

SD08-12 (6-12)	
Cadmium	58.3
Chromium	191
Copper	188
Lead	493
Nickel	93
Zinc	1,050
Aroclor 1254	180

SD08-10 (6-18)	
Cadmium	99.7
Chromium	440
Copper	602
Lead	148
Nickel	372
Zinc	983
Aroclor 1254	6,500

SD08-05 (6-13)	
Cadmium	6.0 J
Chromium	82.6
Copper	51.9 J
Lead	61.8
Nickel	55.9
Zinc	163 J
Aroclor 1254	150 J

SD08-08 (6-18)	
Cadmium	63.5
Chromium	53.8
Copper	84.8
Lead	50.1
Nickel	47
Zinc	864
Aroclor 1254	200

SD08-06 (6-9)	
Cadmium	0.75
Chromium	20.9
Copper	15.7
Lead	17.1
Nickel	21.3
Zinc	60.3
Aroclor 1254	ND

SD08-09 (6-10)	
Cadmium	2.0
Chromium	23.4
Copper	22.1
Lead	28.3
Nickel	27.7
Zinc	107
Aroclor 1254	ND

Notes:
1. Metals data is in mg/kg (ppm).
PCB data is in ug/kg (ppb).

2. All PCBs were quantified as Aroclor 1254. Thus, the Aroclor 1254 concentrations shown on this figure are the total PCB concentrations.

Pond Sample Location

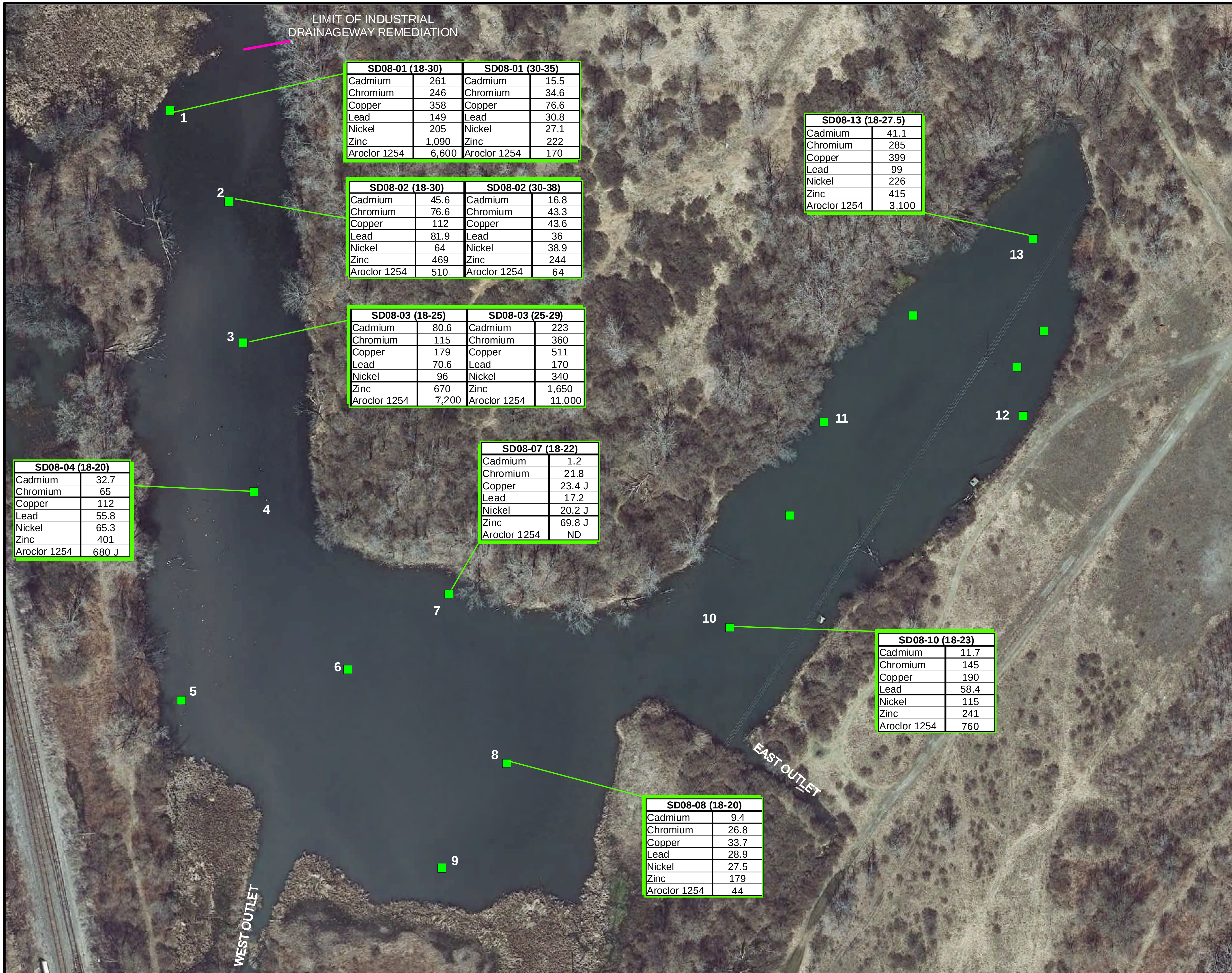
0 100 200 Feet

Prepared For:
KOPPERS POND RI/FS GROUP

CUMMINGS RITER CONSULTANTS, INC.

FIGURE 11
SEDIMENT SAMPLE RESULTS
6 - 18 INCHES DEEP
KENTUCKY AVE. WELLFIELD SITE - OU4
HORSEHEADS, NEW YORK

hheads-10b.mxd



SD08-01 (18-30)		SD08-01 (30-35)	
Cadmium	261	Cadmium	15.5
Chromium	246	Chromium	34.6
Copper	358	Copper	76.6
Lead	149	Lead	30.8
Nickel	205	Nickel	27.1
Zinc	1,090	Zinc	222
Aroclor 1254	6,600	Aroclor 1254	170

SD08-02 (18-30)		SD08-02 (30-38)	
Cadmium	45.6	Cadmium	16.8
Chromium	76.6	Chromium	43.3
Copper	112	Copper	43.6
Lead	81.9	Lead	36
Nickel	64	Nickel	38.9
Zinc	469	Zinc	244
Aroclor 1254	510	Aroclor 1254	64

SD08-03 (18-25)		SD08-03 (25-29)	
Cadmium	80.6	Cadmium	223
Chromium	115	Chromium	360
Copper	179	Copper	511
Lead	70.6	Lead	170
Nickel	96	Nickel	340
Zinc	670	Zinc	1,650
Aroclor 1254	7,200	Aroclor 1254	11,000

SD08-13 (18-27.5)	
Cadmium	41.1
Chromium	285
Copper	399
Lead	99
Nickel	226
Zinc	415
Aroclor 1254	3,100

SD08-04 (18-20)	
Cadmium	32.7
Chromium	65
Copper	112
Lead	55.8
Nickel	65.3
Zinc	401
Aroclor 1254	680 J

SD08-07 (18-22)	
Cadmium	1.2
Chromium	21.8
Copper	23.4 J
Lead	17.2
Nickel	20.2 J
Zinc	69.8 J
Aroclor 1254	ND

SD08-10 (18-23)	
Cadmium	11.7
Chromium	145
Copper	190
Lead	58.4
Nickel	115
Zinc	241
Aroclor 1254	760

SD08-08 (18-20)	
Cadmium	9.4
Chromium	26.8
Copper	33.7
Lead	28.9
Nickel	27.5
Zinc	179
Aroclor 1254	44

Notes:
1. Metals data is in mg/kg (ppm).
PCB data is in ug/kg (ppb).

2. All PCBs were quantified as Aroclor 1254. Thus, the Aroclor 1254 concentrations shown on this figure are the total PCB concentrations.

Pond Sample Location

0 100 200 Feet

Prepared For:
KOPPERS POND RI/FS GROUP
CUMMINGS RITER CONSULTANTS, INC.

FIGURE 12
SEDIMENT SAMPLE RESULTS
18 + INCHES DEEP
KENTUCKY AVE. WELLFIELD SITE - OU4
HORSEHEADS, NEW YORK

hheads-10c.mxd

Prepared For:
KOPPERS POND RI/FS GROUP

WOODARD & CURRAN

FIGURE 13
REMEDIATION FEATURES
REMEDIAL ALTERNATIVES 2/3
KENTUCKY AVE. WELLFIELD SITE - OU4
HORSEHEADS, NEW YORK

hheads-12.mxd

Notes:
1. Configuration of drainage channel and extents of restoration areas to be determined during remedial design.

Prepared For:
KOPPERS POND RI/FS GROUP

WOODARD & CURRAN

FIGURE 14A
CONCEPTUAL DESIGN
REMEDIAL ALTERNATIVE 4A
KENTUCKY AVE. WELLFIELD SITE - OU4
HORSEHEADS, NEW YORK

hheads-17.mxd

N

Notes:
1. Configuration of drainage channel and extents of restoration areas to be determined during remedial design.

0 100 200 Feet

Prepared For:
KOPPERS POND RI/FS GROUP

WOODARD & CURRAN

FIGURE 14B
CONCEPTUAL DESIGN
REMEDIAL ALTERNATIVE 4B
KENTUCKY AVE. WELLFIELD SITE - OU4
HORSEHEADS, NEW YORK

hheads-18a.mxd

APPENDIX A: ESTIMATE OF EQUIVALENT SURFACE WATER CONCENTRATIONS FROM SEDIMENTS IN KOPPERS POND

Estimate of Equivalent Surface Water Concentrations
From Sediments in Koppers Pond

There were no detected PCBs in the surface water of Koppers Pond, but the detection limit (0.38 µg/L) was greater than the NYSDEC bioaccumulation-based surface water criterion based on fish consumption (1×10^{-6} µg/L). To determine whether there is the potential to exceed this conservative criterion, the equivalent surface water PCB concentration in Koppers Pond was calculated based on estimated sediment pore water concentrations. The average sediment total PCB concentration (572 $\mu g/kg_{dw}$)[1] was used to estimate the equivalent sediment pore water concentration (0.065 µg/L), based on a log K_{oc} = 5.12 for PCBs[2] and the average TOC content of the surface sediment (6.7%). Two methods were used to estimate the surface water PCB concentration of Koppers Pond:

- Method 1: Simple dilution model
- Method 2: Fickian diffusion box model

These two methods are discussed below.

METHOD 1 – SIMPLE DILUTION MODEL

A simple dilution model can be used to provide an upper bound estimate of the potential surface water concentrations based on the calculated pore water concentrations. Assumptions and supporting calculations are provided in Attachment 1. For this model, the surface water concentration was estimated based on instantaneous mixing of all the porewater with the static volume of the surface water, as follows:

$$(Volume_{pore\ water})(pore\ water\ [PCB]) = (pore\ water\ PCB\ load)$$

$$(PCB\ load)(Volume_{Total}) = (pond\ water\ [PCB])$$

The volume of pore water was estimated based on the porosity of the Koppers Pond sediments (50%; typical of clayey silts) and the volume of the shallow sediment (4,317 m^3). The latter was calculated as the product of the surface area of Koppers Pond under

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[1] This average reflects total PCB results from sediment samples collected in 2008, 2010 and 2013.

[2] Log K_{oc} was obtained from the ORNL Risk Assessment Information System website (http://rais.ornl.gov/cgi-bin/tools/TOX_search?select=chem_spef).

low inlet flow conditions (7 acres, equivalent to 28,329 m^2) and the six inch surface sediment depth (0.15 m).

This conservative approach yields an equivalent surface water concentration of 8.1×10^{-3} μg/L. This value is greater than the bioaccumulation-based NYSDEC water quality criterion for PCBs based on fish consumption, but is below other water quality criteria. It is also below any current analytical reporting limits for Aroclor PCBs in surface water samples.

However, this method was not representative of the physical system since instantaneous mixing of the pore water and surface water can not occur under normal field conditions. PCBs present in the sediments would migrate more slowly through the sediment from the pore water and into the surface water by molecular diffusion. This is assessed in Method 2.

METHOD 2: FICKIAN DIFFUSION MODEL

This diffusive flux can be accounted for with Fick's law in the mixing model that was employed to estimate the PCB concentration in the surface water of Koppers Pond in Model 2. Since there is no connection between groundwater and surface water at this site, Method 2 only assesses non-advective diffusion from the sediments to the overlaying water. Fick's Law for sediments was used with a mixing model to determine a conservative estimate of the steady-state surface water PCB concentrations in the pond based on the ongoing water balance of the pond. Assumptions and supporting calculations are provided in Attachment 2, and key assumptions are summarized below.

Given

- Pond volume ≈ 4.6 million gal ≈ 17 million L
- Input Stream flow = 600 gal/min = 2,270 L/min. This is representative of average annual flow in absence of treated groundwater discharge (2015 conditions).
- Area of the pond open-water = 7 acres = 28,329 m^2
- Porosity of clayey silt ≈ 0.5 (typical of Koppers Pond surface sediment)
- Surface sediment volume (wet): 4,317 m^3
- Mass of sediment in pond (wet; surface 6 inches): 85 lb/ft^3 ≈ 1,363 kg/m^3
- No advective flow (i.e., no ground water input to pond).

Diffusion constant, $D_s = 2.8\times10^{-8}$ m^2/min (value from ORNL RAIS website)

Calculated

Fick's Law for sediment input by diffusion:

$$J = \varphi D_s\, C_d$$

Where,

- J is the flux of PCBs into the pond (mass per area of total sediment per unit time)
- D_s is the diffusion coefficient (area per time)
- C_d is the concentration of dissolved PCBs (per unit volume of wet sediment)
- Φ is the sediment porosity

Substituting these values into this equation yields the following:

$$J = (0.5)\left(\frac{2.8 \text{ x } 10^{-8}\text{ m}^2}{\text{min}}\right)\left(\frac{0.065\,\mu g}{L}\ x\ \frac{4{,}317\, m^3}{28{,}329\, m^2}\right)\left(\frac{1{,}000\, L}{m^3}\right)$$

$$J = \ 1.39 * 10^{-7}\mu g/min$$

This value (J) represents the pore water PCB flux on a mass per unit time basis across the sediment-water interface in the pond. To estimate the equivalent surface water concentration, the loading is weighted by the mass loss from the outlet stream flow, and the net mass is divided by the pond volume. The outlet flow is assumed to be the same as the input flow (from the Industrial Drainageway), and is calculated using the outlet flow and total pond water volume, as shown on the right side of the equation below.

Mixing equation

x = the mass (μg) of PCBs in the pond at a given time (i.e., mass IN – mass OUT) can be expressed with the following equation:

$$\frac{dx}{dt} = \left[J\,(\frac{\mu g}{\text{min}})\right] - \left[\left(2{,}271\ \frac{L}{min}\right)\left(\frac{x(t)\ (\mu g)}{17{,}300{,}000\ L}\right)\right]$$

$$\frac{dx}{dt} = J - 0.000131\, x(t)$$

And as a differential equation:

$$\int \frac{dx}{dt} = \int \big(J - 0.000131\, x(t)\big) dt$$

Integrating this equation using the integrating factor method yields:

$$x(t) = \left(\frac{J}{0.000131}\right) + Ce^{-0.000131t}$$

At time zero [x(0) = 0 grams PCBs in water], the constant [C] has the following value:

$$C = 0.00106$$

Substituting this value into the equation above yields the following:

$$x(t) = (0.00106) - (0.00106)e^{-0.000131t}$$

As time approaches infinity, the equation solution approaches the following mass in the water column:

$$x = 0.00106 \text{ µg}$$

This solution for x, the net total mass of PCBs in the surface water, was divided by the volume of the pond, to yield the equivalent surface water concentration: 6.1×10^{-11} µg/L.

The results show that passive diffusion of PCBs from sediment pore water under the non-advective flow conditions of Koppers Pond is negligible and does not result in equivalent surface water concentrations above the bioaccumulation-based surface water criterion from NYSDEC.

Attachment 1
Assumptions and Supporting Calculations for Method 1 - Simple Dilution Model
Updated to Reflect Reduction in Pond Volume with Cessation of OU2 Discharge

General

1. Media Concentrations and Key Physico-Chemical Parameters

Sed Conc (Avg)	mg/kg_{dw}	0.57	Average of site surface sediments - 2008, 2010 and 2013
Sed Conc (Avg)	mg/kg_{OC}	8.5	Average of site surface sediments - 2008, 2010 and 2014
Log Kow	L/Kg	6.50	From RAIS website
Log Koc	L/kg_{OC}	5.12	From RAIS website
Koc	L/kg_{OC}	1.31E+05	
TOC	%	6.74	Average of site surface sediments - 2008, 2010 and 2013
Pore Water Conc (est)	mg/L	6.49E-05	Calculated from Koc and TOC
Pore Water Conc (est)	µg/L	0.065	

Pond Properties

2. Koppers Pond Surface Area

Surface Area	acres	7	Revised for lowered water condition
Surface Area	m^2	28,329	1 acre = 4,047 m^2

3. Koppers Pond Water Volume

Avg Water Depth	ft	2	Revised for lowered water condition
Avg Water Depth	m	0.6096	1 ft = 0.3048 m
Volume	m^3	17,269	
Volume	L	1.7E+07	1,000 L = m^3

4. Sediment Characteristics

Depth - surface sediment	inches	6	
Depth - surface sediment	m	0.1524	1 in = 0.0254 m
Volume - surface sediment	m^3	4,317	Pond surface area * sediment depth
Sediment porosity (ϕ)	---	0.5	Pond surface sediment is a clayey silt
Volume - pore water	m^3	2,159	Porosity * sediment volume

Equivalent Surface Water Concentration

Pore water PCB load	µg	1.4E+05	Pore water volume * pore water conc
Pond surface water conc from pore water diffusion	**µg/L**	**8.1E-03**	Pore water load diluted into pond surface water volume

Attachment 2
Assumptions and Supporting Calculations for Method 2 - Fickian Diffusion Box Model
Updated to Reflect Reduction in Pond Volume with Cessation of OU2 Discharge

General

1. Media Concentrations and Key Physico-Chemical Parameters

Sed Conc (Avg)	mg/kg_{dw}	0.57	Average of site surface sediments - 2008, 2010 and 2013
Sed Conc (Avg)	mg/kg_{OC}	8.5	Average of site surface sediments - 2008, 2010 and 2014
Log Kow	L/Kg	6.50	From RAIS website
Log Koc	L/kg_{OC}	5.12	From RAIS website
Koc	L/kg_{OC}	1.31E+05	
TOC	%	6.74	Average of site surface sediments - 2008, 2010 and 2013
Pore Water Conc (est)	mg/L	6.49E-05	Calculated from Koc and TOC
Pore Water Conc (est)	µg/L	0.065	
Aroclor 1254 Water Diffusion Constant (D_s)	cm^2/sec	4.68E-06	From RAIS website
Aroclor 1254 Water Diffusion Constant (D_s)	m^2/min	2.81E-08	

Pond Properties

2. Koppers Pond Surface Area

Surface Area	acres	7	Revised for lowered water condition
Surface Area	m^2	28,329	1 acre = 4,047 m^2

3. Koppers Pond Water Volume

Avg Water Depth	ft	2	Revised for lowered water condition
Avg Water Depth	m	0.6096	1 ft = 0.3048 m
Volume	m^3	17,269	
Volume	gal	4,559,111	1 m^3 = 264 gallons
Volume	L	1.73E+07	1,000 L = m^3

4. Inlet/Outlet Water Flow

Inlet water flow	gpm	600	Low end of reported flow from Industrial Drainageway. Outlet flow assumed to be the same.
Inlet water flow	L/min	2,271	1 gal = 3.785 L

5. Sediment Characteristics

Depth - surface	inches	6	
Depth - surface	m	0.1524	1 in = 0.0254 m
Sediment porosity (ϕ)	---	0.5	Pond surface sediment is a clayey silt
Sediment volume (wet)	m^3	4,317	Surface sediment only Area assumed same as pond surface area
Sediment mass (surface, wet)	lb/ft^3	85	
Sediment mass (surface, wet)	kg/m^3	1,363	1 lb = 0.454 kg 1 ft^3 = 0.0283 m^3

6. Flux Calculations

*$J = D_s * C_s$ * (sediment flux volume/sediment surface area)*			
D_s	m^2/min	2.81E-08	(see #1 above)
C_s (pore water conc)	µg/L	0.065	Pore water conc (calculated)
Flux volume	m^3	2,159	Product of sediment volume and porosity
Surface area of pond	m^2	28,329	Area assumed same as pond surface area
Conversion Factor	L/m^3	1,000	
J	µg/min	1.39E-07	

7. Mixing Equation and Results

Loss Term	L/min	2,271	Assumes outlet flow is same as inlet flow
Pond water volume	L	1.7E+07	
Interim value for diffusion equation	---	1.3E-04	See text
Constant [C]	---	1.06E-03	
Mass at Time Zero	µg	1.06E-03	From integrated equation at t=0

Equivalent Surface Water Concentration

Concentration at infinite time	µg/L	6.11E-11	Mass/current volume

APPENDIX B: MEMORANDUM: TYPICAL LIFE SPANS FOR WARM WATER GAME FISH, PAN FISH, AND CARP, AND SEASONAL OR CLIMATE EFFECTS ON LIFE SPAN

Memorandum

To: L. M. Brausch

From: A. K. Hoffarth

Date: December 5, 2012

Re: Typical Life Spans for Warm Water Game Fish, Pan Fish, and Carp, and Seasonal or Climate Effects on Life Span

---

TYPICAL LIFESPAN OVERVIEW

- Largemouth Bass: 11 to 15 years;
- Crappie: 5 to 7 years;
- Carp: 10 to 20 years; and
- Bluegill: 5 to 7 years.

DETAILED OUTLINE

What are the typical life spans for warm water game fish, pan fish, and carp? Are they temperature/climate dependent?

I. Largemouth Bass (*Micropterus salmoides)*

A. Average age is 11 years.[1]

B. Average age of females: 9; males: 6 in Michigan study[2]

C. Oldest fish was a 15 year old female in South Carolina study[3]

D. Oldest fish in populations studied were 15 years old in study of 698 North American populations[4].

1. At Age 1: 651 populations;
2. At Age 5: 493 populations;
3. At Age 7: 320 populations;
4. At Age 10: 120 populations; and
5. At Age 15: 9 populations.

E. Average age is 16 years in Texas study.[5]

F. Maximum age is 13 years in study including North Carolina, Virginia, Maryland, and Delaware.[6]

G. Average age is 9 years for females, 6 for males.[7]

1. Northern fish typically live longer than southern fish.

II. Crappie

A. Black *(Pomoxis nigromaculatus)*

1. Average age is 7; the maximum recorded is 15 years.[8]
2. The maximum age for black crappie was 11 years old from 8 populations in Nebraska study.[6]
   a. Most populations were 5 to 6 years old.
   b. Only one population had fish older than 8.
3. Range of age in 17 populations across United States: 1 to 7 years old.[9]
4. Age ranged from 2 to 8 years old in 765 individuals sampled in South Dakota study.[10]
   a. Majority were ages 2 to 5.
5. Natural mortality occurs between ages 3 and 5.[7]

B. White *(Pomoxis annularis)*

1. Maximum age 10 years.[8]
2. Maximum age is approximately 9 in study including North Carolina, Virginia, Maryland, and Delaware.[6]
3. Range of age in 16 populations across United States: 1 to 9 years old.[9]
4. Maximum age is 9 years old in Oklahoma study.[11]
   a. After year 5, there was a marked decrease in numbers of fish caught for older age classes.
5. Average age is 5 years or less.[7]

C. Both Species

1. Maximum age reached was approximately 5 years in Wisconsin study.[12]

III. Carp

A. Maximum age attained in the United States is approximately 20 years.[6]

B. Life expectancy: approximately 20 years.[13]

C. 128 fish were aged 3 to 13 years old and 11 were aged 14+ years old in South Dakota study.[14]

D. Maximum age is 13 years old in Clear Lake, Iowa study.[15]

E. Average age is 20 years for wild fish.[16]

F. Average age is 9 to 15 years old in Kentucky.[17]

G. Average age is between 9 and 15.[7]

   1. The oldest recorded was 47 years old.[7]

IV. Bluegill Sunfish

A. Of 21 populations studied, the maximum age was 12 in Nebraska study.[6]

   1. In most populations, age was between 6 and 7 years old.
   2. Continual decrease in number of populations with older fish, and only one age 12.

B. Maximum age was 11 years old (males only) in Ontario, Canada study.[18]

   1. 83 were aged 5;
   2. 34 aged 6; and
   3. 2 aged 11.

C. Average age is 5 to 6 years in Michigan.[19]

D. Aged 0 to 9+ (could not determine past 9 years) in Arkansas study.[20]

E. Average age is 5 to 6 years in Iowa.[21]

   1. Maximum age recorded as 13 years old.

F. Maximum age is 11 years old in study including North Carolina, Virginia, Maryland, and Delaware.[6]

G. Average age is between 9 and 11 years old.[7]

Summary and Discussion

For largemouth bass, there is some literature that states natural mortality is lower in northern waters, correlated to degree days greater than 10°Celsius. Growth is also noted to be slower in northern waters. The studies state, however, that despite finding correlations to environment, populations are highly variable and other factors including habitat availability, prey abundance, water quality, and community composition affect growth and mortality.[5, 6,23].

Regarding crappie, there was not any literature found on differences in maximum age across latitudes or temperatures. The Texas Department of Natural Resources did state that crappie tend to grow faster in warmer waters, which may indirectly affect lifespan (over-winter mortality has been linked to length), but nothing was found stating that outright.

The literature search was conducted on the common carp, as opposed to some of the koi species, or grass carp. The general consensus among studies is that carp have a long lifespan in the wild. They are a hardy species and are now found in 57 countries and all of the lower 48 states. This very wide range suggests that temperature or seasons fluctuations do not significantly affect lifespan.

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