Record of Decision

Olin McIntosh Site

Operable Unit 2 (OU-2)

McIntosh, Washington County, Alabama

April 2014

U.S. Environmental Protection Agency

Region 4

61 Forsyth Street S.W.

Atlanta, Georgia 30303

ERRATA SHEET

This errata sheet lists errors and their correction for the Olin McIntosh Site, Operable Unit 2, Record of Decision, dated April 2014.

Location	*Error*	*Correction*
p. xii, line 12		TMV Toxicity, Mobility, Volume
p. xii, line 13		TRV Toxicity Reference Value
p. 28, par. 2, line 4	0.010 ug/L at a concentration of 0.011 to 0.0113 µg/L	0.010 µg/L with concentrations of 0.011 to 0.013 µg/L
p. 46, par. 3, line 11	18,000 cm2 and 14,110 cm2	18,000 cm^2 and 14,110 cm^2
p. 47, par. 3, line 12	5,700 cm2/event and 4,050 cm2/event, respectively.	5,700 cm^2/event and 4,050 cm^2/event, respectively.
p. 47, par. 4, line 16	1.36E+9 m3/kg	1.36 x 10^9 m^3/kg
p. 51, par. 2, line 9	(mg/kg-day)-1	$(mg/kg\text{-}day)^{-1}$
p. 52, par. 2, line 13	(e.g., 2 x 10-5)	(e.g., 2 x 10^{-5})
p. 52, par. 3, line 17	1x10-6	1x10^{-6}
p. 53, par. 2, line 4	10-6 to 10-4	10^{-4} to 10^{-6}
p. 53, par. 5, line 19	2.3E-05	2.3 x 10^{-5}
p. 54, par. 2, line 8	Uncertainity	Uncertainty
p. 57, par. 1, line 8	3.2E-05 to 2.0E-06	3.2 x 10^{-5} to 2.0 x 10^{-6}
p. 58, par. 3, line 25	COCCs	COCs
p. 65, par. 3, line 20-27	• Alabama red-bellied turtle, Pseudemys alabamensis - Endangered • Alabama sturgeon, Scaphirhyncus suttkusi - Endangered, Critical Habitat in Alabama River • Bald eagle, Haliaeetus leucocephalus - BGEPA • Black pine snake, Pituophis melanoleucus lodingi - Candidate • Gopher tortoise, Gopherus polyphemus - Threatened • Gulf sturgeon, Acipenser oxyrinchus desotoi - Threatened • Louisiana quillwort, Isoetes louisianensis - Endangered	• Alabama red-bellied turtle, *Pseudemys alabamensis* - Endangered • Alabama sturgeon, *Scaphirhyncus suttkusi* - Endangered, Critical Habitat in Alabama River • Bald eagle, *Haliaeetus leucocephalus* - BGEPA • Black pine snake, *Pituophis melanoleucus lodingi* - Candidate • Gopher tortoise, *Gopherus polyphemus* - Threatened • Gulf sturgeon, *Acipenser oxyrinchus desotoi* - Threatened • Louisiana quillwort, *Isoetes louisianensis* – Endangeredp.
p.66, par. 1, line 1-2	• West Indian manatee, Trichechus manatus - MMPA • Wood stork, Mycteria americana – Endangered	• West Indian manatee, *Trichechus manatus* – MMPA • Wood stork, *Mycteria americana* – Endangered
p. 67, par. 2, line 9	comprehensive of biological	comprehensive biological
p. 94, par. 2, line 6	0.28 – 0.43 in	0.28 – 0.43 mg/kg in

ERRATA SHEET

This errata sheet lists errors and their correction for the Olin McIntosh Site, Operable Unit 2, Record of Decision, dated April 2014.

p. 94, par. 3, line 15	RG 0.64 in whole body predatory fish	RG 0.64 mg/kg in whole body predatory fish
p. 104, par. 3, line 21	barrier	barrier.
p. 109, par. 2, line 4	fish tissue with time.	fish tissue over time.
p. 139, par. 2, line 15	WQC of 0.12 µg/L.	WQC of 0.012 µg/L.
p. 152, par. 2, line 18	0.23 in tissues	0.23 mg/kg in tissues
p. 156, line 4 - 8	Rasmussen. 1996. University of Florida Book of Insect Records. Chapter 20 Least Oxygen Dependent. Available: (http://ufbir.ifas.ufl.edu/Chap20.htm) Soil and Water Conservation Society of Metro Halifax. 2008. (http://www.chebucto.ns.ca/ccn/info/Science/SWCS/ZOOBENTH/BENTHOS/xxv.html).	Rasmussen. 1996. University of Florida Book of Insect Records. Chapter 20 Least Oxygen Dependent. Available: (http://ufbir.ifas.ufl.edu/Chap20.htm) Soil and Water Conservation Society of Metro Halifax. 2008. (http://www.chebucto.ns.ca/ccn/info/Science/SWCS/ZOOBENTH/BENTHOS/xxv.html).
Table 26, Notes	[3] Ont LEL = Ontario Lowest Effects Level: Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. D. Persaud , R. Jaagumagi, and A. Hayton. Ontario Ministry of the Environment, Ontario, August 1993. NOAA ER-L = National Oceanic and Atmospheric Administration Effects Range –Low SQC= Sediment Quality Criteria	PEC = Sediment Probable Effects Concentration from McDonald et al 2000. Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Contam. Toxicol. 39: 20-31. WSRC = Ecological screening value for sediment from Westinghouse Savannah River Company WSCR-TR-98-00110 (2000) EPA R4 = Ecological Screening Value from EPA Region 4 NAWQC = National Ambient Water Quality Criterion
Table 28, row 4	0.38 – 0.47 (protection of piscivorous birds)	0.32 – 0.91 (protection of piscivorous birds)

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ACRONYMS AND ABBREVIATIONS

ºC	degree Celsius
°F	degree Fahrenheit
µm	micrometer or micron
cm^3/g	cubic centimeter per gram
5YRR	5-Year Review Report
ADCNR	Alabama Department of Conservation and Natural Resources
ADEM	Alabama Department of Environmental Management
AGS	Alabama Geological Survey
ALDNR	Alabama Department of Natural Resources
AOC	Administrative Order on Consent
ARARs	Applicable or Relevant and Appropriate Requirements
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	Area Use Factor
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factor
BGEPA	Bald and Golden Eagle Protection Act
BHC model	Bachmann-Hoyer-Canfield model
BRA	Baseline Risk Assessment
BMP	Best Management Practice
BSAF	Biota-sediment Accumulation Factor
CD	Consent Decree
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cm	centimeter
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CPC	Crop Protection Chemicals
CSF	Carcinogenic Slope Factor

ACRONYMS AND ABBREVIATIONS (continued)

CSM	Conceptual Site Model
CWA	Clean Water Act
Cy	Cubic Yards
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DDTr	p,p'-isomers of DDT, DDE, and DDD
DDTR	Total dichlorodiphenyl choroethanes (Sum of p,p'-DDT; o,p'-DDT; p,p'-DDE; o,p'-DDE; p,p'-DDD and o,p'-DDD)
ECs	Engineering Controls
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESPP	Enhanced Sedimentation Pilot Project
FS	Feasibility Study
g/day	grams per day
GI	Gastrointestinal
HCB	Hexachlorobenzene
HDPE	High Density Polyethylene
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
ICs	Institutional Controls
IUR	Inhalation Unit Risk
L/hr	liter per hour
LOAEL	Low Observed Adverse Effect Level
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
NAVD88	North American Vertical Datum of 1988

ACRONYMS AND ABBREVIATIONS (continued)

NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	No Observed Adverse Effect Level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSR	Net Sedimentation Rate
NTU	Nephelometric Turbidity Unit
NWS	National Weather Services
O&M	Operation and Maintenance
OM&M	Operation, Maintenance, and Monitoring
Olin	Olin Corporation
ORP	Oxidation Reduction Potential
OU	Operable Unit
OU-1	Olin McIntosh Operable Unit 1
OU-2	Olin McIntosh Operable Unit 2
PCNB	Pentachloronitrobenzene
PPE	Personal Protective Equipment
PRG	Permissible Remediation Goal
PTW	Principal Threat Waste
Q2	Alluvial Aquifer of the Alluvial Sediments
R	Riverine Deposits
RAO	Remedial Action Objective
RCRA	Resource and Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RGO	Remedial Goal Option Report
RGs	Remediation Goals
RI	Remedial Investigation
RM	River Mile
RME	Reasonable Maximum Exposure

ACRONYMS AND ABBREVIATIONS (continued)

ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SERAFM	Spreadsheet-based Ecological Risk Assessment for the Fate of Mercury
SF	Slope Factor
SLERA	Screening Level Ecological Risk Assessment
SPLP	Synthetic Precipitation Leaching Procedure
SWMUs	Solid Waste Management Units
TAG	Technical Assistance Group
TBC	To Be Considered
TCAN	Trichloroacetonitrile
TCLP	Toxicity Characteristic Leaching Procedure
TMV	Toxicity, Mobility, Volume
TRV	Toxicity Reference Value
Terrazole	5-ethoxy-3trichloromethyl-1,2,4-thiadizole
TDS	Total Dissolved Solids
Tm1	The Miocene Confining Unit
TOC	Total Organic Carbon
TRM	Tombigbee River Mile
TSS	Total Suspended Solids
t-TEL	tissue threshold effects level
UCL	Upper Confidence Limit
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WEFH	Wildlife Exposure Factors Handbook
WSE	Water Surface Elevations
WQC	Water Quality Criteria

PART 1

PART 1: DECLARATION

1.1 SITE NAME AND LOCATION

The Olin Corporation (McIntosh Plant) Superfund Site, Operable Unit 2 (OU-2) is located adjacent to and east of the Olin Chlor-Alkali facility at 1638 Industrial Road in McIntosh, Washington County, Alabama. The Site was entered into the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database on July 2, 1979 and the identification number of the Site in CERCLIS is: #ALD008188708. The Site was listed on the NPL in September of 1984. Because the problems at the Olin Site are complex, the Site was organized into two operable units (OUs): OU-1- the active production facility, Solid Waste Management Units (SWMUs), and the upland area of the Olin property; and OU-2 – the Olin Basin located east of the main plant area and adjacent to the Tombigbee River, a floodplain and a wastewater ditch leading to the Basin. OU-2 consists of approximately 209 acres of open ponded water and seasonally flooded wetland. Under base water flow (non-flooded stage) conditions, the open water portion of OU-2 consists of the 76 acre Olin Basin (the Basin), and the 4 acre Round Pond. Olin Basin and Round Pond drain into the Tombigbee River through an inlet channel at the south end of the Basin. OU-2 also includes a wastewater ditch (about 6,000 linear feet) that extends from the main plant to the Basin. This ditch formerly discharged into the southwest corner of the Basin, but currently discharges into the inlet channel to the Tombigbee River.

1.2 STATEMENT OF BASIS AND PURPOSE

This decision document, presents the Selected Remedy for Operable Unit Two (OU-2) of the Olin Corporation (McIntosh Plant) Site, McIntosh, Alabama, (the Site) which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (“CERCLA”), as amended by the Superfund Amendments and Reauthorization Act of 1986 (“SARA”) 42 U.S.C. Section 9601 et seq., and to the extent practicable, the National Contingency Plan (“NCP”) 40 CFR Part

300. This decision is based on the Administrative Record for the Olin OU-2 Site.

The Alabama Department of Environmental Management (ADEM) concurs with the Selected Remedy.

1.3 ASSESSMENT OF SITE

The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

1.4 DESCRIPTION OF SELECTED REMEDY

Based on the information currently available, the Environmental Protection Agency (EPA) believes the selected remedy of in-situ capping of contaminated sediments and soil meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. In compliance with CERCLA Section 121(b), this alternative will be protective of human health and the environment, comply with ARARs, be cost effective, will use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Capping of mercury contaminated sediments has been demonstrated to be reliable for this type of contamination and provides an element of treatment to reduce mobility and toxicity (bioavailability) through physical isolation, stabilization, and chemical immobilization of the contaminants under the cap.

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site whenever possible (NCP §300.430(a)(1)(iii)(A)). The Olin OU-2 mercury contaminated sediments are not readily classifiable as principal threat wastes despite the inherent toxicity of mercury and demonstrated mobility which has contaminated surface water. Although active treatment is not included as a primary component in the selected remedy, the cap may include reactive materials that will sequester mercury and prevent it from migrating through the cap. Capping alternatives have been demonstrated to be reliable containment remedies for this type of contamination in submerged sediments.

The major components of the remedy include:

- *Multi-layered Cap.* A multi-layered cap applied in-situ over approximately 80 acres of sediment exceeding the sediment cleanup levels. The cap will consist of three layers: 1) a mixing zone, 2) an effective cap layer, and 3) a habitat layer. The capping materials and their thicknesses will be determined during remedial design. These capping materials will be physically and chemically compatible with the environment in which they are placed. Geotechnical parameters will be evaluated to ensure compatibility among cap components, native sediment, and surface water. The placement method will minimize short-term risk from the release of contaminated pore water and resuspension of contaminated sediment during cap placement. Reactive materials may be used to reduce the potential for contaminants to migrate through the cap.

- *Additional Sampling and Analyses.* Additional sampling and analyses will be performed in the channel connecting Round Pond to the Basin and the perimeter of the Round Pond floodplain soils that are often inundated, as well as the former wastewater and discharge ditch, to further refine the remedial footprint. Depending on the results of this characterization, these floodplain soil areas may require installation of a cap.

- *Institutional Controls.* The institutional controls (deed and restrictive covenant) that are currently in place as a result of OU-1 (Operable Unit 1) will be amended to include the OU-2 remedial footprint and use restrictions. Also, engineering controls, such as warning signs, including fish advisory signage, fencing, and security monitoring will be implemented to restrict access and prevent exposures to human receptors.

- *Construction Monitoring.* Construction monitoring for capping will be designed to ensure that the design plans and specifications are followed in the placement of the cap and to monitor the extent of any contaminant releases during cap placement. Construction monitoring will likely include interim and post-construction cap material placement surveys, sediment cores, sediment profiling camera, and chemical resuspension monitoring for contaminants. In the initial period following cap construction, sediment samples will be taken to confirm that cleanup levels were achieved and benthic community assessments will be performed to evaluate restoration efforts.

- *Maintenance.* Maintenance of the in-situ cap will include the repair and replenishment of the layers where necessary to prevent releases of contaminants.

- *Long-Term Monitoring.* Long-term monitoring will include physical, chemical, and biological measurements in various media to evaluate long-term remedy effectiveness in achieving remedial action objectives (RAOs), attaining cleanup levels, and in reducing human health and environmental risk. In addition, long-term monitoring data is needed to complete the five-year review process.

1.5 STATUTORY DETERMINATIONS

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action (unless justified by a waiver), is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The remedy in this OU does not satisfy the statutory preference for treatment as a principal element of the remedy. In-situ treatment without a cap was not considered practicable considering the extent, high volumes, and location of the contaminated sediments in the Basin. The toxicity and mobility of mercury in sediments will be significantly reduced through physically and chemically isolating the contaminated sediments from the aquatic environment. In-situ caps are generally accepted as reliable containment for contaminated sediment.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a CERCLA statutory review will be conducted every five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

1.6 ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file for this site.

- ✓ Chemicals of concern and their respective concentrations.
- ✓ Baseline risk represented by the chemicals of concern.
- ✓ Cleanup levels established for chemicals of concern and the basis for these levels.
- ✓ How source materials constituting principal threats are addressed.
- ✓ Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of ground water used in the baseline risk assessment and ROD.
- ✓ Potential land and groundwater use that will be available at the site as a result of the Selected Remedy.
- ✓ Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- ✓ Key factor(s) that led to selecting the remedy that demonstrate how the

Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision.

1.7 AUTHORIZING SIGNATURES

This ROD documents the selected remedy for sediments and soils at the Olin OU-2 Superfund Site. This remedy was selected by EPA with concurrence from ADEM.

Franklin E. Hill, Director [signature] Date 4/23/14

Superfund Division

PART 2

PART 2: DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND BRIEF DESCRIPTION

The Olin Corporation McIntosh Plant is located approximately one mile east-southeast of the town of McIntosh, in Washington County, Alabama. For an area location map and general Site map, see Figure 1. The Olin property is bounded on the east by the Tombigbee River; on the west by land not owned by Olin; on the north by the Ciby-Geigy Superfund Site; and on the south by River Road. The EPA is the lead regulatory agency. Olin Corporation has funded the response actions at the Site.

The Olin plant is an active chemical production facility. The main plant and associated Olin properties cover approximately 1500 acres, with active plant production areas occupying about 60 acres. Olin has produced chlor-alkali chemicals at McIntosh since 1952, first with a mercury-cell process, shut down since 1982, and now with diaphragm-cell and membrane processes. Crop protection chemicals (CPC), basically chlorinated organics, were produced from 1952 to 1982.

Because the problems at the Olin Site are complex, the Site has been organized into two operable units (OUs): OU-1- the active production facility, Solid Waste Management Units (SWMUs), and the upland area of the Olin property; and OU-2 – the Olin Basin located east of the main plant area and adjacent to the Tombigbee River, a floodplain and a wastewater ditch leading to the Basin. Olin OU-2 is located to the east of the main plant site (Figure 2).

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Olin Corporation (Olin) operated a mercury cell chlor-alkali plant (constructed in 1951) on a portion of the Site from 1952 through December 1982. In 1952, Calabama Chemical Company began operation of a chlorinated organics plant on property immediately south of the Olin plant. In 1954, Olin acquired Calabama Chemical and in 1955 began construction of a pentachloronitrobenzene (PCNB) plant on the acquired property. The plant was completed and PCNB production was started in 1956. The McIntosh plant was expanded in 1973 to produce trichloroacetonitrile (TCAN) and 5-ethoxy-3trichloromethyl-1,2,4-thiadiazole (Terrazole). The Terrazole® manufacturing areas were collectively referred to as the Crop Protection Chemicals (CPC) plant. In 1978, Olin began operation of a diaphragm cell caustic soda/chlorine plant, which is still in operation. In 1982, Olin replaced the mercury-cell facility with a diaphragm and membrane cell system that eliminated mercury from the manufacturing process. HCB was no longer produced when Olin discontinued operation of the CPC facility in 1982. Both facilities were demolished in 1984 with demolition debris from the mercury-cell process sent to a secure off-site landfill. The areas of each operation were capped. As a result of these actions, mercury and HCB were eliminated from the production process by 1982 through operational changes at the facility.

In September 1984, Olin's McIntosh plant Site was place on the National Priority List (NPL) of CERCLA or "Superfund." Groundwater contamination at the Site had been established based on the results of various investigations. In listing the Site on the NPL, the EPA found the following hazardous substances associated with the Site: mercury, gamma-hexachlorocyclohexane, hexachlorobenzene, 1,2,4 trichlorobenzene, and 1,4 dichlorobenzene. Mercury contamination was evidently caused by the operation of the mercury chlor-alkali plant during the period of 1952 to 1982.

Source control measures at the Olin McIntosh facility began in the early 1980s and extended into the early 2000s. Starting in 1984, Olin clean closed nine Resource and Conservation and Recovery Act (RCRA) hazardous waste management units at the Site. One RCRA unit was closed with waste left in place. These measures were approved by the Alabama Department of Environmental Management (ADEM) and/or the EPA.

- Clean closure of Mercury Waste Drum Area and Waste Pile Storage Area
- Clean closure of pH Pond

- Clean closure of Chromium Storage Area
- Clean closure of Flammable Drum Storage Area
- Clean closure of PCB and HCB Storage Building
- Closure of Stormwater Pond
- Closure of Filter Backwash Pond
- Closure of the Weak Brine Pond
- Closure of the TCAN Hydrolyzer

These closure activities were conducted under RCRA, which is currently administered and monitored by ADEM under a RCRA Part B Permit. The current permit indicates that 46 of 53 SWMUs and 4 of 7 areas of concern require no further action. All other SWMUs and areas of concern have approved on-going remedies in place.

Extensive groundwater investigations were conducted in the early 1980s. In 1987, Olin initiated groundwater recovery and treatment for mercury and other chemicals of concern (COCs) through five corrective action recovery wells with well-head treatment under RCRA.

In 1989, the EPA and Olin entered into an Administrative Order on Consent (AOC) for Olin to conduct a Remedial Investigation/Feasibility Study (RI/FS) under the EPA's oversight.

In 1990, under a Superfund Administrative Order on Consent, Olin removed 11,407 tons of HCB contaminated soil from the Site.

Olin conducted additional groundwater studies in the early 1990s as part of OU-1. In 1995, Olin entered into a Consent Decree (CD) with the EPA to expand and centralize the groundwater recovery and treatment system for OU-1 under CERCLA. The expanded groundwater recovery system was installed in 2000/2001 and included additional corrective action recovery wells and centralized treatment units. Operations and monitoring of this system are currently administered by ADEM under the RCRA Part B Permit. Semi-annual sampling results are reported to ADEM annually and show that the groundwater corrective action system has effectively reduced the extent of the plume for indicator parameters (mercury, chloroform, and 1,4-dichlorobenzene) and halted migration of groundwater COCs.

Olin also installed a multi-layer cap over the former CPC landfill, implemented institutional controls, and prepared/implemented monitoring plans at OU-1 as part of the 1995 CD. These measures were performed to further control potential source areas and reduce risk to human health and environment.

In 2001, restrictive covenants were placed on the OU-1 Site property, which were designed to prevent exposure to soil and groundwater contamination. One of the restrictive covenants prohibits the use of groundwater from the remediated portion of the alluvial aquifer as a source for potable water. In addition, the second restrictive covenant prohibits the use of remediated surfaces in OU-1 for uses other than approved industrial uses to prevent exposure to contaminated soil.

The construction necessary for the OU-1 cleanup plan began in 2000 and was completed in 2001. The plan was implemented in 2000 and 2001. A 2006 assessment found that the cleanup plan was implemented properly. Closure of SWMUs, implementation of the OU-1 groundwater recovery and treatment system, and installation of a multi-layer cap at the former CPC landfill serve as early source control measures for the Olin McIntosh facility.

The McIntosh plant today produces chlorine, caustic soda, sodium hypochlorite and sodium chloride and blends and stores hydrazine compounds. Current active facilities at the plant include: a diaphragm cell chlorine and caustic production process area; a caustic plant salt process area; a hydrazine blending process area; shipping and transport facilities; process water storage, transport and treatment facilities; and support and office areas. Olin mines a salt dome through a series of brine production wells located to the west of the active plant facility. The salt dome cap rock is at a depth of approximately 500 feet below the surface, and the dome is approximately 4,500 feet in diameter and greater than 2 miles deep.

Nine brine wells have been completed in the salt dome for the production of brine. The first six wells were associated with the mercury cell chlor-alkali plant and are no longer in service. The other three brine production wells were developed in a different portion of the salt dome, have been used exclusively for the diaphragm cell plant, and are still in use. A tenth cavity was developed in the dome by Olin for use by the Alabama Electric Cooperative to store high-pressure air for off-peak power production.

The Olin McIntosh plant currently monitors and reports on numerous facilities within the plant that are permitted through the EPA and ADEM. These include water and air permits as wells as a RCRA post-closure permit. The RCRA post-closure permit requires groundwater monitoring for closed RCRA units, including the weak brine pond, the stormwater pond and the brine filter backwash pond. The post-closure permit also requires corrective action for releases of 40 CFR 261 (Appendix VIII) constituents from any SWMUs at the facility. There are no active RCRA units at the facility. Olin also has permits for three injection wells for mining salt and a neutralization/percolation field.

The plant wastewater ditch currently carries the National Pollutant Discharge Elimination System (NPDES) discharge and storm water runoff from the manufacturing areas of Olin property to the Tombigbee River. From 1952 to 1974, plant wastewater discharge was routed through the Basin and then to the Tombigbee River. In 1974, Olin ceased discharge of process waters from their mercury-cell chlor alkali and CPC facilities to the Basin. A discharge ditch was constructed to reroute the wastewater directly to the Tombigbee River. Two of the three COCs, mercury and HCB, are associated with this former discharge.

The third COC, Dichlorodiphenyltrichloroethane (DDT) along with its metabolites (DDD and DDE), is likely the result of indirect discharges from a Superfund Site located immediately north of OU-2. Ciba-Geigy (currently owned by BASF) manufactured DDT at this Superfund Site beginning in 1952. DDT manufacturing ceased in the 1960s. This ROD uses the term DDTR to refer to the collective sum of the 2,4'- and 4,4'- isomers of DDT, DDE, and DDD. The term DDTr refers to the sum of only the 4,4'- isomers of DDT, DDE, and DDD.

The COCs were deposited in the Basin, Round Pond, wastewater ditches and surrounding floodplains. The deposition pattern of the chemicals was influenced by wastewater discharges, Basin bathymetry, floods, water level conditions, wind effects and geochemical and physical parameters.

2.3 COMMUNITY PARTICIPATION

Under the NCP at 40 CFR 300.430(c), Olin participated in the EPA's community involvement plan. In accordance with this plan, initial community outreach and public meetings have been conducted where information has been presented collectively regarding planned and on-going studies and projects. A Technical Advisory Group (TAG) grant was awarded to the McIntosh Environmental Concerns Committee on February 15, 1993. The EPA attended the yearly meetings held by the TAG Advisor in the 1990s. The last formal contact the EPA had with the concerned citizen group was in 2003. The Olin Corporation also has a Community Advisory Group for the McIntosh Plant.

In March 2005, a civil lawsuit was filed against the Olin Corporation. The lawsuit alleged that releases of mercury from the Olin facility contaminated homes and property of their clients. Based upon the law firm's sampling in the community, the lawsuit alleged that mercury contamination from Olin was wide spread in McIntosh; therefore, Plaintiffs were seeking "class action status" to bring an additional 2000 clients into the case. The court denied the class action status request.

The local newspaper has written many articles on mercury contamination in McIntosh. Allegations of mercury contamination in the community have made the citizens concerned about their health and the quality of the local environment. Responding to the community's concerns, ADEM conducted environmental sampling on and off the Olin facility property. This action was taken in consultation with the Alabama Department of Public Health and the EPA. A public meeting was held in 2005 to present the results of the sampling and to assure residents that there is not a significant mercury health risk to the community from the Site.

As part of ongoing Five Year Reviews of Olin's OU-1 remedy and BASF's remedy, the EPA and ADEM have also communicated regularly with the public.

As part of the OU-2 community outreach, the EPA conducted community interviews in the fall of 2012 and attended a town hall meeting in February 2013. The EPA engaged the local stakeholders to determine what environmental issues concerned most citizens. The Community Involvement Coordinator is in the process of updating the 1991 community involvement plan.

In the February 12, 2013 town hall meeting, the EPA presented the schedule for the upcoming Proposed Plan and a brief description of the proposed remedy. One of the concerns citizens wanted addressed was that the Tombigbee River had no fish advisory signage at any of the boat ramps used by the local community. In response, EPA contacted the State of Alabama to find out how the Health Department addresses fish advisories. The EPA was informed that due to budgetary constraints, the State does not place signage out for fish consumption advisories. This information is maintained on the Alabama Department of Public Health website (http://www.adph.org/tox/index.asp?ID=1360). According to the State official, if the citizens would like fish advisory signage, the town would have to incur that cost. The EPA has contacted the town council and concerned citizens and shared this information with them. The EPA is including the need for signage as part of the selected remedy.

In addition, a Proposed Plan was developed for the local community describing on-going projects and activities. A public meeting to present the Proposed Plan for the Olin-McIntosh Site was held on May 22, 2013. The EPA and ADEM were present to address the State and Public Health agency perspectives on the proposed remedies for the Site. A public comment period was open from May 22, 2013 to June 21, 2013. The EPA's response to the comments received during this period is included in the Responsiveness Summary, which is part of this Record of Decision.

Site documents are available to the public in the administrative record repositories located at the EPA Region 4 Superfund Records Center (61 Forsyth Street, Atlanta, GA 30303) and these documents are also posted on the EPA Region 4 webpage (http://www.epa.gov/region4/foiapgs/readingroom/index.htm). The EPA Region 4's local repository is located at the McIntosh Volunteer Fire Department Building (206 Commerce Street, McIntosh, AL 36553).

2.4 SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

The RI and the FS reports were submitted in July 1993 and February 1994, respectively. The reports were approved for OU-1 only. As with many Superfund sites, the contamination problems at the Olin Site are complex. As a result, the EPA organized the work into operable units (OUs):

- Operable Unit 1 (OU-1): the active production facility, SWMUs, and groundwater contamination in the upland area;
- Operable Unit 2 (OU-2): the Olin Basin located adjacent to the Tombigbee River, the surrounding floodplain and a wastewater ditch leading to the Basin.

OU-1 and OU-2 are depicted in Figure 2.

The Record of Decision (ROD) detailing the cleanup plan for OU-1 was issued on December 16, 1994. It addresses the source of the contamination on the Site as well as the ground water contamination across the entire Site. The major components of the cleanup approach taken include:

- Installation of additional wells to remove and treat contaminated ground water.
- Upgrading the existing cap, or cover, over the CPC landfill with a multimedia cap.
- Extending the clay cap that exists over the former CPC plant to an area west of the former plant.
- Conducting additional ground water monitoring in the vicinity of the sanitary landfills.
- Analyzing the long term effectiveness of the ground water treatment in reducing ground water contaminant migration.
- Implementation of institutional controls for land and ground water use restrictions.

The ROD for OU-1 also indicated that a ROD for OU-2 would be developed if it is determined that cleanup action for OU-2 is necessary.

This ROD for the second operable unit (OU-2), addresses contamination in a lake, referred to as the Olin Basin, Round Pond, the floodplain adjacent to the Tombigbee River, and in a wastewater ditch that flows toward the lake and the River. Since the Olin Basin is located on private property and fenced, the Basin, which is considered waters of the State of Alabama, is not easily accessible to the public. The potential future scenario of unrestricted use results in an unacceptable risk to human health. The risk was driven by ingestion of mercury contaminated fish caught from OU-2, with minimal contribution from dermal contact with surface water and soil, and inhalation of particulates. The ecological risk assessment determined that the most significant potential exposure pathways were direct contact and food chain uptake of mercury and DDTR by fish; ingestion of mercury and DDTR contaminated fish by avian receptors; and incidental ingestion of HCB contaminated sediment by piscivorous mammals.

This OU-2 ROD presents the final response action for this Site.

2.5 SITE CHARACTERISTICS

2.5.1 Site Setting

Washington County is part of the Southern Pine Hills District of the East Gulf Coastal Plain Physiographic Province. OU-2 lies in the Alluvial-deltaic Plain, which consists of sediment deposits associated with larger rivers. The climate in this area is humid subtropical, with relatively mild winters. Rainfall in southern Alabama is relatively evenly distributed throughout the year. Frost and especially snow seldom occur. According to the National Weather Service (NWS) regional report (1971–2000), the region has an average annual precipitation of 66.62 inches, and an average annual temperature is 67.4 degrees Fahrenheit (°F), with July having the highest monthly average (82.1°F) and January having the lowest monthly average (50.7°F). The National Climatic Data Center reported an average annual precipitation of 66.3 inches from 1990 to 2009 in McIntosh, Alabama. Winds are variable throughout the year, but there are general seasonal patterns. Winds are mainly from the south or southeast from March through August; winds tend to be from the north during the remainder of the year.

OU-2 surface water quality is typical of southern freshwater lakes—pH is circum neutral, water temperatures follow seasonal trends and decrease with depth, DO decreases with depth, and oxic conditions in surface water are present throughout most of the year. There is evidence of thermal stratification in the deeper portion of the Basin in late summer. Turbidity is generally less than 15 NTUs throughout the water column during non-flood conditions, except within a foot of the surface water sediment interface where turbidity increases to 50–60 NTUs.

2.5.1.1 Surface Water Features

The permanent water bodies of OU-2 are interpreted as "oxbow-like" features; i.e., vestiges of an abandoned Tombigbee River channel. The Basin and Round Pond cover approximately 76 and 4 acres, respectively, at a normal (nonflooded) stage. Although interpreted as an "oxbow-like" feature, OU-2 has a depression, with depths of nearly 40 feet in the northwest quadrant of the lake. The OU-2 Basin is adjacent to Tombigbee River Mile (TRM) 60.4 and was evidently semi-isolated from the river at least a few centuries ago. The OU-2 Basin is located between a bluff to the west and the Tombigbee River (the river) to the east. The bluff is approximately 30 to 35 feet above the Basin water level at a non-flood elevation of 3 feet North American Vertical Datum 1988 (NAVD88).

Round Pond drains via a direct channel into the Basin. The Basin has a surface area of about 76 acres at normal (nonflooded) stage. Cypress Swamp is the smallest and shallowest of the three water bodies; Round Pond is slightly larger and deeper; and the Basin is the largest and deepest feature.

Prior to construction of the Olin facility, a natural drainage feature carried runoff from the upland areas into the Basin. This drainage feature became the wastewater ditch when the Olin facility was constructed. Prior to 1968, the wastewater flowing from the ditch into the Olin Basin contained releases of lime used to remove chlorine from tailgas (or off-gas) from the chlorine liquefaction process. Later, lime and sulfate were used to neutralize the acidic wastes before they were discharged to the wastewater ditch. Wastewater was discharged through this ditch to the Basin until 1974, leaving concentrations of mercury and HCB in the ditch and Basin sediments and adjacent soils. Steps were taken in 1974 to insure that the wastewater did not "back up" into the Basin during water fluctuations of the Tombigbee River. First, the natural low-lying area south of the Basin was deepened to form the last section of the current wastewater ditch. Second, a sheet pile dam was installed across the Basin outlet. The sheet pile weir was constructed to keep the wastewater stream from discharging into the Basin during periods of low river stages. Third, a small berm was extended around the south and east bank of the Basin to minimize overflow from the river into the Basin during normal water levels. This third step resulted in an excavation feature. A berm was created by excavating and piling soil along the route of the berm. Since 1974, the wastewater ditch has carried Olin's permitted wastewater discharge to the Tombigbee River.

During seasonal high water levels (averaging 4-6 months per year), the Basin and wetland areas are inundated, becoming contiguous with the adjacent Tombigee River. Prior to 2006, the OU-2 water bodies exchanged water and sediment with the river during flood events when water surface elevations (WSE) exceeded 4 feet.

Construction of a berm and gate system around the Basin was initiated by Olin in June 2006 as part of their Enhanced Sedimentation Pilot Project (ESPP). The berm was constructed to an elevation of approximately 12.0 feet around the Basin and some of the floodplain, with a gated structure built on the southern end of the Basin to control flows in and out of the Basin. The intent of the berm and gate system was to enhance the capture of sediment-laden floodwater by increasing the holding time of floodwaters within OU-2, allowing incoming sediment to be deposited therein.

There is typically little or no flow from the Basin to the river or vice versa during non-flood conditions, when the water elevation in the river is approximately 3 feet NAVD88 (or less). At a river WSE of approximately 4.0 feet, river water and sediment flow into the Basin through the gated structure. The Basin and floodplain will eventually fill, with the berms overtopped at a river WSE elevation of 12.0 ft. However, at a river WSE of approximately 10 feet, the Tombigbee River begins to flow into the northernmost floodplain above the Basin, including the adjacent BASF property. Also, at a WSE range of 10 — 12 feet, floodwater is entering the Site from the southernmost connecting channel while the northernmost floodplains are flooding on the river side of the berm. The river water flowing through the floodplains is circulating outside the berm, and returning to the river through a ditch that runs from the BASF property through the Olin property and eventually to the river.

At a river WSE greater than 12 feet, the berms are overtopped, and the Basin, Round Pond and floodplains are inundated and become contiquous with the river. During the ESSP evaluation period, when the flood receded to the top of the berm (WSE of 12 feet), the gate was closed on the connecting channel, and the water was held in the

Basin in an effort to allow suspended sediment to settle out. At that time, the water was released back to the river. For smaller floods for which the WSE did not exceed 12 feet, the gate was closed at the peak of the flood in an effort to trap any sediment that may enter the system through the gate.

Based on analysis of 2008 and 2009 data, the EPA determined that the ESSP contributed very small amounts of river sediment to the Basin. The Basin was provided insufficient sedimentation to effectively cap the Basin and would not be considered as a stand-alone remedy for the Olin OU-2 Superfund Site.

In 2009, Olin decided to operate the berm and gate system to maintain a minimum water depth with a WSE of 6 feet NAVD88 to help reduce the potential for wind-driven resuspension. The inundated area of OU-2 when the water is held at 6 feet NAVD88 is approximately 135 acres, while the area contained within the berm is approximately 156 acres. The 2006 bathymetric study of the area is presented in Figure 3.

A continuously recording data logger with transducers on both the Basin and river sides of the gate maintains a record of water elevations at OU-2. Staff gauges are located on both the Basin and river sides of the gate, and an additional staff gauge is located on the berm to record water elevations above 12-feet NAVD88. The equation relating water levels at the USGS Leroy gauge (02470050) and McIntosh can be used to estimate water levels at the intake channel when an 18-to 24-hour lag time is considered.

Some areas of the Basin, such as the deeper portion and the southern portion, experience more deposition than other areas. Sediment in the northern and central portions of the Basin and Round Pond consists of silts and clays and have total organic carbon (TOC) greater than 10,000 mg/kg. Sediment in the southern portion of the Basin has a sand component and TOC generally less than 10,000 mg/kg. Sediment pH is generally circumneutral and oxidation-reduction potential (ORP) indicates reducing conditions.

2.5.1.2 Geology/Hydrogeology

The Basin and Round Pond lie within the floodplain of the Tombigbee River. Alluvial deposits of unspecified ages are present from the land surface of OU-2 to a depth of approximately 20 to 30 feet. These deposits consist of reworked and redeposited sediments along with river-transported sediment. The sediments consist of interlayered sands, silty or clayey sands, silts, and clays. These sediments represent numerous depositional environments including natural levees, bars, infilled channels, channel deposits, flood-splays, and other deposits associated with meandering rivers. Cores collected within the Basin and Round Pond, including the deepest portion of the Basin, indicated the presence of predominantly clay riverine deposits beneath the Basin and Round Pond. Geologic conditions based on hydrogeologic investigations at OU-2 are conceptualized in cross-section Figures 4, 5 and 6 and are described in the following paragraphs.

Based upon elevation data collected in the 2008 and 2009 investigations, the Miocene clay layer apparently dips to the west-southwest at about 32 feet per mile. An undetermined thickness of Miocene clay was most likely eroded from the bottom of the Basin (Figure 6). A brief description of these alluvial deposits, from the most recent to the oldest, and a hydrogeologic description is provided below.

Riverine deposits (R) are flood deposits from the Tombigbee River. These deposits are near the Basin and Round Pond and are typically composed of tan, black, and dark gray silty clays and clayey silts that are interspersed with fine, medium, and coarse-grained sands. These sediments are underlain by greenish brown, brown, grey, and black clay; organic silty clay; and clayey sand deposits that are interpreted to be floodplain deposits. They vary in thickness from approximately 13 feet to 23 feet and are unconfined. Groundwater flow appears to be to the southeast, based on a Basin surface elevation of 2.9 feet.

The bluff to the west of OU-2 is approximately 20 to 30 feet higher in elevation than the floodplain. Previous investigations indicated that the Upper Clay Unit at the Alluvial Sediment (Q1) west of OU-2 primarily consists of silty/sandy plastic clay (WCC, 1993). Q1 sediments were observed immediately west of the bluff in OU-1 at a thickness ranging from 10 to 20 feet. These sediments were composed of sandy clay, low plasticity clay, and clayey sand.

The Alluvial Aquifer system of the Quaternary Alluvial Sediment (Q2) varies in thickness from approximately 37 feet in the west plant area to 60 feet in OU-1. East of the bluff, Q2 averages about 40 feet thick and typically grades downward from fine sands to coarse-grained sands with some gravel in OU-2. Q2 is divided into two zones, an upper zone and a lower zone, and is generally unconfined near the Basin. Groundwater flow is generally to the southeast.

The upper zone of Q2 is composed primarily of very fine to fine-grained silty quartzose, subangular to subround sand. The lower zone of Q2 is composed of fine to very coarse, orange-brown, quartzose, cherty, subangular to subrounded sands containing varying amounts of gravel. Although composed predominantly of sands, Q2 also contains some thin beds of clay or silty, gravelly clay.

To the north, south, and east of the Basin it appears that Q1 and the upper zone of Q2 have been eroded by the Tombigbee River and are not present, but the lower zone of Q2 is present.

The bottom elevation of the Basin ranges from approximately 2 to -36 feet NAVD88. Shallow areas (2 to -4 feet NAVD88) are located in the southern portion of the Basin. The deepest part of the Basin is in the northwest. Floodplains are located to the north, northeast, and east of the Basin. The Basin is underlain by R, followed by the alluvial sediments of the lower zone of Q2; therefore, the Basin is in direct hydraulic connection with R.

The Miocene Confining Unit (Tm1) underlies Q2. This unit consists of clays, sandy clays, or clayey sands. Although the lithology may be complex, it is predominantly clay, with various amounts of discontinuous sand, silt, or fine gravel. Boring logs from wells that penetrate Tm1 indicate that this unit is laterally continuous beneath OU-1 and approximately 80 to 100 feet thick in the plant areas west of OU-2. At OU-2, Tm1, consisting of a low-plasticity clay, was found along the bluff at depths ranging from 55 to 65 feet below land surface. Just above the clay unit, a 10- to 15-foot layer of coarse sand and gravel was present and served as a marker for the approaching Tm1 unit. Along the southern berm, the top of Tm1 was not always encountered. Where Tm1 was not encountered, a layer of well-graded gravel underlain by poorly graded fine sand was used as a marker bed for approaching the top of Tm1. This gravel layer was encountered at depths ranging from 39 to 42 feet below the top of the berm.

Tm1 is underlain by the Miocene Aquifer. The Miocene Aquifer is composed primarily of thick-bedded, coarse sand and gravel beds; however, sandy clay lenses occur within this unit. The attitude of the upper boundary of this aquifer is nearly horizontal in the main plant area; however, in the west plant area there is a pronounced southeastward dip, from -114 to -166 feet NAVD88 at OU-1. These differences are interpreted to be related to structural deformation of sediments associated with an underlying salt dome. The Miocene Aquifer was not encountered during the OU-2 investigation.

Movement of groundwater at the Olin Site is controlled by hydraulic gradients, porosity, permeability, and continuity of water bearing sediments. The Miocene clay is 55 to 65 feet thick along the bluff at OU-2 and is generally characterized as a continuous confining unit, preventing downward movement of water and contaminants from overlying alluvial sediments into the underlying Miocene aquifer. The dominance of fine-grained sediments encountered in the upper parts of all piezometers and micro-wells constructed in 2008 suggests limited surface-water/groundwater interaction and restricted local vertical movement of groundwater. The juxtaposition of deeper, coarse-grained sediments described earlier, creates pathways for horizontal groundwater movement from the bluff to the floodplain.

The evaluation of potentiometric surface maps constructed from groundwater levels indicates a relatively steep hydraulic gradient from the bluff to the floodplain and a relatively low gradient from the floodplain to the Tombigbee River. The berm between the Basin and the river restricts groundwater movement and the inlet channel connecting the Basin with the river acts as a groundwater sink, which captures and directs groundwater to the Tombigbee River. Although the general characterization of the hydraulic gradient between the berm and the Tombigbee River as an “area of little gradient” is correct, it is important to note there is probably a hydraulic connection between the river and floodplain in the vicinity of micro-wells BA-MW6 and BA-MW7 (Figure 7).

2.5.2 Conceptual Site Model

Information on primary sources of contaminants, chemical release mechanisms, transport media, potential receptors, exposure routes and subsequent complete exposure pathways for Site contaminants at OU-2 are combined to provide a pathway analysis for the Site which is termed the Conceptual Site Model (CSM). The CSM has been refined from the 1991 model. Additional information and data developed between 2006 and 2009 have been used in updating the CSM (Figure 8). This figure indicates potential complete and incomplete pathways. Complete pathways are designated by a closed or open circle. Empty boxes are incomplete pathways or considered to contribute negligible exposure. Exposure routes that were not evaluated are designated by an X. Only complete exposure pathways were addressed in the risk assessment.

The primary constituent of concern (COC) at OU-2 is mercury, which best represents the extent of contamination in sediments and biota in the Basin and Round Pond. The other COCs are HCB and DDTR.

The fate and transport of COCs within the Olin Basin is a complex subject influenced by the hydrology and bathymetry of the Basin, as well as a variety of geochemical and geophysical parameters. Fate and transport of HCB and DDTR are relatively more straightforward than that for mercury, due to the unique biogeochemistry of mercury in aquatic environments.

The primary release mechanism for HCB to OU-2 was the discharge through the former wastewater ditch from 1952 to 1974. The wastewater ditch runs from the plant area in OU-1 to an area south of the Basin. Runoff and treated wastewater from the plant were not discharged to the Basin after 1974. The plant effluent and stormwater discharge are permitted and monitored under the NPDES. Current monitoring data show that the plant effluent and stormwater discharge meet the limits contained in the NPDES permit.

The wastewater ditch and former discharge ditch were investigated during the initial RI sampling activities in 1991/1992 and again in 2001. The highest concentrations of HCB remain in the southern third of the Basin, particularly around the historic discharge channel and the current outflow channel to the Tombigbee River.

DDTR entered OU-2 from the adjacent BASF property to the north. DDTR concentrations decline from north to south, with highest concentrations being in the wetland soils north of the OU-2 Basin. High concentrations were also found in the Basin deep hole subsurface sediment at a depth of 4-6 feet below the sediment surface. DDTR has low solubility and high affinity for organic matter, thus transport in aquatic systems is generally in the form of resuspension and redistribution of particle bound DDTR. DDTR is highly lipophilic, resulting in biomagnifications up the food chain. Currently there is some uncertainty associated with the magnitude and extent of DDTR concentrations in the wetland area northwest of the OU-2 Basin. Supplemental sampling of this area to delineate the extent of DDTR will be performed as part of the remedial design for OU-2.

Mercury entered the Basin from the wastewater discharge channel in the southwest corner of the Basin and was discharged from 1952 to 1974. Mercury was discharged in the form of mercury salts. The highest mercury concentrations in surface and near-surface sediment currently occur in a band that runs from the southwest corner of the Basin near the historic discharge point to the northeast corner of the Basin. This pattern of distribution has persisted since the earliest sediment sampling event in 1991. Sampling of geochemical parameters has shown that the northern and western portions of the Basin are characterized by relatively high sulfide and high TOC concentrations, while the southern and eastern portions are characterized by low sulfide and low TOC. Data suggest mercury is not as strongly bound to TOC and AVS in the northern Basin as one would expect, given levels of sulfide and TOC present in the northern Basin. These geochemical parameters are not conducive to formation of stable mercury compounds, but rather these parameters indicate release and mobilization of mercury.

Available data suggest that mercury is relatively mobile within the Olin Basin under current conditions, while HCB and DDTR are relatively immobile in OU-2 sediments. The focusing of mercury in the Basin sediments suggests mobility of mercury with settling out where conditions favor binding to sediments or precipitation. Available data do not make it clear which chemical properties are controlling this focusing, but any remedial design for mercury in the OU-2 Basin should design for reasonable maximum mobility as if contaminant mobility can occur anywhere within the Basin.

Numerous studies and investigations have been conducted at OU-2 since the 1980s. These studies have been grouped into two categories. Results from studies conducted from the 1980s to 2002 are considered historical. Reports on these historical studies include:

• *Remedial Investigation Report (WCC, 1993)*

• *Additional Ecological Studies of OU-2, Volumes 1 and 2 (WCC, 1994)*

• *Ecological Risk Assessment of Operable Unit 2 (WCC, 1995)*

• *Feasibility Study Operable Unit 2 (WCC, 1996)*

• *OU-2 RGO Support Sampling Report (URS Corporation [URS], 2002)*

Results from studies conducted immediately before the construction of the berm and gate system are considered recent. Reports on these studies include:

- *Remedial Investigation Report* (WCC, 1993)
- *Additional Ecological Studies of OU-2, Volumes 1 and 2* (WCC, 1994)
- *Ecological Risk Assessment of Operable Unit 2* (ERA) (WCC, 1995)
- *Feasibility Study Operable Unit 2* (WCC, 1996)
- *OU-2 RGO Support Sampling Report* (URS Corporation [URS], 2002)
- *Enhanced Sedimentation Pilot Project (ESPP) Baseline Sampling* (baseline report) (MACTEC Engineering and Consulting, Inc. [MACTEC], 2007)
- *Enhanced Sedimentation Pilot Project Annual Report – Year 1 Results* (Year 1 Report) (MACTEC, 2009a)
- *Remedial Technologies Screening and Alternatives Development in Support of a Feasibility Study* (MACTEC, 2009b)
- *Part 1 – Revised Remedial Investigation Addendum and Enhanced Sedimentation Pilot Project Annual Report, Year 2 Results, Operable Unit 2* (AMEC, 2011a)
- *Part 2 – Updated Ecological Risk Assessment, Operable Unit 2* (AMEC 2011b)
- *Part 3 – Updated Human Health Risk Assessment* (AMEC, 2011c)
- *Remedial Goal Option Report for the Development of Preliminary Remediation Goals in Sediment and Floodplain Soils, Revision 3* (AMEC, 2012a)
- *Feasibility Study, Revision 3, Operable Unit 2, McIntosh, Alabama* (AMEC, 2012b)

The data matrix table (Table 1) provides an explanation of how the historical and recent data were used in the remedial process. Historical results for surface water, sediment, and soil are summarized in Table 2. Recent data collections are presented in the following section.

2.5.3 Nature and Extent of Contamination

2.5.3.1 Groundwater

A groundwater investigation of OU-2 was performed to determine whether the OU-2 sediments act as a continuing source of contamination to groundwater and ultimately effect surrounding water bodies, in particular the river.

Seventeen micro-wells were installed in 2008, at eight locations around the Basin for groundwater collection and analysis. Micro-well BA-MW1 in OU-1 serves as an upgradient well to the Basin during non-flood or baseline conditions. The remaining wells are located within OU-2. The OU-2 wells were spaced approximately 500 to 700 feet apart along the berm (Figure 7). The micro-wells were generally positioned at locations thought to be potentially hydraulically downgradient and sidegradient from the largest area of higher mercury concentrations in the Basin sediments. The screens for the micro-wells were installed in the lithologic units of Riverine Deposits (R) and Alluvial Aquifer of the Alluvial Sediments (Q2). The micro-wells were installed in clusters of two or three so that water quality parameters could be collected at shallow and intermediate depths from R and Q2, respectively. Well depth varied based on location because of the variation in unit depth throughout the Site.

Filtered (0.45 µm membrane filter) mercury was not detected above of 0.0012 µg/L [the ADEM fresh water quality criteria (WQC) for protection of aquatic life] in the groundwater samples. Though the ADEM WQC are intended for surface waters, they were used as a point of comparison here to determine if groundwater represents a potential source to surface water at concentrations that exceed levels of concern. Based on concentrations of mercury in groundwater at MW-2, MW-3, MW-4 which are between the Basin and the river, groundwater is not a source of mercury to the river at levels of concern.

DDTR was not detected above the reporting or method detection limits (0.023-0.026 µg/L) in the groundwater samples. The ADEM aquatic life WQC for 4,4' - DDT is 0.001 µg/L. The human health WQC for consumption of fish only for DDTR is 0.0002 µg/L.

HCB was detected in one micro-well above the reporting limit of 0.010 µg/L with concentrations of 0.011 to 0.013 µg/L. The ADEM WQC for HCB is 0.0002 µg/L. One-dimensional fate and transport model results indicate that the HCB concentrations detected in OU-2 would not result in an exceedance of the HCB surface water quality criteria in the Tombigbee River.

The 2009 sediment core results from the Basin, with the exception of SCDR-08, indicate that mercury in sediment in the Basin is not a continuing source to groundwater or the river via the groundwater pathway. The sediment core results are more fully discussed in Section 2.5.3.3. It is important to note that the core from the deep hole, SDCR-08 as depicted in Figure 9, did not fully bound the vertical extent of contamination, but the monitoring wells do suggest that mercury, DDTR, or HCB in deep sediments is not a continuing source to the river. Continued monitoring of groundwater will be included in the remedial process.

Groundwater beneath the Basin may contact and seep upward through the clay-rich sediments. Additional evaluation is needed to estimate the groundwater seepage velocity as part of the remedial design.

2.5.3.2 Floodplain Soil

The analytical results for floodplain soil parameters, including mercury, methylmercury, HCB, and DDTR, are summarized below. Individual results are shown on Figures 10 through 13 and are provided in Table 3. Floodplain soil results for COCs were reported in dry weight. Three of the surficial floodplain soil locations were inundated at the time of sample collection. These locations, FPSS3, FPSS9, and FPSS15, may be considered sediment when the water elevation is maintained at a minimum of 6 feet NAVD88.

Soils in the floodplain consisted of 73 to 95 percent silts and clays, with 3 to 25 percent sand and 0.06 to 2.5 percent gravel. The sand and gravel portions were higher in the southern portion of the floodplain and decreased moving north. Percentage solids of the surficial soils ranged from 48.0 to 78.3 percent, and percentage solids for the inundated (covered with water at the time of sampling) soil samples ranged from 15.1 to 28.7 percent. Total organic carbon (TOC) content in surficial soils ranged from 15,900 milligram per kilogram (mg/kg) to 61,700 mg/kg. TOC concentrations decreased with depth in soil borings. TOC for the three inundated soil samples ranged from 33,700 mg/kg to 298,000 mg/kg. These values are typical of floodplain forested wetlands.

Concentrations of mercury in surficial floodplain soils are shown on Figure 10. The minimum mercury concentration in surficial soil was 0.061 mg/kg at FPSB4 located east of the Basin, and the maximum mercury concentration was 8.9 mg/kg at FPSS2 next to the channel connecting the Basin and Round Pond. The range of mercury concentrations in surficial floodplain soils excluding the maximum value was 0.061 mg/kg to 2.5 mg/kg, with an average of 0.814 mg/kg. The maximum value of 8.9 mg/kg was likely representative of sediment/soils near the channel connecting Round Pond and the Basin. The concentrations of mercury at the three inundated sampling locations were within the range of concentrations of non-inundated floodplain soils.

Mercury concentrations in surficial floodplain soils generally decreased with increasing distance from the water’s edge of the Basin and Round Pond.

Mercury concentrations in the soil borings were generally less than 1 mg/kg with small increases or decreases with depth. The exception was FPSB5, which was near the southeastern Basin edge. Concentrations at this location ranged from 2.4 mg/kg at the surface (0 to 1 inch) to 3.6 mg/kg (6 to 12 inches) at depth.

Methylmercury concentrations in surficial floodplain soils (0 to 1 inch deep) averaged

0.00303 mg/kg and ranged from 0.000367 mg/kg at FPSB4 to 0.00703 mg/kg at FPSB5 (Figure 11). The percentage of mercury that was methylmercury in surficial floodplain soils ranged from 0.123 percent at FPSB6 (southeast of the Basin) to 1.29 percent at FPSB3 (northeast of the Basin). Methylmercury concentrations from 1 to 2 inches deep ranged from 0.000176 JB mg/kg at FPSB6 to 0.00822 mg/kg at FPSB5. The percentage of mercury that was methylmercury in 1 to 2 inch soils ranged from 0.126 percent at FPSB6 to 1.19 percent at FPSB3. The floodplain at OU-2 is bottomland hardwood forest, a type of wetland. Wetlands have saturated soils, and saturated soils are anaerobic because water from the capillary fringe forces oxygen out of the soil. Methylmercury that was formed in the floodplain soils while inundated will likely remain for some time after flood waters recede because of the hydric, anaerobic conditions of the soil.

HCB was collected in surficial soils (0 to 1 inch deep) from three locations in the southern portion of the floodplain as shown on Figure 12. Concentrations ranged from 0.0035 mg/kg at FPSB5 in the southeastern floodplain to 0.275 J mg/kg at FPSS14 in the southwestern floodplain. Location FPSS15 was inundated and had a concentration of 0.135 mg/kg.

DDTR was collected from 15 locations throughout the floodplain (Figure 13). The results for the six analyzed congeners were summed to obtain the DDTR value listed on Figure 13. Zero was used in the summations for congeners that were not detected at the associated reporting limit for the sample. DDTR concentrations in surficial floodplain soils ranged from < 0.002 UJ mg/kg (FPSB6) in the southeast portion of the floodplains to 2.23 mg/kg (FPSS1) in the northwest portion of the floodplain. To evaluate uncertainty in DDTR resulting from non-detected congeners, DDTR was recalculated using one-half the reporting limit for non-detected concentrations. These summations only effected the lower end of the concentration range, and resulted in concentrations ranging from 0.0038 JQ mg/kg (FPSS10) to 2.23 mg/kg (FPSS1). DDTR concentrations decreased from north to south, with the highest concentrations measured in the northwest portion of the floodplain.

DDTR concentrations in the northwest were two to three orders of magnitude higher than those in the eastern and southern portions of the floodplain.

2.5.3.3 Sediment

Surficial Sediment

In 2009, sediment samples were collected along 6 east-west transects. Average surficial sediment mercury concentrations by transect in the Basin ranged from 13.8 mg/kg to 57.0 mg/kg in 2009. The lowest mercury concentration, 2.01 mg/kg, was collected in the southern portion of the Basin and the highest mercury concentration, 116 mg/kg, was collected in the central transect within the Basin. Average mercury concentrations were generally higher in the central portion of the Basin. Round Pond mercury concentrations ranged between 14.1 mg/kg and 32.1 mg/kg, with an average mercury concentration of 21.5 mg/kg, as shown on Figure 14, which shows the distribution of mercury in surficial sediment using isoconcentration contours. The 2009 data are referenced here because these data are the most comprehensive data set, including fine and coarse coring analyses. The range of mercury concentrations detected in 2006 was 6.45 to 95.3 mg/kg; mercury concentrations in 2008 ranged from 0.965 to 213 mg/kg. The range of mercury concentrations in historical sampling events (defined as prior to 2001) was non-detect (detection limit of 0.19 mg/kg) to 290 mg/kg in 1991, 18.6 to 113 mg/kg in 1994, and 0.844 to 780 mg/kg in 1995.

Average surficial sediment methylmercury concentrations by transect in the Basin ranged between 0.00431 mg/kg and 0.0115 mg/kg in 2009. Methylmercury concentrations ranged from 0.00142 mg/kg, in the southernmost transect, to 0.0257 mg/kg, in the north-central transect. Figure 15 depicts the methylmercury results and distribution in sediment for 2009. Round Pond methylmercury concentrations ranged between 0.00451 mg/kg and 0.00640 mg/kg, with an average concentration of 0.00562 mg/kg.

HCB and DDTR were also identified as COCs for OU-2. A summary of HCB and DDTR concentrations and ranges by transect is provided in Table 4. Sediment HCB concentrations ranged from non-detect at a reporting limit of 0.0069 mg/kg to 8.90 mg/kg in 2009. The maximum HCB concentration was reported in the southern portion of the Basin, approximately 200 feet northeast of the inlet channel.

Samples collected north of the gate structure in 2009 indicated an order of magnitude decrease in HCB from 1991 and 1994, in which the concentration range was non-detect (0.67 mg/kg reporting limit) to 265 mg/kg. In 2009, detections of HCB were encompassed within the horizontal footprint of mercury. A comparison of HCB surficial sediment concentrations in 2009 and 1991/1992/1994 is provided on Figure 16.

Only the 4,4'-isomers of DDT, DDE, and DDD (collectively, DDTr) were analyzed in 1991 as part of the RI and in 2008. However, DDTR (both 4,4'- and 2,4' isomers of DDT, DDE, and DDD) were analyzed in subsequent investigations in the 1990s and 2001, as well as 2009.

DDTR concentrations ranged from 0.06 mg/kg to 2.68 mg/kg in 2009 and DDTr ranged from < 0.014 mg/kg to 0.739 mg/kg in 2009. DDTr concentrations decreased from north to south for the RI data. The higher concentrations of DDTr/DDTR were detected in the southern portion of the Basin in 2009. Although the 2009 results show an approximate order of magnitude decrease in DDTr concentrations from 1991, when concentrations ranged from 0.272 mg/kg to 6.9 mg/kg; the sampling locations were different. A comparison of DDTr/DDTR surficial sediment concentrations in 2009 and 1991/1992 is provided on Figure 17.

Sediment Cores

<u>Coarsely Sectioned Cores</u>

Coarsely sectioned core samples were collected at 13 locations throughout the Basin in 2009, as shown on Figure 18. Analytical results for the coarsely sectioned sediment cores are presented in Table 5.

Relatively lower mercury concentrations were encountered near the sediment surface interface (top of cores) at locations in the southern portion of the Basin (SDCR-1, -2), central portion of the Basin (SDCR-4, -5), deeper portion of the Basin (SDCR-8), and northern portion of the Basin (SDCR-10). Relatively higher mercury concentrations appeared closer to the sediment surface in other locations in the southern portion of the Basin (SDCR-3), the central portion of the Basin (SDCR-6, -7, -9), the northern portion of the Basin (SDCR-11), and Round Pond (SDCR-12, -13). Vertical migration of mercury within the sediment deposits was not evident in the data from the 2009 sediment for fine and coarse cores.

Groundwater seepage velocity and erosion/relocation during storm events may also effect migration of mercury if the magnitude of the groundwater seepage velocity and storm event is sufficient. Groundwater seepage will be evaluated during the remedial design.

The mercury deposition pattern indicates that intervals where mercury concentrations are greater than 0.2 mg/kg form a wedge that narrows as one moves north and east from the former discharge ditch across the Basin.

Analytical results for HCB and DDTR for the coarsely sectioned cores are given in Table 5. These constituents were detected within the footprint of mercury.

Density, grain size, and percent solids of the coarsely sectioned sediment cores were also analyzed; the analytical results are presented in Table 5. Density and percent solids generally increased with depth at the sediment core locations. Grain size analysis indicated that clay and silt-sized particles were predominant in the sediment cores collected. These results were consistent with the lithological descriptions of the sediment core logs. The bottom-most layers of each of the sediment cores showed the presence of a dense layer of clay, indicating possible resistance in permeation to the underlying sandy aquifer.

Two sediment samples from SDCR-3 and SDCR-9 at the 0- to 1-foot sample interval were also analyzed for mercury using the synthetic precipitation leaching procedure (SPLP). The SPLP results were 0.03 milligram per liter (mg/L).

Finely Sectioned Cores

Finely sectioned core samples were collected at six locations throughout the Basin, as shown on Figure 18. Samples were collected from 0 to 2, 2 to 4, 4 to 8, 8 to 12, and 12 to 18 inches. Samples were analyzed for mercury, methylmercury, percent moisture, and TOC. These analytical results are presented in Table 6. A detailed description of the fine core results are provided in the RI report. Results were used as input to model transport of mercury through cap material in the FS.

2.5.3.4 Wind-Driven Resuspension Study and Model

The RI report modeled the potential for wind-driven resuspension of sediment using the Bachmann-Hoyer-Canfield (BHC) model. The BHC model uses wind velocity and effective fetch to calculate wave period and wave length to determine the water depth to which various wind-speeds disturb the sediment bottom. The model used the maximum fetch (i.e. maximum dimension across the Basin) to calculate wave period and length, therefore maximizing wave height in the model. Wind speeds in the model were obtained from measurements taken at the plant site from November 2007 to January 2009. The modeled results showed that wind-speeds of 10 mph or less occur 94% of the time in the Basin, and these winds can result in sediment resuspension in water depths of 3 ft or less. The primary uncertainty that was not evaluated regarding wind-driven resuspension is the relative importance of the more frequent low wind-speed events compared to the less frequent high wind speed events in the mobilization and redistribution of bed sediments. While the EPA agrees that maintenance of higher water levels may reduce the potential for sediment resuspension in the most contaminated areas under low wind-speed events, there is concern that potential negative effects associated with maintenance of higher water levels have not been evaluated. Potential negative effects include increased methylation, and increased bioaccumulation due to increased water residence time within the Basin. Due to these concerns, Olin has agreed that maintenance of higher water levels will not be a part of any permanent remedy within the Olin Basin.

2.5.3.5 Surface Water

A summary of surface water analytical results for 2006, 2008, and 2009 is provided in Table 7. The 2009 surface water sampling locations are shown in Figure 19.

Mercury concentrations in surface water in 2009 ranged from 0.00731 micrograms per liter (µg/L) to 0.155 µg/L in unfiltered samples and from 0.00357 µg/L to 0.0147 µg/L in filtered (0.45 µm) samples. Average mercury concentrations per transect (in both filtered and unfiltered surface water samples) decreased from north to south in the Basin and were lowest in Round Pond; however, the ranges of concentrations overlapped. Average mercury concentrations were lower at shallow sample locations (20 percent of total water depth) than at deep sample locations (80 percent of total water depth). Shallow unfiltered mercury concentrations averaged 0.0239 µg/L, and shallow filtered mercury concentrations averaged 0.00574 µg/L. Deep unfiltered mercury concentrations averaged 0.0706 µg/L, and deep filtered mercury concentrations averaged 0.00988 µg/L.

Methylmercury concentrations in 2009 samples, ranged from 0.000613 µg/L to 0.00171 µg/L in unfiltered surface water samples and from 0.000413 µg/L to 0.000649 µg/L in filtered surface water samples. Filtered methylmercury concentrations in shallow water samples averaged 0.000452 µg/L, and unfiltered methylmercury in shallow water samples averaged 0.000831 µg/L. Average filtered methylmercury in deep water samples was 0.000508 µg/L, and unfiltered average methylmercury was 0.000873 µg/L. Average methylmercury concentrations in filtered surface water samples decreased from north to south in the Basin; however, the ranges of concentrations overlapped.

Average methylmercury concentrations in the filtered and unfiltered surface water samples increased from 2006 to 2008 and decreased from 2008 to 2009. The 2009 methylmercury average concentration was similar to that in 2006.

Results for mercury, methylmercury, HCB, DDT and metabolites, and other key water quality parameters for surface water during 1991, 1992, 1994, 1995, and 2001 are presented in Table 2.

2.5.3.6 Biota

Terrestrial Vegetation

The results for mercury, methylmercury, HCB, DDTR, and percent lipids in terrestrial vegetation are summarized below. Vegetation sampled as part of this effort included vines and leaves from shrubs near associated soil samples. Individual results are provided in Table 8 and graphically depicted in Figure 20. Vegetation results for COCs are reported as wet weight. Percent lipids in vegetation ranged from 0.13 to 0.4 percent.

Mercury was not detected in terrestrial vegetation samples above the RL of 0.017 mg/kg. Methylmercury was detected in the terrestrial vegetation samples at concentrations ranging from 0.000643 JQ mg/kg (JQ indicates an estimated concentration between the method detection limit [MDL] and the RL) to 0.0147 mg/kg. The average methylmercury tissue concentration was 0.00314 mg/kg. Six of the 10 vegetation samples had methylmercury concentrations between the MDL and the RL.

HCB was analyzed in five vegetation samples, but was only detected above the reporting limit in one sample (FPVSS14) at 0.0048 J mg/kg. DDTR was analyzed in five vegetation samples. The results for the six analyzed congeners were summed to obtain the DDTR value. Zero was used in the summations for congeners that were not detected at the associated RL for the sample. DDTR was detected above the RL in one sample, FPVSS-1 (northeast of the Basin), at 0.0045 J mg/kg.

Spiders and Insects

The results for mercury, HCB, DDTR, and percent lipids in spiders and insects are summarized below.

Individual results are provided in Table 9. Spider and insect results for COCs are reported as wet weight.

Mercury concentrations in spiders collected in the OU-2 floodplain in 2010 ranged from 0.13 mg/kg to 0.17 mg/kg and were similar throughout the floodplain. HCB concentrations in spiders ranged from 0.001 JQ mg/kg to 0.016 mg/kg. DDTR concentrations in spiders ranged from 0.141 mg/kg to 0.335 mg/kg. The results for the six analyzed congeners were summed to obtain the DDTR value. Zero was used in the summations for congeners that were not detected at the associated RL for the sample. This method was also used for flying and crawling insects. Summations of congeners were also calculated using one-half of the RL for non-detected concentrations at the EPA's request for evaluating uncertainty in non-detected concentrations. These summations resulted in DDTR concentrations ranging from 0.14 JQ mg/kg to 0.33 JQ mg/kg. Percent lipids in spiders ranged from 3.5 to 3.9 percent.

Mercury concentrations in flying insects ranged from 0.14 mg/kg to 0.71 mg/kg. HCB concentrations in flying insects ranged from 0.002 JQ mg/kg to 0.039 mg/kg. DDTR in flying insects (non-detect [ND] = 0) ranged from 0.038 J mg/kg to 0.659 J mg/kg. DDTR in flying insects using one-half the RL for non-detects ranged from 0.05 JQ mg/kg to 0.66 J mg/kg. Percent lipids in flying insects ranged from 3.2 to 4.1 percent.

Mercury concentrations in crawling insects ranged from 0.008 JQ mg/kg to 0.37 mg/kg. HCB concentrations in crawling insects ranged from 0.002 JQ mg/kg to 0.035 mg/kg. DDTR in crawling insects (ND = 0) ranged from 0.004 JQ mg/kg to 0.352 mg/kg. DDTR in crawling insects using one-half the RL for non-detects ranged from 0.015 JQ mg/kg to 0.35 J mg/kg. Percent lipids in crawling insects ranged from 2.8 to 4.4 percent.

Fish

Fish tissue samples have been collected from the Basin since 1986, with the most recent collection occurring in 2008. Fish species collected for tissue analysis from the Basin include largemouth bass, channel catfish, bluegill, smallmouth buffalo, rock bass, mosquitofish, brook silversides, and mullet.

These species are discussed in this section by trophic level. The fish tissue samples have been analyzed historically for mercury, HCB, and DDTR. The movement of mercury, HCB, and DDTR through the food web can be discussed, by examining the fish tissue concentrations of mercury, HCB, and DDTR in fish species that are representative of different trophic levels.

Trends in Fish Concentrations

Summaries of recent (2003 – 2010) and historical (1986 – 2001) fish tissue data are presented in Tables 10 and 11, respectively. Trends in fish tissue concentrations over time in the Basin are summarized as follows:

- Mercury concentrations in upper trophic level fish (largemouth bass) increased from 2006 to 2008. This is likely due to drought conditions during this time period that limited water exchange with the Tombigbee River. A decrease in mercury concentrations in bass was noted in 2010, subsequent to the end of the drought in 2009. However, concentrations of mercury in largemouth bass have not decreased over time compared to historical largemouth bass samples. Mercury concentrations in lower trophic level fish have remained relatively constant from 1994 – 2010.

- HCB concentrations in the upper trophic level fish have decreased over time. HCB concentrations in lower trophic level fish show a slight decreasing trend, though concentrations increased in 2008 during the drought. The 2010 data show that HCB concentrations in lower trophic level fish declined to historical pre-drought levels. No middle trophic level fish sampled from multiple years were available for historical trend comparison.

- DDTR concentrations in the upper and lower trophic level fish have decreased over time (1991 – 2010). No middle trophic level fish sampled from multiple years were available for historical trend comparison

Other Biota

Benthic macroinvertebrate sampling was performed to characterize the infaunal community at OU-2. The sampling was performed in three phases: during the RI/FS investigation in 1991 and 1992 and during the additional ecological studies in 1994. Table 12 provides a summary of the biota analytical results. The benthic community at OU-2 was dominated by oligochaetes (segmented worms, especially of the families Tubificidae and Naididae); larval dipteran insects (especially chironomids [midges] and chaoborids [phantom midges]); and ostracods, as would be expected in a freshwater or oligohaline environment such as OU-2.

2.5.4 Evaluation of Sedimentation Rate

Total suspended solids (TSS) data collected during 2008 and 2009 storm events were used to estimate sediment load associated with representative storm events. The net sedimentation rate (NSR) for the five year period from 2005 to 2009 was estimated based on available Site-specific data. The predicted NSRs for 2005 to 2009 ranged from 0 inch/year during the drought in 2007 to 0.3 inch/year in 2009. The average NSR for this 5-year period was 0.2 inch/year.

The analysis was applied to the 49-year period of historic flow data collected at Coffeeville Dam from 1961 through 2009 to represent a larger set of climatic conditions. The annual NSR ranged from a minimum of 0.0 inch/year in 1963 to a maximum of 1.1 inch/year in 1983. Based on these results, the estimated annual average NSR in the Basin was 0.3 inch/year for the 49-year period, with the 95 percent confidence interval ranging from 0.2 to 0.4 inch/year.

Most of the storm event data were collected during a low-flow period or drought conditions in 2008 and were then applied to represent the quality of storm events from 1961 to 2009. As a result of data collection under drought conditions, annual NSR estimates may be lower than the actual long-term average value.

2.5.5 Debris Evaluation

Sidescan sonar data collected during the bathymetric survey revealed that substantial amounts of buried debris are present in the Basin. Buried debris is significantly larger closer to the Basin edge, up to tens of meters long, several meters wide, and protruding from tens of centimeters to up to a meter from the Basin bed.

This buried debris consists of larger logs and stumps. Approximately 50 percent of the Basin edges are characterized by buried debris of this type. The shallower portion of the Basin (less than approximately -8 meters water depth NAVD88) has numerous smaller features, ranging from less than 1 meter to several meters long, and up to 1 meter or more wide. The average length and/or width of these features is approximately 60 centimeters, with an average height above the sediment bed of less than 20 centimeters, and these features are interpreted to be tree branches and/or other forest litter. This smaller buried debris is more prevalent in the southern portion of the Basin (covering approximately 40 to 50 percent of the Basin bottom) than in the northern portion (approximately 30 percent of the Basin bottom). The deeper portion of the Basin in the northwestern quadrant is composed of significantly softer sediment, which absorbs the seismic energy and results in fewer apparent features (approximately 15 percent of the Basin bottom). The features that are observed are approximately the same size as the larger features of the shallower areas described above, likely tree branches and/or other forest litter. Smaller features might be buried in the softer sediments of the deeper Basin region, or might not reflect sufficient energy to be detectable in the sidescan sonar record.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

Residential land use within 3 miles of OU-2 includes approximately 94 households (2000 U.S. Census). Commercial activity is generally related to basic domestic needs and services along Highway 43. The two main industries within a 3-mile radius of OU-2 are the Olin and BASF (formerly Ciba-Geigy) facilities. A compressed air power plant (Alabama Power) and a cement company are also within a 3-mile radius. Recreation areas include the town park next to River Road, and a fishing camp at McIntosh Landing. Public use areas within a 3-mile radius include town government buildings, public schools, a public library, churches, and cemeteries. The predominant land use with a 3-mile radius is forest, followed by wetland areas.

USFWS classifies OU-2 as seasonally-flooded wetlands, and as such, not suitable for human habitation. More than 95 percent of OU-2 is subject to flooding by the Tombigbee River. Under ADEM's Water Quality Program, the water use classification for the Tombigbee River in the vicinity of the Olin Basin is Fish and Wildlife. Table 13 provides an estimate of the vegetation/land cover types within OU-2.

The area surrounding OU-2 is comprised of a riverine ecoregion of large, sluggish rivers and backwaters with ponds, swamps, and oxbow lakes. River swamp forests of bald cypress and water tupelo and oak dominate bottomland hardwood forests and provide important wildlife corridors and habitat.

Current and future offsite land use is expected to remain unchanged.

2.7 SUMMARY OF SITE RISKS

A Baseline Risk Assessment (BRA) was performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with the Site assuming no remedial action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The public health risk assessment followed a four step process: 1) hazard identification, which identified those hazardous substances which, given the specifics of the site were of significant concern; 2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; 3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and 4) risk characterization and uncertainty analysis, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the site, including carcinogenic and noncarcinogenic risks and a discussion of the uncertainty in the risk estimates. A summary of those aspects of the human health risk assessment which support the need for remedial action is discussed below followed by a summary of the environmental risk assessment.

The response action selected in this Record of Decision is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

2.7.1 Human Health Risk Assessment

2.7.1.1 Chemicals of Concern

The Chemicals of Potential Concern (COPCs) were selected to represent potential site related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment.

COPCs are defined as those chemicals that exceeded screening criteria and required quantification in the Baseline Risk Assessment. COPCs were developed separately for human health and ecological risk assessment. The following table provides a list of COPCs that were evaluated in the human health risk assessment (HHRA).

COPCs
Sediment
Mercury
Methylmercury
HCB
DDTR
Surface Water
Mercury
Methylmercury
HCB
DDTR
Surface Soil
Mercury
HCB
DDTR

The HHRA identified a subset of the COPCs as presenting a significant current or future risk and are referred to as the Chemicals of Concern (COCs) in this ROD. Methylmercury in fish tissue is identified as the primary COC for human health at OU-2. Although mercury in fish tissue was measured as total mercury, it is presumed to be primarily in the form of methylmercury, as other studies have shown that greater than 90% of mercury in fish tissue exists as methylmercury. Clean-up goals for sediment and fish tissue for protection of human health are expressed in terms of total mercury (methylmercury + inorganic mercury). The following sections summarize the process used to identify the COC.

Exposure pathways considered included incidental ingestion of soil, dermal contact with soil, and inhalation of particulates while trespassing at OU-2. Additional exposure pathways included incidental ingestion of surface water during swimming, dermal contact with surface water during swimming, and ingestion of largemouth bass fillets. The recreational fishing scenario assumes that ingestion of fish is limited to skinless fillets, and that ingestion of whole fish is not occurring amongst the general population or subgroups of the population. The exposure pathways are shown in Table 14.

Exposure media evaluated in the human health risk assessment included floodplain soil, surface water, and ingested fish fillets. COPCs in surface water include mercury, HCB and DDTR. The COPCs in floodplain soil include mercury and DDTR. COPCs in fish tissue included mercury (assumed to be methylmercury), HCB, and DDTR.

In the HHRA, the EPA uses a concentration for each COPC to calculate the risk. This concentration, called the exposure point concentration, is a statistically-derived number based on the sampling data for the Site. Generally, the 95 percent upper confidence limit (UCL) on the arithmetic mean concentration for a chemical is used as the exposure point concentration. The 95 percent UCL on the arithmetic mean is defined as a value that, when calculated repeatedly for randomly drawn subsets of the Site data, equals or exceeds the true mean 95 percent of the time. Exposure point concentrations for each exposure medium are shown in Table 15.

2.7.1.3 Exposure Assessment

An exposure assessment was conducted as part of the HHRA. The exposure assessment consists of characterizing the potentially exposed receptors, identifying exposure pathways, and quantifying exposure. Exposure scenarios and pathways were identified based on the conceptual Site model (Figure 8). An exposure pathway usually includes the following: (1) a source and means of contaminant release; (2) a transport medium (e.g., air, ground water, etc.); (3) a point of contact with the medium (i.e., receptor); and (4) an intake route (e.g., inhalation, ingestion, etc.).

The source and primary release for the constituents detected were through transport to surface water. Transport to floodplain soils and bioaccumulation of constituents from surface water and sediment to fish residing in the Basin are also relevant transport pathways at OU-2. As shown in Table 14, direct contact with floodplain soils and surface water, incidental ingestion of floodplain soils and surface water, inhalation of floodplain soil particulate emissions, and ingestion of fish fillets were considered as potential exposure media and pathways of concern. Sediment is submerged and direct exposure to sediment is not a significant exposure pathway to humans at the Site.

The complete exposure pathways identified for this Site were carried through the human health risk assessment. Current and future offsite land use is expected to remain unchanged. Residential and industrial scenarios were not evaluated for potential future use scenarios because the area consists of floodplains that flood annually, precluding the construction of structures on the Site. The most likely receptors include offsite resident trespassers (adults and adolescents aged 7 to 16 years) that may have infrequent access to OU-2. Exposure pathways addressed in the human health risk assessment are summarized below:

Current and Potential Future Offsite Adult and Adolescent Trespassers

- Incidental ingestion of surface water during swimming or fishing
- Dermal contact with surface water during swimming or fishing
- Ingestion of largemouth bass fish fillets
- Incidental ingestion, dermal contact, and inhalation of particulates from floodplain soils during trespassing

Exposure Assumptions

For resident trespasser exposures, the reasonable maximum exposure (RME) duration for an adolescent was assumed to be 10 years (Site-specific assumption) with 30 years assumed for adults. For trespassing and swimming exposures, a Site-specific current exposure frequency of 12 days/year was assumed (i.e., one day per month), and is based on a 1993 fishing survey. Information regarding fishing activity behavior was obtained from a subpopulation that claimed to have actually fished in the Basin. The most conservative response was once per month. This frequency is likely an overestimation because construction in 2007 and continued operation of the berm and gate system further limits access since the survey was conducted in 1993. Therefore, it is likely that an exposure frequency of 12 days per year overestimates current exposures. Per the EPA requirement, trespassers were assumed to have increased exposure in the future scenario. For trespassing and swimming exposures, a potential future exposure frequency of 45 days/year is assumed.

A body weight of 70 kg is assumed for adult resident trespassers and a body weight of 48 kg is assumed for adolescent resident trespassers (7 to 16 years of age). The averaging time for noncarcinogenic exposures is equal to the exposure duration times of 365 days. The averaging time for carcinogenic exposures is assumed to occur over a 70-year lifetime (25,550 days).

Incidental Ingestion of Surface Water

It is assumed that adult and adolescent trespassers ingest 0.02 liter per hour (L/hr) and 0.05 L/hr, respectively for two hours per event (professional judgment).

Dermal Contact with Surface Water

A total body surface area of 18,000 cm^2 and 14,110 cm^2 was assumed for resident trespasser adults and adolescents, respectively.

Ingestion of Fish Fillets

The daily intake of fish is based on the 95th percentile intake for uncooked fish weight in grams per day (g/day) from a freshwater and estuarine source. Adult trespassers are assumed to eat 31.9 g/day. Adolescents are assumed to ingest 17 g/day. The adolescent rate is an age-adjusted rate. The fraction of fish ingested from the Site was based on the non-flood season for OU-2 and the results of the 1993 fishing survey. The fishermen responded that they did not fish during the flood season, which is the only time boat access is available. In the 1993 human health risk assessment, a fraction ingested from the Basin of 0.125 was calculated (or 1/8 of total fish ingested per year). This value was retained for the current exposure fraction ingested in the updated human health risk assessment. However, based on construction in 2007 and continued operation of the berm and gate system that serve to limit Site access, the assumptions based on the 1993 survey potentially overestimate current exposures to OU-2 media. Per the assumption that access restrictions could be reduced in the future, a higher fraction ingested from the Site was assumed (0.5) for the future scenario. The 1993 human health risk assessment included the ingestion of catfish and bass, but the current human health risk assessment assumes only ingestion of bass. Using concentrations for just largemouth bass is a conservative approach to the estimation of exposures for trespassing fishermen because bass have a long lifespan and tend to bioaccumulate more COPCs than other species. Fillet data collected in the Basin in 1991 and 2003 show that bass fillets contain higher concentrations of mercury than catfish fillets, while concentrations of DDTR in the two species were similar.

Ingestion of Soil

The daily intake of soil for adults and adolescents is assumed to be 100 mg/day. Fifty percent of the daily soil intake is assumed to be from the Site.

Dermal Contact with Soil

The exposed surface area is assumed to be hands, forearms, feet, and lower legs with the adult and adolescent surface areas calculated as 5,700 cm^2/event and 4,050 cm^2/event, respectively.

Inhalation of Particulates Emitted from Floodplain Surface Soils

Trespassers are assumed to have 50 percent of their daily dose from the Site. A default particulate emission factor from the EPA guidance (USEPA, 2002b), 1.36 x 10^9 m^3/kg, is used to estimate particulate emissions at the Site. Because of the wet nature of some of the soil and the presence of vegetation, inhalation of particulate emissions at the Site is expected to be a minor pathway of exposure.

Sediment Dermal Contact and Incidental Ingestion

Direct contact with submerged sediment and incidental ingestion of submerged sediment are considered incomplete exposure pathways for the exposure scenarios at OU-2. Though dermal contact with submerged sediments may occur to people wading in the Basin, dermal absorption is considered negligible because sediments are continually being washed from the skin by the surface water.

2.7.1.4 Toxicity Assessment

The toxicity assessment is an integral part of the risk evaluation process. Toxicity values, such as reference doses and carcinogenic slope factors, are based primarily on human and animal studies with supportive evidence from pharmacokinetics, mutagenicity, and chemical structure studies. The EPA has developed toxicity values that reflect the magnitude of adverse non-carcinogenic and carcinogenic effects from exposure to specific chemicals. The hierarchy of sources for toxicity values used in the human health risk assessment is 1) the EPA's Integrated Risk Information System (IRIS) database, 2) the National Center for Environmental Assessment Provisional Peer Reviewed Toxicity Values, and 3) other reviewed toxicity values as published in the EPA RSL table (USEPA, 2010). Values for this HHRA were available in IRIS. A summary of the toxicity assessment is provided in Tables 16 – 17.

Toxicity Values for Non-carcinogenic Effects

Chemicals that give rise to toxic endpoints other than cancer and gene mutations are often referred to as "systemic toxicants" because of their effects on the function of various organ systems. Chemicals considered carcinogenic can also exhibit systemic toxicity effects. For many non-carcinogenic effects, protective mechanisms (i.e., exposure or dose threshold) are believed to exist that must be overcome before an adverse effect is manifested. This characteristic distinguishes systemic toxicants from carcinogens and mutagens, which are often treated as acting without a distinct effects threshold. As a result, a range of exposure exists from zero to some finite value that can be tolerated with essentially no risk of the organism expressing adverse effects. The standard approach for developing toxicity values to evaluate non-carcinogenic effects is to identify the upper bound of this tolerance range or threshold and to establish the toxicity values based on this threshold.

The toxicity values most often used in evaluating non-carcinogenic effects are a reference concentration (RfC) or reference dose (RfD) for inhalation and oral exposures, respectively. Various types of non-carcinogenic toxicity values are available depending on the exposure route of concern (e.g., oral or inhalation), the critical effect of the chemical (e.g., developmental or other), and the length of exposure being evaluated (e.g., chronic or subchronic).

The RfC and RfD are defined as provisional estimated daily exposure levels for the human population, including sensitive subpopulations that are likely to be without appreciable risk of deleterious effects during a portion of a lifetime or a lifetime (chronic). Chronic RfCs/RfDs are specifically developed to be protective for long-term exposures, (i.e., 7 years to a lifetime of 70 years) and subchronic exposures are developed to be protective for short-term exposures. Chronic RfCs/RfDs were used in the human health risk assessment.

Toxicity Values for Carcinogenic Effects

Carcinogenesis, unlike many noncarcinogenic health effects, is generally thought to be a non-threshold effect. Accordingly, the EPA guidance for risk assessments assumes that a small number of molecular events can cause changes in a single cell that can lead to uncontrolled cellular growth. This hypothesized mechanism for carcinogenesis is referred to as “non-threshold” because any level of exposure to such a chemical is considered as posing a finite probability of generating a carcinogenic response.

To evaluate carcinogenic effects, the EPA uses a two-part evaluation in which the chemical is first assigned a weight-of-evidence classification, and then either an inhalation unit risk (IUR) or oral carcinogenic slope factor (CSF) is calculated. The weight-of-evidence classification is based on an evaluation of available data to determine the likelihood that the chemical is a human carcinogen.

Chemicals with the strongest evidence of human carcinogenicity are denoted with Class A, B1, or B2, while chemicals with less supporting evidence are classified as C or D. The slope factor quantitatively defines the relationship between the dose and the response. The slope factor is generally expressed as a plausible upper-bound estimate of the probability of response occurring per unit of chemical.

Toxicity Assessment of Dermal Exposures

RfDs or CSFs have not been derived specifically for dermal absorption. The administered oral RfDs and CSFs may be adjusted by chemical-specific gastrointestinal (GI) absorption rates, resulting in an absorbed dose RfD or CSF, as described in the EPA's risk assessment guidance (USEPA, 1989). The GI absorption rates are obtained from RAGS Part E (USEPA, 2004; 2010b). To evaluate potential risks from dermal exposures, the dermal intakes are compared to the adjusted (i.e., absorbed dose) toxicity values (USEPA, 1989). In accordance with RAGS Part E, when values for oral absorption efficiency are greater than 50 percent, the oral RfD and oral CSF are not adjusted for GI absorption.

2.7.1.5 Risk Characterization

The final step of the risk assessment process is called risk characterization. Risk characterization combines the exposure assessment with the toxicity assessment. The toxicity assessment evaluates the relationship between a dose of a chemical and the predicted occurrence of an adverse health effect. In the risk assessment, toxic effects are separated into two categories: cancer (carcinogenic) effects and non-cancer (non-carcinogenic) effects.

Non-carcinogenic Effects Characterization

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., life-time) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of the daily intake to the RfC/RfD is referred to as the "hazard quotient: or HQ. The sum of the hazard quotients for each chemical in a specific pathway is termed the "hazard index" or HI. The HI is generated by adding the HQs for all chemical(s) of concern that effect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI < 1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An HI > 1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD

where:

CDI = Chronic Daily Intake

RfD = Reference Dose

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term). SF = slope factor, expressed as $(mg/kg\text{-}day)^{-1}$. The EPA's generally acceptable risk range contaminant is less than the RfD, and toxic non-carcinogenic effects from that chemical are unlikely. Non-carcinogenic effects are characterized by comparing the estimated chemical intakes to the appropriate RfC or RfD values. The RfC/RfD value is, by definition, an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without appreciable hazard of deleterious effects during a lifetime. Therefore, when the estimated chronic daily intake of a chemical exceeds the appropriate RfC or RfD, there may be a concern for potential noncancer effects from exposure to that chemical. The ratio of the daily intake to the RfC/RfD is referred to as the "hazard quotient" or HQ. The sum of the hazard quotients for each chemical in a specific pathway is termed the "hazard index" or HI. It is important to note that the hazard quotient does not represent a statistical probability; thus, a ratio of 0.01 does not mean that there is a 1 in 100 chance of the effect occurring. Rather, HQ greater than 1 indicates that the "threshold" for that constituent has been exceeded.

The EPA assumes additive effects in evaluating non-carcinogenic effects from a mixture of chemicals. Strictly, additivity should only be assumed for chemicals that induce the same effect by the same mechanism of action. Practically, this consideration is often addressed by adding HIs for chemicals that critically affect the same target organ system, and additivity across chemicals affecting the same target organ has been addressed in this assessment. The constituent-specific hazard quotients are summed to yield an overall pathway HI; pathway HIs are then summed to yield a total HI for each relevant population. The current and potential future risk characterization tables (non-carcinogens) for adult and pre-adolescent/adolescent resident trespasser exposures to surface water, floodplain surface soil, and fish tissue are presented in Tables 18 through 21. The constituent-specific HQs are grouped and summed by target organ.

Carcinogenic Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

Risk = CDI x SF

where:

Risk = a unitless probability (e.g., 2×10^{-5}) of an individual's developing cancer

CDI = chronic daily intake averaged over 70 years (mg/kg-day).

SF = slope factor, expressed as $(\text{mg/kg-day})^{-1}$

These risks are probabilities that usually are expressed in scientific notation (e.g.,1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three.

Risks from potential carcinogens are estimated as probabilities of excess cancers as a result of exposure to chemicals. The carcinogenic slope factor correlates estimated total lifetime daily intake directly to incremental cancer risk. The results of the risk characterization are expressed as upper bound estimates of the potential carcinogenic risk for each exposure point. Constituent-specific cancer risks are estimated by multiplying the slope factor by the lifetime daily intake estimates.

To be protective of human health, cumulative risk for carcinogenic compounds should be calculated so that the result does not exceed the acceptable risk range of 10^{-4} to 10^{-6}, with a cumulative upper bound excess lifetime cancer risk of one in 10,000 (1×10^{-4}). The current and potential future risk (carcinogens) characterization tables for adult and pre-adolescent/adolescent resident trespasser exposures to surface water, floodplain surface soil, and fish tissue are presented in Tables 22 through 25. For each receptor, the exposure medium is calculated into an individual cancer risk and summarized into a cumulative carcinogenic risk.

Summary of Risk Characterization

The COPCs were selected to represent potential Site related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment. From this, a subset of the chemicals was identified as presenting a significant current or future risk and the subset is referred to as the COCs in this ROD.

Exposures to floodplain soils were not associated with unacceptable risks or hazards and were not carried through to the summary tables.

Carcinogenic risk for all scenarios (current and future) fell within the acceptable risk range for all COPCs (maximum carcinogenic risk of 2.3×10^{-5} was to adult fisherman under the future use scenario).

The noncarcinogenic risk HI values exceed 1 for adult and adolescent receptors for the future use scenarios (HI = 4.0 to 6; Tables 18 - 21). The HI calculations show that the risk is primarily due to ingestion of methylmercury in fish tissue. The ingestion pathway accounted for 99.9% of the HI values, while dermal contact with soil and surface water, and ingestion of soil and surface water accounted for less than 0.1% of the total HI values for adult and adolescent receptors. Within the ingestion pathway, methylmercury in fish tissue accounted for 93 – 97% of the total HI, with ingestion of HCB and DDTR accounting for 3 – 7% of the ingestion HI. Thus, methylmercury in fish tissue is identified as the primary COC for human health at OU-2. Although mercury in fish tissue was measured as total mercury, it is presumed to be primarily in the form of methylmercury, as other studies have shown that greater than 90% of mercury in fish tissue exists as methylmercury. Clean-up goals for sediment and fish tissue for protection of human health are expressed in terms of total mercury (methylmercury + inorganic mercury).

Uncertainty Analysis

Uncertainty is inherent in the risk assessment process. Exposure is hypothetical, and the risk assessment calculations are based in large part on assumed conditions. An important part of the risk assessment process is characterizing the main underlying uncertainties. Understanding the uncertainties is important for the interpretation and ultimate use of the risk assessment results because actual risk may be underestimated or overestimated.

<u>Uncertainties and Assumptions Associated With Data Collection and Data Evaluation</u>

The goal of the sampling at Olin OU-2 is to define nature and extent of contamination and determine the EPCs for exposure media. The data for HCB and DDTR for surface water are from historical sampling events and may not represent current conditions in the Basin and Round Pond.

<u>Uncertainties and Assumptions Associated with the Exposure Assessment</u>

The use of UCLs of the arithmetic mean as a basis for estimating a reasonable maximum exposure (RME) is a conservative approach designed to assure that the mean is not underestimated. Actual EPCs may also vary with space and time. Floodplain surface soil data were collected in 2010 and some of the data points were submerged. However, all the data points were used as dry soil for purposes of the human health risk assessment. Thus, inclusion of these wet soils may under or overestimate soil exposures. However, inclusion of all sampling points is a conservative measure that models exposure to a mixture of soil and sediment. This is appropriate because flood plain soils become submerged sediment during the frequent flooding events that occur on the Tombigbee River.

Fish fillet tissues were analyzed for total mercury. An assumption was made that all detected mercury in fish was methylmercury, because 90% (and greater) of mercury in fish tissue generally exists as methylmercury.

The fish ingestion intakes assumed the ingestion of only one species of fish. Largemouth bass are upper trophic level fish with a long life span. They tend to bioaccumulate higher concentrations of mercury than other species such as sunfish or catfish. However, local fishermen reportedly eat a variety of fish from the surrounding area. Assuming ingestion of largemouth bass only may overestimate risks and hazards associated with mercury, HCB, and DDTR, as historical data showed that largemouth bass contained higher concentrations of mercury than other species that may be consumed by humans, such as channel catfish. However, the assumption that only skinless fillets are consumed may underestimate risk to anyone who consumes the whole fish, as concentrations of DDT and HCB in whole fish are greater than concentrations in skinless fillets. Assuming the local fishermen will obtain 50 percent of the fish ingested from OU-2 in the future also may overestimate exposures to mercury, HCB, and DDTR.

The receptor group of interest in human health is off Site resident trespasser adults and adolescents. The Basin and Round Pond areas are not readily accessible from the river because of the berm located on three sides of OU-2. Olin restricts access to this area. The water level would have to be several feet above the berm elevation of 12 feet NAVD88 to get a boat into OU-2 from the river. Fishermen reported that they do not fish during the flood season when boat access is available. Olin is committed to maintaining restricted access to OU-2 currently and in the future based on its current economic investment at the manufacturing facility. Future exposures for OU-2, where Olin maintains access restrictions, are expected to be very similar to current exposures in regards to exposure frequency. Thus, assumptions developed in 1993 may overestimate current exposures because institutional controls cannot be assumed in the risk analysis. Future exposure assumptions required by the EPA assume unrestricted Site access. Based on Olin's long term commitment to the facility and to maintenance of Site security at OU-2, the potential future scenario may overestimate hazards and risks associated with fish ingestion. The current and future assumption that off Site residents trespass, regularly swim, or fish tends to overestimate risks and hazards for OU-2.

Uncertainties and Assumptions Associated With the Toxicity Assessment

Substantial uncertainties are associated with use of toxicity data extrapolated from rats and mice to humans. In some instances, biological pathways and mechanisms of metabolism differ significantly between mammalian species. As a result of these differences, humans may be either more or less sensitive than the surrogate laboratory species. The application of uncertainty factors in the EPA's RfC/RfD assumes that humans may be more sensitive, although this is not always the case. This extrapolation will likely overestimate risk to some extent. Incorporation of variability in response among individuals in the population is entirely appropriate to ensure that all members of the exposed population are protected. The portion of the uncertainty factor that represents true uncertainty, however, may result in overestimation of risk, even to individuals predisposed to an adverse response.

Uncertainties and Assumptions Associated With the Risk Characterization

The use of conservative assumptions throughout the risk assessment tends to overestimate potential risks and hazards. By examination of uncertainties associated with the exposure assessment and the toxicity assessment, which are combined by multiplication in the risk characterization, it is likely that the RME hazards and risks reported are overestimated. The EPA intends for this approach to help ensure that risks are not underestimated.

The EPA requires a potential future scenario that assumes unrestricted access to OU-2 or unlimited recreational exposures to surface soil, surface water, or fish from the Basin.

This unrestricted potential future scenario has been incorporated into the HHRA. However, these potential future increased exposures are unlikely to occur due to the following current facts:

- Olin plans to continue to operate the facility and maintain Site security, which limits access to the Basin and Round Pond; therefore, exposures to floodplain soil, surface water, and fish tissues will also remain of low frequency; and
- Estimated carcinogenic risks and hazards under the current use scenario are within acceptable limits (Risk Range = 3.2×10^{-5} to 2.0×10^{-6}). Assuming the plant continues operations, future potential exposures will likely remain similar to those predicted in the current scenario. Non-carcinogenic risk shows HI values greater than one for the future use scenarios (HI range = 4 to 6), with ingestion of fish tissue driving the risk. The maximum HI of 6 is associated with future exposure without access restrictions for adults fishing in the Basin.

2.7.2 Ecological Risk Assessment

2.7.2.1 Chemicals of Potential Concern (COPCs)

COPCs are defined as those chemicals that exceeded screening criteria identified in the Screening Level Ecological Risk Assessment (SLERA) and required quantification in the Ecological Risk Assessment (ERA). COPCs were developed separately for human health and ecological risk assessment. Ecological COPCs were developed in the Ecological Risk Assessment Report (WCC, 1995) using data collected for the OU-2 Remedial Investigation in 1991 and 1992. The data used to characterize the Site for the screening-level ecological risk assessment are summarized in their entirely in the RI report (WWC, 1993). COPCs were refined based on frequency of detection and magnitude of exceedance. The COPCs retained for the ERA are summarized below:

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COPCs
Sediment Mercury Methylmercury HCB DDTR
Surface Water Mercury Methylmercury HCB DDTR
Surface Soil Mercury HCB DDTR

Based on the sediment, surface water, and surface soil screening results, the COPCs that were carried forward in the 2011 ERA process for OU-2 include mercury, methylmercury, HCB, and DDTR. The historical and current analytical results for these COPCs were used to estimate EPCs.

The COPCs were selected to represent potential Site related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment. The baseline risk assessment evaluated the COPCs, and based on the results of the baseline risk assessment a subset of the chemicals were identified as presenting a significant current or future risk and are referred to as the COCs in this ROD. The ecological COCCs are DDTR, HCB and mercury (inorganic and methylmercury) (Table 26). The “Background” concentrations in Table 26 are based on concentrations measured at the selected reference area for the OU-2 investigation. The Fred T. Stimpson Wildlife Sanctuary near Jackson, Alabama was selected as the reference area for COPC sampling. The reference area is located on the east side of the Tombigbee River at river mile (RM) 78, about 10 straight-line miles from OU-2 (Figure 1-2 of WWC 1994). The sanctuary comprises 3,800 acres; the studies were performed in the vicinity of two water bodies, the Middle Cutoff lake (ca. 21 acres) and Lower Cutoff lake (ca. 36 acres).

Exposure Point Concentrations

EPCs were based on concentrations to which receptor populations were expected to be exposed. Ecological risk guidance states that the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used to develop EPCs. For instances where samples are insufficient to calculate a UCL or the UCL exceeds the maximum concentration, the maximum detected concentration can be used as a default EPC. The UCLs were developed from multiple samples collected from numerous locations over several years in most cases and used as EPCs where appropriate.

Insects (including crawling insects, spiders, and flying insects), terrestrial vegetation, and floodplain soil EPCs were based on the 2010 sample collection (Figures 20 and 21). Sediment EPC calculations included the Basin and Round Pond sampling locations. Separate Round Pond EPCs were also developed. EPCs were also developed for two water level scenarios. EPCs were calculated for water levels at 3-feet NAVD88 and at 6-feet NAVD88. The minimum water level currently held at OU-2 is 6-feet NAVD88; a minimum water level was maintained starting in February 2009 to the present. EPCs for a 3-foot water level were also provided to represent historical baseline water levels and future water levels expected when operation of the gate and berm system ceases. EPCs at both water level scenarios were developed to allow a comparison of the EPCs for the differing water levels. Ecological EPCs for surface water, sediment, and floodplain soil samples are shown in Table 26 as the 95% UCL of the mean concentration. Constituents for which EPCs were developed included mercury, methylmercury, HCB, and DDTR.

Sampling data used in these EPC calculations were selected to provide representation across each medium and account for the actual likelihood of exposure for organisms to media.

2.7.2.2 Exposure Assessment

Environmental Setting

Considering the topography, hydrography, and associated biota (e.g., vegetative cover types) OU-2 is composed of three major habitat types - permanent water bodies with deepwater habitats, riparian wetlands, and uplands. Nearly 60 percent of the OU-2 is wetland. A formal jurisdictional determination ("delineation") was not performed as part of the RI, but it is clear from the descriptions of the hydrology and the vegetation that most of the OU-2 is riparian wetland. Soils east of the line tracing the edge of the bluff are of the Urbo and Una Series, which are recognized by the U.S. Department of Agriculture, Soil Conservation Service, as hydric. Therefore, all three criteria for formal wetland status are met in the portions of OU-2 between the margins of the permanent water bodies and the base of the bluff or the edge of the Tombigbee River.
Wetlands serve as habitat for a great diversity of organisms.

Vegetation

Six basic vascular plant communities, or vegetative cover types, were identified within OU-2 as presented in Table 13. The cover types include ponds and streams (permanent water bodies), semi-permanently/permanently flooded bottomland forest, temporarily flooded bottomland forest, successional shrub-dominated bottomland areas, herbaceous-dominated bottomland areas, and mixed hardwood/pine upland forest. The vascular flora identified during the 1994 survey were consistent with the current vegetative communities present on Site.

Details of vegetative community structure in these various habitat types (by stratum) are available in earlier reports. There was some evidence of logging, apparently long before the Olin McIntosh Plant was developed. Disturbance also occurred to northern and eastern portions of OU-2, which appeared to be related largely to construction of the BASF (formerly Ciba-Giegy) effluent pipeline in the late 1980s. An approximately 6.4-acre borrow area adjacent to OU-2 was cleared for the construction of the berm in 2006. The berm and gate system was constructed along the northern, eastern, and southern portions of OU-2 in 2006–2007. The detailed vegetative stress survey conducted in the early 1990s and additional observations during recent field activities revealed no indication of adverse effects of Site-related COPCs on individual plants, populations, or communities in OU-2.

The temporarily flooded bottomland forest, semipermanently flooded bottomland forest, and mixed upland forest all appeared to be typical of these types within the Southern Pine Hills District of the Eastern Gulf Coastal Plain in terms of species composition and structural characteristics. The limited signs of stress and disturbance in these wooded areas included;

- Evidence of logging (apparently many decades ago)
- At least one (perhaps more) localized fire
- Localized physical disruption of the soil and/or hydrology (e.g., along where BASF's discharge line was laid adjacent to the eastern property boundary of the Site, where the berm was constructed around the Basin and Round Pond, and in the borrow area on the top of the western bluff area)

Insect and disease damage, including webworms, chewing insects, and rusts, were noted in scattered locations, but were not indicative of a pattern that could be associated with any other stress(es), such as the presence of COPCs, fire, or hydrologic factors. Other than the effects mentioned above, vegetative conditions throughout OU-2 appear to be good, with normal vigor and color. Significant deformities or other indications of altered plant growth were not found.

Benthic and Other Aquatic Invertebrates

Benthic macroinvertebrate sampling to characterize the infaunal community was conducted in three phases at OU-2 during the RI/FS investigation in 1991 and 1992 and during the additional ecological studies in 1994. The benthic community at OU-2 was dominated by oligochaetes (segmented worms, especially of the families Tubificidae and Naididae); larval dipteran insects (especially chironomids [midges] and chaoborids [phantom midges]); and ostracods, as would be expected in a freshwater or oligohaline environment such as OU-2. There was a strong inverse correlation between taxonomic richness and invertebrate densities versus depth, likely due to hypoxic conditions at depth. Multivariate statistical analyses (clustering procedures) indicated no significant relationships between benthic invertebrate diversities and densities and COPC concentrations in the sediments. No clear patterns were evident in a qualitative assessment of the distribution of pollutant tolerant or pollutant-sensitive taxa relative to COPCs. Relatively high incidences of oligochaete worms with aberrant chetae were noted in some locations, although these had no definite relationship to location specific COPC concentrations.

The benthic macroinvertebrate community results were reviewed and bioturbation depths were evaluated. Bioturbation is the movement or alteration of sediment particles or porewater mediated by organisms. Bioturbation is a broadly defined term that includes several distinct processes (including bioadvection, biodiffusion, and bioirrigation) that influence sediment properties. Bioadvection is the nonrandom, generally vertical flux of particles due to biological activity such as feeding and burrow construction or maintenance. Biodiffusion is the vertical and horizontal transport of materials, including contaminants, through the sediment column as a result of biological activity. Bioirrigation is the movement of water and solutes within and out of the sediment column due to active or passive flushing of infaunal burrows. The depth to which organisms will bioturbate depends on behaviors of the specific organisms and the characteristics of the substrate. The roles in bioturbation of the dominant groups described above are discussed in more detail below.

The tubificid worms are most commonly found in soft sediments that are rich in organic matter. As lakes become eutrophic and DO concentrations decrease, tubificid oligochaetes tend to replace other benthic animals due to their tolerance for these conditions (Soil & Water Conservation Society of Metro Halifax, 2008). None of the oligochaete worms identified from OU-2 have a designated habit classification; however, oligochaetes are generally expected to be important freshwater bioturbators (Barbour et al., 1999).

Members of the chironomid family are classified as burrowers (Barbour et al., 1999). Chironomids are often the only insects found in lake sediments of the profundal zone where hypoxic (oxygen concentrations less than 3 mg/L) and even anoxic conditions sometimes occur (Rasmussen, 1996). The larvae and pupae of most species occurring in low-oxygen sediments construct burrows and fixed tubes of sediments held together with silky secretions. Tube and burrow dwellers can ventilate their tubes with fresh water by dorso-ventral undulations of the body, thereby facilitating gas exchange during times of low ambient oxygen and resulting in bioadvection and bioirrigation.

The benthic macroinvertebrates appear to be a freshwater or perhaps an oligohaline system. Freshwater systems are less well-understood than estuarine systems with respect to bioturbation depths, but are largely expected to be confined to the uppermost 6 inches (i.e., 15 cm) of the sediment column.

Additional aquatic invertebrates (various crayfish species, grass shrimp, and blue crab) were encountered during the 1994 ecological studies. Mayflies were also collected in 1994. The benthic invertebrate community of OU-2 exhibited some evidence of stress (lower diversity and abundance, and chetal aberrations in many oligochaetes) based on limited comparisons with a reference area, Hatchetigbee Lake, that may in part be attributable to the presence of COPCs. Another important factor to recognize in characterizing the benthic invertebrate community of OU-2 is that limnological conditions in the deeper portions of the Basin appear to be unfavorable to aerobically respiring organisms.

Fish

The Lower Tombigbee River drainage has 131 documented fish species (Mettee et al., 1996). Approximately 60 of these species are expected to occur in OU-2 or the immediate vicinity based on habitat preferences, as documented in Table 3-2 of the 2011 RI Report. The presence of 41 of the expected species has been confirmed, and approximately 30 to 35 species appear to be relatively abundant. The location of OU-2 in the Lower Tombigbee River Basin near the Mobile River Basin (two of the most diverse river systems in Alabama) accounts for the high species diversity in OU-2. Habitat diversity within OU-2 (deepwater habitat, shallows, large woody debris, permanently and semi-permanently flooded wetlands, and floodplains) and abundant food sources further support the species diversity observed at OU-2. Fish were collected in 1986, 1991, 1994, 1995, 2001, 2003, 2005, 2006, and 2008. Fish tissue data are summarized in Tables 10 and 11. The main objective of fish sampling activities in OU-2 has been to obtain tissues for COPC analyses. The fish community of OU-2 appears to be typical of similar environments throughout the Eastern Gulf Coastal Plain, considering the gear used, level of effort, and the prevailing sampling conditions. The only species that is usually common in such habitats that has not been observed is the bowfin *(Amia calva)*. The OU-2 fish community includes certain euryhaline fishes (e.g., least killifish [*Heterandria formosa*], Atlantic needlefish [*Strongylura marina*], and hogchoker [*Trinectes maculatus*]).

The trends in fish tissue concentrations over time are summarized as follows:

- Mercury concentrations in upper trophic level fish increased from 2006 to 2008, likely due to drought conditions that limited surface water exchange with the Tombigbee River during this time.
- HCB concentrations in the upper and lower trophic level fish have decreased over time. No middle trophic level fish sampled from multiple years are available for historical trend comparison.
- DDTR concentrations in the upper and lower trophic level fish have decreased over time. No middle trophic level fish sampled from multiple years are available for historical trend comparison.

Terrestrial and Semi-Aquatic Vertebrates (Wildlife)

Faunal lists documenting occurrence and relative abundance of terrestrial and semi-aquatic vertebrates were presented in Table 3-3 of the 2011 RI Report. These faunal lists were updated throughout the field investigations at OU-2, in particular the annotations regarding confirmed presence in the area. Many of the strictly terrestrial vertebrates (e.g., some reptiles, most mammals) probably occur in the floodplain area of OU-2 only as dry-season transients.

The available information on tetrapod vertebrates in OU-2 is generally observational and limited, since minimal standardized quantitative sampling was performed. Nevertheless, it provides a basis for a general qualitative description of the higher vertebrate communities in the study area. The presence of at least 12 types of amphibians, 17 types of reptiles, 58 types of birds, and 16 types of mammals in OU-2 have been confirmed directly through observation or indirectly through scat and sign.

Threatened and Endangered Species

The EPA contacted the USFWS, Alabama Ecological Services Field Office and requested an updated list of endangered and threatened species and critical habitat for the Olin OU-2 Site. USFWS reviewed the information and provided the following list of species in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. et seq.), the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended: 16 U.S.C. 1531 et seq.), the Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. § 668-668d) (BGEPA), and the Marine Mammal Protection Act of 1972 (16 U.S.C. § 1361 et seq.). The following federally listed species may occur within the vicinity of the Olin OU-2 Superfund Site in Washington County. Alabama:

- Alabama red-bellied turtle, *Pseudemys alabamensis* - Endangered
- Alabama sturgeon, *Scaphirhyncus suttkusi* - Endangered, Critical Habitat in Alabama River
- Bald eagle, *Haliaeetus leucocephalus* - BGEPA
- Black pine snake, *Pituophis melanoleucus lodingi* - Candidate
- Gopher tortoise, *Gopherus polyphemus* - Threatened
- Gulf sturgeon, *Acipenser oxyrinchus desotoi* - Threatened
- Louisiana quillwort, *Isoetes louisianensis* - Endangered

- West Indian manatee, *Trichechus manatus* - MMPA
- Wood stork, *Mycteria americana* – Endangered

Complete Exposure Pathways

The identification of complete and potentially complete exposure pathways is an important step in the development of a CSM (USEPA, 1997). The selection of endpoint organisms for evaluation in the BERA is based on the identified exposure pathways.

Varying exposure to COPCs in the ecosystem is expected due to differences in habitat, behavior, and life cycles between different species. For example, aquatic organisms, such as fish and aquatic invertebrates, often have more exposure to COPCs in the water column or through the aquatic food web than to COPCs in the sediments. Benthic organisms often have higher exposures from direct contact with sediments than organisms that live in the water column. Mammals, birds, amphibians, and reptiles that live in and/or forage in OU-2 also may be exposed to COPCs in the surface water, sediment, and prey. Potential exposure routes and receptors are summarized in the CSM for ecological receptors, which is presented in Figure 8. A generalized food web model and a Site-specific food web model (Figures 22 and 23, respectively) are also presented to show the relationship between the different levels of the food chain.

No barriers exist to prevent potential exposure to COPCs for ecological receptors on and adjacent to OU-2 because OU-2 and adjacent land consist mainly of forests and other undeveloped lands. Therefore, potential ecological receptors are present along and within OU-2. These ecological receptors include aquatic organisms residing in OU-2, wildlife using OU-2 as a source of food and drinking water, and plant and other terrestrial organisms in floodplain soil areas.

Complete exposure pathways identified for aquatic organisms (e.g., benthic macroinvertebrates and fish) residing within the Basin include dermal contact with surface water and sediments, ingestion of surface water and sediments, and ingestion of prey organisms that may bioaccumulate COPCs. Complete pathways identified for semi-aquatic and terrestrial wildlife using OU-2 as a source of food and drinking water include the incidental ingestion of surface soil, dermal contact with surface soil, inhalation of volatile emissions (qualitative assessment only), ingestion of plants and prey organisms that may bioaccumulate COPCs, and dermal contact with subsurface soil by burrowing species. Table 27 presents the summary for the ecological exposure pathways.

The detailed and updated ERA used in selecting the remedy for this Site incorporates the most recent data and further quantifies the exposure and risk to the receptors for each pathway. A variety of comprehensive biological field assessments were conducted for OU-2. These assessments provide sufficient evidence and information to estimate the exposure to biota in the assessment area. Risk comparisons were performed for constituents in surface water, sediment, floodplain soil, and tissue residues from OU-2.

2.7.2.3 Ecological Effects Assessment and Measurement Endpoints

The ERA defines and addresses issues based on potentially complete exposure pathways and ecological effects. The CSM identifies the relationships between potential exposures and potential exposure effects. Defining ecological concerns during the ERA involves identifying toxic mechanisms, characterizing potential receptors, and estimating exposure and evaluating the resulting potential ecological effects of exposure.

Endpoints were defined to evaluate potential ecological effects. Consistent with the EPA guidance, two types of endpoints were identified. Assessment endpoints are ecological values to be protected (e.g., maintenance of a viable community of aquatic organisms, such as fish inhabiting the Basin). Because direct measurement of these assessment endpoints is often not practical, measurement endpoints are used to evaluate the assessment endpoints. A measurement endpoint is a measurable ecological characteristic and/or response to a stressor (e.g., bioassays measuring survival or growth of organisms, comparison of modeled doses to toxicity reference values based on chronic effects). Assessment endpoints are the principal focus of the ERA and provide the link between the measurement endpoints and risk management decisions. Assessment endpoints are characteristic of the ecological system or its individual components of concern being evaluated. The definition (or specification) of an assessment endpoint should include a subject (e.g., the guild, habitat, or species of interest) and a characteristic of that subject (e.g., survivorship and fecundity). The specification of the assessment endpoint should also describe how the endpoint represents functions important to the health and sustainability of the ecosystem (i.e., biological relevance). Assessment endpoints should consider and reflect societal values and should allow prediction and/or measurement (albeit not always direct measurement). Finally, the assessment endpoints should be susceptible to the stressors being evaluated.

On December 7, 2009, the EPA provided a presentation to Olin and its support contractor AMEC addressing the ERA approach, including the assessment endpoints that should be addressed (USEPA, 2009). This presentation listed assessment endpoints for both terrestrial and aquatic species, and provided the EPA’s requirements regarding the representativeness of each species and the dietary inputs and area use factors (AUFs) that should be used in the ERA. A second presentation by the EPA to Olin and AMEC on December 8, 2009, specified which historical and current data should be used in the ERA (USEPA, 2009). This ERA was performed in accordance with the EPA’s required assessment endpoints and data use specifications. The ERA assessment endpoints were further refined and selected based on the ecology and the COPCs present. Based on this information, the following assessment endpoints were identified for OU-2:

- Assessment Endpoint 1: Protection of the Long-term Health and Reproductive Success of the Benthic Macroinvertebrate Community
- Assessment Endpoint 2: Protection of the Long-term Health and Reproductive Success of the Fish Community
- Assessment Endpoint 3: Protection of the Long-term Health and Reproductive Success of the Soil Invertebrates in Floodplain Soils

- Assessment Endpoint 4: Protection of the Long-term Health and Reproductive Success of Insectivorous Aquatic Mammals
- Assessment Endpoint 5: Protection of the Long-term Health and Reproductive Success of Carnivorous Aquatic Mammals
- Assessment Endpoint 6: Protection of the Long-term Health and Reproductive Success of Insectivorous Aquatic Birds
- Assessment Endpoint 7: Protection of the Long-term Health and Reproductive Success of Piscivorous Aquatic Birds
- Assessment Endpoint 8: Protection of the Long-term Health and Reproductive Success of Omnivorous Aquatic Birds
- Assessment Endpoint 9: Protection of the Long-term Health and Reproductive Success of Carnivorous Aquatic Reptiles
- Assessment Endpoint 10: Protection of the Long-term Health and Reproductive Success of Insectivorous Terrestrial Mammals
- Assessment Endpoint 11: Protection of the Long-term Health and Reproductive Success of Omnivorous Terrestrial Mammals
- Assessment Endpoint 12: Protection of the Long-term Health and Reproductive Success of Herbivorous Terrestrial Mammals
- Assessment Endpoint 13: Protection of the Long-term Health and Reproductive Success of Insectivorous Terrestrial Birds

Assessment Endpoints 1, 2 and 3 were addressed as part of the SLERA. Based on the results of the SLERA, the EPA determined that unacceptable risk exists to Endpoint 2 (fish community) based on levels of mercury and DDTR in fish tissue. Though this endpoint was not further addressed in the ERA, sediment and fish tissue remedial goals (RGs) were developed for protection of fish communities based on the SLERA results. These RGs are discussed further in the RAO section of this ROD. The ERA focused on Assessment Endpoints 4 to 13.

Corresponding Measurement Endpoints

Each assessment endpoint was evaluated using measurement endpoints. These measurement endpoints included comparisons among environmental media concentrations associated with estimates of potential toxicity, and comparisons between doses or exposures measured or modeled in biotic receptors to toxicologically relevant doses or tissue concentrations, dependent on the corresponding assessment endpoint. The EPCs detected in various media at OU-2 are presented in Table 26.

Each measurement endpoint was selected based on Site knowledge, the generalized food web model, information regarding the toxicity of the constituents of concern, and stakeholder consensus. The measurement endpoints constitute a suite of ecotoxicity study concentrations with associated effects, semi-quantitative comparisons to effect and no effect concentrations, and quantitative estimates of potential exposures and potential concerns that were used to assess risks. A summary of the selected assessment and measurement endpoints is presented in Table 27.

Assessment endpoints for the various mammals and birds studied (Assessment Endpoints 4 through 13) were evaluated using a quantitative approach. For the purposes of this ERA, a quantitative approach analyzes biota exposures through food web modeling in addition to direct contact uptake. An estimated exposure dose for each COPC is modeled by using EPCs for site media and prey species tissue. This calculated dose will then be divided by applicable TRVs to assess the likelihood of adverse health effects.

Overview of Quantitative Multi-Pathway Risk Estimation for Assessment Endpoints 4 through 13

Assessment Endpoints 4 through 13 were evaluated using current standard practices in the ERA for estimating potential risks through the estimation of food chain and environmental media exposure for mercury, methylmercury, HCB, and DDTR. The following discussions outline the approach for the risk assessment, including toxicity data, modeling studies and dose conversions, EPCs, study design, weight of evidence, data analysis summary, and risk characterization. Discussions for Assessment

Endpoints 4 through 13, organized by assessment endpoint number, provide descriptions of exposure, discuss associated measurement endpoint(s), and present information regarding the potential for effects on associated receptors.

Assessment Endpoint 4: Protection of the Long-Term Health and Reproductive Success of Insectivorous Aquatic Mammals

Little Brown Bat

Assessment Endpoint 4 addresses the potential risk to insectivorous aquatic mammals residing and foraging within OU-2. This assessment endpoint considers effects on mammals relying on insects as the primary dietary item. The little brown bat (*Myotis lucifugus*) was selected as a conservative representative species of insectivorous aquatic mammals because its dietary intake can consist entirely of insects. The little brown bat's diet, for the purpose of this risk assessment, consists of 100 percent flying insects. The little brown bat is also representative of an aerial mammal with a home range larger than the available habitat at OU-2, therefore only using the site area approximately one-quarter of the time. The little brown bat exposure model was supported by the collection of flying insects in July 2010. This assessment endpoint also addresses other aerial insectivorous mammals, including other species of bats.

Because the NOAEL-based HI exceeded the threshold value of 1 and the LOAEL-based HI was less than 1, the potential for risk for the little brown bat lies between the no observed adverse effects level and the lowest observed adverse effects level. The function, health, and reproductive success for the little brown bat (insectivorous aquatic mammal), appears to have a potential for adverse effects from exposure to COPC concentrations in OU-2.

Assessment Endpoint 5: Protection of the Long-Term Health and Reproductive Success of Carnivorous Aquatic Mammals

Mink and River Otter

Assessment Endpoint 5 addresses the potential risk to carnivorous aquatic mammals residing and foraging in OU-2 habitat. Carnivorous mammals may use pools and river edge habitats. In particular, aquatic carnivores typically feed on fish and crustaceans (i.e., crayfish) from pool and run habitats. The river otter was selected as a representative species of carnivorous aquatic mammals for quantification of a diet based on 85 percent fish (75 percent forage fish and 10 percent predatory fish), 10 percent amphibians, and 5 percent crayfish. The river otter is representative of a carnivorous aquatic mammal with a large home range (approximately 870 acres). This area is significantly larger than the available OU-2 habitat, indicating the river otter's area use factor of OU-2 is only approximately 0.09 (i.e., the river otter is using OU-2 habitat only 9 percent of the time). The river otter exposure model was supported by the collection of forage fish, predatory fish, amphibians, and crayfish.

The NOAEL-based HI for the river otter was 0.20 with contributions of mercury (0.0018), methylmercury (0.086), DDTR (0.083), and HCB (0.029). NOAEL-based HIs for the river otter were less than the threshold value of 1. Thus, river otter (large carnivorous aquatic mammals) are considered unlikely to be adversely affected by mercury, methylmercury, DDTR, and HCB in OU-2.

The mink was also selected as a representative species of carnivorous aquatic mammals for quantification of a diet based not only on aquatic species, but also on mammals and birds that reside in or near aquatic habitat. The mink's dietary makeup consists of 40 percent aquatic mammals/birds, 25 percent amphibians, 10 percent crayfish, 5 percent forage fish, and 20 percent predatory fish. The mink represents a carnivorous aquatic mammal that would spend nearly all of its time at OU-2 habitat. It has a relatively small home range (approximately 1.34 miles of shoreline), which is essentially the same as the available shoreline of OU-2. The mink exposure model was supported by the collection of amphibians, crayfish, forage fish, predatory fish, and birds (little blue herons).

The NOAEL-based HI for the mink was 5.4 with contributions of mercury (1.8), methylmercury (1.3), DDTR (1.2), and HCB (1.1). NOAEL-based HIs for the mink exceeded the threshold value of 1 for mercury, methylmercury, and HCB with potential risk being derived approximately equally from mercury, methylmercury, DDTR, and HCB. The mercury and HCB HQs for the mink were driven only by the incidental ingestion of sediments (assumed to be 9 percent). The methylmercury and DDTR HQs were driven equally by aquatic vertebrate prey items and predatory fish. Because NOAEL-based HQs exceeded the threshold value of 1 for mercury, methylmercury, DDTR, and HCB, further assessment in the form of LOAEL-based HIs was performed for these chemicals.

The LOAEL-based HI for the mink was 4.2 with contributions of mercury (1.8), methylmercury (0.64), DDTR (0.62), and HCB (1.1). LOAEL-based HQs for the mink exceeded the threshold value of 1 for mercury and HCB with the majority of potential risk being derived from mercury. HQs greater than 1 (i.e., mercury and HCB) were driven by sediment ingestion (assumed to be 9 percent incidental ingestion).

Mercury and HCB concentrations have the potential to impair the function, health, or reproductive success of the mink (small carnivorous terrestrial mammals) with relatively small home ranges. The representativeness of this RI for current site conditions is fairly uncertain due to the reliance on 1994 vertebrate prey data and a conservative percentage of incidental sediment ingestion.

<u>Assessment Endpoint 6: Protection of the Long-Term Health and Reproductive Success of Insectivorous Aquatic Birds</u>

Pied-billed Grebe

Assessment Endpoint 6 addresses the potential risk to insectivorous aquatic birds residing and foraging in OU-2 habitats. Insectivorous aquatic birds, represented by the pied-billed grebe, typically feed on fish, crustaceans, and aquatic insects by diving under water for food, whether in open water or among vegetation. The pied-billed grebe (*Podilymbus podiceps*) represents a species whose diet is approximately 60 percent aquatic insects, 20 percent forage fish, and 20 percent crayfish. In addition, the home range of a pied-billed grebe is relatively small, only 3.3 acres, compared to the open water area of OU-2, which is 80 acres. This indicates the pied-billed grebe is representative of a receptor that could spend all of its time within OU-2 habitat. The pied-billed grebe exposure model was supported by the collection of forage fish and crayfish. Aquatic insect concentrations were estimated using current sediment concentrations and a site-specific BAF from historical data.

The NOAEL-based HI for the pied-billed grebe was 11 with contributions of mercury (1.6), methylmercury (1.2), DDTR (8.0), and HCB (0.31). NOAEL-based HQs for the pied-billed grebe exceeded the threshold value of 1 for mercury, methylmercury, and DDTR with the majority of potential risk being derived from DDTR. HQs were driven by ingestion of forage fish for methylmercury (assumed to be from bluegill and silverside samples collected in 2008), ingestion of aquatic insects for DDTR, and incidental ingestion of sediments for mercury (assumed to be from sediment samples collected in 2008 and 2009). The mercury HQ was driven by incidental ingestion of sediments. Methylmercury HQs were driven by ingestion of forage fish (bluegill and silverside samples). Because NOAEL based HQs exceeded the threshold value of 1 for mercury, methylmercury, and DDTR, further assessment in the form of a LOAEL-based HI was performed for these chemicals.

The LOAEL-based HI for the pied-billed grebe was 8.5 with contributions of mercury (0.78), methylmercury (1.2), and DDTR (6.4). The LOAEL-based HQ for the pied-billed grebe exceeded the threshold value of 1 for methylmercury and DDTR. HIs were driven primarily by the ingestion of forage fish for methylmercury and aquatic insects for DDTR. The pied-billed grebe was considered to have a small home range (completely within OU-2) and a diet consisting primarily of aquatic insects, with lesser amounts of forage fish and crayfish. The pied-billed grebe was assumed to use the Site for all of its dietary needs because of the grebe's small home range. These assumptions accounted for the exceedance of the threshold value of 1 for mercury, methylmercury, and DDTR for the NOAEL-based calculation, while the NOAEL HQ for HCB was less than the threshold value of 1.

Methylmercury and DDTR concentrations have the potential to impair the function, health, or reproductive success of the pied-billed grebe (insectivorous aquatic birds) with relatively small home ranges. The accuracy of the DDTR HQ was considered somewhat uncertain due to the reliance on estimated aquatic insect data.

Assessment Endpoint 7: Protection of The Long-Term Health and Reproductive Success of Piscivorous Aquatic Birds

Belted Kingfisher

Piscivorous aquatic birds are represented by the belted kingfisher, little blue heron, and great blue heron for the purposes of risk quantification for Assessment Endpoint 7. Assessment Endpoint 7 addresses the potential risk to piscivorous aquatic birds residing and foraging in OU-2. Piscivorous birds may use pool, river, or lake-edge habitats as foraging and bedding areas, and piscivorous birds may feed on fish caught from pool and run habitats.

The belted kingfisher (*Ceryle alcyon*) was selected as one of the representative species of piscivorous aquatic birds for quantification of an aquatic piscivore since this species is a year-round resident in Alabama. The belted kingfisher exposure model was supported by the collection of forage fish from the Basin. The belted kingfishers were evaluated using two different exposure scenarios to account for the range of exposure parameters and site conditions that are present in OU-2. The first exposure scenario assumes that the belted kingfisher forages exclusively on forage fish obtained from the Basin. This is the recommended exposure scenario by the EPA, and it is consistent with USEPA's *Wildlife Exposure Factors Handbook* (WEFH) (1993c). In the second exposure scenario, the dietary composition of the belted kingfisher was adjusted to reflect a more diverse diet that includes forage fish (51 percent), amphibians (25 percent), aquatic insects (19 percent), and crayfish (5 percent). This dietary makeup was obtained from the WEFH for belted kingfishers in a lake-type environment. The area use factor was also set to 0.5 representing a kingfisher that forages 50 percent of the time within OU-2 and 50 percent of the time outside of OU-2. The two scenarios are presented to provide a range of potential risk values.

The NOAEL-based HI for the first exposure scenario for the belted kingfisher was 11 with contributions of mercury (0.060), methylmercury (7.0), DDTR (3.9), and HCB (0.12). NOAEL-based HQs for the belted kingfisher were greater than the threshold value of 1 for methylmercury and DDTR. Potential risk for the belted kingfisher was driven by consumption of forage fish (which was assumed to be 100 percent of the belted kingfisher's diet). The NOAEL-based methylmercury TRV for avian receptors could not be identified in scientific literature, so the LOAEL based methylmercury TRV was used as the NOAEL-based TRV in the risk assessment. Because NOAEL based HIs exceeded the threshold value of 1 for methylmercury and DDTR, further assessment in the form of LOAEL-based HI was performed for these chemicals. The LOAEL-based HI for the first exposure scenario for the belted kingfisher was 10 with contributions of methylmercury (7.0) and DDTR (3.2). LOAEL-based HIs for the belted kingfisher exceeded the threshold value of 1 for methylmercury and DDTR with the majority of potential risk being derived from methylmercury. HIs were driven by ingestion of forage fish (which was assumed to be 100 percent of the belted kingfisher's diet).

The NOAEL-based HI for the second exposure scenario for the belted kingfisher was 4.8 with contributions of mercury (0.054), methylmercury (2.0), DDTR (2.7), and HCB (0.084). NOAEL-based HQs for the belted kingfisher were greater than the threshold value of 1 for methylmercury and DDTR. Potential risk for the belted kingfisher was driven by consumption of forage fish for methylmercury (which was assumed to be 51 percent of the belted kingfisher's diet) and consumption of aquatic insects for DDTR (which was assumed to be 19 percent of the belted kingfisher's diet). The NOAEL-based methylmercury TRV for avian receptors could not be identified in scientific literature, so the LOAEL-based methylmercury TRV was used as the NOAEL-based TRV in the risk assessment. Because NOAEL-based HIs exceeded the threshold value of 1 for methylmercury and DDTR, further assessment in the form of LOAEL-based HI was performed for these chemicals. The LOAEL-based HI for the second exposure scenario for the belted kingfisher was 4.2 with contributions of methylmercury (2.0) and DDTR (2.2). LOAEL-based His for the belted kingfisher exceeded the threshold value of 1 for methylmercury and DDTR with potential risk being derived from methylmercury and DDTR at approximately the same levels. Methylmercury HQs were driven by ingestion of forage fish (which was assumed to be 51 percent of the belted kingfisher's diet) and DDTR HQs were driven by the ingestion of aquatic insects (which was assumed to be 19 percent of the belted kingfisher's diet).

Methylmercury and DDTR concentrations have the potential to impair the function, health, or reproductive success of the belted kingfisher (piscivorous aquatic birds) with relatively high fish consumption rates.

Although a conclusion of potential risk must be stated based on the NOAEL-based HI exceeding 1, there is uncertainty related to the NOAEL-based and LOAEL-based HI calculation for the belted kingfisher. No nesting habitat is available in OU-2 for belted kingfishers, so nesting belted kingfishers feeding in OU-2 must live along the Tombigbee River. The maximum exposure scenario for the belted kingfisher feeding 100 percent of the time in OU-2 may cause an overestimation of potential risk for this receptor during nesting season. However, belted kingfishers only utilize nest burrows during the nesting season, and utilize trees as overnight perches the remainder of the year. Therefore, an assumption of 100% feeding in OU-2 may be realistic during non-nesting seasons.

Little Blue Heron

The little blue heron (*Egretta caerula*) was selected as one of the representative species of piscivorous aquatic birds. This receptor was selected to represent a diet that is composed of 75 percent forage fish and 25 percent aquatic insects. The little blue heron is also a year-round resident in Alabama and has been observed in OU-2 habitat. The little blue heron exposure model was supported by the collection of forage fish and aquatic insects.

The NOAEL-based HI for the little blue heron was 10.2 with contributions of mercury (1.5), methylmercury (3.7), DDTR (4.9), and HCB (0.20). The NOAEL-based HQs for the little blue heron were greater than the threshold value of 1 for mercury, methylmercury, and DDTR. Potential risk for the little blue heron was driven by consumption of forage fish for methylmercury and DDTR, which represents 75 percent of the little blue heron's diet, and consumption of aquatic insects for DDTR, which represents 25 percent of the little blue heron's diet. The mercury HQ was driven by incidental ingestion of sediments. The NOAEL-based methylmercury TRV for avian receptors could not be identified in scientific literature, so the LOAEL-based methylmercury TRV was used as the NOAEL-based TRV in the risk assessment. Because NOAEL-based HIs exceeded the threshold value of 1 for mercury, methylmercury, and DDTR, further assessment in the form of a LOAEL-based HI was performed for these chemicals.

The LOAEL-based HI for the little blue heron was 8.4 with contributions of mercury (0.75), methylmercury (3.7), and DDTR (3.9). LOAEL-based HQs for the little blue heron exceeded the threshold value of 1 for methylmercury and DDTR with potential risk being derived from methylmercury and DDTR at approximately the same levels. The HQs were driven by ingestion of forage fish for methylmercury (which was assumed to be 75 percent of the little blue heron's diet) and DDTR and the ingestion of aquatic insects for DDTR (which was assumed to be 25 percent of the little blue heron's diet).

Methylmercury and DDTR concentrations have the potential to impair the function, health, or reproductive success of the little blue heron (piscivorous aquatic birds) with diets consisting of forage fish and aquatic insects.

Great Blue Heron

The great blue heron (*Herodia ardea*) was also selected as a representative species of piscivorous aquatic bird. In addition to forage fish (50 percent of the great blue heron diet), its dietary makeup consists of 35 percent predatory fish, 10 percent amphibians, and 5 percent aquatic insects. These additional species represent consumption of sediment-dwelling organisms by piscivorous aquatic birds. The great blue heron is also a year-round resident in Alabama, with a home range (approximately 1.1 miles of shoreline) smaller than the available habitat at OU-2, indicating it could spend nearly all of its time in OU-2 habitat. The great blue heron exposure model was supported by the collection of forage fish, predatory fish, amphibians, and aquatic insects.

The NOAEL-based HI for the great blue heron was 6.0 with contributions of mercury (0.91), methylmercury (3.5), DDTR (1.5), and HCB (0.089). The NOAEL-based HQs for the great blue heron were greater than the threshold value of 1 for methylmercury and DDTR. Potential risk for the great blue heron was driven by consumption of forage fish and predatory fish for methylmercury, which combined to represent 85 percent of the great blue heron's diet and forage fish for DDTR, which represents 50 percent of the great blue heron's diet. The NOAEL-based methylmercury TRV for avian receptors could not be identified in scientific literature, so the LOAEL-based methylmercury TRV was used as the NOAEL-based TRV in the risk assessment. Because NOAEL based HIs exceeded the threshold value of 1 for methylmercury and DDTR, further assessment in the form of LOAEL-based HIs was performed for these chemicals. The LOAEL-based HI for the great blue heron was 4.7 with contributions of methylmercury (3.5) and DDTR (1.2). LOAEL-based HQs for the great blue heron exceeded the threshold value of 1 for methylmercury and DDTR. The methylmercury HQ was driven by ingestion of forage fish and predatory fish. The DDTR HQ was driven by the ingestion of forage fish.

Methylmercury and DDTR concentrations have the potential to impair the function, health, or reproductive success of the great blue heron or other piscivorous aquatic birds with diets consisting of forage fish, predatory fish, and other sediment dwelling organisms. There is uncertainty related to the NOAEL-based and LOAEL-based HI calculation for the great blue heron. The dataset used to calculate the EPC for DDTR in fish was collected in 2001. Concentrations in upper trophic fish tissue may have declined in nine years. In addition, a conversion factor for DDTR was used to calculate whole body fish tissue concentrations in predatory fish from fish fillet tissue concentrations. In comparison to the other piscivorous birds evaluated in this risk assessment, the great blue heron had a significantly higher percentage of predatory fish in its diet—35 percent compared to 0 percent for both the belted kingfisher and little blue heron. The great blue heron HIs were greater than 1 primarily due to the predatory fish portion of its diet (requiring conversion from fillet concentrations for DDTR).

Assessment Endpoint 8: Protection of the Long-Term Health and Reproductive Success of Omnivorous Aquatic Birds

Wood Duck

Assessment Endpoint 8 addresses the potential risk to omnivorous aquatic birds residing and foraging in OU-2 habitats. Omnivorous birds, such as the wood duck (*Aix sponsa*), will nest next to water, often using trees or nest boxes. This receptor feeds by picking or “dabbling” at the surface, and frequently dives for submerged food items (i.e., vegetation). The wood duck was selected as the representative species of omnivorous aquatic birds at OU-2 for quantification of an aquatic omnivore with a dietary makeup of 75 percent vegetation and 25 percent insects. The wood duck’s home range is less than the available open water habitat at the Basin, indicating this receptor could spend all of its time at the Site.

The wood duck exposure model was supported by the collection of insect (i.e., crawling insects, flying insects, and spiders) and vegetation data. Site-specific aquatic vegetation data are not available for use in the exposure model because no aquatic vegetation was available for collection in OU-2. Therefore, terrestrial vegetation data were used in the exposure model for the wood duck.

The NOAEL-based HI for the wood duck was 1.0 with contributions of mercury (0.71), methylmercury (0.15), DDTR (0.12), and HCB (0.023). The individual NOAEL-based HQs for the wood duck did not exceed the threshold value of 1. However, the NOAEL-based HI for the wood duck was equal to the threshold value of 1. The HI was driven by the incidental ingestion of sediments (assumed to be 3.3 percent). Mercury provided the greatest magnitude of the NOAEL-based HI with a HQ of 0.71. Because the NOAEL–based HI was equal to the threshold value of 1, further assessment in the form of a LOAEL-based HI was performed. The LOAEL-based HI for the wood duck was 0.63, which is below the threshold value of 1.

There is potential for the impairment of the function, health, or reproductive success of the wood duck (omnivorous aquatic birds) with small home ranges residing and foraging in OU-2 based on the NOAEL-based HI.

Assessment Endpoint 9: Protection of the Long-Term Health and Reproductive Success of Carnivorous Aquatic Reptiles

American Alligator

Assessment Endpoint 9 addresses the potential risk to carnivorous aquatic reptiles residing and foraging within OU-2. This assessment endpoint considers effects on reptiles relying on fish, small mammals, birds, and amphibians also foraging or residing within OU-2 habitats. The American alligator (*Alligator mississippiensis*) was selected as a conservative representative species of carnivorous aquatic reptile because its dietary intake includes fish (60 percent predatory fish, 30 percent forage fish), 5 percent amphibians, and 5 percent small mammals and birds. The American alligator also represents a large reptile whose home range is smaller than the OU-2 habitat, and therefore has an area use factor of 1, indicating it could spend all of its time with OU-2 habitat. The American alligator exposure model was supported by the collection of predatory fish, forage fish, amphibians, small mammals, and birds

The NOAEL-based HI for the American alligator was 0.011 with contributions of mercury

(0.0037), methylmercury (0.0025), and DDTR (0.0047). Potential risk was not quantifiable for HCB as no TRVs were available for reptiles specifically for HCB. The NOAEL-based HI for the American alligator was less than the threshold value of 1.

There is little potential for impairment of the function, health, or reproductive success of the American alligator. It is not anticipated that the American alligator (carnivorous aquatic reptiles) will experience adverse effects due to exposure to COPCs while residing or foraging in OU-2.

Assessment Endpoint 10: Protection of the Long-Term Health and Reproductive Success of Insectivorous Terrestrial Mammals

Short-Tailed Shrew

Assessment Endpoint 10 addresses the potential risk to insectivorous terrestrial mammals residing and foraging within OU-2. This assessment endpoint considers effects on mammals relying on terrestrial invertebrates. The short-tailed shrew (*Blarina blevicada*) was selected as a conservative representative species of insectivorous terrestrial mammals because its dietary intake is entirely (100 percent) composed of terrestrial insects and spiders. The short-tailed shrew represents a terrestrial mammal with a home range smaller than the available habitat at OU-2, indicating it could spend all of its time within OU-2. The short-tailed shrew exposure model was supported by the collection of crawling insects and spiders.

The NOAEL-based HI for the short-tailed shrew was 1.6 with contributions of mercury (0.28), methylmercury (0.56), DDTR (0.78), and HCB (0.0036). The individual NOAEL-based HQs for the short-tailed shrew did not exceed the threshold value of 1. However, the NOAEL-based HI, which is derived by the sum of the NOAEL-based HQs, exceeded the threshold value of 1. The HI was driven by the ingestion of insects and spiders. Methylmercury and DDTR provided the greatest magnitude of the NOAEL-based HI with HQs of 0.56 and 0.78, respectively. Because the NOAEL–based HI exceeded the threshold value of 1, further assessment in the form of a LOAEL-based HI was performed. The LOAEL-based HI for the short-tailed shrew was 0.98, which is below the threshold value of 1. The short-tailed shrew was considered to have a small home range (completely within OU-2) and a diet consisting entirely of terrestrial insects and spiders. These assumptions accounted for the NOAEL-based HI exceedance of the threshold value of 1, while the individual HQs for mercury, methylmercury, DDTR, and HCB were all less than the threshold value of 1.

There is potential for the impairment of the function, health, or reproductive success of the short-tailed shrew (other insectivorous terrestrial mammals) with small home ranges residing and foraging in OU-2 based on the NOAEL-based HI.

Assessment Endpoint 11: Protection of the Long-Term Health and Reproductive Success of Omnivorous Terrestrial Mammals

Raccoon

Assessment Endpoint 11 addresses the potential risk to omnivorous terrestrial mammals residing and foraging within OU-2. This assessment endpoint considers effects on mammals relying on terrestrial insects, small mammals, birds, and vegetation as primary dietary items. The raccoon (*Procyon lotor*) was selected as a conservative representative species of omnivorous terrestrial mammals because its dietary intake includes a variety of terrestrial prey items (40 percent terrestrial invertebrates, 40 percent terrestrial vertebrates) and vegetation (20 percent) and is found near virtually every aquatic habitat. The raccoon represents mammalian receptors that spend approximately half their time in OU-2 habitat, with an area use factor of 0.48. The raccoon exposure model was supported by the collection of insects, small mammals, birds, and vegetation.

The NOAEL-based HI for the raccoon was 0.30 with contributions of mercury (0.046), methylmercury (0.13), DDTR (0.12), and HCB (0.0007). The NOAEL-based HI for the raccoon was less than the threshold value of 1.

There is little potential for impairment of the function, health, or reproductive success of the raccoon. It is not anticipated that the raccoon and other omnivorous terrestrial mammals will experience adverse effects due to exposure to COPCs while residing or foraging in OU-2.

Assessment Endpoint 12: Protection of the Long-Term Health and Reproductive Success of Herbivorous Terrestrial Mammals

Pine Vole

Assessment Endpoint 12 addresses the potential risk to herbivorous terrestrial mammals residing and foraging within OU-2. This assessment endpoint considers effects on mammals relying on terrestrial vegetation as the primary dietary item. The pine vole (*Microtus pinetorum*) was selected as a conservative representative species of herbivorous terrestrial mammals because its dietary intake consists entirely (100 percent) of terrestrial vegetation. The pine vole represents herbivorous mammals with an area use factor of 1. The pine vole exposure model was supported by the collection of terrestrial vegetation. This species served as a surrogate species for voles, moles, mice, and rats residing in OU-2.

The NOAEL-based HI for the pine vole was 0.20 with contributions of mercury (0.054), methylmercury (0.034), DDTR (0.11), and HCB (0.0016). The NOAEL-based HI for the pine vole was less than the threshold value of 1.

There is little potential for impairment of the function, health, or reproductive success of the pine vole. It is not anticipated that the pine vole and other herbivorous terrestrial mammals will experience adverse effects due to exposure to COPCs while residing or foraging in OU-2.

Assessment Endpoint 13: Protection of the Long-Term Health and Reproductive Success of Insectivorous Terrestrial Birds

Carolina Wren

Assessment Endpoint 13 addresses the potential risk to insectivorous terrestrial birds residing and foraging within OU-2. This assessment endpoint considers effects on birds relying heavily on terrestrial invertebrates as dietary items. The Carolina wren (*Thryothorus ludovicianus*) was selected as a conservative representative species of insectivorous terrestrial birds because its dietary intake is comprised entirely (100 percent) of terrestrial invertebrates. The Carolina wren represents an insectivorous bird with an area use factor of 1, as its home range is smaller than the area of OU-2. The Carolina wren model was supported by the collection of insects (i.e., crawling insects, flying insects, and spiders).

The NOAEL-based HI for the Carolina wren was 5.2 with contributions of mercury (1.0), methylmercury (2.4), DDTR (1.8), and HCB (0.022). NOAEL-based HQs for the Carolina wren were equal to or exceeded the threshold value of 1 for mercury, methylmercury, and DDTR with the highest potential risk being derived from methylmercury. The NOAEL-based HQ for HCB did not exceed the threshold value of 1. HQs were driven by the ingestion of insects. Because the NOAEL-based HQs exceeded the threshold value of 1 for mercury, methylmercury and DDTR, further assessment in the form of LOAEL-based HQs was performed for the Carolina wren.

The LOAEL-based HI for the Carolina wren was 4.3 with contributions of mercury (0.50), methylmercury (2.4), and DDTR (1.4). The LOAEL-based HI for the Carolina wren exceeded the threshold value of 1 with the methylmercury and DDTR HQs also exceeding the threshold value of 1. HQs were driven by the ingestion of insects.

Mercury, methylmercury, and DDTR concentrations have the potential to impair the function, health, or reproductive success of the Carolina wren and other insectivorous terrestrial birds. Thus, insectivorous terrestrial birds residing or foraging in OU-2 appear to be at a level of potential concern based on the assumptions and calculations performed in this ERA.

2.7.2.4 Ecological Risk Characterization

The ERA was performed to evaluate the potential for adverse effects associated with mercury, methylmercury, DDTR, and HCB concentrations from various environmental media at OU-2. Results from biological field investigations and extensive OU-2 sample data were used to develop potential risk estimates.

NOAEL-based HIs for the river otter, the American alligator, the raccoon, and the pine vole were less than the threshold value of 1, which indicates that the potential for these receptors to experience adverse health effects is unlikely. The remaining receptors have at least one COPC whose HQ exceeds the threshold value of 1 or the HI (i.e., the summation of the HQs) was equal to or exceeded the threshold value of 1. The little brown bat, the short-tailed shrew, and the wood duck have NOAEL-based HIs that are equal to or exceed the threshold value of 1, but the LOAEL-based HIs are below the threshold value of 1. COPCs with NOAEL-based and LOAEL-based HQs exceeding the threshold value of 1 by pathway of concern and receptor for OU-2 are as follows:

- Mercury
  - o Incidental ingestion of sediments (mink: LOAEL HQ = 1.1)
- Methylmercury
  - o Ingestion of forage fish (pied-billed grebe (LOAEL HQ = 1.2), belted kingfisher (LOAEL HQ = 2.0 to 7.0), little blue heron (LOAEL HQ = 3.7), great blue heron (LOAEL HQ = 3.5))
  - o Ingestion of predatory fish (great blue heron: LOAEL HQ = 3.5)
  - o Ingestion of insects (Carolina wren: LOAEL HQ = 2.4)
- DDTR
  - o Ingestion of forage fish (belted kingfisher (LOAEL HQ = 2.2 to 3.2), little blue heron (LOAEL HQ = 3.5), and great blue heron (LOAEL HQ = 1.4))

  - o Ingestion of aquatic insects (pied-billed grebe (LOAEL HQ = 5.4), belted kingfisher (LOAEL HQ = 2.2 to 3.2), and little blue heron (LOAEL HQ = 3.5))
  - o Ingestion of insects (Carolina wren: LOAEL HQ = 1.4)
- HCB
  - o Incidental ingestion of sediments (mink: LOAEL HQ = 1.1)

Several receptors had NOAEL-based HQs that exceeded the threshold value of 1 but the LOAEL based HQs did not exceed the threshold value of 1. This indicates that these receptors' potential risk lies between the NOAEL and the LOAEL. These receptors were the mink for methylmercury; the pied-billed grebe for mercury; the little blue heron for mercury; and the Carolina wren for mercury. There is a borderline potential for risk to these receptors from the listed COCs.

The little brown bat, the short-tailed shrew, and the wood duck have NOAEL-based HI values that are equal to or exceed the threshold value of 1, but the LOAEL-based HI values are below the threshold value of 1. The individual HQs for mercury, methylmercury, DDTR, and HCB were all less than the threshold value of 1, but the HI exceeded the threshold value of 1, indicating the potential for risk.

As shown above, the risk assessment found risk to Carolina wren from methylmercury and DDTR in insect tissue. The flying insects collected in 2010 and included in the risk characterization typically had higher concentrations of site COPCs than the 2010 crawling insects and spiders that would be typically consumed by the Carolina wren. Carolina wrens are primarily ground foragers and may not ingest significant amounts of flying insects. The inclusion of flying insects for the Carolina wren increased the EPCs for the site COPCs and may have overestimated potential risk for this receptor. To better understand this uncertainty, RGs were developed based on risk to Carolina wren with and without flying insects included in their diet (see Section 2.7.2.5 Ecological Risk Assessment Summary).

For aquatic avian receptors, the most significant potential exposure pathway was determined to be ingestion of fish. The DDTR dataset for this pathway was from 2001, which is historical and adds a notable level of uncertainty for receptors with diets consisting of forage fish and predatory fish.

One of the three qualitatively evaluated endpoints (Assessment Endpoint 2: Protection of Resident Fish Populations) showed risk with OU-2 fish tissue concentrations exceeding risk-based fish tissue thresholds for mercury and DDTR, based on thresholds developed by Beckvar, et al., 2005. Six receptors, representing four of the ten assessment endpoints that were quantitatively assessed had LOAEL-based HIs that are equal to or greater than the threshold value of 1. These endpoints are as follows:

- Assessment Endpoint 5: Carnivorous Aquatic Mammals - Receptor Species: Mink
- Assessment Endpoint 6: Insectivorous Aquatic Birds - Receptor Species: Pied-Billed Grebe
- Assessment Endpoint 7: Piscivorous Aquatic Birds - Receptor Species: Belted Kingfisher, Little Blue Heron, and Great Blue Heron
- Assessment Endpoint 13: Insectivorous Terrestrial Birds – Receptor Species: Carolina Wren

2.7.2.5 Ecological Risk Assessment Summary

Various biotic and abiotic field assessments were conducted for OU-2. These assessments provide weight of evidence and information to estimate the potential risk to biota in the assessment area. Because LOAEL-based HIs were equal to or exceeded the threshold value of 1 for four of the ten assessment endpoints that were quantitatively evaluated, and one of the three assessment endpoints that were qualitatively evaluated (protection of fish), potential risk must be concluded for these five assessment endpoints.

DDTR, HCB and mercury (inorganic and methylmercury) present a significant risk and are referred to as the COCs in this ROD. Table 26 presents the ecological COCs and their associated concentrations in each medium.

RGs for four of the five assessment endpoints were developed for mercury, HCB, and DDTR in sediment and soil in the Remedial Goal Option Report (RGO)(AMEC, 2012a). The RGO report did not develop RGs based on risk to fish from the same exposure pathways. The EPA derived mercury and DDTR RGs for fish tissue; made changes to the DDTR RG for insectivorous birds exposed to floodplain soils; made changes to the DDTR RG for piscivorous birds feeding upon predatory fish; and modified the DDTR RGs to include consideration of total organic carbon (TOC) concentrations (Appendix I of this ROD).

RGs are intended to correspond to minimal and acceptable levels of effects on the ecological assessment endpoints. In general, they correspond to small effects on individual organisms that would be expected to cause minimal effects on populations and communities. Though the risk assessment evaluated both total mercury and methylmercury separately, RGs were established only for total mercury (inorganic + methyl). Reducing total mercury and controlling the transformation processes that produce methylmercury are the keys to reducing methylmercury concentrations in OU-2. The RGs developed for fish tissue, soil and sediment are presented in Figures 24-30.

RGs for sediment were calculated using four methods:

- **Biota-sediment Accumulation Factor (BSAF).** RGs for mercury and DDTR were calculated using the BSAF method. The BSAF method is typically appropriate for lipophilic chemicals, and involves normalizing sediment concentrations to organic carbon content, and normalizing biotic tissue to organism lipid content. Mercury is not lipophilic, so normalizing to lipid content is not necessary for mercury. However, in the OU-2 RGO document, the term BSAF was defined more broadly, and the following process was conducted using both normalized and non-normalized data to determine the best regression relationship. The BSAF method is a four-step process. Average fish tissue concentrations (both normalized to lipid content and non-normalized) were first graphed against average sediment concentrations (normalized to TOC and non-normalized) based on the home ranges of various fish species. Site-specific regression equations relating the tissue concentrations to sediment concentrations were then developed using the graphs. The target fish tissue concentration was then determined by back calculation of the aquatic risk equations presented in the updated ERA. The target fish tissue concentration was entered into the site-specific regression equation to obtain a corresponding target sediment concentration (RG).

- **The Ratio Method.** RGs for mercury and DDTR were calculated by dividing the average fish tissue concentration by the average sediment concentration. Home ranges of the various fish species were not considered in the ratio method. This approach is a simplified description of bioaccumulation and assumes mercury and DDTR concentrations in fish increase without an upper bound as sediment concentrations increase.
- **Direct Calculation of RG.** The RG for HCB was estimated by direct reduction of sediment concentration in the forward risk calculation to achieve a hazard index (HI) equivalent to 1. The BSAF approach was not required for HCB since risk was driven by direct ingestion of abiotic media (i.e., sediment) and not through ingestion of prey items that may bioaccumulate HCB through the food chain.
- **Spreadsheet-based Ecological Risk Assessment for the Fate of Mercury (SERAFM).** SERAFM is a Microsoft® Excel model provided by the EPA that is used to estimate target mercury sediment concentrations for aquatic ecological receptors. SERAFM contains a mercury cycling module that models mercury transformation processes (mercury ←→ methylmercury) based on site-specific conditions, and calculates RGs in terms of total mercury. SERAFM was used as a line of evidence in the calculation of mercury RGs for sediment, along with the BSAF and ratio BAF methods.

The sediment RG is the mercury concentration in sediment that will be protective of ecological receptors. The sediment remedial goals for mercury presented in Figure 24 are based the BSAF approach. RG ranges based on SERAFM were higher than those derived from the BSAF approach, with little overlap in the ranges generated by the two different approaches for some receptors. A comparison of the RG ranges developed from the two different approaches is shown below.

Receptor	RG Range - BSAF Approach (mg/kg)	RG Range – SERAFM Approach (mg/kg)
Belted Kingfisher – Forage Fish Diet	0 – 2.3	4.2 – 7.4
Belted Kingfisher – Mixed Diet	4.4 - 20	14.8 – 17.6
Little Blue Heron	1.2 - 9	10.7 - 13.6
Great Blue Heron	1 - 12	13.1 – 16.0
Mink	27	30.6 – 32.7
Pied-billed Grebe	14 - 109	33.9 – 35.9

RGs for floodplain soils were calculated using the following methods:

- **Soil-to-invertebrate Bioaccumulation Factor (BAF).** Invertebrate tissue concentrations were graphed against average floodplain soil concentrations (0- to 6- inch-depth interval), and site-specific regression equations relating the tissue concentrations to surface soil concentrations were developed. The target invertebrate tissue concentration was then determined by back calculation of the terrestrial risk equations presented in the updated ERA, with one modification: the EPA substituted a TRV for terrestrial birds that was not based on an eggshell thinning endpoint. This change was made because, as reported elsewhere, egg-shell thinning does not appear to be an important mechanism for reproductive impairment in terrestrial birds (Beaver, 1980; Gill, et. al, 1993). For derivation of the floodplain soil RG, the EPA selected a NOAEL TRV of 1.04 mg/kg-d and a LOAEL TRV of 1.3 mg/kg-d from data presented in the EPA Eco SSL for DDT

(USEPA, 2007). The LOAEL TRV represents the first bounded reproduction study with a LOAEL less than 4.66 (the geometric mean of all NOAELs for DDT) that did not have an eggshell endpoint (Table 5-1 of USEPA, 2007). For the NOAEL TRV, the EPA selected the highest NOAEL less than 1.3 mg/kg-d that was not an eggshell study. The target invertebrate tissue concentration was entered into the site-specific regression equation to obtain a corresponding target surface soil RG.

- **The Ratio Method.** RGs for mercury and DDTR were calculated by dividing the average invertebrate tissue concentration by the average floodplain soil concentration. Home ranges of the various invertebrate species were not considered in the ratio method. This approach is a simplified description of bioaccumulation and assumes mercury and DDTR concentrations in invertebrates increase without an upper bound as soil concentrations increase.

RGs for fish tissues were calculated using the following methods:

- **Wildlife Dose Modeling**. Fish RGs based on protection of wildlife receptors were based on the same BSAF relationships used to derive the wildlife RGs. Fish RGs for protection of wildlife represent the fish tissue concentration that results in a dose equal to the TRV. Equations representing the BSAFs for fish from sediment were presented in the RGO report.

- **Selection of Tissue Effects Levels.** Fish RGs based on protection of fish themselves represent toxicological thresholds selected from the literature. The fish RG for mercury represents the 10^{th} percentile lower effects level from Beckvar, et. al (2005), and the fish RG for DDTR represents the tissue threshold effects level (t-TEL) from Beckvar et. al (2005).

Table 28 presents the RGs for ecological receptors.

2.8 REMEDIAL ACTION OBJECTIVES

The primary COC at OU-2 is mercury, which best represents the extent of contamination in sediments and biota in the Basin and Round Pond. The other COCs include HCB and DDTR. The primary release mechanism for mercury and HCB to OU-2 was the discharge through the former wastewater ditch. The presence of DDTR is a result of indirect discharges from the Ciba-Geigy Superfund site located immediately north of OU-2. Olin did not manufacture DDT or intermediate daughter products associated with DDTR at its McIntosh plant.

Remedial action objectives (RAOs) are established to support the evaluation of remedial alternatives for areas with the potential for unacceptable risk as identified in the human health and ecological risk assessments. The RAOs are established by specifying contaminants and media of concern, potential exposure pathways, and remediation goals.

- ***Reduce, or mitigate, risk to piscivorous birds from ingestion of fish exposed to mercury contaminated sediments***. The mercury RG recommended for sediments range from 1.6 to 10.7 mg/kg. The lower end of the recommended range represents the RG for protection of little blue heron based on the BSAF model approach, while the upper end of the range represents risk to little blue heron based on the SERAFM model.

- ***Reduce or mitigate, risk to piscivorous mammals from incidental ingestion of HCB contaminated sediments.*** The HCB RG for OU-2 sediments is 7.6 mg/kg. The HCB RG is recommended for protection of piscivorous mammals.

- ***Reduce, or mitigate, risk to piscivorous birds from ingestion of fish exposed to DDTR contaminated sediments.***
  The recommended DDTR RG range for OU-2 sediments is 0.32 - 0.91 mg/kg to be protective of piscivorous birds.

- ***Reduce risk to humans from ingestion of fish.***

  The recommended RG of 0.3 mg/kg for mercury in fish fillets is based on the fish tissue based water quality criterion.

- **Reduce fish tissue concentrations of mercury to levels protective of fish and piscivorous wildlife**

  The EPA selected a mercury RG range of 0.20 – 0.28 mg/kg in whole body forage fish (e.g. mosquitofish) to be protective of fish and piscivorous wildlife. The EPA selected a mercury RG range of 0.28 – 0.43 mg/kg in whole body predatory fish (e.g., largemouth bass) to be protective of fish and piscivorous wildlife.

- ***Reduce fish tissue concentrations of DDTR to levels protective of fish and piscivorous wildlife.***

  The EPA selected a DDTR RG range of 0.23 – 0.52 mg/kg in whole body forage fish (e.g. mosquitofish) to be protective of fish and piscivorous wildlife. The EPA selected a DDTR RG 0.64 mg/kg in whole body predatory fish (e.g., largemouth bass) to be protective of fish. The recommended sediment DDTR RG for protection of fish is 0.21 mg/kg.

- ***Reduce, or mitigate, risk to ecological receptors exposed to COCs in contaminated floodplain soils.***

  The recommended mercury RG range for OU-2 soils is 0.54 – 1.9 mg/kg to be protective of insectivorous birds. The recommended DDTR RG range for OU-2 soils is 0.18 - 1.12 mg/kg to be protective of insectivorous birds.

- ***Restore surface water to meet water quality standards.***

  The water quality criteria for mercury, DDTR, and HCB in impaired waters of Alabama is 0.012 μg/L; 0.0001 μg/L; and 0.0002 μg/L, respectively. The criterion will be applied in the Basin to ensure that mercury, DDTR, and HCB are not leaving the Site at levels of concern.

2.9 DESCRIPTION OF ALTERNATIVES

Under its legal authorities, the EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including: a requirement that the EPA's remedial action, when complete, must comply with all federal and more stringent state environmental and facility siting standards, requirements, criteria or limitations, unless a waiver is invoked; a requirement that the EPA select a remedial action that is cost-effective and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a preference for remedies in which treatment permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances is a principal element over remedies not involving such treatment. Remedial alternatives were developed to be consistent with these Congressional mandates. Treatment of contaminated sediments at OU-2 is not practical because of the high volume of contaminants anticipated and the low concentration of mercury. Therefore, treatment alternatives for sediment were not generated. The remedial action alternatives for the Olin OU2 Site are as follows:

1. No Action
2A. In situ capping, institutional controls (ICs) and engineering controls (ECs)
2B. In situ capping, dry capping, ICs and ECs
2C. Dry capping, ICs and ECs
3. Debris removal, hydraulic dredging, dewatering, onsite or offsite disposal, ICs and ECs

2.9.1 Alternative 1: No Action

The No Action alternative provides a baseline for comparison with the range of other developed alternatives. Its inclusion among the alternatives is mandated by the EPA guidance. The No Action alternative assumes that the berm and gate structure would not be maintained and that current restrictions on trespassing and fishing would not be enforced.

2.9.2 Alternative 2A: In Situ Capping, Institutional Controls (ICs) and Engineering Controls (ECs)

Alternative 2A combines in situ capping, ICs and ECs. In this alternative, a cap would be applied over the areas of sediment exceeding the RGs. Figure 30 shows the area where mercury concentrations are above and below the RGs for surficial sediment and includes the channel connecting the Basin and Round Pond. The footprint for DDTR and HCB falls within the mercury remedial footprint. The sorption characteristics associated with HCB and DDTR are such that a cap effective at containing mercury will also be effective at containing DDTR and HCB. The remedial footprint for capping is approximately 72.5 acres based on the 1.6 mg/kg mercury contour. The remedial footprint for capping mercury encompasses sediments above the HCB and DDTR PRGs. Figures 31 and 32 show the HCB and DDTR contours along with the mercury remedial footprint for capping. Surficial sediment would be sampled again during the design phase and prior to cap placement to confirm the remedial footprint. This cap would serve as a barrier between the environment and the COCs in the sediment, thus reducing risks to acceptable levels. A cap typically consists of 3 layers: 1) a mixing zone layer, 2) a cap material layer, and 3) a habitat layer. The mixing or transition zone layer would consist of native soil and would be placed immediately above the sediment surface. It allows for mixing between the sediment and the cap material during placement. The cap material layer is placed above the mixing zone and should not mix into the contaminated sediment. A thin layer of reactive cap material such as, but not limited to, pelletized activated carbon, apatite, or biopolymers, may also be applied to further sequester and isolate the COCs. The uppermost layer is the habitat layer, and, if needed, with armor (stone placement to prevent erosion). The habitat layer provides a depth of material that allows burrowing organisms to re-colonize the habitat without breaching the cap material layer. A model for the migration of mercury was performed, and preliminary results indicate that an appropriate cap would be effective in meeting cleanup levels. Biogenic gases may be generated underneath a cap and may be released episodically. Cap design typically includes active or passive venting mechanisms to prevent gas ebullition from disturbing the cap. Slopes amenable to capping without special measures must be less than or equal to 2:1 (horizontal to vertical). Review of the slopes in the deeper portion of the Basin indicates that the slopes are 2:1 or less. Implementation would take approximately 1 year. Water levels would be managed through the berm and gate system through the completion of construction to maintain a consistent water level for equipment mobility and limit the influence of potential floods.

ICs and ECs would be employed to limit risks to human receptors. ICs would consist of modifying the existing OU-1 deed and use restrictions to include OU-2; ECs would consist of warning signs, some of which are already present at OU-2, fencing, and continuation of security measures. OU-2 is currently fenced along the west, north, and southwest boundary.

This alternative would need to comply with the substantive requirements of the Clean Water Act (CWA) and Alabama NPDES requirements and with Floodplain Management, Protection of Wetlands, the ADEM Coastal Area Management Program, and Alabama Water Pollution Control regulations.

2.9.3 Alternative 2B: In situ Capping, Dry Capping, ICs and ECs

Alternative 2B combines in situ capping, dry capping, ICs and ECs. In this alternative, the portion of the Basin that is at elevation -5 feet NAVD88 (approximately 22 acres) or lower would be capped in situ, as in Alternative 2A. The portions of the Basin that are shallower than -5 feet NAVD88 (approximately 43 acres) and Round Pond (approximately 8 acres) would be capped in the dry. This area would be incrementally segregated with cofferdams into 300- by 400-foot sections and dewatered. The water would be pumped from this small, segregated portion of the Basin to above-ground modular settling tanks, located on the bluff. Solids would settle inside the modular settling tank, and the water would be returned to the remaining portion of the Basin. A geotextile would be placed in the dewatered parcel, and then a cap would be applied by earth moving equipment. This cap would provide a barrier between the environment and the COCs in the sediment, thus reducing risks to acceptable levels. The cap would be as described in Alternative 2A (including the mixing zone, cap material layer, and habitat layer), but would be a total thickness of approximately 24 inches to provide a stable surface for equipment. Work would begin in shallower areas of the Basin (south and southeast) and move towards the deeper portion of the Basin in an incremental fashion, moving the cofferdams as each parcel is capped. Water levels would be managed through the berm and gate system through the completion of construction to maintain the dewatered sections or to provide appropriate water levels for equipment access. Water-level management would also limit the influence of potential floods during remedial action. ICs would consist of modifying the OU-1 deed and use restrictions to include OU-2; ECs would consist of signs, some of which are already present at OU-2, fencing, and continuation of security measures. OU-2 is currently fenced along the west, north, and southwest boundary. Implementation would take approximately 7 months.

2.9.4 Alternative 2C: Dry Capping, ICs and ECs

In this alternative, Alternative 2C combines dry capping, ICs and ECs. Areas of Basin and Round Pond that exceed the remediation goal as specified in Alternative 2A would be capped in the dry as described in Alternative 2B. In this alternative, 300- by 400-foot sections of the Basin and Round Pond would be isolated with cofferdams and dewatered. The water would be pumped to above-ground storage tanks, located on the bluff. Solids would settle inside the storage tanks, and the water would be returned to the Basin. A geotextile would be placed in the dewatered parcel, and then a cap would be applied over the areas of the sediment exceeding the remediation goal, as shown in Figure 33.

This cap would provide a barrier between the environment and the COCs in the sediment, thus reducing risks to acceptable levels. The cap would be as described in Alternative 2A but would be a total thickness of about 24 inches to provide a stable surface for equipment. Work would begin from the bluff and proceed towards the east side of the Basin in an incremental fashion, moving the portadams as each section is capped. Implementation would take approximately 7 months. Water levels would be managed using the berm and gate system through the completion of construction to maintain the dewatered section. ICs, including deed and use restrictions, and ECs, including signs, fencing, and security monitoring, would be employed to limit risks to human receptors.

2.9.5 Alternative 3: Debris Removal, Dredging, Dewatering, Onsite or Offsite Disposal, ICs and ECs

Alternative 3 combines mechanical debris removal, hydraulic dredging, dewatering, onsite or offsite disposal, ICs and ECs. The extensive buried debris identified in the debris survey would be removed using a mechanical rake. Debris, consisting of mostly large logs and stumps, is buried within the sediment and covers over 40 to 50 percent of the southern portion of the Basin and 30 percent of the northern portion of the Basin. Buried debris is present over approximately 15 percent of the area in the deeper central portion of the Basin. The estimate for the central portion of the Basin may be low because fine materials in the sediment may absorb the seismic energy used in the survey so that buried features are not detected. Hydraulic dredging would follow debris removal.

The approximate footprints for dredging from 0 to 4 feet in depth are shown in 1-foot increments on Figures 30-33 and are based on an RG of 1.6 to 10.7 mg/kg mercury in sediment. The isoconcentration contours drawn on Figure 35 are based on the 2009 surficial sediment results, including both fine core and grab sample results. Figures 36-38 show isoconcentration contours based on the 2009 coarse core results for sediment. Mercury concentrations exceeding 1.6 to 10.7 mg/kg at depths greater than 4 feet are present in the deeper portion of the Basin. This deeper portion of the Basin is delineated by the pink line on Figure 35. Mercury concentrations in sediment greater than 4 feet in depth are listed on Figures 36 through 38. Mercury isoconcentration contours were not drawn for depths greater than 4 feet, because mercury sample locations with concentrations exceeding 1.6 to 10.7 mg/kg are limited to one to three locations, depending on depth. Most of the Basin would be dredged to 4 feet in depth. The area shown on Figure 35 encompassing the deeper portion of the Basin and reaching to the area of the former discharge ditch would be dredged to an average depth of 6 feet. The center of the deeper portion could be dredged up to a depth of 13 feet. Round Pond would be dredged to a depth of 1 foot. The area in the Basin to be dredged to 4 feet is approximately 43 acres; the area within the deeper portion of the Basin to be dredged is approximately 21 acres; and the area in Round Pond to be dredged to 1 foot is approximately 8 acres. Additional sediment sampling is recommended in the remedial design phase to confirm the area and volume for the remedial footprint before implementing the remedial action. The remedial footprint includes the channel connecting Round Pond to the Basin and the perimeter of floodplain soils that are often inundated. The volume of in-place sediment to be removed in this alternative is approximately 590,000 cubic yards (cy).

Hydraulic dredging would mix water into the sediments to yield a dredged material consisting of approximately 10 percent solids. The average in place percent solids is approximately 40 percent. Reducing the solids content from 40 percent to 10 percent would consume more than the 2.9 times the volume of water available in the Basin at the 6-foot water elevation. Water from the Tombigbee River would need to be directed into the Basin during dredging to provide sufficient water for dredging. The dredged material would then be dewatered either mechanically or in Geotubes®. The volume of dredged material to be dewatered in this alternative would be approximately 2,390,000 cy. It is assumed that the dredged material would then be dewatered to approximately 60 percent solids. It is assumed the dewatered solids would be disposed of as non-hazardous material. This assumption would be verified through TCLP analysis. Dewatering fluid would then be treated to meet AWQC and discharged to the Basin. Treatment would primarily consist of an equalization tank and a minimum of two activated carbon units.

Silt curtains would be used to limit the migration of suspended sediment. Water levels would be managed through the berm and gate system during dredging to maintain a consistent water level for equipment mobility. The remedial action would take approximately 17 months. Transport of suspended sediment would increase during the flooding season. OU-1 ICs would need to be modified to consist of deed and use restrictions; ECs would consist of signs, some of which are already present at OU-2, fencing, and continuation of security measures. OU-2 is currently fenced along the west, north, and southwest boundary.

2.10 DETAILED ANALYSIS OF ALTERNATIVES

2.10.1 Alternative 1: No Action

Estimated Capital Costs: $ 0
Estimated O & M Costs: $ 0
Estimated Present Worth: $ 0
Estimated Construction Time: Not Applicable
Estimated Time to Achieve Cleanup Levels and RAOs: Would Not Achieve

2.10.1.1 Overall Protection of Human Health and the Environment

The No Action alternative provides a baseline for comparison with the range of other developed alternatives. Its inclusion among the alternatives is mandated by the EPA guidance. The No Action alternative assumes that the berm and gate structure would not be maintained and that Olin's current security monitoring and restrictions on trespassing and fishing would not be enforced so that risk to human receptors would increase above acceptable levels. Risk to ecological receptors through bioaccumulation would not be mitigated. Under this alternative the timeframe to achieve the sediment cleanup levels in the Basin and Round Pond would be very lengthy and beyond the timeframe evaluated in this FS.

The No Action alternative is not considered protective of human health or the environment.

2.10.1.2 Compliance with ARARs

The No Action alternative does not comply with ARARs.

2.10.1.3 Long-Term Effectiveness

The No Action alternative is not considered effective in the long term.

2.10.1.4 Short-Term Effectiveness

The No Action alternative is not considered effective in the short term.

2.10.1.5 Reduction of TMV through Treatment

This alternative does not include any measures to reduce TMV.

2.10.1.6 Implementability

No measures are implemented under this alternative.

2.10.1.7 Cost

The No Action Alternative has no capital or maintenance cost.

2.10.1.8 State/Support Agency Acceptance

During implementation of the RI, FS, and BLRA, the EPA has worked under a Cooperative Management Agreement with the State of Alabama (represented by ADEM). ADEM has concurred on the RI, FS, and BLRA, the underlying studies upon which selection of the remedial action is based. ADEM has expressed concerns regarding the proposed DDTR cleanup level. The response to their comments are included in the Responsiveness Summary to this ROD.

2.10.1.9 Community Acceptance

During the public comment period for the proposed plan, only two entities submitted written comments. In general, all comments supported the preferred alternative presented in the Proposed Plan, although there were comments regarding the DDTR cleanup levels. The responses to these comments are included in the Responsiveness Summary to this ROD.

2.10.2 Alternative 2A- In Situ Capping, ICS, and ECS

Estimated Capital Costs: $ 12,400,000 - $21,500,000
Estimated O & M Costs: $ 993,000
Estimated Present Worth: $ 12,900,000 - $22,000,0000
Estimated Construction Time: 12 months
Estimated Time to Achieve Cleanup Levels and RAOs: 10 years

2.10.2.1 Overall Protection of Human Health and the Environment

An in situ cap serves as a barrier separating other media and potential ecological receptors from exposure to COCs in the sediment, thereby reducing risk. Risk to piscivorous birds stems from ingestion of fish exposed to mercury or DDTR in sediments. A cap would prevent fish exposure to the COCs in sediments and diffusion into surface water. Fish tissue mercury and DDTR concentrations would meet the EPA fish tissue concentration remediation goals once the current generations of fish have naturally expired. Risk to piscivorous mammals stems from incidental ingestion of HCB-contaminated sediments. A cap would provide a barrier between the piscivorous mammals and the contaminated sediments, eliminating their exposure pathway. ICs and ECs currently in place have already achieved the RAO to reduce or mitigate the current potential risk to humans from ingestion of fish. This alternative includes the current potential risk to humans from ingestion of fish. This alternative includes the continuation of these ICs and ECs.

2.10.2.2 Compliance with ARARs

This alternative would comply with ARARs. A cap would prevent exposure of fish to COCs in sediment, and fish tissue mercury concentrations would reduce over time to the risk-based fish tissue residue criterion for mercury of 0.3 mg/kg. A cap would cover the sediments, meeting the RGs for mercury, DDTR, and HCB in sediment. Workers would wear appropriate personal protective equipment (PPE) for the protection of worker safety. Discharges to waters of the State would comply with the substantive requirements of the Clean Water Act (CWA) and Alabama NPDES requirements. Engineering controls would be employed to prevent the disruption of, impact to, or alteration of wetlands during remedial action, thereby complying with Floodplain Management, Protection of Wetlands, the ADEM Coastal Area Management Program, and Alabama Water Pollution Control ARARs.

2.10.2.3 Long-Term Effectiveness

An in situ cap would be effective in the long term at achieving RAOs. Sediment caps have been approved by the EPA for remediation at many sites. The footprint of the cap would encompass approximately 72.5 acres based on the 1.6 mg/kg mercury contour and would cover the areas where sediment RGs are exceeded so that the exposure pathway is eliminated. The cap will be constructed to effectively create the exposure barrier.

A cap is typically applied in multiple lifts to minimize resuspension of sediment and mixing. Allowing the sediment and cap materials a zone for mixing ensures that mixing will not extend into the cap material layer. The potential for suspended particles that contain mercury to become entrained in the water column will be reduced through the layered application of the mixing zone and cap material. Amendments and polishing agents such as pelletized activated carbon, apatite, hematite, organoclay, pelletized

Selection of cap material, potential amendments, and/or a polishing layer will be evaluated during the remedial design. Cap design typically includes venting mechanisms to prevent gas ebullition from disturbing the cap. The effectiveness of various cap materials can be evaluated and compared using models that predict the migration of mercury through the cap materials.

The Steady-State Cap Design Model (Lampert and Reible, 2008 or equivalent) will be used during remedial design phase after performing a treatability study to predict the performance and longevity of the cap materials to contain mercury based on prior agreement with the EPA.

All input test parameters including Kd values of cap materials would be calculated from site-specific treatability studies during the design phase. Other input parameters that are impractical to simulate in a laboratory setting will be estimated based on conservative calculations/challenged conditions. For example, calculation of the Darcy velocity assumes that a groundwater pathway between the bluff and Basin exists. Core logs show that clay indicative of a hydraulic conductivity of 10^{-5} to 10^{-11} centimeters per second (cm/s) underlies the Basin/Round Pond throughout and provides an effective barrier between the Basin and groundwater. Groundwater flow from the bluff is expected to travel under the Basin through the more permeable sand aquifer beneath the Basin or parallel to the Basin to discharge south of the Basin to the Tombigbee River. A pathway under or parallel to the Basin is the pathway of least resistance, resulting in little, if any, groundwater upwelling through the clay and into a cap. Extremely conservative assumptions will be used to calculate a Darcy velocity or groundwater upwelling to this input to the model. Darcy velocity or groundwater upwelling is a function of hydraulic conductivity and the hydraulic gradient within the cap layer. The hydraulic gradient between the bluff area and the Basin/Round Pond will be used as a very conservative value. The hydraulic gradient was estimated using the water level elevation in monitoring well MW-1B along the bluff and 3 feet NAVD88. An elevation of 3 feet presents a worst case or higher gradient when water levels in the Basin are near drought conditions and a minimum water elevation is not maintained in the Basin. A minimum water elevation of 6 feet is currently maintained in the Basin. The hydraulic conductivity near the surface of the sediment core is estimated at 10^{-5} cm/s, while the hydraulic conductivity near the bottom of the deeper cores is estimated at 10^{-11} cm/s. Using a value greater than 10^{-11} cm/s for hydraulic conductivity is extremely conservative, because groundwater flow or upwelling would be controlled by the lower of the hydraulic conductivity values. The range of inputs using the effective hydraulic conductivity, hydraulic gradient, and effective porosity results in an equivalent seepage velocity range of 0.96 to 96 cm/year.

The preliminary model, performed during the feasibility study, showed that migration of mercury through typical cap materials can effectively protect human health and the environment. The actual cap thickness and composition would be determined during the remedial design phase of the remedial action.

HCB and DDTR

Cap material attenuating mercury should be capable to attenuate both HCB and DDTR due to their hydrophobicity and low solubility in water. The water solubility of mercuric chloride is several orders of magnitude higher than that of HCB (0.0062 mg/L; USEPA, 1996) and DDT (4,4’ DDT of 5.5 µg/L to 2,4’ of µg/L 85 ug/L). These chemical properties indicate that an effective cap for mercury would also be effective for HCB and DDTR. The actual cap thickness and composition would be determined during the remedial design phase.

2.10.2.4 Short-Term Effectiveness

RAOs would be achieved with the completion of the cap placement and natural replacement of the current generation of fish. A period of 10 years is common for higher trophic fish such as largemouth bass and less for lower trophic fish. Unacceptable risk to the community is not anticipated during remedial activities. Engineering controls such as appropriate PPE would be employed to mitigate short-term risks during construction. Short-term impacts to the Basin/Round Pond habitat are expected with the capping alternative. Placement of cap materials could bury benthic organisms, which could impact feeding of upper trophic level animals, such as some fish and bird species. Placement of cap materials may also bury large, woody debris, thus limiting habitat, cover, and food for aquatic species. These impacts are expected to be temporary. Benthic organisms would recolonize the habitat layer of the cap. A temporary increase in turbidity associated with the fine material in the cap material is expected during cap placement, but this turbidity increase would not be excessive and would be controlled through the application rate and placement method of the cap. The short-term adverse effects of capping would be temporary and manageable.

2.10.2.5 Reduction of TMV Through Treatment

In situ capping would reduce the mobility of contaminated sediment by creating a barrier over the contamination and preventing exposure. The habitat would provide a clean layer of material for benthic organisms to populate without breaching the integrity of the cap material layer from the top of the cap. The mixing zone at the bottom of the cap, immediately above the sediment, would provide a zone for sediment and cap mixing, preventing the sediment from breaching the integrity of the cap layer from the bottom of the cap.

Capping with an appropriate material that contains active ingredients provides sequestration of contaminants (a treatment) by design and installing the cap so that it achieves the following risk reduction objectives in accordance with the Contaminated Sediment Guidance for Hazardous Waste Site (USEPA, 2005).

- “Physical isolation of the contaminated sediment sufficient to reduce exposure due to direct contact and to reduce the ability of burrowing organisms to move contaminants to the surface”
- “Stabilization of contaminated sediment and erosion protection of sediment and cap, sufficient to reduce resuspension and transport to other sites”
- “Chemical isolation of contaminated sediment sufficient to reduce exposure from dissolved and colloidally bound contaminants transported into the water

column”

Mobility and toxicity to biota would be reduced as a result of this treatment. Treatment residuals are not a concern for this alternative. Capping is considered permanent with appropriate armor for protection against erosion/resuspension and proper maintenance.

2.10.2.6 Implementability

ICs would need to be modified to include OU-2 and ECs are already implemented. The capping placement technologies under consideration in this alternative are generally available and sufficiently demonstrated for use at OU-2. The necessary equipment and specialists are also available. Silt curtains would be employed to isolate a capped area from a non-capped area so that potential resuspension in a working area would not affect a completed capped area.

A debris survey of the Basin indicated that large buried debris (tens of meters long by several meters wide) is present in 30 to 50 percent of the Basin and protrudes 10s of centimeters from the sediment bed. An advantage of a cap is that it does not require debris removal; the cap can be applied over and around the debris, avoiding the significant resuspension caused by the removal of buried debris.

Uncertainties identified with this alternative include:

- Road conditions: Roads and/or bridges in and around OU-2 would need improvement to handle the movement of cap materials from the onsite borrow area or the delivery of offsite materials.
- Land availability: Parcels of land near OU-2 would need to be developed as construction equipment and material staging areas. The bluff area could be used to stage and store materials.
- Construction: Implementation would be approximately 1 year from initiation of mobilization to completion of demobilization. Application of the cap would take approximately six of the twelve total months.

approximately six of the twelve total months.

Future remedial actions are not anticipated once the cap is placed. Compliance with permits would be required. Monitoring would consist of sampling to monitor COC concentrations in sediment and fish tissue over time.

2.10.2.7 Cost

The cost for Alternative 2A is presented in the table below. The actual composition and thickness of the cap would be specified during the remedial design. Costs for Alternative 2A include the following:

- Remedy design, treatability studies, and project/construction management
- Mobilization and setup of decontamination facilities
- Labor, equipment, and materials for 12 months of operations
- Site preparation, including building of access roads, and the reinforcement of existing bridges and roads
- Cap slurry system for mixing and pumping of cap material into the Basin and Round Pond
- Erosion controls such as silt fences and silt curtains
- Pre-construction bathymetric survey and ongoing surveys during application
- Cap materials – four types of typical cap materials were included in the cost estimates, representing the range of potential costs
- Site restoration such as re-grading the borrow area of the bluff prior to demobilization
- Demobilization
- Post construction confirmation sampling of sediment and surface water.
- Long-term operations, maintenance, monitoring, and reporting including:
    - o Annual berm inspections and maintenance
    - o 30 years of long term monitoring at the following schedule:
        - Topographic survey of cap 4 years after remedy completion and every five years thereafter

completion and every 5 years thereafter

- Surface water monitored for low-level mercury quarterly for the first year and annually thereafter
- Largemouth bass monitored for mercury 18 months after remedy completion and annually until year 5, then every 5 years, coinciding with the year before the 5-Year Review Report (5YRR)
- Forage fish tissue monitored for mercury and DDTR 12 months after remedy completion and annually until year 5, then every 5 years, coinciding with the year prior to 5YRR
- Spiders and flying insects monitored for mercury and DDTR 12 months after remedy completion and annually until year 5, then every 5 years, coinciding with the year prior to 5YRR

o Monitoring Reports and 5-Year Review Reports

The projected costs are tabulated below.

Alternative 2A	**Total Cost (Capital + O&M)**	**Total Present Worth**
Native Soil Cap	$13,400,000	$12,900,000
Bentonite Pellet Cap	$16,900,000	$16,400,000
Native Cap/Polishing Soil Layer	$18,900,000	$18,400,000
Bentonite Pellet Cap/Polishing Layer	$22,500,000	$22,000,000

The estimated present worth cost is based on the capital costs incurred during the first year and operation, maintenance, and monitoring (OM&M) for 30 years. It is expected that remedial goals would be met within 10 years, based on the life cycle of the higher trophic fish species. The costs incurred beyond the 30 years was negligible for this project. An annual discount rate of 7 percent was applied to calculate present worth.

2.10.2.8 State/Support Agency Acceptance

During implementation of the RI, FS, and BLRA, the EPA has worked under a Cooperative Management Agreement with the State of Alabama (represented by ADEM). ADEM has concurred on the RI, FS, and BLRA, the underlying studies upon which selection of the remedial action is based. ADEM has expressed concerns regarding the proposed DDTR cleanup level. The response to their comments are included in the Responsiveness Summary to this ROD.

2.10.2.9 Community Acceptance

During the public comment period for the proposed plan, only two entities submitted written comments. In general, all comments supported the preferred alternative presented in the Proposed Plan, although there were comments regarding the DDTR cleanup levels. The responses to these comments are included in the Responsiveness Summary to this ROD.

2.10.3 Alternative 2B – In Situ Capping, Dry Cappings, ICS and ECS

Estimated Capital Costs: $ 13,300,000 - $22,400,000
Estimated O & M Costs: $ 981,000
Estimated Present Worth: $ 13,800,000 - $22,900,000
Estimated Construction Time: 7 months
Estimated Time to Achieve Cleanup Levels and RAOs: 10 years

2.10.3.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment for Alternative 2B is consistent with Alternative 2A.

2.10.3.2 Compliance with ARARs

Compliance with ARARs for the in situ capping portion of Alternative 2B is consistent with Alternative 2A. The dry capping portion of Alternative 2B would also comply with

ARARs. A cap placed in the dry would comply with chemical-specific ARARs by preventing exposure of fish to COCs in sediment, thereby reducing fish tissue mercury concentrations over time to the risk-based fish tissue residue criterion for mercury of 0.3 mg/kg. A cap would cover the sediments, meeting the PRGs for mercury, DDTR, and HCB in sediment. Workers would wear appropriate PPE for the protection of worker safety. Dry capping activities would be completed in compliance with the action specific general construction standards for land disturbing activities such as implementation of best management practices (BMPs). Discharges to Waters of the State would comply with the substantive requirements of the Clean Water Act (CWA) and Alabama NPDES requirements. Engineering controls would be employed to prevent the disruption of, impact to, or alteration of wetlands during remedial action, thereby complying with the location-specific ARARs for Floodplain Management, Protection of Wetlands, the ADEM Coastal Area Management Program, and Alabama Water Pollution Control. USFWS would be consulted prior to implementation of this alternative, in compliance with the location-specific ARAR for drainage of water bodies.

2.10.3.3 Long-Term Effectiveness

Long-term effectiveness for Alternative 2B is consistent with Alternative 2A.

2.10.3.4 Short-Term Effectiveness

Short-term effectiveness for Alternative 2B is consistent with Alternative 2A, with some exceptions. Short-term impacts to the Basin/Round Pond habitat are expected to be higher in the portion that is capped in the dry compared to that which is capped in situ. Dry capping involves segregating the Basin/Round Pond, dewatering one section at a time, and placing a geotextile and covering with native soils. Dewatering and covering areas of the Basin/Round Pond would temporarily destroy the benthic habitat, which could impact feeding of upper trophic level animals, such as some fish and bird species. Aquatic and semi-aquatic species would be impacted because of the lack of water in some areas of the Basin. Placement of cap materials may also bury large woody debris, limiting habitat, cover, and food for aquatic species once water is returned to the previously dry areas. These impacts are expected to be temporary, but may last several years. Benthic organisms will recolonize the habitat layer of the cap. Unlike dredging, which is associated with substantially increased risks, as discussed later, the short-term adverse effects of capping are temporary and manageable.

2.10.3.5 Reduction of TMV Through Treatment

Reduction of TMV through treatment for Alternative 2B is consistent with 2A. Capping with amendments provides a treatment element by designing the cap so that it achieves the following risk reduction objectives in accordance with the Contaminated Sediment Guidance for Hazardous Waste Site (USEPA, 2005).

- "Physical isolation of the contaminated sediment sufficient to reduce exposure due to direct contact and to reduce the ability of burrowing organisms to move contaminants to the surface"
- "Stabilization of contaminated sediment and erosion protection of sediment and cap, sufficient to reduce resuspension and transport to other sites"
- "Chemical isolation of contaminated sediment sufficient to reduce exposure from dissolved and colloidal-bound contaminants transported into the water column"

  Mobility and toxicity to biota would be reduced as a result of this treatment. Treatment residuals are not a concern for this alternative. Capping is considered permanent with appropriate armor for protection against erosion/resuspension and proper maintenance.

2.10.3.6 Implementability

The ICs for OU-1 will need to be modified to include OU-2 and ECs are already implemented. The technologies for in situ capping and for using portadams to segregate the Basin/Round Pond, dewatering sections of the Basin/Round Pond, and placing the cap in this alternative are generally available. The necessary equipment and specialists are available. Additional materials, such as geotextiles and an increased cap thickness, would also be required to create a stable working surface. Debris, within the sediment bed to be capped in the dry, would be removed after dewatering and prior to the placement of the geotextile. This debris is assumed to be nonhazardous and would be transported to an offsite landfill for disposal. Uncertainties identified with this alternative include:

- Road conditions: Roads and/or bridges in and around OU-2 would need improvement to handle the movement of cap materials from the onsite borrow area or the delivery of offsite materials.
- Land availability: Parcels of land near OU-2 would need to be developed as construction equipment and material staging areas. The bluff area could be used to stage and store materials.
- Timeframe: Implementation is estimated to be of shorter duration than in situ capping alone (approximately 7 months from initiation of mobilization to completion of demobilization). Actual time spent on placing the cap accounts for about 4 out of the 7 months (2 months for dry portion and 2 months for in situ portion). However, flooding greater than 11 feet NAVD88 would shut down the dry capping operation and disrupt operations. This would lead to a greater amount of downtime during the dry capping portion of operations.

Future remedial actions are not anticipated once the cap is placed. Compliance with permits would be required. Monitoring would consist of sediment sampling to monitor COC concentrations in sediment and fish tissue over time.

2.10.3.7 Cost

The cost for Alternative 2B is presented in the table below. Costs for Alternative 2B include the following:

- Remedy design, treatability studies, and project/construction management
- Mobilization and setup of decontamination facilities
- Labor, equipment, and materials for 7 months of operations
- Site preparation, including building of access roads, and the reinforcement of existing bridges and roads
- Erosion controls such as silt fences and silt curtains

- Pre-construction bathymetric survey and ongoing surveys during application
- For the in situ capping portion (23 acres):
  - o Cap slurry system for mixing and pumping of native soil cap material into the Basin and Round Pond
- For the dry capping portion (49.5 acres):
  - o Installation of portadams in Basin to segregate and dewater
  - o Dewatering of Basin segments and Modutanks
  - o Excavation and transport of borrow area soil from bluff to Basin
- Total thickness of native soil cap equal to 24 inches to provide a firm base for equipment mobility: cap design consists of a 2 inch native soil mixing zone, 18 inches of native soil cap material layer, and a 4 inch habitat layer consisting native soil with armor. Gas venting mechanisms would be included in the cap placement.
- Site restoration such as regrading the borrow area of the bluff prior to demobilization
- Demobilization
- Site restoration such as regrading the borrow area after excavation
- Long-term operations, maintenance, monitoring, and reporting, including:
  - o Berm and cap maintenance
  - o 30 years of long term monitoring at the following schedule:
    - ▪ Topographic survey of cap 4 years after remedy completion and every five years thereafter
    - ▪ Sediment cores monitored for mercury 4 years after remedy completion and every 5 years thereafter
    - ▪ Surface water monitored for low-level mercury quarterly for the first year and annually thereafter
    - ▪ Predatory fish tissue monitored for mercury 18 months after remedy completion and annually until year 5, then every 5 years, coinciding with the year before the 5-Year Review Report (5YRR)
    - ▪ Forage fish tissue monitored for mercury and DDTR 12 months after remedy completion and annually until year 5, then every 5 years,

coinciding with the year prior to 5YRR

- Spiders and flying insects monitored for mercury and DDTR 12 months after remedy completion and annually until year 5, then every 5 years, coinciding with the year prior to 5YRR
- Monitoring Reports and 5-Year Review Reports

A native soil cap composition for Alternative 2B was used for costing to provide a basis of comparison to the OU-2 native soil cap in Alternative 2A. Costs for adding cap amendments or polishing layers would be similar to the costs for these materials provided in Alternative 2A. The projected costs are tabulated below.

Alternative 2B	**In Situ Capping and Dry Capping**
Total Cost (Capital + O&M)	$14,300,000 - $24,400,000
Total Present Worth	$13,800,000 - $22,900,000

The estimated present worth cost is based on the capital costs incurred during the first year and operation, maintenance, and monitoring (OM&M) for 30 years. It is expected that remedial goals would be met within 30 years, based on the life cycle of the higher trophic fish species (approximately 10 years). Costs incurred beyond the 30 years were negligible for this project. An annual discount rate of 7 percent was applied to calculate present worth.

2.10.3.8 State/Support Agency Acceptance

During implementation of the RI, FS, and BLRA, the EPA has worked under a Cooperative Management Agreement with the State of Alabama (represented by ADEM). ADEM has concurred on the RI, FS, and BLRA, the underlying studies upon which selection of the remedial action is based. ADEM has expressed concerns regarding the proposed DDTR cleanup level. The response to their comments are included in the Responsiveness Summary to this ROD.

2.10.3.9 Community Acceptance

During the public comment period for the proposed plan, only two entities submitted written comments. In general, all comments supported the preferred alternative presented in the Proposed Plan, although there were comments regarding the DDTR cleanup levels. The responses to these comments are included in the Responsiveness Summary to this ROD.

2.10.4 Alternative 2C- Dry Cappings, ICS, and ECS

Estimated Capital Costs: $ 15,400,000 - $24,500,000
Estimated O & M Costs: $ 981,000
Estimated Present Worth: $ 15,900,000 - $25,000,000
Estimated Construction Time: 7 months
Estimated Time to Achieve Cleanup Levels and RAOs: 10 years

2.10.4.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment for Alternative 2C is consistent with Alternatives 2A and 2B.

2.10.4.2 Compliance with ARARs

Compliance with ARARs for Alternative 2C is consistent with Alternative 2A and 2B.

2.10.4.3 Long-Term Effectiveness

Long-term effectiveness for Alternative 2C is consistent with Alternatives 2A and 2B.

2.10.4.4 Short-Term Effectiveness

Short-term effectiveness for Alternative 2C is consistent with Alternative 2B. Short-term impacts to the Basin/Round Pond habitat are expected to be higher with the dry capping alternative compared to in situ capping. The dry capping alternative involves segregating the Basin/Round Pond, dewatering one section at a time, and placing a geotextile and covering with native soils. Dewatering and covering areas of the Basin/Round Pond would temporarily destroy the benthic habitat, which could impact feeding of upper trophic level animals, such as some fish and bird species. Aquatic and semi-aquatic species would be impacted because of the lack of water in some areas of the Basin. Placement of cap materials may also bury large woody debris, limiting habitat, cover, and food for aquatic species once water is returned to the previously dry areas. These impacts are expected to be temporary, but may last several years. Benthic organisms will recolonize the habitat layer of the cap. Unlike dredging, which is associated with substantially increased risks, as discussed later, the short-term adverse effects of capping are temporary and manageable.

2.10.4.5 Reduction of TMV Through Treatment

Reduction of TMV through treatment for Alternative 2C is consistent with Alternatives 2A and 2B. Capping with or without amendments provides a treatment element by designing the cap so that it achieves the following risk reduction objectives in accordance with the Contaminated Sediment Guidance for Hazardous Waste Site (USEPA, 2005).

- “Physical isolation of the contaminated sediment sufficient to reduce exposure due to direct contact and to reduce the ability of burrowing organisms to move contaminants to the surface”
- “Stabilization of contaminated sediment and erosion protection of sediment and cap, sufficient to reduce resuspension and transport to other sites”
- “Chemical isolation of contaminated sediment sufficient to reduce exposure from dissolved and colloidal-bound contaminants transported into the water column”

Mobility and toxicity to biota would be reduced as a result of this treatment. Treatment residuals are not a concern for this alternative. Capping is considered permanent with appropriate armor for protection against erosion/resuspension and proper maintenance.

2.10.4.6 Implementability

ICs and ECs are already implemented. The technologies for using portadams to segregate the Basin/Round Pond, dewatering sections of the Basin/Round Pond, and placing the cap in this alternative are generally available. The necessary equipment and specialists are available. Additional materials, such as geotextiles and an increased cap thickness, would also be required to create a stable working surface.

Uncertainties identified with this alternative include:

- Road conditions: Roads and/or bridges in and around OU-2 would need improvement to handle the movement of cap materials from the onsite borrow area or the delivery of offsite materials.
- Land availability: Parcels of land near OU-2 would need to be developed as construction equipment and material staging areas. The bluff area could be used to stage and store materials.
- Timeframe: Implementation is estimated to be of shorter duration than in situ capping (approximately 7 months from initiation of mobilization to completion of demobilization). It is estimated that 4 out of the 7 months would be spent on placing the cap. However, flooding greater than 11 feet NAVD88 would shut down the dry capping operation and disrupt operations. This would lead to a greater amount of downtime.

Future remedial actions are not anticipated once the cap is placed. Compliance with permits would be required. Monitoring would consist of sediment sampling to monitor COC concentrations in sediment and fish tissue over time.

2.10.4.7 Cost

The cost for Alternative 2C is presented in the table below. Costs for Alternative 2C include the following:

- Remedy design, treatability studies, and project/construction management
- Mobilization and setup of decontamination facilities
- Labor, equipment, and materials for 7 months of operations
- Site preparation, including building of access roads, and the reinforcement of existing bridges and roads
- Erosion controls such as silt fences and silt curtains
- Pre-construction bathymetric survey and ongoing surveys during application
- Installation of portadams in Basin to segregate and dewater
- Dewatering of Basin segments and Modutanks
- Excavation and transport of borrow area soil from bluff to Basin
- Total thickness of native soil cap equal to 24 inches: cap design consists of a 2 inch native soil mixing zone, 18 inches of native soil cap material layer, and a 4 inch habitat layer consisting native soil with armor, Site restoration such as regrading the borrow area of the bluff prior to demobilization
- Demobilization
- Long-term operations, maintenance, monitoring, and reporting, including:
  - o Berm and cap maintenance
  - o 30 years of long term monitoring at the following schedule:
    - Topographic survey of cap 4 years after remedy completion and every five years thereafter
    - Sediment cores monitored for mercury 4 years after remedy completion and every 5 years thereafter
    - Surface water monitored for low-level mercury quarterly for the first year and annually thereafter
    - Predatory fish tissue monitored for mercury 18 months after remedy completion and annually until year 5, then every 5 years, coinciding with the year before the 5-Year Review Report (5YRR)
    - Forage fish tissue monitored for mercury and DDTR 12 months after remedy completion and annually until year 5, then every 5

years, coinciding with the year prior to 5YRR
- Spiders and flying insects monitored for mercury and DDTR 12 months after remedy completion and annually until year 5, then every 5 years, coinciding with the year prior to 5YRR

o Monitoring Reports and 5-Year Review Reports

A native soil cap composition for Alternative 2C was used for costing to provide a basis of comparison to the site native soil cap in Alternative 2A. Costs for adding cap amendments as polishing layers would be similar to the costs for these materials provided in Alternative 2A. The projected costs are tabulated below.

Alternative 2C	**Dry Capping with Native Soil**
Total Cost (Capital + O&M)	$16,400,000 - $25,000,000
Total Present Worth	$15,900,000 - $25,000,000

The estimated present worth cost is based on the capital costs incurred during the first year and operation, maintenance, and monitoring (OM&M) for 30 years. It is expected that remedial goals would be met within 30 years, based on the life cycle of the higher trophic fish species (approximately 10 years). Costs incurred beyond the 30 years are negligible for this project. An annual discount rate of 7 percent was applied to calculate present worth.

2.10.4.8 State/Support Agency Acceptance

During implementation of the RI, FS, and BLRA, the EPA has worked under a Cooperative Management Agreement with the State of Alabama (represented by ADEM). ADEM has concurred on the RI, FS, and BLRA, the underlying studies upon which selection of the remedial action is based. ADEM has expressed concerns regarding the proposed DDTR cleanup level. The response to their comments are included in the Responsiveness Summary to this ROD.

2.10.4.9 Community Acceptance

During the public comment period for the proposed plan, only two entities submitted written comments. In general, all comments supported the preferred alternative presented in the Proposed Plan, although there were comments regarding the DDTR cleanup levels. The responses to these comments are included in the Responsiveness Summary to this ROD.

2.10.5 Alternative 3- Debris Removal, Hydraulic Dredging, Dewatering, Onsite or Offsite Disposal, ICS, and ECS

Estimated Capital Costs: $ 54,400,000 - $69,000,000
Estimated O & M Costs: $ 784,000
Estimated Present Worth: $ 54,800,000 - $69,400,0000
Estimated Construction Time: 17 months
Estimated Time to Achieve Cleanup Levels and RAOs: 10 years

2.10.5.1 Overall Protection of Human Health and the Environment

Dredging would provide for mass removal of COCs but may or may not be successful in removing sediments without significant COC residuals remaining. Risk to ecological receptors may or may not be reduced to acceptable levels as a result of resuspension during dredging and post-dredging residuals. Dredging would resuspend sediment, release contamination, and generate residuals. Resuspension and residuals remaining in the sediment would likely be up to 5% depending on characteristics of sediment, despite efforts to reduce residuals using hydraulic dredging methodologies, because of the extensive mechanical debris removal required. Dredging would limit other media and potential ecological receptors from exposure to COCs, thereby reducing risk. Risk to piscivorous birds stems from ingestion of fish exposed to mercury- or DDTR-contaminated sediments. Sediment removal may prevent fish exposure to the contaminated sediments and diffusion into surface water. Fish tissue mercury and DDTR concentrations may meet the EPA-recommended fish tissue concentration consumption guideline once the current generations of fish have naturally expired. Risk to piscivorous mammals stems from incidental ingestion of HCB-contaminated sediments. Sediment removal would reduce their exposure to the COCs. ICs and ECs currently in place have already achieved the RAO to reduce or mitigate the current potential risk to humans from ingestion of fish. This alternative includes the continuation of these ICs and ECs.

2.10.5.2 Compliance with ARARs

This alternative would comply with ARARs if risk reduction standards are met. Sediment removal would theoretically prevent fish from exposure to contaminated sediment above 3 to 6 mg/kg, and fish tissue mercury concentrations may reduce over time to the risk-based fish tissue residue criterion of 0.3 mg/kg. Discharges to waters of the State would comply with the substantive requirements of the CWA and Alabama Water Quality Standards and NPDES requirements. Engineering controls would be employed to prevent the disruption of, impact to, or alteration of wetlands during remedial action, thereby complying with Floodplain Management, Protection of Wetlands, the ADEM Coastal Area Management Program, and Alabama Water Pollution Control ARARs.

2.10.5.3 Long-Term Effectiveness

While dredging is considered effective in mass removal, it is often unsuccessful in reducing surficial sediment concentrations and reducing risk to acceptable levels because resuspension of sediment generates a residual layer of contamination that is left behind. It is difficult to estimate the amount of contamination that may be released or the amount of residual contamination that will remain after dredging. Releases of contaminants into surface water may be up to about 5 percent of the contaminant mass, even when proper precautions and equipment are used to reduce resuspension. Low sediment bulk density and the presence of debris tend to increase resuspension and residuals. Extensive buried debris is present in the Basin as discussed above. Resuspension and post dredge residuals could prevent achievement of RAOs. Monitoring after implementation of this alternative would consist of fish tissue and sediment sampling to evaluate the reduction of mercury concentrations. Long-term maintenance and management would consist of maintaining the ICs and ECs.

2.10.5.4 Short-Term Effectiveness

RAOs may or may not be achieved depending on resuspension and post-dredge residuals. The timeframe to reach RAOs would be approximately 10 years for higher level trophic fish such as largemouth bass. Unacceptable risk to the community is not anticipated during remedial activities. Engineering controls such as appropriate PPE would be employed to mitigate short-term risks to workers during construction.

2.10.5.5 Reduction of TMV Through Treatment

Dredging reduces the volume of contamination by removing mass. Reducing the solids content from 40 percent to 10 percent during hydraulic dredging would consume more than 2.9 times the volume of water available in the Basin at the 6-foot water elevation. Water from the Tombigbee River would need to be directed into the Basin during dredging to provide sufficient water for dredging. Mixing water from the Tombigbee River directly with sediment containing COCs above the PRGs during the dredging process would increase the volume of material requiring dewatering, handling, and discharge. This alternative is considered permanent.

2.10.5.6 Implementability

OU-1 ICs would need to be modified to include OU-2 and ECs are already implemented. The dredging technologies under consideration in this alternative are generally available and sufficiently demonstrated for use at OU-2. The necessary equipment and specialists are also available. Silt curtains would be employed to isolate areas actively being dredged from those previously dredged so that potential resuspension in a working area would limit effects on a completed area.

A debris survey of the Basin indicated that large buried debris (tens of meters long by several meters wide) is present over 30 to 50 percent of the shallow area of the Basin. Buried debris is a significant disadvantage to dredging alternatives. Presence of debris is a contributing factor to increased resuspension and residual volume, which can prevent the achievement of RAOs.

This alternative would require the disposal of dewatered solids from dredging either onsite or offsite. Dredged material is assumed to be non-hazardous for disposal. This assumption would be verified through TCLP analysis. Adequate landfill capacity is available for the disposal of the dredged material. Offsite disposal would require the transport of materials to the EPA-approved and permitted facility. Sufficient land for onsite disposal is available along the bluff, as depicted in Figure 34.

Uncertainties identified with this alternative include:

- Road conditions: Roads and/or bridges in and around OU-2 would need improvement to handle the movement of construction materials and process equipment.
- Land availability: Parcels of land near OU-2 would need to be developed as construction equipment and material staging areas and potentially for Geotube® dewatering areas. The bluff area could be used to stage and store materials and eventually be used as an onsite landfill area.
- Timeframe: Implementation would be approximately 17 months with approximately 12 of the 17 months spent on sediment dredging. Flooding greater than 11 feet NAVD88 would disrupt operations and potentially increase duration.

Future remedial actions are not anticipated once dredging is complete. ICs and ECs would be maintained in the long term. Compliance with the substantial requirements of the permits would be required. Monitoring would consist of sampling to evaluate COC concentrations in sediment and fish tissue with time.

2.10.5.7 Cost

The costs for Alternative 3 with onsite and offsite disposal of the dredged sediments are presented in the tables below. Either all of the dewatered sediment would be disposed of onsite or offsite. A combination of onsite and offsite disposal is not anticipated.

Costs for Alternative 3 include the following:

- Remedy design, treatability studies, and project/construction management
- Mobilization and setup of decontamination facilities
- Labor, equipment, and materials for 17 months of operations
- Site preparation, including building of access roads, and the reinforcement of existing bridges and roads
- Installation of land-based filter press dewatering system and pipeline to pump dredged material from barge to filter press
- Erosion controls such as silt fences and silt curtains
- Pre-construction bathymetric survey and ongoing surveys during dredging
- Mechanical debris removal and hydraulic dredging
- Dewatering of dredged material through a mechanical filter press
- Treatment of decanted water using settling tanks and activated carbon units and discharge to Basin or NPDES discharge
- Transportation and disposal of debris in an offsite non-hazardous landfill
- Onsite disposal:
  - o Construction of a disposal cell in the borrow area to be lined with an high density polyethylene (HDPE) liner and 2-feet of clay.
  - o Transportation of dredged material to the onsite disposal cell
  - o 2-foot clay cover over the dredged material
  - o Re-grading and seeding the landfill area
- For offsite disposal:
  - o Transportation and disposal of dredged material in an offsite non-hazardous landfill
- Demobilization
- Long-term operations, maintenance, monitoring, and reporting including:
  - o Berm and landfill cell maintenance
  - o Confirmation sampling performed upon completion of dredging and 1 year

later

- o 30 years of long term monitoring at the following schedule:
  - Surface water monitored for low-level mercury quarterly for the first year and annually thereafter
  - Predatory fish tissue monitored for mercury 18 months after remedy completion and annually until year 5, then every 5 years, coinciding with the year before the 5-Year Review Report (5YRR)
  - Forage fish tissue monitored for mercury and DDTR 12 months after remedy completion and annually until year 5, then every 5 years, coinciding with the year prior to 5YRR
  - Spiders and flying insects monitored for mercury and DDTR 12 months after remedy completion and annually until year 5, then every 5 years, coinciding with the year prior to 5YRR
- o Monitoring Reports and 5-Year Review Reports

The projected costs are tabulated below.

Alternative 3	**Dredging with Onsite Disposal**	**Dredging with Offsite Disposal**
Total Cost (Capital + O&M)	$55,200,000	$69,800,000
Total Present Worth	$54,800,000	$69,400,000

The estimated present worth cost is based on the capital costs incurred during the first year and OM&M for 30 years. It is expected that remedial goals would be met within 30 years, based on the life cycle of the higher trophic fish species (approximately 10 years). Costs incurred beyond the 30 years tend to be negligible for this project. An annual discount rate of 7 percent was applied to calculate present worth.

2.10.5.8 State/Support Agency Acceptance

During implementation of the RI, FS, and BLRA, the EPA has worked under a

Cooperative Management Agreement with the State of Alabama (represented by ADEM). ADEM has concurred on the RI, FS, and BLRA, the underlying studies upon which selection of the remedial action is based. ADEM has expressed concerns regarding the proposed DDTR cleanup level. The response to their comments are included in the Responsiveness Summary to this ROD.

2.10.5.9 Community Acceptance

During the public comment period for the proposed plan, only two entities submitted written comments. In general, all comments supported the preferred alternative presented in the Proposed Plan, although there were comments regarding the DDTR cleanup levels. The responses to these comments are included in the Responsiveness Summary to this ROD.

2.11 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The EPA uses nine NCP criteria to evaluate remedial alternatives for the cleanup of a release. These nine criteria are categorized into three groups: threshold, balancing, and modifying. The threshold criteria must be met in order for an alternative to be eligible for selection. The threshold criteria are overall protection of human health and the environment and compliance with Applicable or Relevant and Appropriate Requirements (ARARs). The balancing criteria are used to weight major tradeoffs among alternatives. The five balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness; implementability; and cost. The modifying criteria are state acceptance and community acceptance.

2.11.1 Overall Protection of Human Health and the Environment

No Action, Alternative 1, would result in unacceptable risk to human health and the environment through lack of maintenance of the current ICs and ECs. Alternative 1 would not reduce COC concentrations in sediment to remedial goals. The capping alternatives 2A, 2B, and 2C, isolate COCs in sediment from contact with other media and receptors and are protective of human health and the environment. Alternative 3, which involves dredging, carries a risk of residual COCs, particularly for mercury, and resuspension that could prevent the achievement of RAOs and temporarily increase COC concentrations in surface water and biota. Alternative 3 may not be protective of human health and the environment. There is more certainty that capping mercury contaminated sediments at OU-2 will be protective of human health and the environment as compared to dredging mercury contaminated sediments at OU-2.

2.11.2 Compliance with ARARs

Section 121(d) of CERCLA and the NCP §300.430(f)(I)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and more stringent State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA §121(d)(4). Compliance with ARARs addresses whether a remedial alternative will meet all of the applicable or relevant and appropriate requirements of other Federal and more stringent State environmental statutes/regulations or provides a basis for invoking a waiver. *See* 40 C.F.R. § 300.430(e)(9)(iii)(B).

Applicable requirements, as defined in 40 C.F.R. § 300.5, means 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, or contaminant, remedial action, location, or other circumstance at a CERCLA site. *Relevant and appropriate requirements,* as defined in 40 C.F.R. § 300.5, means 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, or contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by the state in a timely manner and that are more stringent than federal requirements may be applicable or relevant and appropriate. *See* 40 C.F.R. § 300.400(g)(4).

For purposes of ease of identification, the EPA has created three categories of ARARs: Chemical-, Location- and Action-specific. Under 40 C.F.R. § 300.400(g)(5), the lead and support agencies shall identify their specific ARARs for a particular site and notify each other in a timely manner as described in 40 C.F.R. § 300.515(d). Chemical-, and Location-specific ARARs should be identified as early as scoping phase of the Remedial Investigation, while Action-specific ARARs are identified as part of the Feasibility Study for each remedial alternative. *See* 40 C.F.R. §§ 300.430(b)(9) & 300.430(d)(3). In addition, per 40 CFR 300.405(g)(3), other advisories, criteria, or guidance may be considered in determining remedies (known as To Be Considered or TBC). The TBC category typically consists of advisories, criteria, or guidance that were developed by the EPA, other federal agencies, or states that may be useful in developing CERCLA remedies.

In accordance with 40 CFR §300.400(g), the EPA and the State of Alabama have identified site-specific ARARs and TBC for the remedial alternatives including the selected remedy. The Chemical-specific, Action-specific, and Location-specific ARARs and TBC for the each of the remedial alternatives were included in Table 2-1, Table 2-2, and Table 2-3 of the Olin OU-2 Feasibility Study.

Capping Alternatives 2A, 2B, and 2C comply with ARARs. The dredging Alternative 3 may or may not comply with ARARs depending upon the amount of resuspension and residuals remaining after dredging. There is concern that mercury remaining in dredge residuals and resuspended sediment in Alternative 3 will result in noncompliance with ARARs based on the estimated amount of residuals and resuspension up to 5%.

2.11.3 Long-Term Effectiveness

Alternative 3 may not be effective in the long term based on the amount of resuspension and residuals associated with debris removal and dredging. Modeling using site-specific data has predicted that capping, Alternatives 2A, 2B, and 2C, would be effective in the long term. The EPA has approved caps for remediation at many sites.

2.11.4 Short-Term Effectiveness

Alternative 3 is not considered effective in the short term. In addition, severe, adverse, short-term impacts, such as increases of mercury concentrations in fish tissue and surface water are expected to occur with the dredging Alternative 3.

The capping Alternatives 2A, 2B, and 2C would effectively isolate the contaminated sediment in the short term. Short-term impacts from capping would be temporary and reversible.

2.11.5 Reduction of TMV through Treatment

Capping Alternatives 2A, 2B, and 2C with amendments would provide an element of treatment to reduce mobility and toxicity (bioavailability) through physical isolation, stabilization, and chemical isolation of the COCs in sediment under the cap. The dredging Alternative, 3, would reduce volume through mass removal, but would temporarily increase COC mobility through release and resuspension. The dredging alternative would also increase the volume of contaminated sediment by increasing the water content through hydraulic dredging.

2.11.6 Implementability

ICs and ECs are already implemented at OU-2. Alternative 2A, capping, is implementable with well-proven technologies and equipment. Uncertainties are associated with Alternatives 2B and 2C, which involve dry capping, such as the ability to segregate and dewater the Basin/Round Pond and the ability to create a stable working surface. Additional time, materials, and labor would be required for Alternatives 2B and 2C. Alternative 3, dredging, is implementable with proven technologies and equipment.

2.11.7 Cost

Alternatives 2A, 2B, and 2C have similar costs and are within the range of $12,900,000 - $25,000,000 depending upon what amendments are added to the cap. Alternative 3 has a cost range of $54,800,00 - $69,400,000. The cost difference is significant between the capping alternatives and the dredging alternative.

2.11.8 State/Support Agency Acceptance

During implementation of the RI, FS, and BLRA, the EPA has worked under a Cooperative Management Agreement with the State of Alabama (represented by ADEM). ADEM has concurred on the RI, FS, and BLRA, the underlying studies upon which selection of the remedial action is based and the preferred alternative. ADEM has expressed concerns regarding the proposed DDTR cleanup level. The response to their comments are included in the Responsiveness Summary to this ROD.

2.11.9 Community Acceptance

During the public comment period for the proposed plan, only two entities submitted written comments. In general, all comments supported the preferred alternative presented in the Proposed Plan, although there were comments regarding the DDTR cleanup levels. The responses to these comments are included in the Responsiveness Summary to this ROD.

2.11.10 Summary

Five alternatives for remediation of sediments at OU-2 were compared in the previous section. Dredging (Alternative 3) can be expected to result in mobilization and redistribution of mercury as well as potential increases in fish tissue and surface water mercury concentrations. Dredging may also not be effective in the long term based on the amount of resuspension and residual concentrations associated with dredging and debris removal. Dredging is also a more costly alternative. There is more certainty that in situ or dry capping or a combination of the two (Alternatives 2A, 2B, and 2C), will be protective of human health and the environment, will comply with ARARs, and would effectively isolate the sediment from exposure to humans and the environment. Preliminary model results, based on current information and assumptions discussed in this FS, predicted that capping would be effective in the long term. While the costs of in situ capping (Alternative 2A) are comparable to dry capping (Alternative 2C) or a combination of the two (Alternative 2B), there is less uncertainty with the implementation of Alternative 2A. Uncertainties associated with Alternatives 2B and 2C include disruption due to flooding. The specific cap composition and thickness will be refined as part of the remedial design. The preliminary conclusion of the model that a cap will be effective will be verified by treatability studies during the design phase.

2.12 PRINCIPAL THREAT WASTE

Waste classified as a principal threat is a "source material considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur". Source material is defined by the EPA as "material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, to air, or acts a source for direct exposure." The EPA expects to use "treatment to address the principal threats posed by a site, wherever practicable" and "engineering controls, such as containment, for waste that poses a relatively low long-term threat" as stated in the NCP.

Low level threat wastes generally can be reliably contained and present only a low risk in the event of a release. They typically exhibit low toxicity, low mobility, or are near health-based levels. The inherent toxicity, the physical state, the potential mobility, and the degradation products of the material are all taken into account. Although there is not a "bright-line" threshold, if the toxicity and mobility of the source material combine to pose a potential risk of 10-3 or greater, the EPA generally expects that treatment alternatives (i.e. soil vapor extraction, biodegradation, in-situ oxidation, stabilization, grouting, etc.) should be evaluated. For example, surface or subsurface soils that contain high concentrations of contaminants of concern that are potentially mobile due to volatilization, surface runoff, or sub-surface transport, would generally be considered principal threat wastes. Similarly, highly toxic or bioaccumulative wastes that have the potential to pose an immediate threat to human health or the environment, or which may accumulate through the food chain, such as soil or waste materials containing mercury, may be considered principal threat wastes.

Conversely, surface soil that contains contaminants of concern that are relatively immobile in air or groundwater (i.e. non-liquid, low volatility, low leachability) would be more likely categorized as low level threat waste and not necessarily require treatment.

The EPA provided further guidance on principal threat waste in a 1997 “rules of thumb” document (USEPA, 1997). In addition to the concepts above, guidance states that the reasonably anticipated future land use at a site should be taken into account when determining whether wastes pose a principal threat. “When the baseline risks associated with the reasonably anticipated future land use trigger action, the definition of principal threat wastes may be determined by the reasonably anticipated future land use scenario as well. A general rule of thumb is to consider as a principal threat those source materials with toxicity and mobility characteristics that combine to pose a potential risk several orders of magnitude greater than the risk level that is acceptable for the current or reasonably anticipated future land use, given realistic exposure scenarios.”

The COCs at Olin OU-2 are mercury, DDTR, and HCB. The following sections address these COCs as they relate to toxicity, mobility, and containment at Olin OU-2.

2.12.1 Human Health and Ecological Risk Summary

A HHRA was performed to evaluate the total risk from the COCs based on migration pathway, exposure routes, exposure concentrations, receptors, and geochemical and ecological factors. It was determined that carcinogenic risk from DDTR and HCB did not exceed the 1.0E-3 level discussed in the 1991 USEPA Guidance. The current carcinogenic risk to humans ranges from 2.0E-06 to 7.0E-06 and is within the EPA generally acceptable range. Potential future risk rises only to 3.0E-05 even if access is unrestricted by Olin, which is below the 1.0E-03 threshold that may be considered in making a principal threat waste determination. The non-carcinogenic risk from mercury is due to ingestion of mercury in fish tissue, not due to direct contact with sediment or water. Under a future use scenario, the non-carcinogenic risk to an adult consumer of fish is an estimated HI of 6. DDTR and HCB were negligible contributors to non-carcinogenic risk with maximum HQs of 0.2, and accounted for less than 5% of the total HI values in all scenarios. While the EPA has not verified an acute-based toxicity value for methylmercury, ATSDR does have a recommended Minimal Risk Level (MRL) of 0.0007 mg/kg-d for acute oral exposure to mercuric chloride (inorganic mercury). Since this value is 70 times the chronic RfD/MRL used in the Olin HHRA for methyl mercury, no health effects would be expected from an acute exposure to the dose calculated in the HHRA.

Using conservative methods of calculating risk, ecological risk associated with OU-2 is also low, with a maximum low-effects based HI of 10 for belted kingfisher modeled with a maximum dose scenario. Low-effects HI values ranged from 0.63 to 10, dependent upon receptor. Ingestion of mercury in fish tissue accounted for 70% of the HI for belted kingfisher, with ingestion of DDTR in fish tissue accounting for the remaining 30% of the HI. For little blue heron, the next most sensitive receptor, consumption of mercury and DDTR in prey items each accounted for roughly 50% of the HI. These HI values are based on potential chronic effects, and though an HI in excess of 1 is indicative of chronic risk, an HI less of 10 does not likely indicate the potential for acute risk. As with human health risk, ecological risk was driven largely by ingestion of COCs in the food-chain and not due to direct contact with COCs in sediment or water.

The source material is at the bottom of the Basin and Round Pond, 76 and 4 acres, respectively. Water depths range up to 40 feet in the Basin. The area is inundated by floodwaters from the Tombigbee River between fall and the end of spring each year. The consolidated sediment bed in the Basin and Round Pond are stable throughout various hydrodynamic events, such as wind-driven currents, or river flows during floods and it is highly unlikely that sediments below 6 inches would ever be mobilized or scoured. Therefore, a reasonable anticipated exposure to the submerged sediments is within the top 6 inches of consolidated bed sediment and suspended sediment.

2.12.2 Toxicity

Mercury is generally considered a toxic substance with the degree of toxicity dependent upon the form of mercury and concentration. Mercury was historically discharged to the Basin in the form of mercuric salts, not as elemental mercury. Mercury likely exists in the sediment and surface water as mercury (2+) and to a lesser degree as methylated mercury. Methylmercury comprised approximately 0.00736 to 0.136 percent of the total mercury species based on 2009 data, The maximum methylmercury percentage observed in all data collected from 2008 to 2010 was 0.29%, which was observed during the drought year of 2008.

DDTR and HCB concentrations in the sediment and floodplains soils do not pose an acute risk to human health or ecological receptors as documented in the human health risk assessment and ecological risk assessment. The HHRA determined that the quantitative risk from DDTR and HCB is orders of magnitude below the 10-3 level discussed in the 1991 USEPA Guidance for carcinogens, as shown below. Mercury is not considered a carcinogen and thus is not included in the carcinogenic risk evaluation.

Receptor Population	Carcinogenic Risk (Total Risk Across All Media)
Resident Trespasser, Adult (Current)	6×10^{-6}
Resident Trespasser, Adult (Future)	3×10^{-5}
Resident Trespasser, Pre-Adolescent/Adolescent (Current)	2×10^{-6}
Resident Trespasser, Pre-Adolescent/Adolescent (Future)	7×10^{-6}

The NCP discusses principal threat waste as having high concentrations of toxic compounds. The preamble of the NCP defines high concentrations of toxic compounds as "several orders of magnitude above levels that allow for unrestricted use and unlimited access." The principal threat waste fact sheet (USEPA, 1991) further refines these "levels" to mean risk-based levels. For OU-2, the mercury risk-based remedial goals generally fall within the range of 3 to 6 mg/kg total mercury in sediment. Two orders of magnitude greater than this clean-up range would be 300 to 600 mg/kg. Since 1991, 502 surface sediment samples, defined here as any sample within the top 6 inches of sediment, have been collected in OU-2. Since 1991, different depth intervals (e.g. 0 to 4 inches, 0 to 6 inches) have been designated as surface sediment samples. For purposes of this discussion, anything with the top 6 inches is defined here as "surface sediment" because this represents the most likely exposure horizon and bioturbation zone for ecological receptors in OU-2. Seven of the 502 surface sediment samples (1.4%) exceeded 300 mg/kg, and one sample (0.2%) exceeded 600 mg/kg, as listed below.

178 subsurface samples, defined as any depth interval below the top 6 inches of sediment, have been collected in OU-2, with three samples (1.7%) exceeding 300 mg/kg and no samples exceeding 600 mg/kg. Two of the three subsurface samples that exceeded 300 mg/kg were collected in 2009 in the deeper portion of the Basin (Locations SDCR-5 and SDCR-8), and occurred at sediment depths of 3 to 4 feet and 5 to 6 feet below sediment surface, respectively. The third subsurface sample that exceeded 300 mg/kg was not collected in the Basin, but was collected in the outfall ditch that carried runoff from the manufacturing facility. This sample was collected at a depth of 4 to 5 feet below the sediment surface.

Number of Samples Exceeding 300 mg/kg and 600 mg/kg for Mercury

Year	Total Number of Samples	# of Samples Exceeding 300 mg/kg	# of Samples Exceeding 600 mg/kg	Range of Concentrations (mg/kg)
Surface Sediment				
2006 - 2010	247	0	0	1 - 220
2001	76	5	0	3.4 - 590
1994 - 1995	31	1	1	0.07 - 780
1991 - 1992	148	1	0	0.13 - 329
Subsurface Sediment				
2009	110	2	0	0.02 - 440
2001	30	0	0	0.4 – 270
1995	6	0	0	0.35 – 161
1991-1992	32	1	0	0.19 - 329

Another interpretation of the NCP and fact sheet referenced above is that the exposure point concentration may be used to equate a COC concentration to a risk level. The 95 percent upper confidence limit (UCL) for mercury in sediment was used in the ecological and human health risk assessments as the exposure point concentration. The data collected amongst years, locations, and depths were combined to form 24 different exposure concentration scenarios. The 95 percent UCLs for mercury in sediment ranged from 20.5 to 70.7 mg/kg across the 24 scenarios. These values are less than the “several orders of magnitude” specified in the NCP (USEPA, 1990). In this scenario, high concentrations of toxic compounds are defined as those associated with risk above 10-3 and 95% UCLs. OU-2 sediment does not contain high concentrations of toxic compounds under this definition.

2.12.3 Mobility

Source material may be considered principal threat waste if it is able to migrate to groundwater, surface water, the air, or acts as a source for direct exposure. Amongst metal contaminants, mercury has a unique chemistry where mobility of mercury varies from highly immobile to highly mobile depending on the form of mercury present, and the existence of specific bio-geochemical conditions that promote methylation of inorganic mercury.

Mercury in surface water and sediment at OU-2 is mobile under current conditions due to biological and chemical transformation processes (methylation) that occur near the surface water-sediment interfaces of OU-2. Mercury transport potential is also high due to the suspended sediment loads present in OU-2 surface water. Available OU-2 data show that these suspended sediments contain bound mercury that can be transported offsite in surface water flowing from the Basin to the Tombigbee River. The geochemical and ecological factors that influence how mercury moves and changes form in the OU-2 environment can be changed which directly effects the methylation process and therefore the mobility. Mobility mechanisms associated with the potential for wind-driven resuspension, groundwater seepage, interchanges at the surface water-sediment interface, and variation in geochemical conditions is restricted to the Basin and Round Pond.

Water leaving the Basin through the gated discharge channel was collected during five flood events at varying elevations throughout the flood events in 2009 and 2010. The average dissolved mercury concentration was 0.00769 µg/L, which is less than the WQC of 0.012 µg/L. A mass balance indicated that the mercury concentration in the Tombigbee River at the confluence with the Basin would not exceed the WQC.

The mobility of mercury from sediment is also limited by the presence of an uncontaminated clay layer, which lies beneath the Basin and Round Pond. Cores within the sediment indicate a consistent layer of clay beneath the sediments. Some sandy zones within the clay or thin sand layers were noted in the cores, but these zones are not interconnected and clay was observed above and below these zones. Groundwater results from monitoring wells surrounding OU-2 show that mercury, DDTR, and HCB in sediments do not act as a continuing source to groundwater or the Tombigbee River via the groundwater pathway, because COC concentrations above screening levels were not detected in groundwater associated with OU-2. Core data collected within the Basin during the RI further support that mercury in sediment is not a continuing source to groundwater. The core results collected in 2010 indicate that mercury does not fully penetrate the sediment deposits. A pathway from the sediment to the underlying aquifer is not complete and is expected to remain incomplete.

HCB and DDTR have very limited solubility and would not be very mobile within OU-2, based on literature values for solubility (HCB solubility in water = 5 parts per billion; DDT solubility in water = 1.2 parts per billion in water). Mobility of these compounds within OU-2 is primarily due to movement of soil or sediment particles containing bound HCB or DDTR.

The volatility of non-elemental mercury, DDTR, and HCB are low so that volatilization to air is not a significant pathway. COCs in the sediments are not a source for migration to air.

2.12.4 Containment

Sediment caps have been approved by the EPA for remediation at many sites and are generally accepted as reliable containment for contaminated sediment. The Steady-State Model (Lampert and Reible, 2008), referred to as the Reible model, was used to evaluate whether a cap would be effective as an isolation barrier at OU-2. Varying cap materials were modeled under mid-level, less, and more conservative scenarios. The results show the sediments at OU-2 can be effectively isolated through in-situ capping.

2.12.5 Source Material

Source material is defined as a material that acts as a reservoir for migration of contamination to groundwater, to surface water, to air, or acts a source for direct exposure. Typical forms of source wastes identified in the NCP, such as liquid wastes, drums, tanks or free product are not present at OU-2. COCs in sediment and surface water do not act as a reservoir for migration to groundwater or air, as discussed above. Although sediment contamination is contributing to surface water contamination at the Site, it has not been shown to cause an exceedance of the WQC in surface water beyond the OU 2 boundaries, as shown in the 2009-2010 sampling of water discharge from OU-2.

2.12.6 Summary of Principal Threat Waste Analysis

The COCs in sediments at OU-2 are not highly mobile outside of OU-2, can be reliably contained, and do not pose an acute risk to human health or the environment. Although the mercury contaminated sediments meet the definition of a source material, the sediments do not contain elemental mercury and only a small percentage of the samples have mercury concentrations exceeding remedial goals by two orders of magnitude. These exceedances are widely scattered throughout the Basin and mercury concentrations in OU-2 have been shown to be very heterogeneous. Mercury, DDTR, and HCB can be reliably contained through effective capping. The conditions that favor mercury methylation are changed when capped because the geochemical conditions that favor methylation are changed. The EPA believes that mercury at OU-2 is unclassifiable as either a principal threat waste or low level threat waste. The principal threat waste characterization was not applied to DDTR and HCB in OU-2 because of the low mobility and toxicity of these compounds in OU-2.

2.13 SELECTED REMEDY

2.13.1 Summary of the Rationale for the Selected Remedy

Five alternatives for remediation of sediments at OU-2 were compared in the previous section. No Action (Alternative 1) will result in unacceptable risk to human health and the environment. Dredging (Alternative 3) can be expected to result in adverse short-term impacts, such as increases in fish tissue and surface water concentrations of mercury. Dredging may also not be effective in the long term based on the amount of resuspension and residual concentrations associated with dredging and debris removal. Dredging is also a more costly alternative. There is more certainty that in situ or dry capping or a combination of the two (Alternatives 2A, 2B, and 2C), will be protective of human health and the environment, will comply with ARARs, and would effectively isolate the sediment from humans and the environment. Preliminary model results, based on current information and assumptions discussed in the FS, predicted that capping would be effective in the long term. While the costs of in situ capping (Alternative 2A) are comparable to dry capping (Alternative 2C) or a combination of the two (Alternative 2B), there is less uncertainty with the implementation of Alternative 2A. Uncertainties associated with Alternatives 2B and 2C include disruption due to flooding.

Based on the information currently available, the EPA believes that Alternative 2A meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria.

2.13.2 Description of the Selected Remedy

- *Multi-layered Cap.* A multi-layered cap applied in-situ over the areas of sediment exceeding the sediment cleanup levels (Figure 39), approximately 80 acres. The cap will consist of three layers: 1) a mixing zone, 2) an effective cap material layer, and 3) a habitat layer. The cap materials and thickness will be determined during remedial design. Reactive materials may be used to reduce the potential for contaminants to migrate through the cap. The cap will meet the following criteria:
  - The cap material will be physically and chemically compatible with the environment in which it is placed.
  - In habitat areas, the uppermost layers of caps will be designed using suitable habitat materials and, if needed, armoring to prevent erosion. Cap thickness may vary due to gradient in the basin to prevent sloughing and erosion.
  - Geotechnical parameters will be evaluated to ensure compatibility among cap components, native sediment, and surface water
  - The placement method will minimize short-term risk from the release of contaminated pore water and resuspension of contaminated sediment

during cap placement.

- The cap material will immobilize the COCs and have a cap life of at least 100 years or more.

- *Additional Sampling and Analyses.* Additional sampling and analyses will be performed in the channel connecting Round Pond to the Basin and the perimeter of the Round Pond floodplain soils that are often inundated; and the former wastewater and discharge ditch to further refine the remedial footprint.

- *Institutional Controls*. ICs, including deed and use restrictions currently in place as a result of OU-1, will be amended to include the OU-2 remedial footprint and use restrictions. Also, engineering controls (ECs), such as warning signs, including fish advisory signage, fencing and security monitoring to restrict access and prevent exposures to human receptors. Water levels will be managed through the berm and gate system through the completion of construction to maintain a consistent water level for equipment mobility and limit the influence of flooding.

- *Construction Monitoring.* Construction monitoring will be designed to ensure design plans and specifications are followed in the placement of the cap and to monitor the extent of any contaminant releases during cap placement. Construction monitoring will likely include interim and post-construction cap material placement surveys, sediment cores, sediment profiling camera, and chemical resuspension monitoring for contaminants. In the initial period following cap construction, sediment samples will be taken to confirm the cleanup levels were achieved and benthic community assessment will be performed to evaluate restoration efforts.

- *Maintenance.* Maintenance of the in-situ cap will include the repair and replenishment of the layers where necessary to prevent releases of contaminants.

- *Long-Term Monitoring.* Long-term monitoring will include physical, chemical, and biological measurements in various media to evaluate long-term remedy effectiveness in achieving remedial action objectives (RAOs), attaining cleanup levels, and in reducing human health and environmental risk. In addition, long-term monitoring data is needed to complete the five-year review process.

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- Depending on the results of this characterization, these areas may require installation of a cap

Because this Remedy will result in hazardous substances, pollutants, or contaminants remaining on-Site above levels that allow for unlimited use and unrestricted exposure, a CERCLA statutory review would be conducted every five years after the completion of remediation to ensure that the remedy is, or will be, protective of human health and the environment.

2.13.3 Summary of the Estimated Costs

The Selected Remedy, Alternative 2A's estimated cost is $13,400,000 - $21,500,000. The cost range is based upon different reactive materials, containing sequestering materials, that may be used to reduce the potential for contaminants to migrate through the cap. Table 30 shows the estimated cost summary for the Selected Remedy. The cost summary is based on the capital and annual operating and maintenance cost to implement the remedy. The information in the cost summary is based on the best available information regarding the anticipated scope of the selected remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Changes in cost for the selected remedy may be documented in the Remedial Design, an Explanation of Significant Differences, or an Amendment to the ROD depending upon NCP requirements for the change in question. Net present values are estimated using a discount rate of 7% and an operating period of 30 years. Costs incurred beyond the 30 years were negligible for this project. The accuracy of the cost estimates shall be within +50 percent to -30 percent.

2.13.4 Expected Outcomes of the Selected Remedy

The remedial action objectives address the exposure pathways and contaminant levels in the exposure media. The Selected Remedy, Alternative 2A, is expected to achieve the RAOS with the completion of the cap placement and natural replacement of the current generation of fish. The RAOs are designed to allow the reduction of mercury, HCB, and DDTR levels in sediments, soils, biota and surface water such that the overall risk throughout the Olin Basin will approach that which would be present but for the historic Olin McIntosh Plant discharges to the Basin. Recovery, which is estimated to occur in 10 years, will be achieved when mercury, DDTR, and HCB levels in biota in the Olin Basin are low enough to be protective of human health and not pose an unacceptable ecological risk. The EPA has selected Alternative 2A because it is expected to achieve substantial and long-term risk reduction through isolation and immobilization of COCs, and is expected to allow the property to be used for the reasonably anticipated future land use, which is fish and wildlife. OU-2 as seasonally-flooded wetlands, and as such, is not suitable for human habitation. More than 95 percent of OU-2 is subject to flooding by the Tombigbee River. Under ADEM's Water Quality Program, the water use classification for the Tombigbee River in the vicinity of the Olin Basin is Fish and Wildlife.

Unacceptable risk to the community is not anticipated during remedial activities. Engineering controls such as appropriate PPE will be employed to mitigate short-term risks during construction. Short-term impacts to the Basin/Round Pond habitat are expected with the capping alternative. Placement of cap materials could bury benthic organisms, which could impact feeding of upper trophic level animals, such as some fish and bird species. Placement of cap materials may also bury large, woody debris, thus limiting habitat, cover, and food for aquatic species. These impacts are expected to be temporary. Benthic organisms would recolonize the habitat layer of the cap. A temporary increase in turbidity associated with the fine material in the cap material is expected during cap placement, but this turbidity increase would not be excessive and would be controlled through the application rate and placement method of the cap. The short-term adverse effects of capping would be temporary and manageable.

The cleanup levels for each medium (i.e., contaminant specific cleanup levels, basis for cleanup levels, and risk at cleanup levels (if appropriate) are presented in Table 29. The cleanup levels are summarized in the following table.

Cleanup Levels	
Sediment	
Chemical of Concern	**Cleanup Level**
Mercury	3 mg/kg
HCB	7.6 mg/kg
DDTR	0.21 mg/kg
Surface Water	
Chemical of Concern	**Cleanup Level**
Mercury (dissolved)	0.012 ug/L
DDTR	0.0001 ug/L
HCB	0.0002 ug/L
Floodplain Soil	
Chemical of Concern	**Cleanup Level**
Mercury	1.7 mg.kg
DDTR	0.63 mg/kg
Fish Tissue	
Chemical of Concern	**Cleanup Level**
Mercury	0.2 mg/kg (mosquitofish whole body) 0.3 mg/kg (largemouth bass fillet) 0.28 mg/kg (largemouth bass whole body)
DDTR	0.23 mg/kg (mosquitofish whole body) 0.64 mg/kg (largemouth bass whole body)

2.14 STATUTORY DETERMINATIONS

The remedial action selected for implementation at the Olin OU-2 Site is consistent with CERCLA and, to the extent practicable, the NCP. The Selected Remedy for Olin OU-2 is protective of human health and the environment, will comply with ARARs and is cost effective. In addition, the Selected Remedy utilizes permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable, and although it does not satisfy the statutory preference for treatment, the Selected Remedy does significantly reduce the mobility and toxicity that could be considered as a principal threat. Capping of mercury contaminated sediments has been demonstrated to be reliable for this type of contamination and provides an element of treatment to reduce mobility and toxicity (bioavailability) through physical isolation, stabilization, and chemical immobilization of the contaminants under the cap.

2.14.1 Protection of Human Health and the Environment

An in situ cap serves as a barrier separating other media and potential ecological receptors from exposure to COCs in the sediment, thereby reducing risk. Risk to piscivorous birds stems from ingestion of fish exposed to mercury or DDTR in sediments. A cap would prevent fish exposure to the COCs in sediments and diffusion into surface water. Fish tissue mercury and DDTR concentrations would meet the EPA recommended fish tissue concentration consumption guideline once the current generations of fish have naturally expired. Risk to piscivorous mammals stems from incidental ingestion of HCB-contaminated sediments. A cap would provide a barrier between the piscivorous mammals and the contaminated sediments, eliminating their exposure pathway. ICs and ECs currently in place would be modified and would achieve the RAO to reduce or mitigate the current potential risk to humans from ingestion of fish. .

2.14.2 Compliance with ARARs

Section 121(d) of CERCLA, as amended, specifies, in part, that remedial actions for cleanup of hazardous substances must comply with requirements and standards under federal or more stringent state environmental laws and regulations that are applicable or relevant and appropriate (*i.e.*, ARARs) to the hazardous substances or particular circumstances at a site or obtain a waiver under CERCLA Section 121(d)(4). *See also* 40 C.F.R. § 300.430(f)(1)(ii)(B). ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker protection requirements. Compliance with OSHA standards is required by 40 C.F.R. § 300.150 and therefore the CERCLA requirement for compliance with or wavier of ARARs does not apply to OSHA standards.

Under CERCLA Section 121(e)(1), federal, state, or local permits are not required for the portion of any removal or remedial action conducted entirely on-site as defined in 40 C.F.R. § 300.5. *See also* 40 C.F.R. §§ 300.400(e)(1) & (2). Also, on-site CERCLA response actions must only comply with the “substantive requirements,” not the administrative requirements of a regulation. Administrative requirements include permit applications, reporting, record keeping, and consultation with administrative bodies. Although consultation with state and federal agencies responsible for issuing permits is not required, it is recommended for determining compliance with certain requirements such as those typically identified as Location-specific ARARs.

In accordance with 40 C.F.R. § 300.400(g)(5), the EPA and State of Alabama have identified the ARARs and TBCs for the selected remedy. Table 31-33, lists respectively, the Chemical-specific, Location-specific and Action-specific ARARs for the selected remedy. The Selected Remedy is expected to attain all identified ARARs and a statutory waiver is not necessary. *See* 40 C.F.R. § 300.430(f)(5)(ii)(B).

2.14.3 Cost Effectiveness

In the EPA’s judgment, the Selected Remedy is cost-effective because the remedy’s costs are proportional to its overall effectiveness (see 40 CFR 300.430(f)(1)(ii)(D)). This determination was made by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (i.e., that are protective of human health and the environment and comply with all federal and any more stringent ARARs, or as appropriate, waive ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria -- long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness, in combination. The overall effectiveness of each alternative then was compared to the alternative's costs to determine cost-effectiveness. The relationship of the overall effectiveness of the selected remedial alternative was determined to be proportional to its costs and hence represents a reasonable value for the money to be spent.

2.14.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The NCP establishes an expectation that the EPA will use treatment to address the principal threat posed at a site wherever practicable (Section 300.430(a)(1)(iii)[A]). In practice, the "principal threat" concept is applied by the EPA to the characterization of "source materials" at a Superfund site. A source material includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to ground water, surface water or air, or acts as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. The Olin OU-2 mercury contaminated sediments are not readily classifiable as principal threat wastes despite the inherent toxicity of mercury and demonstrated mobility which has contaminated surface water. However, capping alternatives have been demonstrated to be reliable containment remedies for this type of contamination.

The selected remedy for OU-2 does not satisfy the statutory preference for treatment as a principal element of the remedy. Because of the relatively high volume of sediments involved, and the concentrations of mercury involved, treatment of sediments was not considered practical. The toxicity, mobility and volume of mercury in sediments will be significantly reduced through physically and chemically isolating the contaminated sediments from the aquatic environment. In-situ caps are generally accepted as reliable containment for contaminated sediment.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-Site above levels that allow for unlimited use and unrestricted exposure, a CERCLA statutory review is required and will be conducted every five years after initiation of remediation to ensure that the remedy is, or will be, protective of human health and the environment. Based upon the results of those reviews, as well as on-going monitoring, modifications to the Selected Remedy may be required to ensure remedy effectiveness and protection of human health and the environment.

2.15 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan was released for public comment in May 2014. It identified Alternative 2A, in-situ capping, as the Preferred Alternative for contaminated sediments and soils; and presented cleanup levels or remedial goals for COCs. During the public comment period, the EPA received comments and additional fish data from Olin that resulted in additional evaluation of the RGs and the selection of cleanup levels.

The ecological RGs presented in the Proposed Plan were selected based upon the RGO Report, which was prepared in accordance with the EPA ecological risk assessment methodologies and is consistent with the NCP and the EPA guidance documents or other scientific literature. The following table presents the cleanup levels selected in the ROD and whether modifications were made to the RG ranges and cleanup levels presented in the Proposed Plan. The EPA evaluation that resulted in modifications to the RGs presented in the Proposed Plan is documented in Appendix 1 of this ROD.

Sediment		
Mercury	3 mg/kg	Same as Proposed Plan
HCB	7.6 mg/kg	Same as Proposed Plan
DDTR	0.21 mg/kg	0.33 – 1.7 mg/kg in Proposed Plan
Surface Water		
Mercury (dissolved)	0.012 ug/L	Same as Proposed Plan
DDTR	0.0001 ug/L	Not in Proposed Plan
HCB	0.0002 ug/L	Not in Proposed Plan
Floodplain Soil		
Mercury	1.7 mg/kg	Not in Proposed Plan
DDTR	0.63 mg/kg	0.039 – 0.25 mg/kg in Proposed Plan
Fish Tissue		
Mercury	0.2 mg/kg (mosquitofish/silverside) 0.3 mg/kg (largemouth bass fillet) 0.28 mg/kg (largemouth bass whole body)	Not in Proposed Plan Same as Proposed Plan Not in Proposed Plan
DDTR	0.23 mg/kg (mosquitofish/silverside) 0.64 mg/kg (largemouth bass)	Not in Proposed Plan Same as Proposed Plan

Fish Tissue RGs

Although the RGO Report developed sediment RGs for a variety of piscivorous wildlife to reduce their risk from exposure to chemicals of concern through ingestion of contaminated media, the RGO report did not develop RGs to protect fish from the COCs they accumulate in their bodies through bioaccumulation and direct exposure to water and sediment. Because the Proposed Plan did not present fish tissue RGs for protection of ecological receptors (fish and piscivorous wildlife), the fish tissue RGs based on protection of ecological receptors are summarized below.

Mercury in Fish Tissue

The fish tissue mercury RG range (0.11 mg/kg – 0.58 mg/kg) based on protection of piscivorous wildlife was presented in the RGO report, but was not presented in the Proposed Plan. The mercury cleanup level for whole body forage fish based on protection of piscivorous birds falls within the RG range presented in the RGO report. The mercury RG for whole body predatory fish is based on protection of fish themselves, and was not presented in either the RGO Report or the Proposed Plan. Derivation of RGs for whole body forage fish and whole body predatory fish are detailed in Appendix 1 of the ROD.

Cleanup Levels Selected:

- Mercury in whole body forage fish: 0.20 mg/kg based on protection of piscivorous birds feeding on forage fish
- Mercury in whole body predatory fish: 0.28 mg/kg based on protection of predatory fish

DDTR in Fish Tissue

Ecological RGs for DDTR in fish tissue are based on protection of fish in OU-2, and were not presented in either the RGO Report or the Proposed Plan. The DDTR whole body fish tissue level of 0.64 mg/kg in tissues of predatory fish and 0.23 mg/kg in tissues of forage fish, is based on protection of predatory fish. The derivation of the DDTR RGs based on protection of fish is detailed in Appendix 1 of the ROD.

Cleanup Levels Selected:

- DDTR in whole body forage fish: 0.23 mg/kg based on protection of predatory fish feeding on forage fish
- DDTR in whole body predatory fish: 0.64 mg/kg based on protection of predatory fish

Sediment RGs for DDTR

The EPA re-evaluated sediment RGs for DDTR based on the fish tissue RGs. As result of the evaluation, the EPA determined that the sediment level needed to be protective of predatory fish is 0.21 mg/kg. Site-specific bioaccumulation relationships developed for fish at Olin OU-2 suggest that a sediment DDTR concentration of 0.21 mg/kg results in a protective fish tissue concentration of 0.64 mg/kg. The RG range presented in the Proposed Plan was 0.33 – 1.7 mg/kg.

Surface Water RGs for DDTR and HCB

In the Proposed Plan, the RAO includes a statement that the surface water will be restored to meet water quality standards. A numeric standard was presented for mercury, but not for the other COCs. For clarification, the EPA added the numeric standards for DDTR and HCB.

Floodplain Soil RG for Mercury

The floodplain mercury RG range (1.1 mg/kg – 1.9 mg/kg) based on protection of insectivorous birds was presented in the RGO report, but was not presented in the Proposed Plan. The mercury cleanup level for floodplain soil based on protection of insectivorous birds falls within the range presented in the RGO report.

Floodplain Soil RG for DDTR

The RGO report derived RGs for floodplain soil based on risk to insectivorous birds, as represented by Carolina wren. TRVs used to derive RGs for the wren were selected from the information presented in the EPA Eco-SSL guidance for DDTR (EPA, 2007), and were the same TRVs used to derive RGs for piscivorus birds at OU-2. The TRVs selected for evaluation of piscivorous birds were based on analysis of data considering all toxicological endpoints, including egg-shell thinning. However, egg-shell thinning does not appear to be an important mechanism for reproductive impairment in terrestrial birds other than raptors, so use of this as a toxicological endpoint for RG development for terrestrial songbirds is not appropriate. Based on evidence that suggests that eggshell thinning is not a relevant toxicological endpoint for songbirds, the EPA re-evaluated the TRVs and determined that the soil level needed to be protective is 0.63 mg/kg. The RG range presented in the Proposed Plan was 0.039 – 0.25 mg/kg. The derivation of the DDTR RG for floodplain soil to be protective of insectivorous birds is detailed in Appendix 1 of the ROD.

PART 3

PART 3: REFERENCES

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TABLES

NOTICE

Data are used for reference purposes only. U.S. EPA makes no warranty or guarantee as to the content (the source is often third party), accuracy, timeliness, or completeness of any of the data provided, and assumes no legal responsibility for the information contained in these tables.

Table 1. Data Use Matrix for Current Olin OU-2 Reports

	2010 Groundwater Report	2011 RI Addendum	2011 Update ERA	2011 Updated HHRA	2012 RGO Report	2012 FS	Post-FS Data Usage (not included in previous reports)	Remarks
Surface Sediment								
1991/1992	--	⊙	⊙	--	◆	⊙	--	Qualitative use of DDTR & HCB data; data was collected in a phased approach that began in 1991 and extended into 1992
1994	--	⊙	◆	--	◆	--	--	Used for determining BSAFs for vertebrate prey collected in 1994
1995	--	⊙	⊙	--	--	--	--	
2001	--	⊙	◆	--	◆	--	--	Used for determining BAFs/BSAFs for aquatic insects collected in 2001
2006	--	◆	⊙	⊙	◆	◆	--	Sediment discussed qualitatively for HHRA because Region 4 considers incomplete exposure pathways to sediment
2008	--	◆	◆	⊙	◆	◆	--	Sediment discussed qualitatively for HHRA because Region 4 considers incomplete exposure pathways to sediment
2009	◆	◆	◆	⊙	◆	◆	--	Sediment discussed qualitatively for HHRA because Region 4 considers incomplete exposure pathways to sediment
Subsurface Sediment								
1991/1992	--	--	--	--	--	⊙	--	
1995	--	--	--	--	--	⊙	--	
2009	◆	◆	--	--	--	◆	--	
Floodplain Soil								
1991/1992	--	⊙	⊙	⊙	--	--	--	
1994	--	⊙	⊙	⊙	--	--	--	
2010	--	◆	◆	◆	◆	◆	--	
Surface Water								
1991	--	--	◆	◆	--	--	--	1991 used for HCB and DDTR HHRA exposures
1994	--	--	◆	◆	--	--	--	1994 used for HCB and DDTR HHRA exposures
1995	--	--	--	--	--	--	--	
2006	--	--	--	--	--	--	--	
2008	--	◆	◆	◆	◆	◆	--	Hg and MeHg
2009	--	◆	◆	◆	◆	◆	--	Hg and MeHg
2010	--	--	--	--	--	--	--	
Surface Water (Gate Overflow)								
2009-2010	--	◆	--	--	--	◆	--	
Pore Water								
1995	--	--	--	--	--	--	--	
2009	--	◆	--	--	--	◆	--	
Groundwater								
1991	--	--	--	--	--	--	--	
2008	◆	◆	--	--	--	◆	--	

Table 1. Data Use Matrix for Current Olin OU-2 Reports (continued)

	2010 Groundwater Report	2011 RI Addendum	2011 Update ERA	2011 Updated HHRA	2012 RGO Report	2012 FS	Post-FS Data Usage (not included in previous reports)	Remarks
Fish Tissue								
Largemouth Bass (whole body)								
1991	--	⊙	--	--	--	--	--	
1994	--	⊙	--	--	--	--	--	
2001	--	⊙	--	--	--	--	--	
2008	--	◆	◆	--	◆	--	--	
2010	--	--	--	--	--	--	◆	2010 LMB data used to refine remedial goals for Great Blue Heron post FS
Largemouth Bass Fillet								
1986	--	--	--	--	--	--	--	
1991	--	⊙	--	--	--	--	--	
2001	--	⊙	--	◆	--	--	--	Used to develop exposure point concentration for DDTR
2003	--	⊙	--	--	--	--	--	
2006	--	◆	--	--	--	--	--	
2007	--	◆	--	--	--	--	--	
2008	--	◆	--	◆	--	--	--	Used to develop exposure point concentrations for Hg and HCB
2010	--	--	--	--	--	--	◆	2010 fillet data used qualitatively post FS to estimate sediment levels protective of human health
Bluegill (whole body)								
1995	--	--	--	--	--	--	--	
2008	--	◆	◆	--	◆	--	--	Used to develop exposure point concentrations for Hg and HCB
2010	--	--	--	--	--	--	◆	2010 bluegill data used to refine BSAF models for forage fish to derive remedial goals post-FS
Mosquitofish (whole body composites)								
1994	--	--	--	--	--	--	--	
2001	--	⊙	◆	--	◆	--	--	Used to develop exposure point concentration for DDTR
Silversides (whole body composites)								
2008	--	◆	◆	--	◆	--	--	Used to develop exposure point concentrations for Hg and HCB
2010	--	--	--	--	--	--	◆	2010 silversides data used to refine BSAF models for forage fish to derive remedial goals post-FS

Table 1. Data Use Matrix for Current Olin OU-2 Reports (continued)

	2010 Groundwater Report	2011 RI Addendum	2011 Update ERA	2011 Updated HHRA	2012 RGO Report	2012 FS	Post-FS Data Usage (not included in	Remarks
Other Biota								
Aquatic Insects								
1994	--	⊙	--	--	--	--	--	
1995	--	⊙	--	--	--	--	--	
2001	--	⊙	◆	--	◆	--	--	
Terrestrial Insects and Spiders								
1994	--	⊙	◆	--	◆	--	--	
1995	--	⊙	◆	--	◆	--	--	
2010	--	◆	◆	--	◆	--	--	
Crayfish								
1994	--	⊙	◆	--	◆	--	--	
Bull Frogs								
1994	--	⊙	◆	--	◆	--	--	
Mussels								
1994	--	--	--	--	--	--	--	
Raccoon and Little Blue Heron (whole body)								
1994	--	⊙	◆	--	◆	--	--	
Terrestrial Vegetation								
2010	--	◆	◆	--	◆	--	--	

Note: Symbols denote ◆ Data used Quantitatively; ⊙ Data used Qualitatively; -- Data not used

Table 2. Analytical Results Summary for Historical Surface Water, Sediment, and Soil Samples

Surface Water	Range of Concentrations - 1991 shallow samples	Range of Concentrations - 1991 deep samples	Range of Concentrations - 1992	Range of Concentrations - 1994	Range of Concentrations - 1995 surface samples	Range of Concentrations - 1995 bottom samples	Range of Concentrations - 2001
Mercury (unfiltered)	0.26 - 1.5 µg/L	0.45 - 1.8 µg/L	na	0.23 - 3.6 µg/L	0.447 - 1.65 µg/L	0.451 - 4.61 µg/L	na
Mercury (filtered)	<0.2 µg/L	<0.2 µg/L	na	na	0.00642 - 0.0367 µg/L	0.00720 - 0.0118 µg/L	na
Methylmercury (unfiltered)	na		na	na	0.00245 - 0.00431 µg/L	0.00409 - 0.0121 µg/L	na
Methylmercury (filtered)	na		na	na	0.000359 - 0.000576 µg/L	0.000233 - 0.00174 µg/L	na
Dissolved Oxygen	5 - 10.5 mg/L	3.1 - 6.4 mg/L	na	na	4.7 - 8.0 mg/L	0.1 - 5.7 mg/L	na
Dissolved Organic Carbon	na		na	na	na	3.7 - 7.0 mg/L	na
4,4'-DDD	<0.1 µg/L		na	0.0286 - 0.092 µg/L	na		na
Pesticides 4,4'-DDE	<0.1 µg/L		na	0.018 - 0.0983 µg/L	na		na
4,4'-DDT	<0.1 µg/L		na	<0.00047 - 0.0082 µg/L	na		na
Hexachlorobenzene	<10 µg/L		na	0.00313 - 0.0442 µg/L	na		na
pH	7.2 - 8.79	7.07 - 7.66	na	na	7.1 - 8.4	6.5 - 7.8	na
Specific Conductance	1.94 - 2.13 mS/cm	2.06 - 2.19 mS/cm	na	na	na	na	na
Temperature	28.6 - 34.9 °C	28.5 - 29.3 °C	na	na	29.7 - 32.2 °C	27.8 - 30.5 °C	na
Iron	na		na	na	0.284 - 0.452 mg/L	na	na
Manganese	na		na	na	0.083 - 0.259 mg/L	na	na
Total Organic Carbon	6.1 - 15.8 mg/L	5.6 - 8.9 mg/L	na	na	na	4.0 - 6.0 mg/L	na

Surficial Sediment	Range of Concentrations - 1991	Range of Concentrations - 1992	Range of Concentrations - 1994	Range of Concentrations - 1995	Range of Concentrations - 2001
Mercury	<0.19 - 290 mg/kg dw	na	18.6 - 113 mg/kg dw	0.844 - 780 mg/kg dw	3.4 - 590 mg/kg dw
Methylmercury	na	na	na	0.00191 - 0.255 mg/kg dw	na
Methylmercury %	na	na	na	0.012 - 0.267%	na
Total Sulfate	<130 - 1,360 mg/kg dw	na	na	na	na
Total Sulfide	259 - 2,830 mg/kg dw	na	na	na	na
DDTr	0.272 - 6.9 mg/kg dw	na	0.67 - 4.01 mg/kg dw	na	0.082 - 25.9 mg/kg dw
DDTR	0.775 - 11.8 mg/kg dw	na	1.41 - 7.14 mg/kg dw	na	0.16 - 51.0 mg/kg dw [1]
Pesticides 4,4'-DDD	0.12 - 1.8 mg/kg dw	na	na	na	na
4,4'-DDE	0.1 - 1.4 mg/kg dw	na	na	na	na
4,4'-DDT	0.052 - 4 mg/kg dw	na	na	na	na
Hexachlorobenzene	<0.67 - 265 mg/kg dw	na	na	na	<0.01 - 53 mg/kg dw
Total Organic Carbon	6,000 - 80,500 mg/kg dw	na	3,220 - >16,000 mg/kg dw	5,600 - 53,300 mg/kg dw	2,600 - 170,000 mg/kg dw
pH	6.93 - 7.37	na	na	na	na

Floodplain Soils	Range of Concentrations - 1991	Range of Concentrations - 1992	Range of Concentrations - 1994	Range of Concentrations - 1995	Range of Concentrations - 2001
Mercury	na	<0.15 J - 6.6 J mg/kg dw	2.7 - 25 mg/kg dw	na	24 - 480 mg/kg dw
2,4'-DDD	na	na	0.0327 D - 28 mg/kg dw	na	0.2 - 1.7 mg/kg dw
2,4'-DDE	na	na	0.163 D - 43 mg/kg dw	na	1.5 - 5.7 mg/kg dw
2,4'-DDT	na	na	0.0269 D - 27 mg/kg dw	na	0.032 - 0.096 mg/kg dw
Pesticides 4,4'-DDD	na	na	0.0326 D - 11 mg/kg dw	na	0.34 - 2.4 mg/kg dw
4,4'-DDE	na	na	0.413 D - 41 mg/kg dw	na	1.2 - 4.9 mg/kg dw
4,4'-DDT	na	na	0.0199 D - 31 mg/kg dw	na	0.12 - 0.36 mg/kg dw
DDTr	na	na	0.52 - 83 mg/kg dw	na	1.66 - 7.66 mg/kg dw
DDTR	na	na	0.739 - 177 mg/kg dw	na	3.36 - 15.1 mg/kg dw
Hexachlorobenzene	na	<0.5 - 2.7 mg/kg dw	0.051 - 0.67 mg/kg dw	na	0.032 - 0.16 mg/kg dw
Total Organic Carbon	na	na	na	na	48,000 - 130,000 mg/kg dw

Notes:

°C - degrees Celsius
D - sample was diluted
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethylene
DDT - dichlorodiphenyltrichloroethane
DDTr - sum of 4,4' - isomers DDT, DDD, DDE
DDTR - sum of 2,4' - and 4,4' - isomers DDT, DDD, DDE
dw - dry weight
J - estimated

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
mS/cm - milliSiemens per centimeter
na - not analyzed for this constituent
µg/L - microgram per liter
< - less than the reporting limit
% - percent
Ranges reported for surficial sediment samples include samples collected within the upper 6 inches.
[1] - Where only DDTr was reported, an estimate of DDTR is provided based on a ratio of DDTR to DDTr where both are available (DDTR = DDTr*1.97).

Table 3. Floodplain Soil Analytical Results (year 2010)

Analyte	Number of Samples	Units[2]	2010 Range of Concentrations	Mean Concentration	Median Concentration
Grain Size					
Gravel	3	%	0.06 - 2.5	1.5	1.3
Sand	3	%	3.3 - 24.7	13	11
Silt/Clay/Colloids	3	%	72.8 - 95.4	85.7	88.9
Total Organic Carbon	39	mg/kg	4,200 - 298,000	36,800	26,300
Percent Solids	39	%	15.1 - 78.3	60.5	63
Mercury	39	mg/kg	0.061 - 8.9	0.98	0.37
Methylmercury	12	mg/kg	0.000176 - 0.00822	0.00275	0.002
Hexachlorobenzene	8	mg/kg	<0.00076 - 3.5	0.437	0.0057
DDTR	15	mg/kg	0.0011 - 2.21	0.43	0.055

Table 4. Sediment Data Summary by Transect

TABLE 3
SEDIMENT DATA S[illegible]ONCENTRATIONS, 2009
Feasibility Study
Olin McIntosh OU-2

Analysis	Transect: Round Pond (n=6)	5 (North, n=10)	0 (Northeast, n=1)[1]	Deeper Portion of Basin (n=1)	4 (North-central, n=4)	1 (Central, n=14)	2 (South-central, n= 13)	3 (South, n=8)
Mercury, Total (mg/kg dw)	22.6 (14.1 - 32.1)	54.3 (24.7 - 112)	38.3	29.1	26.6 (18.9 - 35.7)	38.3 (22.6 - 77.6)	57.0 (7.1 - 116)	13.8 (2.01 - 20.9)
Methylmercury (mg/kg dw)	0.00562 (0.00451 - 0.00640)	0.0115 (0.00310 - 0.0238)	0.00487	0.00431	0.00944 (0.00286 - 0.0257)	0.00615 (0.00265 - 0.0212)	0.00721 (0.00219 - 0.0128)	0.00465 (0.00142 - 0.00756)
% Methylmercury	0.0265 (0.0140 - 0.0379)	0.0223 (0.0100 - 0.0736)	0.0127	0.0148	0.0442 (0.0116 - 0.136)	0.0187 (0.00763 - 0.0918)	0.0152 (0.00736 - 0.0425)	0.0406 (0.0161 - 0.0706)
AVS/SEM ratio	47.1 (27.0 - 69.9)	NA	32.0	80.4	40.5	57.0 (18.7 - 99.0)	67.0 (12.3 - 156)	27.4 (9.93 - 55.6)
Grain Size (%)								
Clay	48.0 (40.6 - 56.1)	38.6 (<0.01 - 54.9)	36	66	37.3 (25.6 - 54.8)	39.6 (32.9 - 54.9)	23.0 (9.4 - 35.6)	14.3 (2.7 - 28)
Silt	48.8 (41.6 - 57.2)	49.6 (44.6 - 56.1)	60.9	34	55.3 (36.4 - 70.8)	56.7 (44.9 - 64.4)	51.9 (34.2 - 66.8)	53.2 (13.2 - 68.4)
Sand	3.0 (1.7 - 6.3)	11.7 (0.1 - 50)	3.1	< 0.01	7.4 (1.4 - 15.6)	3.6 (0.2 - 14.5)	24.9 (2.6 - 56.2)	32.5 (4.3 - 84.1)
Gravel	< 0.01	0.1 (<0.01 - 0.6)	< 0.01	< 0.01	0.1 (<0.01 - 0.5)	0.2 (<0.01 - 2.7)	0.2 (<0.01 - 1.3)	< 0.01
Bulk Density (g/cm^3 dw)	1.13 (1.07 - 1.19)	NA	1.21	1.13	1.31	1.17 (0.921 - 1.32)	1.45 (1.13 - 2)	1.55 (1.38 - 1.77)
Percent Moisture	79.1 (77.4 - 81.4)	68.2 (<0.1 - 78)	70	79.6	76.0 (74.2 - 77.6)	71.7 (68.8 - 78.3)	52.3 (33.1 - 70.6)	40.1 (30.5 - 59.7)
Pesticides (mg/kg dw)								
4,4'-DDD	0.0438 J	NA	NA	NA	<0.0147	0.0541	0.172	0.259
4,4'-DDE	0.0509 J	NA	NA	NA	0.019	0.0839	0.191	0.480
4,4'-DDT	0.0292 J	NA	NA	NA	<0.0147	< 0.0252	0.0368	<0.0569
2,4'-DDD	0.0325 J	NA	NA	NA	0.0099	0.0394	0.233	0.336
2,4'-DDE	0.0652 J	NA	NA	NA	0.0311	0.128	0.507	1.60
2,4'-DDT	<0.0085	NA	NA	NA	<0.0074	<0.0126	<0.0067	<0.0284
DDTr	0.124	NA	NA	NA	0.0190	0.138	0.400	0.739
DDTR	0.222	NA	NA	NA	0.0600	0.305	1.14	2.68
Hexachlorobenzene (mg/kg dw)	NA	NA	NA	NA	0.0267 (0.0221 - 0.0313)	NA	2.49 (0.628 - 5.97)	4.45 (<0.0069 - 8.90)
Sulfate, Total (mg/kg dw)	< 2,200	NA	<1,660	< 2,440	NA	< 1,850	<1,650	NA
Sulfide, Total (mg/kg dw)	2,100	NA	1,600	3,300	NA	2,500 J	1,200 (800 - 1,600)	NA
TOC (mg/kg dw)	32,000 (29,000 - 39,000)	29,000 (12,600 - 53,600)	16,300	14,400	22,300 (2,630-60,500)	16,900 (10,700 - 57,700)	5,730 (644 - 10,600)	5,120 (1,550 - 11,200)
ORP (mV)	-372 (-382 - -360)	-380 (-397 - -352)	-393	-393	-433 (-440 - -423)	-381 (-417 - -314)	-365 (-419 - -296)	-361 (-410 - -165)
pH	6.75 (6.29 - 6.91)	6.75 (6.63 - 6.91)	7.20	6.55	7.36 (6.81 - 8.81)	6.84 (6.59 - 7.01)	7.00 (6.65 - 7.19)	6.93 (6.81 - 7.00)
Temperature (°C)	23.3 (22.5 - 24.2)	24.5 (22.6 - 27.8)	22.9	24.4	26.1 (24.9 - 26.6)	25.2 (22.4 - 28.3)	25.4 (23.8 - 26.5)	25.9 (22.9 - 27.9)

Notes:

°C - degree Celsius
AVS/SEM - ratio of acid-volatile sulfide to simultaneously extracted metals. One half of the reporting limit was used in this calculation when analytical results were less than the reporting limit.
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethylene
DDT - dichlorodiphenyltrichloroethane
DDTr - sum of 4,4'-isomers of DDD, DDE, and DDT. Zero was used in this calculation when analytical results were less than the reporting limit.
DDTR - sum of 4,4'-DDD; 4,4'-DDE; 4,4'-DDT, 2,4'-DDD; 2,4'-DDE; and 2,4'-DDT. Zero was used in this calculation when analytical results were less than the reporting limit.
dw - dry weight
g/cm^3 - gram per cubic centimeter
J - estimated concentration based on data quality evaluation or result between method detection limit and reporting detection limit
mg/kg - milligram per kilogram
mV - millivolt
n - number of samples analyzed for mercury
NA - not analyzed
ORP - oxidation-reduction potential
TOC - total organic carbon
% - percent
< - less than the reporting limit.
[1]Location between northern and north-central transect.
Round Pond - samples OU2R-SED-101 and 102
Transect 5 - samples OU2B-SED-501 and 502
Transect 0 - sample OU2B-SED-004
Deep hole - sample OU2B-SED-DH

Table 5. Sediment Core Analytical Results – Coarse Cores

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
0 - 1 ft	Grain Size					
	Gravel	13	%	0 - 0.5	0.04	0
	Sand	13	%	0.5 - 63.3	7.4	2.2
	Silt/Clay/Colloids	13	%	36.8 - 99.4	92.6	97.6
	Percent Solids	11	%	15.1 - 78.3	35.2	29
	Mercury	10	mg/kg	0.03 - 121	49.6	23
	Hexachlorobenzene	4	mg/kg	<0.034 - 330	82.8	1.3
	DDTR	4	mg/kg	<0.05 - 156	0.63	0.48

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
1 - 2 ft	Grain Size					
	Gravel	13	%	0 - 0	0	0
	Sand	13	%	0.1 - 49.2	5.4	1.3
	Silt/Clay/Colloids	13	%	50.9 - 99.9	94.6	98.8
	Percent Solids	16	%	25 - 64	39	35
	Mercury	13	mg/kg	0.14 - 170	29.3	47.3
	Hexachlorobenzene	4	mg/kg	<0.035 - 320	80	0.063
	DDTR	4	mg/kg	<0.1 - 1.01	0.485	0.39

Table 5. Sediment Core Analytical Results – Coarse Cores (continued)

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
2 - 3 ft	Grain Size					
	Gravel	13	%	0 - 0	0	0
	Sand	13	%	0.3 - 35.9	5.9	1
	Silt/Clay/Colloids	13	%	64.1 - 99.8	94.1	98.9
	Percent Solids	13	%	26 - 60	40.8	40
	Mercury	13	mg/kg	0.13 - 230	31.5	15
	Hexachlorobenzene	4	mg/kg	0.0055 - 120	30	0.015
	DDTR	4	mg/kg	0.004 - 0.23	0.069	0.021

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
3 - 4 ft	Grain Size					
	Gravel	13	%	0 - 0	0	0
	Sand	13	%	0.1 - 10	3	0.8
	Silt/Clay/Colloids	13	%	90 - 99.7	97	99.2
	Percent Solids	13	%	27 - 65	44.8	46
	Mercury	13	mg/kg	0.16 - 300	42.2	3.1
	Hexachlorobenzene	4	mg/kg	<0.0031 - 9.9	2.5	0.0185
	DDTR	4	mg/kg	< 0.04 - 2.04	0.512	0.02

Table 5. Sediment Core Analytical Results – Coarse Cores (continued)

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
4 - 5 ft	Grain Size					
	Gravel	13	%	0 - 0	0	0
	Sand	13	%	0 - 4.7	0.97	0.55
	Silt/Clay/Colloids	13	%	95.3 - 99.9	99.1	99.5
	Percent Solids	13	%	28 - 63	46.8	47
	Mercury	13	mg/kg	0.066 - 96.0	17.9	0.25
	Hexachlorobenzene	4	mg/kg	0.001 - 0.25	0.092	0.058
	DDTR	4	mg/kg	0.0023 - 1.50	0.38	0.0056

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
5 - 6 ft	Grain Size					
	Gravel	10	%	0 - 0	0	0
	Sand	10	%	0.2 - 2.1	0.9	0.6
	Silt/Clay/Colloids	10	%	97.9 - 99.8	99.1	99.4
	Percent Solids	10	%	38 - 61	48.1	46.5
	Mercury	10	mg/kg	0.018 - 440	56.3	0.36
	Hexachlorobenzene	3	mg/kg	0,012 - 0.62	0.36	0.46
	DDTR	3	mg/kg	<0.004 - 4.3	1.44	0.012

Table 5. Sediment Core Analytical Results – Coarse Cores (continued)

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
6 - 7 ft	Grain Size					
	Gravel	8	%	0 - 0	0	0
	Sand	8	%	0.1 - 6.4	1.8	0.4
	Silt/Clay/Colloids	8	%	93.6 - 99.9	98.2	99.6
	Percent Solids	8	%	43 - 66	53.9	53.5
	Mercury	8	mg/kg	0.06 - 120	16.2	0.15
	Hexachlorobenzene	4	mg/kg	0.004 - 0.51	0.14	0.022
	DDTR	2	mg/kg	< 0.012 - 2.47	NA	NA

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
7 - 8 ft	Grain Size					
	Gravel	7	%	0 - 0	0	0
	Sand	7	%	0.2 - 4	0.9	0.4
	Silt/Clay/Colloids	7	%	96 - 99.8	99.1	99.6
	Percent Solids	7	%	43 - 64	53	54
	Mercury	7	mg/kg	0.06 - 120	17.4	0.07
	Hexachlorobenzene	4	mg/kg	0.011 - 0.29	0.104	0.12
	DDTR	2	mg/kg	0.012 - 3.25	NA	NA

Table 5. Sediment Core Analytical Results – Coarse Cores (continued)

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
8 - 9 ft	Grain Size					
	Gravel	5	%	0 - 0	0	0
	Sand	5	%	0.1 - 1.2	0.7	0.7
	Silt/Clay/Colloids	5	%	98.8 - 99.9	99.3	99.3
	Percent Solids	5	%	48 - 59	52.6	51
	Mercury	5	mg/kg	0.06 - 230	46.2	0.11
	Hexachlorobenzene	3	mg/kg	ND	ND	ND
	DDTR	2	mg/kg	0.001 - 34.2	NA	NA

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
9 - 10 ft	Grain Size					
	Gravel	7	%	0 - 0	0	0
	Sand	7	%	0.2 - 10.7	0.3	3.7
	Silt/Clay/Colloids	7	%	89.3 - 99.8	99.7	96.3
	Percent Solids	7	%	51 - 64	58	59
	Mercury	3	mg/kg	0.055 - 170	56.7	0.14
	Hexachlorobenzene	3	mg/kg	ND	ND	ND
	DDTR	2	mg/kg	0.01 - 3.24	NA	NA

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
10 - 11 ft	Grain Size					
	Gravel	1	%	0 - 0	NA	NA
	Sand	1	%	0.3	NA	NA
	Silt/Clay/Colloids	1	%	99.7	NA	NA
	Percent Solids	1	%	51	NA	NA
	Mercury	1	mg/kg	63	NA	NA
	Hexachlorobenzene	Not Analyzed				
	DDTR	1	mg/kg	1.02	NA	NA

Table 6. Sediment and Pore Water Core Analytical Results – Fine Cores

A. Fine Core Pore Water Results

Depth Interval	Analyte	Number of Samples	Units	2009 Range of Concentrations	Mean Concentration	Median Concentration
0 - 2 in	Mercury	6	ug/L	0.025 - 23.3	5.68	0.106
	Methyl Mercury	6	ug/L	0.00064 - 0.0067	0.00239	0.001
0 - 4 in	Dissolved Organic Carbon	6	mg/L	31 - 120	57	48

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
2 - 4 in	Mercury	6	ug/L	0.0137 - 4.7	1.01	0.183
	Methyl Mercury	6	ug/L	0.00064 - 0.0067	0.0014	0.00072

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
4 - 8 in	Mercury	6	ug/L	0.017 - 1.93	0.6	0.13
	Methyl Mercury	6	ug/L	0.00018 - 0.0049	0.0019	0.00083
	Dissolved Organic Carbon	6	mg/L	20 - 150	53	33.5

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
8 - 12 in	Mercury	6	ug/L	0.010 - 0.74	2.18	0.49
	Methyl Mercury	6	ug/L	0.00096 - 0.0041	0.0024	0.0023
8 - 18 in	Dissolved Organic Carbon	6	mg/L	19 - 85	48.8	45

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
12 - 18 in	Mercury	6	ug/L	0.089 - 10.3	0.36	0.34
	Methyl Mercury	6	ug/L	0.00012 - 0.0041	0.0018	0.0011

Table 6. Sediment and Pore Water Core Analytical Results – Fine Cores (continued)

B. Fine Core Sediment Results

Depth Interval	Analyte	Number of Samples	Units[2]	2009 Range of Concentrations	Mean Concentration	Median Concentration
0 - 2 in	Mercury	6	mg/kg	2.5 - 46.7	24.5	26.5
	Methyl Mercury	6	mg/kg	0.0014 - 0.0067	0.0042	0.0041
	Total Organic Carbon	6	mg/kg	3300 - 38000	20000	18500
Depth Interval	**Analyte**	**Number of Samples**	**Units[2]**	**2009 Range of Concentrations**	**Mean Concentration**	**Median Concentration**
2 - 4 in	Mercury	6	mg/kg	7.7 - 128	54.8	33
	Methyl Mercury	6	mg/kg	0.0012 - 0.0071	0.0046	0.005
	Total Organic Carbon	6	mg/kg	1600 - 34000	16655	17500
Depth Interval	**Analyte**	**Number of Samples**	**Units[2]**	**2009 Range of Concentrations**	**Mean Concentration**	**Median Concentration**
4 - 8 in	Mercury	6	mg/kg	0.41 - 96.6	34.3	27
	Methyl Mercury	6	mg/kg	0.0019 - 0.0167	0.0072	0.0045
	Total Organic Carbon	6	mg/kg	5100 - 33000	16500	15500
Depth Interval	**Analyte**	**Number of Samples**	**Units[2]**	**2009 Range of Concentrations**	**Mean Concentration**	**Median Concentration**
8 - 12 in	Mercury	6	mg/kg	18 - 200	62.6	33.3
	Methyl Mercury	6	mg/kg	0.0031 - 0.014	0.008	0.007
	Total Organic Carbon	6	mg/kg	3100 - 27000	13920	15000
Depth Interval	**Analyte**	**Number of Samples**	**Units[2]**	**2009 Range of Concentrations**	**Mean Concentration**	**Median Concentration**
8 - 12 in	Mercury	6	mg/kg	0.37 - 46	15.7	15
	Methyl Mercury	6	mg/kg	0.00022 - 0.0045	0.0021	0.0021
	Total Organic Carbon	6	mg/kg	1320 - 21000	12470	15500

TABLE 6

Table 7. Surface Water Analytical Results (years 2006, 2008, and 2009)

Feasibility Study
Olin McIntosh OU-2

	Transect 1					
	Deep Samples			Shallow Samples		
Sample ID:	OU2B-SW-101DD-06	OU2B-SW-101DD-08	OU2B-SW-101DD-09	OU2B-SW-101DS-06	OU2B-SW-101DS-08	OU2B-SW-101DS-09
Sample Date:	05/22/2006	06/04/2008	06/04/2009	05/22/2006	06/04/2008	06/04/2009
Sample Depth (ft.):	8	9	13	2	2	3.5
Depth to Bottom (ft.):	10	11.3	16.6	10	11.3	16.6
FIXED BASE LABORATORY ANALYSIS:						
Alkalinity - EPA 310.1, SM 2320B, mg/L	39	53.5	31.8	39	53.5	31.8
Dissolved Organic Carbon - SM 5310B, SW846 9060, mg/L	13	8.7	16	10	8.9	16
Hardness, Total - EPA 130.2, SM 2340C, mg/L	64	72	36	60	74	36
Mercury - SW846 7470, EPA 1631, µg/L[1]						
Mercury, Filtered	< 0.2	0.0121	0.0142	< 0.2	0.014	0.00457
Mercury, Unfiltered	< 0.2	0.292	0.0547	< 0.2	0.137	0.0106
Methylmercury - EPA 1630, µg/L						
Methylmercury, Filtered	0.000396	0.000883	0.00048	0.000244	0.000867	0.000461
Methylmercury, Unfiltered	0.000487	0.00301	0.000693	0.000435	0.00308	0.000782
Sulfate, Total - SW846 9038, mg/L	35.1	NA	NA	29.9	NA	NA
Sulfide, Total - SW846 9030A, mg/L	< 1	NA	NA	4.4	NA	NA
Total Dissolved Solids - EPA 160.1, SM 2540C, mg/L	140	420	55	136	410	57.5
Total Suspended Solids - EPA 160.2, SM 2540D, mg/L	7	7	< 4	12	12	4.5
FIELD PARAMETERS:						
Dissolved Oxygen - EPA 360.1, mg/L	4.25	1.78	1.86	9.64	11.1	5.3
Oxidation Reduction Potential - A2580A, mV	215	33.4	304	204	-19.1	292
pH - EPA 150.1, pH Units	6.78	7.46	6.35	7.29	8.06	6.72
Specific Conductance - EPA 120.1, mS/cm	2.95	0.668	0.129	2.67	0.655	0.123
Temperature - EPA 170.1, °C	21.9	27.0	22.9	25.0	29.9	24.4
Turbidity - EPA 180.1, NTU	17.8	4.3	11.8	14.4	8.8	6.8

Notes:
°C - degrees Celsius
EPA - Environmental Protection Agency
J - estimated concentration based on data quality evaluation or result between method detection limit and reporting detection limit
mg/L - milligram per liter
mS/cm - milliSiemens per centimeter
mV - millivolt
NA - not analyzed
NTU - nephelometric turbidity unit
SM - Standard Methods
µg/L - microgram per liter
< - result less than the reporting limit
[1] Mercury analyzed by 7471 in 2006 and EPA 1631 in 2008.

Table 7. Surface Water Analytical Results (years 2006, 2008, and 2009) (continued)

TABLE 6
SURFACE WATER ANALYTICAL RESULTS - 2006, 2008, AND 2009
Feasibility Study
Olin McIntosh OU-2

	Transect 1					Transect 2				
	Deep Sample		Shallow Samples			Deep Sample		Shallow Samples		
Sample ID:	OU2B-SW-105DD-08	OU2B-SW-105DD-09	OU2B-SW-105DS-06	OU2B-SW-105DS-08	OU2B-SW-105DS-09	OU2B-SW-201DD-08	OU2B-SW-201DD-09	OU2B-SW-201DS-06	OU2B-SW-201DS-08	OU2B-SW-201DS-09
Sample Date:	06/03/2008	06/08/2009	05/23/2006	06/03/2008	06/08/2009	06/04/2008	06/03/2009	05/22/2006	06/04/2008	06/04/2009
Sample Depth (ft.):	4	4.8	2	1	1.2	4	8.8	2	1	2.2
Depth to Bottom (ft.):	5.8	6.17	3.15	5.8	6.17	5.7	11.3	3	5.7	11.3
FIXED BASE LABORATORY ANALYSIS:										
Alkalinity - EPA 310.1, SM 2320B, mg/L	53.5	31.8	39	58	31.8	55.8	31.8	39	53.5	31.8
Dissolved Organic Carbon - SM 5310B, SW846 9060, mg/L	16	17	2.9	16	17	16	16	< 2	17	16
Hardness, Total - EPA 130.2, SM 2340C, mg/L	76	38	58	70	36	80	44	60	70	46
Mercury - SW846 7470, EPA 1631, µg/L[1]										
Mercury, Filtered	0.0121	0.0129	< 0.2	0.0124	0.0116	0.019	0.0127	< 0.2	0.0143	0.0053
Mercury, Unfiltered	0.0918	0.155	< 0.2	0.0914	0.0879	0.275	0.0957	< 0.2	0.18	0.0087
Methylmercury - EPA 1630, µg/L										
Methylmercury, Filtered	0.000679	0.000649	0.000227	0.000960	0.000419	0.000858	0.000468	0.000261	0.000843	0.000422
Methylmercury, Unfiltered	0.00245	0.00171	0.000508	0.00228	0.00119	0.00316	0.000756	0.000480	0.00257	0.000748
Sulfate, Total - SW846 9038, mg/L	NA	NA	33.2	NA	NA	NA	NA	30.3	NA	NA
Sulfide, Total - SW846 9030A, mg/L	NA	NA	< 1	NA	NA	NA	NA	2.6	NA	NA
Total Dissolved Solids - EPA 160.1, SM 2540C, mg/L	420	72.5	140	400	72.5	385	82.5	136	405	65
Total Suspended Solids - EPA 160.2, SM 2540D, mg/L	12	22	15	12	16	< 4	4.5	6	7	6.5
FIELD PARAMETERS:										
Dissolved Oxygen - EPA 360.1, mg/L	7.16	7.20	5.7	11.2	9.31	7.47	3.17	9.7	8.99	9.36
Oxidation Reduction Potential - A2580A, mV	-17.1	264	165	-52.1	257	405	277	192	372	263
pH - EPA 150.1, pH Units	8.58	6.72	8.41	8.7	6.92	6.96	6.53	7.35	7.21	6.96
Specific Conductance - EPA 120.1, mS/cm	0.635	0.143	3.71	0.631	0.144	0.742	0.117	2.66	0.747	0.121
Temperature - EPA 170.1, °C	28.7	24.6	27.0	31.9	25.9	27.7	23.1	24.6	28.2	26.4
Turbidity - EPA 180.1, NTU	18.8	26.7	13.8	9.3	9.8	< 0.1	10.8	20.5	< 0.1	8.4

Notes:
°C - degrees Celsius
EPA - Environmental Protection Agency
J - estimated concentration based on data quality evaluation or result between method detection limit and reporting detection limit
mg/L - milligram per liter
mS/cm - milliSiemens per centimeter
mV - millivolt
NA - not analyzed
NTU - nephelometric turbidity unit
SM - Standard Methods
µg/L - microgram per liter
< - result less than the reporting limit
[1] Mercury analyzed by 7471 in 2006 and EPA 1631 in 2008.

Table 7. Surface Water Analytical Results (years 2006, 2008, and 2009) (continued)

TABLE 6
SURFACE WATER ANALYTICAL RESULTS - 2006, 2008, AND 2009
Feasibility Study
Olin McIntosh OU-2

	Transect 2								Transect 2				
	Deep Samples			Shallow Samples			Deep Sample		Shallow Samples				
Sample ID:	OU2B-SW-203DD-06	OU2B-SW-203DD-08	OU2B-SW-203DD-09	OU2B-SW-203DS-06	OU2B-SW-203DS-08	OU2B-SW-203DS-09	OU2B-SW-205DD-08	OU2B-SW-205DD-09	OU2B-SW-205DS-06	OU2B-SW-205DS-08	OU2B-SW-205DS-09		
Sample Date:	05/22/2006	06/04/2008	06/04/2009	05/22/2006	06/04/2008	06/04/2009	06/03/2008	06/08/2009	05/22/2006	06/03/2008	06/03/2009		
Sample Depth (ft.):	5	7	12	1	2	3	4	4	1	1	1		
Depth to Bottom (ft.):	6.15	9.5	14.7	6.15	9.5	14.7	4.9	5.83	1.5	4.9	5.83		
FIXED BASE LABORATORY ANALYSIS:													
Alkalinity - EPA 310.1, SM 2320B, mg/L	35.9	53.5	31.8	42.1	53.5	31.8	53.5	31.8	37.4	55.8	33.9		
Dissolved Organic Carbon - SM 5310B, SW846 9060, mg/L	4.8	16	16	3.4	16	16	18	17	< 2	16	17		
Hardness, Total - EPA 130.2, SM 2340C, mg/L	58	80	34	60	78	34	70	36	56	76	34		
Mercury - SW846 7470, EPA 1631, µg/L[1]													
Mercury, Filtered	< 0.2	0.0158	0.0147	< 0.2	0.0227	0.00458	0.0111	0.00824	< 0.2	0.0123	0.0116 J		
Mercury, Unfiltered	< 0.2	0.308	0.0925	< 0.2	0.36	0.0119	0.319	0.0623	< 0.2	0.0942	0.0563		
Methylmercury - EPA 1630, µg/L													
Methylmercury, Filtered	0.000249	0.000625	0.000506	0.000249	0.000606	0.000468	0.000609	0.000413	0.000148	0.000673	0.000468		
Methylmercury, Unfiltered	0.000416	0.00238	0.000702	0.000429	0.00271	0.000767	0.00310	0.00106	0.000399	0.00236	0.00087		
Sulfate, Total - SW846 9038, mg/L	31.1	NA	NA	29.1	NA	NA	NA	NA	29.9	NA	NA		
Sulfide, Total - SW846 9030A, mg/L	< 1	NA	NA	3.5	NA	NA	NA	NA	< 1	NA	NA		
Total Dissolved Solids - EPA 160.1, SM 2540C, mg/L	136	400	72.5	144	410	45	400	70	136	400	55 J		
Total Suspended Solids - EPA 160.2, SM 2540D, mg/L	9	7	< 4	7	8	4	19	15	14	8	10 J		
FIELD PARAMETERS:													
Dissolved Oxygen - EPA 360.1, mg/L	4.64	0.78	2.25	8.09	6.62	9.98	8.94	9.16	10.59	12.9	10.32		
Oxidation Reduction Potential - A2580A, mV	197	47.4	251	191	46.5	197	381	287	195	328	282		
pH - EPA 150.1, pH Units	7.13	6.69	6.44	7.15	6.78	7.20	7.37	7.04	7.51	8.74	7.24		
Specific Conductance - EPA 120.1, mS/cm	2.67	0.622	0.127	2.61	0.613	0.125	0.760	0.141	2.80	0.758	0.145		
Temperature - EPA 170.1, °C	23.2	27.2	22.9	25.1	29.3	25.6	28.0	25.2	26.7	30.6	27.1		
Turbidity - EPA 180.1, NTU	18.9	6.8	13.5	12.8	11.7	5.4	18.8	26.8	17.5	8.9	7.5		

Notes:
°C - degrees Celsius
EPA - Environmental Protection Agency
J - estimated concentration based on data quality evaluation or result between method detection limit and reporting detection limit
mg/L - milligram per liter
mS/cm - milliSiemens per centimeter
mV - millivolt
NA - not analyzed
NTU - nephelometric turbidity unit
SM - Standard Methods
µg/L - microgram per liter
< - result less than the reporting limit
[1] Mercury analyzed by 7471 in 2006 and EPA 1631 in 2008.

Table 7. Surface Water Analytical Results (years 2006, 2008, and 2009) (continued)

TABLE 6
SURFACE WATER ANALYTICAL RESULTS - 2006, 2008, AND 2009
Feasibility Study
Olin McIntosh OU-2

	Transect 3					Transect 3				
	Deep Sample		Shallow Samples			Deep Sample		Shallow Samples		
Sample ID:	OU2B-SW-301DD-08	OU2B-SW-301DD-09	OU2B-SW-301DS-06	OU2B-SW-301DS-08	OU2B-SW-301DS-09	OU2B-SW-303DD-08	OU2B-SW-303DD-09	OU2B-SW-303DS-06	OU2B-SW-303DS-08	OU2B-SW-303DS-09
Sample Date:	06/03/2008	06/03/2009	05/23/2006	06/03/2008	06/03/2009	06/03/2008	06/03/2009	05/22/2006	06/03/2008	06/03/2009
Sample Depth (ft.):	3.2	8	1	0.8	2	4	8	2	1	2
Depth to Bottom (ft.):	4.3	10.2	1.4	4.3	10.2	5.7	10.8	3.03	5.7	10.8
FIXED BASE LABORATORY ANALYSIS:										
Alkalinity - EPA 310.1, SM 2320B, mg/L	53.5	31.8	37.4	53.5	31.8	53.5	31.8	40.6	53.5	31.8
Dissolved Organic Carbon - SM 5310B, SW846 9060, mg/L	17	16	2.5	16	16	15	16	6.8	16	16
Hardness, Total - EPA 130.2, SM 2340C, mg/L	72	50	61	72	40	68	44	58	72	40
Mercury - SW846 7470, EPA 1631, µg/L[1]										
Mercury, Filtered	0.0209	0.00444	< 0.2	0.0146	0.00358	0.0249	0.00693	< 0.2	0.0138	0.00405
Mercury, Unfiltered	0.471	0.0142	0.329	0.181	0.00961	0.909	0.0608	< 0.2	0.131 J	0.0114
Methylmercury - EPA 1630, µg/L										
Methylmercury, Filtered	0.000952	0.00046	0.000295	0.000643	0.00042	0.000731	0.000476	0.000214	0.000893	0.000413
Methylmercury, Unfiltered	0.00403	0.000714	0.000970	0.00311	0.000786	0.00345	0.000652	0.000354	0.00191	0.000918
Sulfate, Total - SW846 9038, mg/L	NA	NA	30.6	NA	NA	NA	NA	29.4	NA	NA
Sulfide, Total - SW846 9030A, mg/L	NA	NA	< 1	NA	NA	NA	NA	< 1	NA	NA
Total Dissolved Solids - EPA 160.1, SM 2540C, mg/L	384	87.5	160	392	72.5	404	105	124	404	87.5
Total Suspended Solids - EPA 160.2, SM 2540D, mg/L	13	4.5	48	15	5	23	< 4 UJ	8	12 J	7
FIELD PARAMETERS:										
Dissolved Oxygen - EPA 360.1, mg/L	9.71	3.11	NA	11.66	8.93	7.82	3.29	8.48	12.73	7.71
Oxidation Reduction Potential - A2580A, mV	427	259	198	401	236	380	277	205	326	262
pH - EPA 150.1, pH Units	7.03	6.45	6.99	7.57	6.68	7.61	6.47	7.66	8.81	6.86
Specific Conductance - EPA 120.1, mS/cm	0.738	0.116	NA	0.744	0.122	0.756	0.117	2.62	0.754	0.120
Temperature - EPA 170.1, °C	28.0	23.2	26.1	28.8	26.2	27.6	23.2	26.1	29.9	25.9
Turbidity - EPA 180.1, NTU	11.9	10.5	32.3	7.3	8.6	23.8	11.5	17.8	5.5	9.0

Notes:
°C - degrees Celsius
EPA - Environmental Protection Agency
J - estimated concentration based on data quality evaluation or result between method detection limit and reporting detection limit
mg/L - milligram per liter
mS/cm - milliSiemens per centimeter
mV - millivolt
NA - not analyzed
NTU - nephelometric turbidity unit
SM - Standard Methods
µg/L - microgram per liter
< - result less than the reporting limit
[1] Mercury analyzed by 7471 in 2006 and EPA 1631 in 2008.

Table 7. Surface Water Analytical Results (years 2006, 2008, and 2009) (continued)

TABLE 6
SURFACE WATER ANALYTICAL RESULTS - 2006, 2008, AND 2009
Feasibility Study
Olin McIntosh OU-2

	Transect 3					Round Pond					Deep Hole	
	Deep Sample		Shallow Sample			Deep Sample		Shallow Samples			Deep Samples	Shallow Samples
Sample ID:	OU2B-SW-304DD-08	OU2B-SW-304DD-09	OU2B-SW-304DS-06	OU2B-SW-304DS-08	OU2B-SW-304DS-09	OU2R-SW-101DD-08	OU2R-SW-101DD-09	OU2R-SW-101DS-06	OU2R-SW-101DS-08	OU2R-SW-101DS-09	OU2B-SW-DHDD-09	OU2B-SW-DHDS-09
Sample Date:	06/03/2008	06/03/2009	05/22/2006	06/03/2008	06/03/2009	06/03/2008	06/04/2009	05/23/2006	06/03/2008	06/04/2009	06/04/2009	06/04/2009
Sample Depth (ft.):	4	8	2	1	8	4.5	8.8	2	1	2.2	36	9
Depth to Bottom (ft.):	5.6	10.4	3.2	5.6	10.4	6.1	10.8	2.5	6.1	10.8	44.1	44.1
FIXED BASE LABORATORY ANALYSIS:												
Alkalinity - EPA 310.1, SM 2320B, mg/L	53.5	31.8	40.6	53.5	31.8	55.8	31.8	39	55.8	31.8	44.5	31.8
Dissolved Organic Carbon - SM 5310B, SW846 9060, mg/L	15	16	4.2	16	16	18	16	5.4	18	15	18	16
Hardness, Total - EPA 130.2, SM 2340C, mg/L	78	46	60	66	46	80	48	61	80	46	52	40
Mercury - SW846 7470, EPA 1631, µg/L[1]												
Mercury, Filtered	0.0141	0.00579	< 0.2	0.0114	0.00416	0.0109	0.00463	< 0.2	0.00858	0.00357	0.0117	0.00588
Mercury, Unfiltered	0.335	0.0223 J	0.2	0.0838	0.0121	0.0834	0.0139	< 0.2	0.0443	0.00731	0.110	0.0347
Methylmercury - EPA 1630, µg/L												
Methylmercury, Filtered	0.000586	0.000491	0.000204	0.000883	0.000476	0.00342	0.000556	0.000108	0.00225	0.000532	0.000638	0.00047
Methylmercury, Unfiltered	0.00269	0.000833	0.000550	0.00238	0.000791	0.00553	0.000788	0.000239	0.00484	0.000825	0.00108	0.000735
Sulfate, Total - SW846 9038, mg/L	NA	NA	30	NA	NA	NA	NA	28.9	NA	NA	NA	NA
Sulfide, Total - SW846 9030A, mg/L	NA	NA	< 1	NA	NA	NA	NA	< 1	NA	NA	NA	NA
Total Dissolved Solids - EPA 160.1, SM 2540C, mg/L	435	115	140	360	97.5	280	125	120	328	112	62.5	52.5
Total Suspended Solids - EPA 160.2, SM 2540D, mg/L	20	6.5	24	7	12	8	9.5	16	18	< 4	8	4
FIELD PARAMETERS:												
Dissolved Oxygen - EPA 360.1, mg/L	9.68	2.93	NA	NA	10.44	2.85	2.16	5.1	7.78	9.5	0.16	2.45
Oxidation Reduction Potential - A2580A, mV	386	239	196	385	200	38.7	286	176	41.6	268	72.8	248
pH - EPA 150.1, pH Units	7.54	6.53	7.29	8.39	7.14	7.12	6.50	6.96	7.38	7.01	6.40	6.41
Specific Conductance - EPA 120.1, mS/cm	0.756	0.116	NA	0.763	0.122	0.453	0.119	2.40	0.493	0.120	0.188	0.126
Temperature - EPA 170.1, °C	28.5	23.4	25.5	29.9	26.9	26.8	23.1	25.8	28.5	26.4	20.9	23.2
Turbidity - EPA 180.1, NTU	15.2	11.5	30.6	4.8	9.3	12.8	15.8	74.1	4.0	9.2	26.6	9.0

Notes:
°C - degrees Celsius
EPA - Environmental Protection Agency
J - estimated concentration based on data quality evaluation or result between method detection limit and reporting detection limit
mg/L - milligram per liter
mS/cm - milliSiemens per centimeter
mV - millivolt
NA - not analyzed
NTU - nephelometric turbidity unit
SM - Standard Methods
µg/L - microgram per liter
< - result less than the reporting limit
[1] Mercury analyzed by 7471 in 2006 and EPA 1631 in 2008.

TABLE 8
2010 VEGETATION ANALYTICAL RESULTS
Feasibility Study
Olin McIntosh OU-2

Table 8. Vegetation Analytical Results (2010)

Location ID:	FPV-SB1	FPV-SB3	FPV-SB4	FPV-SB5	FPV-SS1	FPV-SS1	FPV-SS4	FPV-SS10	FPV-SS11	FPV-SS11	FPV-SS12	FPV-SS14
Sample ID:	OU2B-FPVSB1-10	OU2B-FPVSB3-10	OU2B-FPVSB4-10	OU2B-FPVSB5-10	OU2B-FPVSS1-10	OU2B-FPVSSDUP01-10	OU2B-FPVSS4-10	OU2B-FPVSS10-10	OU2B-FPVSS11-10	OU2B-FPVSSDUP02-10	OU2B-FPVSS12-10	OU2B-FPVSS14-10
Sample Date:	7/7/2010	7/8/2010	7/8/2010	7/7/2010	7/7/2010	7/7/2010	7/7/2010	7/8/2010	7/7/2010	7/7/2010	7/7/2010	7/7/2010
Sample Type:	Normal	Normal	Normal	Normal	Normal	Duplicate	Normal	Normal	Normal	Duplicate	Normal	Normal
Mercury, EPA 245.6, mg/Kg												
Mercury	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	NA	< 0.017	< 0.017
Methylmercury, EPA 1630, mg/Kg												
Methylmercury	0.000829 JQ	0.000704 JQ	0.000656 JQ	0.0147	0.00139 J	0.000643 JQ	0.000903 JQ	0.000927 JQ	0.00112	0.000748 JQ	0.000751 JQ	0.00226
Percent Lipids, %												
Percent Lipids	0.24	0.32	0.15	0.19	0.40	0.40	0.13	0.38 J	0.13	0.20	0.20	0.18
Pesticides - SW846 8081, mg/Kg												
2,4'-DDD	NA	< .0025	< 0.0025	NA	0.0011 JQ	< 0.0025	< 0.0025	NA	NA	NA	NA	NA
2,4'-DDE	NA	0.00082 JQ	< 0.0025	NA	< 0.0025	< 0.0025	< 0.0025	NA	NA	NA	NA	NA
2,4'-DDT	NA	< 0.0025	< 0.0025	NA	0.0034 J	< 0.0025 UJ	< 0.0025	NA	NA	NA	NA	NA
4,4'-DDD	NA	< 0.0050	< 0.0050	NA	< 0.0050	< 0.0050	0.0049 JQ	NA	NA	NA	NA	NA
4,4'-DDE	NA	< 0.0050	< 0.0050	NA	< 0.0050	< 0.0050	< 0.0050	NA	NA	NA	NA	NA
4,4'-DDT	NA	< 0.0050	<0.0050	NA	< 0.0050	< 0.0050	< 0.0050	NA	NA	NA	NA	NA
DDTr	NA	0.00082	<0.0050	NA	<0.0050	<0.0050	0.0049	NA	NA	NA	NA	NA
DDTR	NA	0.00082	<0.0050	NA	0.0045	<0.0050	0.0049	NA	NA	NA	NA	NA
Hexachlorobenzene	< .0025	NA	NA	< 0.0025	NA	NA	NA	< 0.0025	< 0.0025	< 0.0025 UJ	0.00060 JQ	0.0048 J

Notes:
DDTr = 4,4'-DDD, -DDE, and -DDT
DDTR = 2,4'- and 4,4'-DDD, -DDE, -DDT
SW846 = *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
mg/Kg = milligrams per kilogram dry weight
When calculating DDTr and DDTR, a value of zero was used for results below the Method Detection Limit (MDL) and/or the Reporting Limit (RL).

Data Flag Definitions:
J = Estimated concentration based on qc data
JQ = Estimated concentration, result reported is between the Method Detection Limit (MDL) and the Reporting Limit (RL)
UJ = The analyte was not detected; however, the result is estimated due to discrepancies in meeting certain analyte-specific quality control criteria
NA = Not Analyzed
< = Result is less than the Reporting Limit

TABLE 9

Table 9. 2010 Spider and Insect Analytical Results

Feasibility Study
Olin McIntosh OU-2

Location ID:	INS-1B	INS-2C	INS-3B	INS-4B	INS-4C	INS-5B	INS-5C	INS-6A	INS-6B	INS-6C	INS-NEA	INS-NEC	INS-SEA
Sample ID:	OU2B-INS1B-10	OU2B-INS2C-10	OU2B-INS3B-10	OU2B-INS4B-10	OU2B-INS4C-10	OU2B-INS5B-10	OU2B-INS5C-10	OU2B-INS6A-10	OU2B-INS6B-10	OU2B-INS6C-10	OU2B-INSNEA-10	OU2B-INSNEC-10	OU2B-INSSEA-10
Sample Date:	7/12/2010	7/12/2010	7/12/2010	7/9/2010	7/12/2010	7/13/2010	7/13/2010	7/9/2010	7/9/2010	7/9/2010	7/12/2010	7/12/2010	7/12/2010
Sample Type:	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Mercury, EPA 245.6, mg/Kg													
Mercury	0.32	0.37	0.31	0.26	0.0075 JQ	0.14	0.067	0.15 J	0.71	0.026	0.17	0.075	0.13
Percent Lipids, %													
Percent Lipids	3.2	3.3	4.0	4.1	2.8	4.0	3.3	3.9	3.3	3.6	3.5	4.4	3.6
Pesticides - SW846 8081, mg/Kg													
2,4'-DDD	0.0054	0.0052	0.006	0.0044	< 0.0050	0.0045	< 0.0038	0.0026 JQ	0.0020 JQ	< 0.0032	0.0019 JQ	0.0035 JQ	0.0013 JQ
2,4'-DDE	0.0168 J	0.0138 J	0.0292	0.0225	0.0041 JQ	0.0226 J	< 0.0038	0.0095	< 0.0061	< 0.0032	0.0064	0.0054 J	0.0077
2,4'-DDT	0.00068 JQ	< 0.0025	0.00072 JQ	0.00070 JQ	< 0.0050	0.00091 JQ	< 0.0038	0.0028 JQ	< 0.0061	< 0.0032	0.0010 JQ	< 0.0046	< 0.0025
4,4'-DDD	0.014	0.0113	0.01	0.0121	< 0.0099	0.0033 JQ	0.0022 JQ	< 0.0122	< 0.0122	<0.0065	0.0206	0.0052 JQ	0.0057 J
4,4'-DDE	0.606	0.318	0.288	0.233	<0.0099	0.0866 J	0.0053 JQ	0.175	0.0337	0.0042 JQ	0.301	0.0307	0.121
4,4'-DDT	0.0166	0.0040 JQ	0.0033 JQ	0.0094	< 0.0099	0.0024 JQ	0.0020 JQ	0.0078 JQ	0.0022 JQ	< 0.0065	0.0040 JQ	0.0015 JQ	0.0052
DDTr[1]	0.64	0.33	0.30	0.25	<0.0099	0.092 J,JQ	0.0095 JQ	0.18 JQ	0.036 JQ	0.0042 JQ	0.33 JQ	0.037 JQ	0.13 J
DDTr[2]	0.64	0.33	0.30	0.25	< 0.0099	0.092 J,JQ	0.0095 JQ	0.20 JQ	0.042 JQ	0.011 JQ	0.33 JQ	0.037 JQ	0.13 J
DDTR[1]	0.66 J,JQ	0.35 J,JQ	0.34 JQ	0.29	0.0041 JQ	0.12 J,JQ	0.0095 JQ	0.20 JQ	0.038 JQ	0.0042 JQ	0.33 JQ	0.046 J,JQ	0.14 J,JQ
DDTR[2]	0.66 J,JQ	0.35 J,JQ	0.34 JQ	0.29	0.024 JQ	0.12 J,JQ	0.015 JQ	0.21 JQ	0.050 JQ	0.016 JQ	0.33 JQ	0.049 J,JQ	0.14 J,JQ
Hexachlorobenzene	0.0018 JQ	0.0088	0.0029 J	0.017	0.0025 JQ	0.0133	0.015	0.0157	0.039	0.035	0.0023 JQ	0.0099	0.0010 JQ

Notes:
DDTr = 4,4'-DDD, -DDE, and -DDT
DDTR = 2,4'- and 4,4'-DDD, -DDE, -DDT
SW846 = *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
mg/Kg = milligrams per kilogram dry weight
[1] When calculating DDTr and DDTR, a value of zero was used for results below the Method Detection Limit (MDL) and/or the Reporting Limit (RL).
[2] When calculating DDTr and DDTR, a value of half the detection limit was used for results below the method detection limit and/or the reporting limit.

Data Flag Definitions:
J = Estimated concentration based on qc data
JQ = Estimated concentration, result reported is between the Method Detection Limit (MDL) and the Reporting Limit (RL)
< = Result is less than the Reporting Limit

Table 10. Historical Fish Tissue Analytical Results (1986 – 2001)

Sample Type	Sample Location	Constituent	Units[2]	1986 Range of Concentrations	1991 Range of Concentrations	1994 Range of Concentrations	1995 Range of Concentrations	2001 Range of Concentrations
Smallmouth Buffalo Filet	OU-2	Hg	mg/kg	0.59	--	--	--	--
Channel Catfish Whole Body	OU-2	Hg	mg/kg	--	<0.20 - 0.60	--	--	--
		HCB	mg/kg	--	0.16 J N - 1.8 J N	--	--	--
		DDTr	mg/kg	--	2.9 - 29.0	--	--	--
Channel Catfish Fillet	OU-2	Hg	mg/kg	0.66 - 0.68	0.28 - 0.67	--	--	--
		HCB	mg/kg	--	<0.66 - 0.58 J N	--	--	--
		DDTr	mg/kg	--	1.1 - 9.3	--	--	--
Mosquitofish[1] Whole Body	OU-2	Hg	mg/kg	--	--	0.27 J - 0.58 J	--	0.19 - 0.51
		HCB	mg/kg	--	--	<0.027 - 0.13	--	<0.10 - 0.14
		DDTR	mg/kg	--	--	2.8 - 43.2	--	--
		DDTr	mg/kg	--	--	2.2 - 30.7	--	0.49-10.8
	Tombigbee River	Hg	mg/kg	--	--	0.04 J - 0.14 J	--	--
		HCB	mg/kg	--	--	<0.031	--	--
		DDTR	mg/kg	--	--	<0.01 - 0.026	--	--
		DDTr	mg/kg	--	--	<0.01 - 0.026	--	--
Rock Bass Fillet	OU-2	Hg	mg/kg	0.97	--	--	--	--
Bluegill Whole Body	OU-2	Hg	mg/kg	--	--	--	0.69 - 1.2	--
		MeHg	mg/kg	--	--	--	0.57 - 1.2	--
Bluegill Filet	OU-2	Hg	mg/kg	0.78	--	--	--	--
Largemouth Bass Whole Body	OU-2	Hg	mg/kg	--	0.47 - 1.2	0.49 - 1.2	--	0.2 - 1.58
		HCB	mg/kg	--	0.23 J N - 1.6	0.093 - 1.8	--	--
		DDTR	mg/kg	--	--	8.8 - 106	--	1.08 - 31.79[3]
		DDTr	mg/kg	--	7.0 - 47	6.6 - 80.8	--	--
	Lake Hatchetigbee (Reference)	Hg	mg/kg	--	--	0.13 - 0.36	--	--
		HCB	mg/kg	--	--	<0.01	--	--
		DDTR	mg/kg	--	--	0.042 - 0.36	--	--
		DDTr	mg/kg	--	--	0.042 - 0.31	--	--
Largemouth Bass Fillet	OU-2	Hg	mg/kg	0.12 - 1.9	0.9 - 2.2	--	--	0.30 - 2.3
		HCB	mg/kg	--	<0.66 - 0.20 J N	--	--	<0.025 - 0.18
		DDTr	mg/kg	--	1.4 - 10.0	--	--	<0.05 - 2.61

Notes:
[1] Composite sample
[2] Sample basis as received
[3] Whole body concentration estimated from fillet and offal data
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethylene
DDT - dichlorodiphenyltrichloroethane

DDTr - the sum of the 4,4'- isomers of DDT, DDD, and DDE
DDTR - the sum of the 2,4'- and 4,4' - isomers of DDT, DDD, and DDE
HCB - hexachlorobenzene
Hg - mercury
J - estimated result
MeHg - methylmercury

mg/kg - milligrams per kilogram
N - spiked sample recovery was not within detection limits
-- - sample not collected and/or sample not analyzed for specified constituent
< - less than the reporting limit

Table 11. Recent Fish Tissue Analytical Results (2003 – 2010)

Sample Type	Sample Location	Constituent	Units[2]	2003 Range of Concentrations	2005 Range of Concentrations	2006 Range of Concentrations	2007 Range of Concentrations	2008 Range of Concentrations	2010 Range of Concentrations
Longnose Gar Whole Body	OU-2	Hg	mg/kg	--	1.7	--	--	--	--
Channel Catfish Fillet	OU-2	Hg	mg/kg	0.10 - 0.51	--	--	--	--	--
Silversides[1] Whole Body	OU-2	Hg	mg/kg	--	--	--	--	0.60 - 1.2	0.40 - 0.51
		HCB	mg/kg	--	--	--	--	0.087 - 2.0	0.040 - 0.096
		DDTR	mg/kg	--	--	--	--	--	0.88 - 1.82
Striped Bass Whole Body	OU-2	Hg	mg/kg	--	0.38	--	--	--	--
Bluegill Whole Body	OU-2	Hg	mg/kg	--	--	--	--	0.54 - 1.20	0.30 - 0.96
		HCB	mg/kg	--	--	--	--	0.054 - 0.64	0.022 - 0.301
		DDTR	mg/kg	--	--	--	--	--	0.56 - 5.46
Largemouth Bass Whole Body	OU-2	Hg	mg/kg	--	--	--	--	1.1 - 2.0	0.6 - 1.5
		HCB	mg/kg	--	--	--	--	0.034 - 1.03	0.020 - 1.04
		DDTR	mg/kg	--	--	--	--	--	0.674 - 39.2
Largemouth Bass Fillet	OU-2	Hg	mg/kg	0.30 - 1.3	--	1.0 - 1.5	1.5 - 2.2	1.6 - 3.0	0.86 - 2.8
		HCB	mg/kg	--	--	--	--	0.036 - 0.14	0.012 - 0.039
		DDTR	mg/kg	--	--	--	--	--	0.095 - 0.367

Notes:
1 Composite sample
2 Sample basis as received
HCB - hexachlorobenzene
Hg - mercury
mg/kg - milligrams per kilogram
-- - sample not collected and/or sample not analyzed for specified constituent

Table 12. Analytical Results for Other Biota

Sample Type	Sample Location	Constituent	Units (e)	1994 Range of Concentrations	1995 Range of Concentrations	2001 Range of Concentrations
Terrestrial Insects and Spiders	OU-2	Hg	mg/kg	0.10 - 0.21	0.05 - 0.24	--
		HCB	mg/kg	<0.014 - 0.45	--	--
Spiders	OU-2	Hg	mg/kg	--	0.24 (a)	--
Terrestrial Insects (f)	OU-2	Hg	mg/kg	<0.04 - 0.21	0.05 (b)	--
		HCB	mg/kg	<0.013 - 0.45	--	--
		DDTr	mg/kg	0.07 - 2.9	--	--
		DDTR	mg/kg	0.08 - 5.3	--	--
	Lake Hatchetigbee (Reference)	Hg	mg/kg	<0.03 - 0.04	--	--
		HCB	mg/kg	<0.012 - 0.048	--	--
		DDTr	mg/kg	<0.020	--	--
		DDTR	mg/kg	<0.020	--	--
Aquatic Insects (f)	OU-2	Hg	mg/kg	0.20 - 0.24	0.25 (c)	0.033 - 0.15
		HCB	mg/kg	1.1 - 1.2	--	<0.25 - 3.1
		DDTr	mg/kg	5.3 - 6.5	--	--
		DDTR	mg/kg	11.7 - 14.1	--	4.19 - 27.3
	Lake Hatchetigbee (Reference)	Hg	mg/kg	0.06	--	--
		HCB	mg/kg	<0.016	--	--
		DDTr	mg/kg	<0.020	--	--
		DDTR	mg/kg	<0.020	--	--
Raccoon Whole Body (d) (f)	OU-2	Hg	mg/kg	0.53 - 0.96	--	--
		HCB	mg/kg	<0.01 - 0.21	--	--
		DDTr	mg/kg	0.055 - 0.556	--	--
		DDTR	mg/kg	0.07 - 0.57	--	--
	Lake Hatchetigbee (Reference)	Hg	mg/kg	0.14 - 0.29	--	--
		HCB	mg/kg	<0.01	--	--
		DDTr	mg/kg	<0.01	--	--
		DDTR	mg/kg	<0.01	--	--
Raccoon Whole Hair (f)	OU-2	Hg	mg/kg	12 - 14	--	--
		HCB	mg/kg	<0.0071 - 0.053	--	--
		DDTr	mg/kg	0.028 - 0.18	--	--
		DDTR	mg/kg	0.038 - 0.29	--	--
	Lake Hatchetigbee (Reference)	Hg	mg/kg	0.93 - 3.0	--	--
		HCB	mg/kg	<0.0076	--	--
		DDTr	mg/kg	<0.0076	--	--
		DDTR	mg/kg	<0.0076	--	--

Table 12. Analytical Results for Other Biota (continued)

Sample Type	Sample Location	Constituent	Units (e)	1994 Range of Concentrations	1995 Range of Concentrations	2001 Range of Concentrations
Little Blue Heron Whole Body (d) (f)	OU-2	Hg	mg/kg	0.30 - 1.7	--	--
		HCB	mg/kg	<0.01 - 0.41	--	--
		DDTr	mg/kg	0.339 - 28.1	--	--
		DDTR	mg/kg	0.35 - 32.8	--	--
	Lake Hatchetigbee (Reference)	Hg	mg/kg	0.48 - 0.91	--	--
		HCB	mg/kg	<0.01	--	--
		DDTr	mg/kg	<0.01 - 0.13	--	--
		DDTR	mg/kg	<0.01 - 0.147	--	--
Little Blue Heron Feathers (g)	OU-2	Hg	mg/kg	0.60 - 7.7	--	--
		HCB	mg/kg	<0.01 - 0.017	--	--
		DDTr	mg/kg	<0.01 - 0.745	--	--
		DDTR	mg/kg	<0.01 - 0.878	--	--
	Lake Hatchetigbee (Reference)	Hg	mg/kg	1.6 - 3.3	--	--
		HCB	mg/kg	<0.01	--	--
		DDTr	mg/kg	<0.05	--	--
		DDTR	mg/kg	<0.05	--	--
Bull Frog (f)	OU-2	Hg	mg/kg	0.1 - 0.46	--	--
		HCB	mg/kg	<0.01 - 0.057	--	--
		DDTr	mg/kg	0.033 - 2.73	--	--
		DDTR	mg/kg	0.048 - 2.795	--	--
	Lake Hatchetigbee (Reference)	Hg	mg/kg	<0.04 - 0.06	--	--
		HCB	mg/kg	<0.01	--	--
		DDTr	mg/kg	<0.01	--	--
		DDTR	mg/kg	<0.01	--	--
Crayfish (g)	OU-2	Hg	mg/kg	0.13 - 0.20	--	--
		HCB	mg/kg	0.088 - 0.91	--	--
		DDTr	mg/kg	0.4 - 1.5	--	--
		DDTR	mg/kg	0.43 - 1.6	--	--
	Lake Hatchetigbee (Reference)	Hg	mg/kg	<0.04 - 0.04	--	--
		HCB	mg/kg	<0.008	--	--
		DDTr	mg/kg	<0.008	--	--
		DDTR	mg/kg	<0.008	--	--
Mussels (g)	OU-2	Hg	mg/kg	0.05 - 0.25	--	--
		HCB	mg/kg	0.017 - 0.16	--	--
		DDTr	mg/kg	0.522 - 2.297	--	--
		DDTR	mg/kg	0.951 - 4.52	--	--
	Lake Hatchetigbee (Reference)	Hg	mg/kg	<0.04	--	--
		HCB	mg/kg	<0.008	--	--
		DDTr	mg/kg	<0.008	--	--
		DDTR	mg/kg	<0.008	--	--

Notes: DDTr - the sum of the 4,4'- isomers of DDT, DDE, and DDD; DDTR - the sume of the 2,4'- and 4,4'- isomers of DDT, DDE, and DDD
(a) Samples (n=36) collected during prothonotary warbler study collected at the site. Concentration is the average concentration of the 36 samples.
(b) Samples (n=201) collected during prothonotary warbler study collected at the site. Concentration is the average concentration of the 201 samples.
(c) Samples (n=30) collected during prothonotary warbler study collected at the site. Concentration is the average concentration of the 30 samples.
(d) Contents of digestive systems were not removed prior to analysis
(e) Sample basis as received by the laboratory; (f) DDTr and DDTR were calculated historically using one-half the detection limits where non-detect
(g) Obtained from database, which were calculated using 0 where non-detect

Table 13. Vegetation and Land Cover Types

Updated Ecological Risk Assessment
Olin – McIntosh
Operable Unit 2
McIntosh, Alabama

Vegetation/Land Cover Type	Acres	Percentage of Total
Mixed Upland Forest	1	1%
Semi-Permanently Flooded Bottomland Forest	35	18%
Temporarily Flooded Bottomland Forest	60	30%
Shrub Dominated Zone	4	2%
Herbaceous Dominated Zone	2	1%
Open Water Ponds and Streams	82	42%
Other (roads, etc.)	12	6%

Notes :
Vegetation survey conducted in September 1991.

Table 14. Selection of Human Health Exposure Pathways

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On Site/ Off-Site	Type of Analysis	Rationale for Selection of Exclusion of Exposure Pathway
Current/ Future	Surface Soil	Floodplain Soil	Trespassing (walking/ hiking) in OU-2 Floodplain	Trespasser	Adult	Ingestion	Onsite	Quantitative	Assumes infrequent access to areas around Basin and Round Pond.
				Trespasser	Adult	Dermal	Onsite	Quantitative	Assumes infrequent access to areas around Basin and Round Pond.
				Trespasser	Adolescent	Ingestion	Onsite	Quantitative	Assumes infrequent access to areas around Basin and Round Pond.
				Trespasser	Adolescent	Dermal	Onsite	Quantitative	Assumes infrequent access to areas around Basin and Round Pond.
		Particulates	Fugitive Dust	Trespasser	Adult	Inhalation	Onsite	Quantitative	Assumes infrequent access to areas around Basin and Round Pond.
				Trespasser	Adolescent	Inhalation	Onsite	Quantitative	Assumes infrequent access to areas around Basin and Round Pond.
	Surface Water	Surface Water	Swimming or Fishing in the Basin	Trespasser	Adolescent	Ingestion	Onsite	Quantitative	Assumes infrequent contact with surface water in the Basin and Round Pond.
				Trespasser	Adolescent	Dermal	Onsite	Quantitative	Assumes infrequent contact with surface water in the Basin and Round Pond.
				Trespasser	Adolescent	Inhalation	Onsite	None	No volatiles related to the site.
				Trespasser	Adult	Ingestion	Onsite	Quantitative	Assumes infrequent contact with surface water in the Basin and Round Pond.
				Trespasser	Adult	Dermal	Onsite	Quantitative	Assumes infrequent contact with surface water in the Basin and Round Pond.
				Trespasser	Adult	Inhalation	Onsite	None	No volatiles related to the site.
	Fish Tissue	Fish Tissue	Fishing in the Basin	Trespasser	Adolescent	Ingestion	Onsite	Quantitative	Assumes infrequent fishing in the Basin area.
				Trespasser	Adult	Ingestion	Onsite	Quantitative	Assumes infrequent fishing in the Basin area.

Table 15. Summary of Chemicals of Potential Concern and Medium-Specific Exposure Point Concentrations

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Point	COPC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Surface Water – Direct Contact	Mercury	0.0044	0.36	ug/L	42/42	0.169	ug/L	95% Chebyshev UCL
	Methylmercury	0.000613	0.0053	ug/L	42/42	0.0027	ug/L	95% Chebyshev UCL
	Hexachloro-benzene	0.0215	0.0442	ug/L	6/15	0.0396	ug/L	95% KM (bootstrap) UCL
	DDTR (a)	0.0964	0.214	ug/L	6/15	0.135	ug/L	95% KM (t) UCL

Key
ug/L: micrograms per liter
(a) DDTR is the sum of 2,4' and 4,4'-isomers of DDT, DDD, DDE.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Fish Tissue

Exposure Point	COPC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concen-tration Units	Statistical Measure
		Min	Max					
Ingestion of Fish Tissue	Methylmercury	1.6 (a)	3 (a)	mg/kg	20/20	2.47	mg/kg	95% Student's-t UCL
	Hexachloro-benzene	0.0362	0.135	mg/kg	20/20	0.077	mg/kg	95% approximate gamma UCL
	DDTR (b)	0.075	0.598	mg/kg	7/7	0.397	mg/kg	95% KM (t) UCL

Key
mg/kg: milligrams per kilogram

(a) 100% of total mercury analyzed assumed to be methylmercury
(b) DDTR is the sum of 2,4' and 4,4'-isomers of DDT, DDD, DDE.

Scenario Timeframe: Current/Future
Medium: Floodplain Soil
Exposure Medium: Surface Soil

Exposure Point	COPC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentr-ation Units	Statistical Measure
		Min	Max					
Flood-plain Soil	Mercury	0.061	8.9	mg/kg	39/39	1.58	mg/kg	95% H-UCL
	Methylmercury	3.67E-04	8.22E-03	mg/kg	11/12	NC	NA	NA
	Hexachloro-benzene	0.0011	0.275	mg/kg	7/9	NC	NA	NA
	DDTR (a)	0.00375	2.23	mg/kg	14/15	1.23	mg/kg	95% KM (Chebyshev) UCL

Note
mg/kg: milligrams per kilogram
NC: exposure point not calculated because this chemical was not a human health COPC in this medium
NA: Not Applicable
(a) DDTR is the sum of 2,4' and 4,4'-isomers of DDT, DDD, DDE.

Table 16. Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal							
COPC	Oral Cancer Slope Factor	Oral Absorption Efficiency for Dermal (1)	Adjusted Dermal Cancer Slope Factor (2)	Slope Factor Units	Weight of Evidence / Cancer Guideline Description	Source	Date
Mercury (inorganic salts)	NA	0.07	NA	$mg/kg\text{-}d^{-1}$	C	IRIS	06/01/1995
Methylmercury	NA	1.0	NA	$mg/kg\text{-}d^{-1}$	C	IRIS	07/27/2001
Hexachlorobenzene	1.60E+00	1.0	1.60E+00	$mg/kg\text{-}d^{-1}$	B2	IRIS	11/01/1996
DDTR (a)	3.40E-01	1.0	3.40E-01	$mg/kg\text{-}d^{-1}$	B2	IRIS	05/01/1991
Pathway: Inhalation							
	Unit Risk	Units	Inhalation Cancer Slope Factor	Slope Factor Units	Weight of Evidence / Cancer Guideline Description	Source	Date
Mercury (inorganic salts)	NA	$(mg/m3)^{-1}$	NA	NA	C	IRIS	06/01/1995
Methylmercury	NA	$(mg/m3)^{-1}$	NA	NA	C	IRIS	07/27/2001
Hexachlorobenzene	4.6E-01	$(mg/m3)^{-1}$	NA	NA	B2	IRIS	11/01/1996
DDTR (a)	9.7E-02	$(mg/m3)^{-1}$	NA	NA	B2	IRIS	05/01/1991

(a) DDT used as a surrogate.
NA = Not Available
(1) Source: RSL Table
(2) Slope Factor / Efficiency
$mg/kg\text{-}day^{-1}$ = reciprocal of milligrams per kilogram per day
$(mg/m^3)^{-1}$ = reciprocal of milligrams per cubic meter
Weight of Evidence Group:
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen

Table 17. Non-Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal

COPC	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Adjusted Dermal RfD (1)	Dermal RfD Units	Oral Absorption Efficiency for Dermal (2)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ
Mercury (inorganic salts)	Chronic	3.0E-04	mg/kg-day	2.1E-05	mg/kg-day	0.07	Immune	1000 / 1	IRIS	05/01/1995
Methylmercury	Chronic	1.0E-04	mg/kg-day	1.0E-04	mg/kg-day	1.0	CNS	10 / 1	IRIS	07/27/2001
Hexachlorobenzene	Chronic	8.0E-04	mg/kg-day	8.0E-04	mg/kg-day	1.0	Liver	100 / 1	IRIS	04/01/1991
DDTR (a)	Chronic	5.0E-04	mg/kg-day	5.0E-04	mg/kg-day	1.0	Liver	100 / 1	IRIS	02/01/1996

Pathway: Inhalation

COPC	Chronic/ Subchronic	Inhalatipn RfC	Inhalation RfC Units	Inhalation RfD	Inhalation RfD Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfC-RfD: Target Organ	Dates of RfD: Target Organ
Mercury (inorganic salts)	Chronic	NA	mg/m^3	--	--	NA	NA	IRIS	04/01/1994
Methylmercury	Chronic	NA	mg/m^3	--	--	NA	NA	IRIS	07/27/2001
Hexachlorobenzene	Chronic	NA	mg/m^3	--	--	NA	NA	IRIS	03/01/1991
DDTR (a)	Chronic	NA	mg/m^3	--	--	NA	NA	IRIS	NA

(a) DDT used as a surrogate.
NA = Not Available
(1) Source: RSL Table
(2) Slope Factor / Efficiency
mg/kg-day = milligrams per kilogram per day

Table 18. Human Health Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe: Current
Receptor Population: Resident/Trespasser/Fisherman
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	COPC	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Swimming	Mercury	Immune	1.0E-05	NA	1.0E-04	1.1E-04
			Methylmercury	CNS	5.0E-07	NA	5.0E-07	1.0E-06
			Hexachlor-benzene	Liver	9.0E-07	NA	4.0E-04	4.0E-04
			DDTR	Liver	5.0E-06	NA	5.0E-03	5.0E-03
Surface Water Hazard Index Total=								**5.5E-03**
Surface Soil	Floodplain Soil	Onsite	Mercury	Immune	1.0E-04	--	7.0E-06	1.1E-04
			DDTR	Liver	6.0E-05	--	7.0E-06	6.7E-05
Surface Soil Hazard Index Total								**1.8E-04**
Fish Tissue	Fish Tissue	Fishing in Basin	Methylmercury	CNS	1.4E+00	NA	NA	1.4E+00
			Hexachlor-benzene	Liver	5.5E-03	NA	NA	5.5E-03
			DDTR	Liver	4.5E-02	NA	NA	4.5E-02
Fish Ingestion Hazard Index								**1.5E+00**
Receptor Hazard Index=								**1.5E+00**
Liver Hazard Index=								5.0E-02
Immune Hazard Index=								2.2E-04
CNS Hazard Index=								1.4E+00

Key
-- : Toxicity criteria are not available to quantitatively address this route of exposure
NA: Route of exposure is not applicable to this medium

Table 19. Human Health Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe: Current
Receptor Population: Resident/Trespasser/Fisherman
Receptor Age: Pre-adolescent/Adolescent

Medium	Exposure Medium	Exposure Point	COPC	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Swimming	Mercury	Immune	4.0E-05	NA	2.0E-04	2.4E-04
			Methylmercury	CNS	2.0E-06	NA	5.0E-07	2.5E-06
			Hexachlor-benzene	Liver	3.0E-06	NA	4.0E-04	4.0E-04
			DDTR	Liver	2.0E-05	NA	6.0E-03	6.0E-03
							Surface Water Hazard Index Total=	**6.6E-03**
Surface Soil	Floodplain Soil	Onsite	Mercury	Immune	2.0E-04	--	2.0E-05	2.5E-04
			DDTR	Liver	8.0E-05	--	2.0E-05	1.0E-04
							Surface Soil Hazard Index Total	**3.5E-04**
Fish Tissue	Fish Tissue	Fishing in Basin	Methylmercury	CNS	1.0E+00	NA	NA	1.0E+00
			Hexachlor-benzene	Liver	4.0E-03	NA	NA	4.0E-03
			DDTR	Liver	4.0E-02	NA	NA	4.0E-02
							Fish Ingestion Hazard Index	**1.0E+00**
							Receptor Hazard Index=	**1.0E+00**
							Liver Hazard Index=	5.0E-02
							Immune Hazard Index=	4.9E-04
							CNS Hazard Index=	1.0E+00

Key
-- : Toxicity criteria are not available to quantitatively address this route of exposure
NA: Route of exposure is not applicable to this medium

Table 20. Human Health Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident/Trespasser/Fisherman
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	COPC	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Swimming	Mercury	Immune	4.0E-05	NA	5.0E-04	5.4E-04
			Methylmercury	CNS	2.0E-06	NA	2.0E-06	4.0E-06
			Hexachlor-benzene	Liver	3.0E-06	NA	1.0E-03	1.0E-03
			DDTR	Liver	2.0E-05	NA	2.0E-02	2.0E-05
Surface Water Hazard Index Total=								**1.6E-03**
Surface Soil	Floodplain Soil	Onsite	Mercury	Immune	5.0E-04	--	3.0E-05	5.3E-04
			DDTR	Liver	2.0E-04	--	3.0E-05	2.3E-04
Surface Soil Hazard Index Total								**7.6E-04**
Fish Tissue	Fish Tissue	Fishing in Basin	Methylmercury	CNS	6.0E+00	NA	NA	6.0E+00
			Hexachlor-benzene	Liver	2.0E-02	NA	NA	2.0E-02
			DDTR	Liver	2.0E-01	NA	NA	2.0E-01
Fish Ingestion Hazard Index								**6.2E+00**
Receptor Hazard Index=								**6.2E+00**
Liver Hazard Index=								2.2E-01
Immune Hazard Index=								5.3E-04
CNS Hazard Index=								6.0E+00

Key
-- : Toxicity criteria are not available to quantitatively address this route of exposure
NA: Route of exposure is not applicable to this medium

Table 21. Human Health Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident/Trespasser/Fisherman
Receptor Age: Pre-adolescent/Adolescent

Medium	Exposure Medium	Exposure Point	COPC	Primary Target Organ	Non-Carcinogenic Hazard Quotient: Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Swimming	Mercury	Immune	1.0E-04	NA	6.0E-04	7.0E-04
			Methylmercury	CNS	7.0E-06	NA	2.0E-06	9.0E-06
			Hexachlor-benzene	Liver	1.0E-05	NA	2.0E-03	2.0E-03
			DDTR	Liver	7.0E-05	NA	2.0E-02	2.0E-02
							Surface Water Hazard Index Total=	**2.3E-02**
Surface Soil	Floodplain Soil	Onsite	Mercury	Immune	7.0E-04	--	8.0E-05	7.8E-04
			DDTR	Liver	3.0E-04	--	8.0E-05	3.8E-04
							Surface Soil Hazard Index Total	**1.2E-03**
Fish Tissue	Fish Tissue	Fishing in Basin	Methylmercury	CNS	4.0E+00	NA	NA	4.0E+00
			Hexachlor-benzene	Liver	2.0E-02	NA	NA	2.0E-02
			DDTR	Liver	1.0E-01	NA	NA	1.0E-01
							Fish Ingestion Hazard Index	**4.1E+00**
							Receptor Hazard Index=	**4.1E+00**
							Liver Hazard Index=	1.4E-01
							Immune Hazard Index=	1.5E-03
							CNS Hazard Index=	4.0E+00

Key
-- : Toxicity criteria are not available to quantitatively address this route of exposure
NA: Route of exposure is not applicable to this medium

Table 22. Human Health Risk Characterization Summary – Carcinogen

Scenario Timeframe: Current **Receptor Population: Resident/Trespasser/Fisherman** **Receptor Age: Adult**							
Medium	**Exposure Medium**	**Exposure Point**	**COPC**	**Carcinogenic Risks**			
				Ingestion	**Inhalation**	**Dermal**	**Exposure Routes Total**
Surface Water	Surface Water	Swimming	Hexachloro-benzene	5.1E-10	NA	2.2E-07	2.2E-07
			DDTR	3.7E-10	NA	4.0E-07	4.0E-07
						Surface Water Risk Total=	**6.2E-07**
Surface Soil	Floodplain Soil	Onsite	Hexachloro-benzene	NA	NA	NA	NA
			DDTR	4.0E-09	6.0E-13	5.0E-10	4.5E-09
						Surface Soil Risk Total	**4.5E-09**
Fish Tissue	Fish Tissue	Fishing in Basin	Hexachloro-benzene	3E-06	NA	NA	3.0E-06
			DDTR	3E-06	NA	NA	3.0E-06
						Fish Ingestion Risk Total	**6.0E-06**
						Total Risk=	**6.7E-06**

Key
- : Toxicity criteria are not available to quantitatively address this route of exposure
NA: Route of exposure is not applicable to this medium

Table 23. Human Health Risk Characterization Summary – Carcinogen

Scenario Timeframe: Current
Receptor Population: Resident/Trespasser/Fisherman
Receptor Age: Pre-adolescent/Adolescent

Medium	Exposure Medium	Exposure Point	COPC	Carcinogenic Risks			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Swimming	Hexachloro-benzene	6.0E-10	NA	8.0E-08	8.1E-08
			DDTR	4.0E-10	NA	2.0E-07	2.0E-07
						Surface Water Risk Total=	**2.1E-07**
Surface Soil	Floodplain Soil	Onsite	Hexachloro-benzene	NA	NA	NA	NA
			DDTR	2.0E-09	2.0E-13	5.0E-10	2.5E-09
						Surface Soil Risk Total	**2.5E-09**
Fish Tissue	Fish Tissue	Fishing in Basin	Hexachloro-benzene	8E-07	NA	NA	8.0E-07
			DDTR	9E-07	NA	NA	9.0E-07
						Fish Ingestion Risk Total	**1.70E-06**
						Total Risk=	**2.0E-06**

Key
- : Toxicity criteria are not available to quantitatively address this route of exposure
NA: Route of exposure is not applicable to this medium

Table 24. Human Health Risk Characterization Summary – Carcinogen

Scenario Timeframe: Future
Receptor Population: Resident/Trespasser/Fisherman
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	COPC	Carcinogenic Risks			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Swimming	Hexachloro-benzene	1.9E-09	NA	8.1E-07	8.1E-07
			DDTR	1.4E-09	NA	1.5E-06	1.5E-06
						Surface Water Risk Total=	**2.3E-06**
Surface Soil	Floodplain Soil	Onsite	Hexachloro-benzene	NA	NA	NA	NA
			DDTR	2.0E-08	2.0E-12	2.0E-9	2.2E-08
						Surface Soil Risk Total	**2.2E-08**
Fish Tissue	Fish Tissue	Fishing in Basin	Hexachloro-benzene	1.5E-05	NA	NA	1.5E-05
			DDTR	1.5E-05	NA	NA	1.5E-06
						Fish Ingestion Risk Total	**3.0E-05**
						Total Risk=	**3.2E-05**

Key
- : Toxicity criteria are not available to quantitatively address this route of exposure
NA: Route of exposure is not applicable to this medium

Table 25. Human Health Risk Characterization Summary – Carcinogen

Scenario Timeframe: Future
Receptor Population: Resident/Trespasser/Fisherman
Receptor Age: Pre-adolescent/Adolescent

Medium	Exposure Medium	Exposure Point	COPC	Carcinogenic Risks			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Swimming	Hexachloro-benzene	2.0E-09	NA	3.0E-07	3.0E-07
			DDTR	2.0E-09	NA	6.0E-07	6.0E-07
						Surface Water Risk Total=	**9.0E-07**
Surface Soil	Floodplain Soil	Onsite	Hexachloro-benzene	NA	NA	NA	NA
			DDTR	8.0E-09	8.0E-13	2.0E-09	1.0E-08
						Surface Soil Risk Total	**2.5E-09**
Fish Tissue	Fish Tissue	Fishing in Basin	Hexachloro-benzene	3.5E-06	NA	NA	3.5E-06
			DDTR	3.5E-06	NA	NA	3.5E-06
						Fish Ingestion Risk Total	**7.0E-06**
						Total Risk=	**8.0E-06**

Key
- : Toxicity criteria are not available to quantitatively address this route of exposure
NA: Route of exposure is not applicable to this medium

Table 26. Occurrence, Distribution, and Selection of Chemicals of Concern

Exposure Medium: Sediment								
Chemical of Potential Concern	Minimum Conc.[1] (mg/kg)	Maximum Conc.[1] (mg/kg)	95% UCL of the Mean[2] (mg/kg)	Background Conc. (mg/kg)	Screening Toxicity Value (mg/kg)	Screening Toxicity Value Source[3]	HQ Value[4]	COC Flag (Y or N)
Mercury	0.965	213	51.0	<0.09	1.06	PEC	200	Y
Methylmercury	0.00142	0.0257	0.00728	NA	NA	--	--	N [5]
Hexachlorobenzene	0.0221	34.1	8.29	<0.0005	0.020	PEC	1,705	Y
DDTR	0.066	2.72	1.57	<0.005	0.0025	WSRC	1,088	Y
Exposure Medium: Surface Water								
Chemical of Potential Concern	Minimum Conc.[1] (ug/L)	Maximum Conc.[1] (ug/L)	95% UCL of the Mean[2] (ug/L)	Background Conc. (ug/L)	Screening Toxicity Value (ug/L)	Screening Toxicity Value Source[3]	HQ Value[4]	COC Flag (Y or N)
Mercury (total)	0.0044	0.36	0.169	<0.003	0.012	EPA R4	30	Y
Mercury (dissolved)			0.0147	<0.003	0.012	EPA R4	1.2	N [5]
Methylmercury	0.000613	0.00553	0.00274	NA	NA	--	--	Y
Hexachlorobenzene	0.0031	0.044	0.0396	<0.001	NA	--	--	Y
DDTR	0.096	0.403	0.135	<0.001	0.001	NAWQC	400	Y
Exposure Medium: Surface Soil								
Chemical of Potential Concern	Minimum Conc.[1] (mg/kg)	Maximum Conc.[1] (mg/kg)	95% UCL of the Mean[2] (mg/kg)	Background Conc. (mg/kg)	Screening Toxicity Value (mg/kg)	Screening Toxicity Value Source[3]	HQ Value[4]	COC Flag (Y or N)
Mercury	0.061	8.9	1.60	<0.07	0.1	EPA R4	89	Y
Methylmercury	0.000176	0.0082	NA	NA	0.67	EPA R4	0.01	N
Hexachlorobenzene	0.0011	0.275	NA	<0.0004	0.0025	EPA R4	110	Y
DDTR	0.066	2.23	1.20	<0.002	0.0025	EPA R4	892	Y

Key
Conc. = Concentration
N/A = Not Applicable

Notes

1 Minimum/ maximum detected concentration above the sample quantification limit (SQL)

2 The 95% Upper Confidence Limit (UCL) represents the RME concentration

3 PEC = Sediment Probable Effects Concentration from McDonald et al 2000. Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Contam. Toxicol. 39: 20-31.
WSRC = Ecological screening value for sediment from Westinghouse Savannah River Company WSCR-TR-98-00110 (2000)
EPA R4 = Ecological Screening Value from EPA Region 4
NAWQC = National Ambient Water Quality Criterion

4 Hazard Quotient (HQ) is defined as Maximum Concentration/ Screening Toxicity Value.

5 Methylmercury is the primary form in which mercury is moved through the food chain. Remedial goals for mercury are developed for Total Mercury (inorganic + methyl).

TABLE 27. Ecological Exposure Pathways of Concern

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Endangered / Threatened Species Flag (Y or N)	Exposures Routes	Assessment Endpoints	Measurement Endpoints
QUALITATIVE SLERA ENDPOINTS						
Sediment	N	1) Benthic Invertebrates		Direct contact, ingestion	Protection of Long-term Health and Reproductive Success of Benthic Invertebrate Community	Comparison of COC concentrations in sediment and crayfish tissue to media-specific toxicity values protective of benthic invertebrates
Sediment, Surface Water	N	2) Fish		Direct contact, ingestion	Protection of Long-term Health and Reproductive Success of the Fish Community	Comparison of COC concentrations in sediment, surface water, and fish tissue to media-specific toxicity values protective of fish.
Floodplain Soil	N	3) Soil dwelling invertebrates		Direct Contact, Ingestion	Protection of Long-term Health and Reproductive Success of Soil Invertebrates in Floodplain Soil	Comparison of COC concentrations in soil to soil toxicity values protective of soil-dwelling invertebrates
QUANTITATIVE BERA ENDPOINTS						
Sediment, Surface Water	N	4) Aquatic invertebrate feeding mammals	N	Ingestion	Protection of Long-term Health and Reproductive Success of Insectivorous Aquatic Mammals	Food chain dose modeling to little brown bat using COC concentrations in sediment, surface water, and emergent aquatic insect tissue
	N	5) Carnivorous aquatic mammals	N	Ingestion	Protection of Long-term Health and Reproductive Success of Carnivorous Aquatic Mammals	Food chain dose modeling to river otter and mink using COC concentrations in sediment, surface water, forage fish tissue, and predatory fish tissue
	N	6) Insectivorous aquatic birds	N	Ingestion	Protection of Long-term Health and Reproductive Success of Insectivorous Aquatic Birds	Food chain dose modeling to pied-billed grebe using COC concentrations in sediment, surface water, vertebrate tissue, frog tissue, crayfish tissue, aquatic insect tissue, crayfish tissue, and forage fish tissue
	N	7) Piscivorous aquatic birds	N	Ingestion	Protection of Long-term Health and Reproductive Success of Piscivorous Aquatic Birds	Food chain dose modeling to belted kingfisher using COC concentrations in sediment, surface water, forage fish tissue, aquatic insect tissue, crayfish tissue, and amphibian tissue; modeling to little blue heron using forage fish and aquatic insect tissue; modeling to great blue heron using sediment, surface water, aquatic insect tissue, amphibian tissue, forage fish tissue, and predatory fish tissue.

TABLE 27. Ecological Exposure Pathways of Concern (continued)

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Endangered / Threatened Species Flag (Y or N)	Exposures Routes	Assessment Endpoints	Measurement Endpoints
	N	8) Omnivorous aquatic birds	N	Ingestion	Protection of Long-term Health and Reproductive Success of Omnivorous Aquatic Birds	Food chain dose modeling to wood duck using COC concentrations in sediment, surface water, insect tissue, and terrestrial (floodplain) plant tissue
	N	9) Carnivorous aquatic reptiles	N	Ingestion	Protection of Long-term health and Reproductive Success of Carnivorous Aquatic Reptiles	Food chain dose modeling to American alligator using
Soil	N	10) Insectivorous terrestrial mammals	N	Ingestion	Protection of Long-term Health and Reproductive Success of Insectivorous Terrestrial Mammals	Food chain dose modeling to short-tailed shrew using COC concentrations in floodplain soil and terrestrial insect and spider tissue
	N	11) Omnivorous terrestrial mammals	N	Ingestion	Protection of Long-term Health and Reproductive Success of Omnivorous Terrestrial Mammals	Food chain dose modeling to raccoon using COC concentrations in floodplain soil, terrestrial insect and spider tissue, vertebrate tissue, and terrestrial (floodplain) plant tissue
	N	12) Herbivorous terrestrial mammals	N	Ingestion	Protection of Long-term Health and Reproductive Success of Herbivorous Terrestrial Mammals	Food chain dose modeling to pine vole using COC concentrations in floodplain soil and terrestrial (floodplain) plant tissue
	N	13) Insectivorous terrestrial birds	N	Ingestion	Protection of Long-term Health and Reproductive Success of Insectivorous Terrestrial Birds	Food chain dose modeling to Carolina wren using COC concentrations in floodplain soil and terrestrial insect and spider tissue

Table 28. COC Concentrations Expected to Provide Adequate Protection of Ecological Receptors

Exposure Medium	COC	Protective Level[1]	Units	Basis[2]	Assessment Endpoint
Sediment	Mercury	1.6 to 10.7	mg/kg	Lower end of range based on geometric mean of NOAEL and LOAEL RGs for little blue heron derived using sediment to fish BSAF uptake model. Upper end of range based on NOAEL RG derived from SERAFM mercury uptake model.	Protection of piscivorous birds (little blue heron)
	HCB	7.6	mg/kg	NOAEL	Protection of piscivorous mammals (mink)
	DDTR	0.21 (protection of predatory fish) 0.32 – 0.91 (protection of piscivorous birds) 0.63 (protection of forage fish)	mg/kg	Predatory fish goal based on sediment concentration resulting in biomagnification into piscivorous fish exceeding the 10th percentile LER fish tissue protective goal. Range of goals based on protection of piscivorous birds ingesting fish at OU-2. Forage fish goal based on sediment concentration resulting in forage fish tissue concentration exceeding the 10th percentile LER fish protective level.	Protection of fish; Protection of piscivorous birds (little blue heron and great blue heron)
Floodplain Soil	Mercury	0.54 – 1.9	mg/kg	RG range based on NOAEL PRG for Carolina wren modeled with varying diets of different invertebrate types.	Protection of terrestrial insectivorous birds
	DDTR	0.18 – 1.12	mg.kg	RG range based on geometric mean of NOAL and LOAEL PRGs for Carolina wren modeled with varying diets of different invertebrate types.	Protection of terrestrial insectivorous birds
Fish Tissue (forage fish)	Mercury	0.20 – 0.28	mg/kg	Lower end of range represents piscivorous bird goal based on geometric mean of NOAEL and LOAEL PRGs for little blue heron. Upper end of range represents 10th percentile value protective of fish.	Protection of fish and piscivorous birds
	DDTR	0.23 (protection of predatory fish) 0.42 – 0.52 (protection of piscivorous birds)	mg/kg	Low value (0.23) represents forage fish concentration resulting in biomagnification into bass tissue equal to fish tissue protective level for bass. Piscivorous bird range based on protection of birds using the geometric mean of the NOAEL and LOAEL.	Protection of fish and protection of piscivorous birds (little blue heron and great blue heron)
Fish Tissue (Large Mouth Bass)	Mercury	0.28 (Predatory Fish RG for fish protection – whole body); 0.43 (Predatory Fish RG for piscivorous eating birds – whole body); 0.3 (Predatory Fish human health RG - filets)	mg/kg	Fish protection goal based on t-TEL from Beckvar et al, 2005) Piscivorous bird goal based on geometric mean of NOAEL and LOAEL RGs for great blue heron. Human health goal is ARAR for human consumption.	Protection of fish and protection of piscivorous birds (little blue heron and great blue heron). Protection of human health.
	DDTR	0.64	mg/kg	Based on T-TEL from	Protection of Fish

Notes
[1] A range of levels may be provided. [2] Basis of Selection of protection level.

Table 29. Olin OU-2 Cleanup Levels for Chemicals of Concern

Sediment			
Chemical of Concern	**Cleanup Level**	**Basis for Cleanup Level**	**Risk at Cleanup Level**
Mercury	3 mg/kg	Risk Assessment – weight of evidence based on protection of piscivorous bird species at LOAEL	Human Health HQ = 0.29 (a) Ecological HQ = 0.43 (b)
HCB	7.6 mg/kg	Risk Assessment – protection of piscivorous mammals (direct contact with sediment) at LOAEL	Human Health ILCR = 1E-05 (c) Ecological HQ = 1 (d)
DDTR	0.21 mg/kg	Risk Assessment – protection of predatory fish at threshold effects level	Human Health HQ < 1 Ecological HQ = 1
Surface Water			
Chemical of Concern	**Cleanup Level**	**Basis for Cleanup Level**	**Risk at Cleanup Level**
Mercury (dissolved)	0.012 ug/L	ARAR	NA
DDTR	0.0001 ug/L	ARAR	NA
HCB	0.0002 ug/L	ARAR	NA
Floodplain Soil			
Chemical of Concern	**Cleanup Level**	**Basis for Cleanup Level**	**Risk at Cleanup Level**
Mercury	1.7 mg.kg	Risk Assessment – protection of insectivorous birds based on diet of crawling insects and spiders at LOAEL	Human Health HQ = 0.001 (e) Ecological HQ = 1 (f)
DDTR	0.63 mg/kg	Risk Assessment – protection of insectivorous birds based on diet of crawling insects and spiders at LOAEL	Human Health ILCR = 1E-08 (g) Ecological HQ = 1 (f)

Table 29. Olin OU-2 Cleanup Levels for Chemicals of Concern (continued)

Fish Tissue			
Chemical of Concern	**Cleanup Level**	**Basis for Cleanup Level**	**Risk at Cleanup Level**
Mercury	0.2 mg/kg (mosquitofish) 0.3 mg/kg (largemouth bass fillet) 0.28 mg/kg (largemouth bass whole body)	Risk Assessment Mosquitofish goal based on protection of piscivorous birds at LOAEL Largemouth bass filet goal based on Human Health ARAR Largemouth bass whole body goal based on protection of fish at 10^{th} percentile effects level	Ecological HQ = 1 (mosquitofish and whole body bass) Human Health HQ < 1 based on fish tissue ARAR (largemouth bass fillet)(i)
DDTR	0.23 mg/kg (mosquitofish) 0.64 mg/kg (largemouth bass)	Risk Assessment Mosquitofish goal is body burden threshold effects level based on protection of predatory fish feeding on mosquitofish Largemouth bass goal is body burden threshold effects level based on protection of bass and other pisicvorous fish	Ecological HQ = 1 (forage fish) Ecological HQ = 1 (largemouth bass)

Notes:
NA – Not Applicable
(a) Human health hazard quotient for mercury in sediment based on future time-frame fisherman scenario, which was the most sensitive non-cancer exposure scenario identified in the human health risk assessment.
(b) Ecological hazard quotient for mercury in sediment based on risk to little blue heron as a surrogate for piscivorous birds
(c) Human health ILCR for HCB in sediment based on future time-frame fisherman scenario, which was the most sensitive cancer exposure scenario identified in the human health risk assessment.
(d) Ecological hazard quotient for HCB in sediment based on risk to mink as a surrogate for carnivorous mammals
(e) Human health HQ for mercury in floodplain soil based on future-use adolescent trespasser scenario, which was the most sensitive non-cancer exposure scenario identified I the human health risk assessment
(f) Ecological HQ for mercury in floodplain soil based on risk to Carolina wren as a surrogate for insectivorous birds
(g) Human health ILCR for DDTR in floodplain soil based on future-use adult trespasser scenario, which was the most sensitive non-cancer exposure scenario identified I the human health risk assessment
(h) Ecological HQ for DDTR in floodplain soil based on risk to Carolina wren as a surrogate for insectivorous birds
(i) The HHRA calculated an HI of 6 based on an exposure concentration of 2.47 mg/kg, the concentration for an HI of 1 would be 2.47/6 = 0.4 mg/kg.

Table 30. Cost Estimate Summary

Alternative 2A
IN SITU CAPPING

Site: Olin McIntosh Operable Unit 2
Location: McIntosh, Alabama
Phase: Feasibility Study
Base Year: 2012

Alternative 2A consists of capping of sediment and institutional controls (ICs). Timeframe is 30 years. Capital Costs occur in Year 0, periodic cost frequency is listed at the bottom of the table. This cost estimate table is for an in situ cap with different cap materials and thicknesses.

CAPITAL COSTS

DESCRIPTION	QTY	UNITS	UNIT COST	TOTAL[1]	REMARKS
Implementation of ICs	1	LS	$1,600	$1,600	
SUBTOTAL				$1,600	
Capping Remedy					
Design and Treatability Study	1	LS	$60,000	$60,000	
Cap Placement	1	LS	$11,987,511	$11,987,511 - $20,783,368	
SUBTOTAL				$12,049,111 - $20,844,968	
Post Construction Confirmation Sampling					
Cap Sediment Sampling	1	LS	$20,214	$20,214	
Surface Water Sampling	1	LS	$10,359	$10,359	
SUBTOTAL				$12,079,683 - $20,875,541	
Contingency	1	per cent	$12,049,111	$120,491	1% of Scope
SUBTOTAL				$12,200,174 - $21,083,991	
Management					
Project Management	1	per cent	$12,049,111	$120,491	1% of Scope
Construction Management	1	per cent	$12,049,111	$120,491	1% of Scope
SUBTOTAL				$12,441,157 - $21,500,890	
TOTAL CAPITAL COSTS				**$12,400,000 - $21,500,000**	

1: Higher end of the cost range is shown in sixth column.

Table 30. Cost Estimate Summary (continued)

ANNUAL COSTS DESCRIPTION		QTY	UNITS	UNIT COST	TOTAL	REMARKS
Inspection and Maintenance		1	LS	$3,500	$3,500	
SUBTOTAL					$3,500	
Contingency		10	per cent	$3,500	$350	10% of Scope
SUBTOTAL					$3,850	
Management						
Project Management		5	per cent	$3,500	$175	5% of Scope
SUBTOTAL					$4,025	
TOTAL ANNUAL COST					**$4,000**	
PERIODIC COSTS	**YEAR**					
Fish Sampling and Analysis		1	LS	$9,236	$9,236	
Spiders/Insects Sampling & Analysis		1	LS	$11,320	$11,320	
Surface Water Sampling & Analysis		4	LS	$10,359	$41,436	
SUBTOTAL					$61,992	
Contingency		10	per cent	$61,992	$6,199	10% of Scope
SUBTOTAL					$68,192	
Management						
Project Management		5	per cent	$61,992	$3,100	5% of Scope
SUBTOTAL	1				$71,291	
Fish Sampling and Analysis		1	LS	$9,236	$9,236	
Spiders/Insects Sampling & Analysis		1	LS	$11,320	$11,320	
Surface Water Sampling and Analysis		1	LS	$10,359	$10,359	
SUBTOTAL					$30,915	
Contingency		10	per cent	$30,915	$3,092	10% of Scope
SUBTOTAL					$34,007	
Management						
Project Management		5	per cent	$30,915	$1,546	5% of Scope
SUBTOTAL	2				$35,553	

Table 30. Cost Estimate Summary (continued)

DESCRIPTION	YEAR	QTY	UNITS	UNIT COST	TOTAL	REMARKS
Fish Sampling and Analysis		1	LS	$9,236	$9,236	
Spiders/Insects Sampling & Analysis		1	LS	$11,320	$11,320	
Surface Water Sampling and Analysis		1	LS	$10,359	$10,359	
SUBTOTAL					$30,915	
Contingency		10	per cent	$30,915	$3,092	10% of Scope
SUBTOTAL					$34,007	
Management						
Project Management		5	per cent	$30,915	$1,546	5% of Scope
SUBTOTAL	3				$35,553	
Pre-5-Year Review Report Monitoring						
Topographic Survey		1	LS	$10,070	$10,070	
Sediment Core Sampling		1	LS	$20,214	$20,214	
Fish Sampling and Analysis		1	LS	$9,236	$9,236	
Spiders/Insects Sampling & Analysis		1	LS	$11,320	$11,320	
Surface Water Sampling and Analysis		1	LS	$10,359	$10,359	
SUBTOTAL					$61,199	
Contingency		10	per cent	$61,199	$6,120	10% of Scope
SUBTOTAL					$67,319	
Management						
Project Management		5	per cent	$61,199	$3,060	5% of Scope
SUBTOTAL	4				$70,379	
Surface Water Sampling and Analysis		1	LS	$10,359	$10,359	
Fish Sampling and Analysis		1	LS	$9,236	$9,236	
Spiders/ Insects Sampling & Analysis		1	LS	$11,320	$11,320	
5-Year Review Report		1	LS	$5,000	$5,000	
SUBTOTAL					$35,915	
Contingency		10	per cent	$35,915	$3,592	10% of Scope
SUBTOTAL					$39,507	

Table 30. Cost Estimate Summary (continued)

DESCRIPTION		YEAR	QTY	UNITS	UNIT COST	TOTAL	REMARKS
Management							
Project Management			5	per cent	$35,915	$1,796	5% of Scope
	SUBTOTAL	5				$41,303	
Annual Surface Water Sampling & Analysis							
Surface Water Sampling and Analysis			1	LS	$10,359	$10,359	
	SUBTOTAL					$10,359	
Contingency			10	per cent	$10,359	$1,036	10% of Scope
	SUBTOTAL					$11,395	
Management							
Project Management			5	per cent	$10,359	$518	5% of Scope
	SUBTOTAL	6				$11,913	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	7				$11,913	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	8				$11,913	
Pre-5-Year Review Report Monitoring							
Topographic Survey			1	LS	$10,070	$10,070	
Sediment Core Sampling			1	LS	$20,214	$20,214	
Fish Sampling and Analysis			1	LS	$9,236	$9,236	
Spiders/Insects Sampling & Analysis			1	LS	$11,320	$11,320	
Surface Water Sampling and Analysis			1	LS	$10,359	$10,359	
	SUBTOTAL					$61,199	
Contingency			10	per cent	$61,199	$6,120	10% of Scope
	SUBTOTAL					$67,319	
Management							
Project Management			5	per cent	$61,199	$3,060	5% of Scope
	SUBTOTAL	9				$70,379	

Table 30. Cost Estimate Summary (continued)

DESCRIPTION		YEAR	QTY	UNITS	UNIT COST	TOTAL COST	REMARKS
5-Year Review Report & Annual Surface Water Monitoring							
5-Year Review Report			1	LS	$5,000	$5,000	
Surface Water Sampling and Analysis			1	LS	$10,359	$10,359	
	SUBTOTAL					$15,359	
Contingency			10	per cent	$15,359	$1,536	10% of Scope
	SUBTOTAL					$16,895	
Management							
Project Management			5	per cent	$15,359	$768	5% of Scope
	SUBTOTAL	10				$17,663	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	11				$11,913	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	12				$11,913	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	13				$11,913	
Pre-5-Year Review Report Monitoring			1	LS	$70,379	$70,379	Same as Year 9
	SUBTOTAL	14				$70,379	
5-Year Review Report & Annual SW Monitoring			1	LS	$17,663	$17,663	Same as Year 10
	SUBTOTAL	15				$17,663	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	16				$11,913	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	17				$11,913	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	18				$11,913	
Pre-5-Year Review Report Monitoring			1	LS	$70,379	$70,379	Same as Year 9
	SUBTOTAL	19				$70,379	
5-Year Review Report & Annual SW Monitoring			1	LS	$17,663	$17,663	Same as Year 10
	SUBTOTAL	20				$17,663	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	21				$11,913	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	22				$11,913	
Annual Surface Water Sampling & Analysis			1	LS	$11,913	$11,913	Same as Year 6
	SUBTOTAL	23				$11,913	

Table 30. Cost Estimate Summary (continued)

DESCRIPTION	YEAR	QTY	UNITS	UNIT COST	TOTAL COST	REMARKS
Pre-5-Year Review Report Monitoring		1	LS	$70,379	$70,379	Same as Year 9
SUBTOTAL	24				$70,379	
5-Year Review Report & Annual SW Monitoring		1	LS	$17,663	$17,663	Same as Year 10
SUBTOTAL	25				$17,663	
Annual Surface Water Sampling & Analysis		1	LS	$11,913	$11,913	Same as Year 6
SUBTOTAL	26				$11,913	
Annual Surface Water Sampling & Analysis		1	LS	$11,913	$11,913	Same as Year 6
SUBTOTAL	27				$11,913	
Annual Surface Water Sampling & Analysis		1	LS	$11,913	$11,913	Same as Year 6
SUBTOTAL	28				$11,913	
Pre-5-Year Review Report Monitoring		1	LS	$70,379	$70,379	Same as Year 9
SUBTOTAL	29				$70,379	
5-Year Review Report & Annual SW Monitoring		1	LS	$17,663	$17,663	Same as Year 10
SUBTOTAL	30				$17,663	

Table 30. Cost Estimate Summary (continued)

PRESENT VALUE ANALYSIS (AT DISCOUNT RATE OF 7%)					
COST TYPE	**YEAR**	**TOTAL COST**	**TOTAL COST PER YEAR**	**DISCOUNT FACTOR**	**PRESENT VALUE**
Capital Costs	0	$12,400,000 - $21,500,000	NA	1.000	$12,400,000 - $21,500,000
Annual O&M	1 - 30	$120,000	$4,000	12.409	$49,636
Periodic Cost	1	$71,291	$71,291	0.935	$66,627
Periodic Cost	2	$35,553	$35,553	0.873	$31,053
Periodic Cost	3	$35,553	$35,553	0.816	$29,022
Periodic Cost	4	$70,379	$70,379	0.763	$53,692
Periodic Cost	5	$41,303	$41,303	0.713	$29,448
Periodic Cost	6	$11,913	$11,913	0.666	$7,938
Periodic Cost	7	$11,913	$11,913	0.623	$7,419
Periodic Cost	8	$11,913	$11,913	0.582	$6,933
Periodic Cost	9	$70,379	$70,379	0.544	$38,281
Periodic Cost	10	$17,663	$17,663	0.508	$8,979
Periodic Cost	11	$11,913	$11,913	0.475	$5,660
Periodic Cost	12	$11,913	$11,913	0.444	$5,289
Periodic Cost	13	$11,913	$11,913	0.415	$4,943
Periodic Cost	14	$70,379	$70,379	0.388	$27,294
Periodic Cost	15	$17,663	$17,663	0.362	$6,402
Periodic Cost	16	$11,913	$11,913	0.339	$4,035
Periodic Cost	17	$11,913	$11,913	0.317	$3,771
Periodic Cost	18	$11,913	$11,913	0.296	$3,525
Periodic Cost	19	$70,379	$70,379	0.277	$19,460
Periodic Cost	20	$17,663	$17,663	0.258	$4,564
Periodic Cost	21	$11,913	$11,913	0.242	$2,877
Periodic Cost	22	$11,913	$11,913	0.226	$2,689
Periodic Cost	23	$11,913	$11,913	0.211	$2,513
Periodic Cost	24	$70,379	$70,379	0.197	$13,875
Periodic Cost	25	$17,663	$17,663	0.184	$3,254
Periodic Cost	26	$11,913	$11,913	0.172	$2,051
Periodic Cost	27	$11,913	$11,913	0.161	$1,917
Periodic Cost	28	$11,913	$11,913	0.150	$1,792
Periodic Cost	29	$70,379	$70,379	0.141	$9,893
Periodic Cost	30	$17,663	$17,663	0.131	$2,320
		$13,393,000 – 22,493,000			$12,857,000 – 21,957,000

Total Cost (Capital + O&M) $13,400,000 - $22,500,000
Total Present Value of Alternative 12,900,000 - $22,000,000
Note: Totals rounded to the nearest $100,000.

Table 31. Chemical-Specific Applicable and Relevant and Appropriate Requirements and To-Be Considered Guidance (TBC)

Action/Media	Requirements	Prerequisite	Citation
Risk-based Fish Tissue Residue Criterion for Mercury	Recommends a fish tissue residue water quality criterion of 0.3 mg methylmercury/kg.	Mercury and/or methylmercury in fish tissue residue **– To Be Considered (TBC)**	U.S. EPA, Office of Science and Tech., Office of Water, EPA-823-R-01-001, *Final Water Quality Criterion for the Protection of Human Health: Methylmercury* (Jan. 2001).
Protection of surface water	State waters shall be free from substances attributable to sewage, industrial wastes or other wastes in concentrations or combinations which are toxic or harmful to human, animal or aquatic life to the extent commensurate with the designated usage of such waters.	Pollution of waters of the State of Alabama, as defined by ADEM Admin. Code r. 335-6-10-.02– **relevant and appropriate**	ADEM Admin. Code r. 335-6-10-.06(c) *Minimum Conditions Applicable to All State Waters*
	Toxic substances attributable to sewage, industrial wastes, or other wastes shall be only in such amounts, whether alone or in combination with other substances, as will not exhibit acute toxicity or chronic toxicity, as demonstrated by effluent toxicity testing or by application of numeric criteria given in ADEM Admin. Code r. 335-6-10-.07, to fish and aquatic life, including shrimp and crabs in estuarine or salt waters or the propagation thereof.	Pollution of waters of the State of Alabama classified for Fish and Wildlife use per ADEM Admin. Code r. 335-6-11-.02 – **relevant and appropriate**	ADEM Admin. Code r. 335-6-10-.09(5)(e)(5) *Specific Water Quality Criteria*

Table 31. Chemical-Specific Applicable and Relevant and Appropriate Requirements and To-Be Considered Guidance (TBC)

Action/Media	Requirements	Prerequisite	Citation
	There shall be no turbidity of other than natural origin that will cause substantial visible contrast with the natural appearance of waters or interfere with any beneficial uses which they serve. Furthermore, in no case shall turbidity exceed 50 [NTU] above background. Background will be interpreted as the natural condition of the receiving waters without the influence of man-made or man-induced causes. Turbidity levels caused by natural runoff will be included in establishing background levels.	Discharges to waters of the State of Alabama classified for Fish and Wildlife useper ADEM Admin. Code r. 335-6-11-.02 – **relevant and appropriate**	ADEM Admin. Code r. 335-6-10-.09(5)(e)(9) *Specific Water Quality Criteria*
Protection of surface water *con't*	Concentrations of toxic pollutants in State waters shall not exceed the criteria indicated to the extent commensurate with the designated usage of such waters: • 4,4'-DDD: 0.0002 μg/L [1] • 4,4'-DDE: 0.0001μg/L [1] • 4,4'-DDT: 0.001 μg/L[2] • 4,4'-DDT: 0.0001μg/L [1] • Hexachlorobenzene: 0.0002 μg/L [1] • Mercury: 0.012 μg/L[2] • Mercury: 0.042 μg/L[3]	Concentrations of toxic pollutants in waters of the State of Alabama as defined by ADEM Admin. Code r. 335-6-10-.02 – **relevant and appropriate**	ADEM Admin. Code r. 335-6-10-.07(1), Table 1*Toxic Pollutant Criteria*

[1] As calculated by Eq. 19 specified in ADEM Admin. Code r. 335-6-10-.07(1)(d)(2)(ii), relating to calculation of human health criteria for consumption of fish only for those toxic pollutants classified by EPA as carcinogens, applicable to all waters of the State of Alabama. *See* ADEM Admin. Code r. 335-6-10-.07(1)(e).

[2] This is the chronic freshwater criteria for protection of aquatic life. The criterion for 4,4'-DDT applies to DDT and it metabolites (DDTR).

[3] As calculated by Eq. 17 specified in ADEM Admin. Code r. 335-6-10-.07(1)(d)(1)(ii), relating to calculation of human health criteria for consumption of fish only for those toxic pollutants classified by EPA as non-carcinogens, applicable to all waters of the State of Alabama. *See* ADEM Admin. Code r. 335-6-10-.07(1)(e).

Table 31. Chemical-Specific Applicable and Relevant and Appropriate Requirements and To-Be Considered Guidance (TBC)

Action/Media	Requirements	Prerequisite	Citation
	Recommends the following concentration shall not be exceeded. • DDTR: 0.001 µg/L[4]	Presence of toxic pollutant in waters of the State – **TBC**	*EPA 1980 Criteria Document and* *Quality Criteria for Water 1986* (EPA 440/5-86-001)

[4] This criterion applies to DDT and its six metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value).

Table 32. Action-Specific Applicable and Relevant and Appropriate Requirements and To-Be-Considered Guidance

Action	Requirements	Prerequisite	Citation
General Construction Standards — All Land Disturbing Activities			
Activities causing stormwater runoff (*e.g.*, clearing, grading, excavation)	Shall fully implement and regularly maintain effective best management practices (BMPs) to the maximum extent practicable, and in accordance with the operator's Construction Best Management Practices Plan (CBMPP). Appropriate, effective pollution abatement/prevention facilities, structural and nonstructural BMPs, and management strategies shall be fully implemented prior to and concurrent with commencement of the regulated activities and regularly maintained during construction as needed at the site to meet or exceed the requirements of this chapter until construction is complete, effective reclamation and/or stormwater quality remediation is achieved. NOTE – CBMPP will be included as part of a CERCLA document such as the Remedial Design or Remedial Action Work Plan.	All new and existing construction activities as defined in ADEM Admin. Code r. 335-6-12-.02(e) disturbing one (1) acre or more in size – **applicable**	ADEM Admin. Code r. 335-6-12-.05(2)
	The operator shall take all reasonable steps to prevent and/or minimize, to the maximum extent practicable, any discharge in violation of this chapter or which has a reasonable likelihood of adversely affecting the quality of groundwater or surface water receiving the discharge(s).		ADEM Admin. Code r. 335-6-12-.06(4)
	Implement a comprehensive CBMPP appropriate for site conditions consistent with the substantive requirements of ADEM Admin. Code r. 335-6-12-.21 that has been prepared and certified by a Qualified Credentialed Professional (QCP). The CBMPP shall include a description of appropriate, effective water quality BMPs to be implemented at the site as needed to ensure compliance with this chapter and include but not limited to the measures provided in subsections 1. thru 14.		ADEM Admin. Code r. 335-6-12-.21(2)(a) & (b)
	BMPs shall be designed, implemented, and regularly maintained to provide effective treatment of discharges of pollutants in stormwater resulting from runoff generated by probable storm		ADEM Admin. Code r. 335-6-12-.21(4)

Table 32. Action-Specific Applicable and Relevant and Appropriate Requirements and To-Be-Considered Guidance

Action	Requirements	Prerequisite	Citation
	events expected/predicted during construction disturbance based on historic precipitation information, and during extended periods of adverse weather and seasonal conditions		
Activities causing fugitive dust emissions	Shall not cause, suffer, allow or permit any materials to be handled, transported, or stored; or a building, its appurtenances, or a road to be used . . . without taking reasonable precautions to prevent particulate matter from becoming airborne. Shall not cause or permit the discharge of visible fugitive dust emissions beyond the lot line of the property on which the emissions originate.	Fugitive emissions from construction operations, grading, or the clearing of land – **TBC**	ADEM Admin. Code r. 335-3-4-.02(1) & (2)[5]
In-Situ Capping of Contaminated Sediments			
Design of in-situ subaqueous cap of contaminated sediments	Provides guidance for planning and design of in-situ, subaqueous capping projects, including cap design, equipment and placement techniques, and monitoring and management considerations.	In-situ, subaqueous capping of contaminated sediments – **TBC**	U.S. Army Corps of Engineers, Tech. Report DOER-1, *Guidance for Subaqueous Dredged Material Capping* (1998).

[5] ADEM Admin. Code r. 335-3-4-.02(1) and (2) were held unconstitutional for being unduly vague (335-3-4-.02(1)) and too restrictive (335-3-4-.02(2)). See Ross Neeley Express, Inc. v. Ala. Dep't of Envtl. Mgmt., 437 So.2d 82 (Ala. 1983).

Table 32. Action-Specific Applicable and Relevant and Appropriate Requirements and To-Be-Considered Guidance

Action	Requirements	Prerequisite	Citation
Waste Characterization — Primary Wastes (e.g., contaminated sediments and soil samples) and Secondary Wastes (e.g., decon wastewaters)			
Characterization of solid waste	Must determine if solid waste is excluded from regulation under 40 C.F.R. § 261.4(b); and Determine if waste is listed as hazardous waste under subpart D 40 C.F.R. Part 261.	Generation of solid waste as defined in 40 C.F.R. § 261.2 – **applicable**	40 C.F.R. § 262.11(a) and (b) ADEM Admin. Code r. 335-14-3-.01(2)
	Must determine whether the waste is (characteristic waste) identified in subpart C of 40 C.F.R. part 261by either: (1) Testing the waste according to the methods set forth in subpart C of 40 C.F.R. part 261, or according to an equivalent method approved by the Administrator under 40 C.F.R. 260.21; or (2) Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.		40 C.F.R. § 262.11(c) ADEM Admin. Code r. 335-14-3-.01(2)(c)
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste which is determined to be hazardous waste – **applicable**	40 C.F.R. § 262.11(d) ADEM Admin. Code r. 335-14-3-.01(2)(d)
Characterization of hazardous waste	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 C.F.R. Parts 264 and 268.	Generation of RCRA-hazardous waste for storage, treatment or disposal – **applicable**	40 C.F.R. § 264.13(a)(1) ADEM 335-14-5-.01(1)(j)(2)
Determinations for management of hazardous waste	Must determine each EPA Hazardous Waste Number (waste code) applicable to the waste in order to determine the applicable treatment standards under 40 C.F.R. Part 268 *et seq.* *Note:* This determination may be made concurrently with the hazardous waste determination required in Sec. 262.11 of this chapter.	Generation of hazardous waste for storage, treatment or disposal – **applicable**	40 C.F.R. § 268.9(a) ADEM Admin. Code r. 33-14-9-.01

Table 32. Action-Specific Applicable and Relevant and Appropriate Requirements and To-Be-Considered Guidance

Action	Requirements	Prerequisite	Citation
Determinations for management of hazardous waste *con't*	Must determine the underlying hazardous constituents [as defined in 40 C.F.R. § 268.2(i)] in the waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal **– applicable**	40 C.F.R. § 268.9(a) ADEM Admin. Code r. 33-14-9-.01
	Must determine if the hazardous waste meets the treatment standards in 40 C.F.R. §§ 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste. *Note:* This determination can be made concurrently with the hazardous waste determination required in 40 C.F.R. 262.11.		40 C.F.R. § 268.7(a) ADEM Admin. Code r. 33-14-9-.01
Waste Storage — Primary Wastes (e.g., contaminated sediments and soil samples and Secondary Wastes (e.g., decon wastewaters)			
Temporary onsite storage of hazardous waste in containers	A generator may accumulate hazardous waste at the facility provided that: • Waste is placed in containers that comply with 40 CFR 265.171-173; and • The date upon which accumulation begins is clearly marked and visible for inspection on each container; and • Container is marked with the words "hazardous waste";	Accumulation of RCRA hazardous waste on site as defined in 40 CFR 260.10 **– applicable**	40 C.F.R. § 262.34(a)(1)(i); ADEM Admin. Code r. 335-14-3-.03(5)(a)1(i) 40 C.F.R. § 262.34(a)(2) &(3); ADEM Admin. Code r. 335-14-3-.03(5)(a)(2)&(3)
Use and management of hazardous waste in containers	If container is not in good condition (e.g. severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers **– applicable**	40 C.F.R. § 265.171 ADEM Admin. Code r. 335-14-5-.09(2)
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired.		40 C.F.R. § 265.172 ADEM Admin. Code r. 335-14-5-.09(3)
Use and management of hazardous waste in containers *con't*	Keep containers closed during storage, except to add/remove waste.	Storage of RCRA hazardous waste in containers**– applicable**	40 C.F.R. § 265.173 ADEM Admin. Code r. 335-14-5-.09(4)(a)&(b)

Table 32. Action-Specific Applicable and Relevant and Appropriate Requirements and To-Be-Considered Guidance

Action	Requirements	Prerequisite	Citation
	Open, handle and store containers in a manner that will not cause containers to rupture or leak.		
	Containers having capacity greater than 30 gallons must not be stacked over two containers high		ADEM Admin. Code r. 335-14-5-.09(4)(c)
Storage of hazardous waste in container area	Area must have a containment system designed and operated in accordance with 40 CFR 264.175(b)(1)-(5).	Storage of RCRA hazardous waste in containers *with free liquids* – **applicable**	40 C.F.R. § 264.175(a) ADEM Admin. Code r. 335-14-5-.09(6)(a)
	Area must be sloped or otherwise designed and operated to drain liquid resulting from precipitation, or Containers must be elevated or otherwise protected from contact with accumulated liquid.	Storage of RCRA hazardous waste in containers that *do not contain free liquids* (other than F020, F021, F022, f023,F026 and F027) – **applicable**	40 C.F.R. § 264.175(c)(1) and (2) ADEM Admin. Code r. 335-14-5-.09(6)(c)(1) and (2)
Closure of hazardous waste container storage with containment system	At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soils containing or contaminated with hazardous waste and hazardous waste residues must be decontaminated or removed. [Comment: At closure, as throughout the operating period, unless the owner or operator can demonstrate in accordance with40 CFR 261.3(d) of this chapter that the solid waste removed from the containment system is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of parts 262 through 266 of this chapter].	Storage of RCRA hazardous waste in containers in a unit *with a containment system* – **applicable**	40 C.F.R. § 264.178 ADEM Admin. Code r. 335-14-5-.09(9)(a)
Waste Disposal — Primary Wastes (e.g., contaminated sediments and soil samples and Secondary Wastes (e.g., decon wastewaters)			
Disposal of RCRA hazardous waste in an off-site land-based unit	May be land disposed if it meets the requirements in the table “Treatment Standards for Hazardous Waste” at 40 C.F.R. 268.40 before land disposal.	Land disposal, as defined in 40 C.F.R. 268.2, of restricted RCRA waste – **applicable**	40 C.F.R. § 268.40(a) ADEM Admin. Code r. 33-14-9-.04

Table 32. Action-Specific Applicable and Relevant and Appropriate Requirements and To-Be-Considered Guidance

Action	Requirements	Prerequisite	Citation
	All underlying hazardous constituents [as defined in 40 C.F.R. 268.2(i)] must meet the Universal Treatment Standards, found in 40 C.F.R. 268.48 Table UTS prior to land disposal	Land disposal of restricted RCRA characteristic wastes (D001 – D043) that are not managed in a wastewater treatment system that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well – **applicable**	40 C.F.R. § 268.40(e) ADEM Admin. Code r. 33-14-9-.04
Disposal of RCRA – *hazardous waste soil* in an off-site land–based unit	Must be treated according to the alternative treatment standards of 40 C.F.R. 268.49(c) or according to the UTSs specified in 40 C.F.R. 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Land disposal, as defined in 40 C.F.R. 268.2, of restricted hazardous soils – **applicable**	40 C.F.R. § 268.49(b) ADEM Admin. Code r. 33-14-9-.04(9)
Disposal of RCRA characteristic wastewaters in an NPDES permitted WWTU	Are not prohibited, if the wastes are managed in a treatment system which subsequently discharges to waters of the U.S. pursuant to a permit issued under 402 the CWA (i.e., NPDES permitted), unless the wastes are subject to a specified method of treatment other than DEACT in 40 C.F.R. 268.40, or are D003 reactive cyanide.	Land disposal of RCRA restricted hazardous wastewaters that hazardous only because they exhibit a characteristic and are not otherwise prohibited under 40 C.F.R. 268 – **applicable**	40 C.F.R. 268.1(c)(4)(i) ADEM Admin. Code r. 33-14-9-.01
Transport and conveyance of collected RCRA wastewater to WWTU located on the facility	Any dedicated tank systems, conveyance systems, and ancillary equipment used to treat, store or convey wastewater to an on–site NPDES–permitted wastewater treatment facility are exempt from the requirements of RCRA Subtitle C standards.	On-site wastewater treatment unit (as defined in 40 C.F.R. 260.10) subject to regulation under § 402 or § 307(b) of the CWA (i.e., NPDES–permitted) that manages hazardous wastewaters – **applicable**.	40 C.F.R. 264.1(g)(6)
Disposal of RCRA characteristic wastewaters in a POTW	Are not prohibited, if the wastes are treated for purposes of the pretreatment requirements of Section 307 of the CWA, unless the wastes are subject to a specified method of treatment other than DEACT in 40 C.F.R. 268.40, or are D003 reactive cyanide.	Land disposal of hazardous wastewaters that hazardous only because they exhibit a characteristic and are not otherwise prohibited under 40 C.F.R. 268 – **applicable**	40 C.F.R. §268.1(c)(4)(ii) ADEM Admin. Code r. 33-14-9-.01
Transportation of Wastes			

Table 32. Action-Specific Applicable and Relevant and Appropriate Requirements and To-Be-Considered Guidance

Action	Requirements	Prerequisite	Citation
Transportation of hazardous materials	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR at 49 C.F.R. §§ 171–180 related to marking, labeling, placarding, packaging, emergency response, etc.	Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material – **applicable**	49 C.F.R. § 171.1(c)
Transportation of hazardous waste *off–site*	Must comply with the generator standards of Part 262 including 40 C.F.R. §§ 262.20–23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding,	Preparation and initiation of shipment of hazardous waste off–site – **applicable**	40 C.F.R. § 262.10(h); ADEM Admin. Code r. 335-14-3-.03(1) – (4)
	A generator who transports, or offers for transportation, hazardous waste for off-site treatment, storage, or disposal, or a treatment, storage, and disposal facility who offers for transportation a rejected hazardous waste load, must prepare a Manifest (OMB control number 2050-0039) on EPA Form 8700-22, and, if necessary, EPA Form 8700-22A, according to the instructions in 335-14-3-Appendix I.		ADEM Admin. Code r. 335-14-3-.02(1)(a)
Transportation of hazardous waste *on–site*	The generator manifesting requirements of 40 C.F.R. 262.20–262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 C.F.R. 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right–of–way.	Transportation of hazardous wastes on a public or private right–of–way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right–of–way – **applicable**	40 C.F.R. § 262.20(f)
Transportation of samples (*i.e.* soil, sediments and wastewaters)	Are not subject to any requirements of 40 C.F.R. Parts 261 through 268 or 270 when: • the sample is being transported to a laboratory for the purpose of testing; or • the sample is being transported back to the sample collector after testing. • the sample is being stored by sample collector before transport to a lab for testing	Samples of solid waste <u>or</u> a sample of water, soil for purpose of conducting testing to determine its characteristics or composition – **applicable**	40 C.F.R. § 261.4(d)(1)(i)–(iii)

Table 32. Action-Specific Applicable and Relevant and Appropriate Requirements and To-Be-Considered Guidance

Action	Requirements	Prerequisite	Citation
	In order to qualify for the exemption in paragraphs (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must: • Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements • Assure that the information provided in (1) thru (5) of this section accompanies the sample. • Package the sample so that it does not leak, spill, or vaporize from its packaging.		40 C.F.R. § 261.4(d)(2)(i)(A) and (B)

Table 33. Location-Specific Applicable and Relevant and Appropriate Requirements and To-Be Considered Guidance (TBC)

Location	Requirements	Prerequisite	Citation
	Floodplains		
Presence of floodplain, designated as such on a map	Shall 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.	Federal actions that involve potential impacts to, or take place within, floodplains – **TBC**	Executive Order 11988 – *Floodplain Management* Section 1. *Floodplain Management*
	Shall consider alternatives to avoid, to the extent possible, adverse effects and incompatible development in the floodplain. Design or modify its action in order to minimize potential harm to or within the floodplain		Executive Order 11988 Section 2.(a)(2) *Floodplain Management*
Presence of floodplain, designated as such on a map	If there is no practicable alternative to locating in or affecting the floodplain, the potential harm to the floodplain shall be minimized. The natural and beneficial values of floodplains shall be restored and preserved.	Federal actions that involve potential impacts to, or take place within, floodplains **– relevant and appropriate**	40 C.F.R. Part 6, App. A, § 6(a)(5)
	Endangered and/or Threatened Species		
Presence of federally endangered or threatened species, as designated in 50 C.F.R. §§ 17.11 and 17.12 **-or-** critical habitat of such species listed in 50 C.F.R. § 17.95	Actions that jeopardize the existence of a listed species or results in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures taken.	Action that is likely to jeopardize fish, wildlife, or plant species or destroy or adversely modify critical habitat— **applicable**	16 U.S.C. § 1538(a) ADEM Admin. Code r. 335-13-4-.01(1)(b)

Table 33. Location-Specific Applicable and Relevant and Appropriate Requirements and To-Be Considered Guidance (TBC)

Location	Requirements	Prerequisite	Citation
	Each Federal agency shall, in consultation with and with the assistance of the Secretary [of DOI], insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by [DOI] to be critical.	Actions authorized, funded, or carried out by any Federal agency, pursuant to 16 U.S.C. § 1536 – **relevant and appropriate**	16 U.S.C. § 1536(a)(2); 50 C.F.R. §§ 402.13(a), 402.14
Migratory Birds			
Presence of any migratory bird, as defined by 50 C.F.R. § 10.13	It shall be unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird, any part, nest, or eggs of any such bird.	Federal actions that have, or are likely to have, a measurable negative effect on migratory bird populations – **relevant and appropriate**	16 U.S.C. § 703(a)
	Avoid or minimize, to the extent practicable, adverse impacts on migratory bird resources.	Federal actions that have, or are likely to have, a measurable negative effect on migratory bird populations – **TBC**	Executive Order 13186
Wetlands			
Presence of wetlands, as defined by ADEM Admin. Code r. 335-8-1-.02(nnn)	Impacts to wetlands shall be mitigated through the creation of wetlands or the restoration and enhancement of existing degraded wetlands.	Actions in wetlands – **relevant and appropriate**	ADEM Admin. Code r. 335-8-2-.02(4), 335-8-2-.03(1)

Table 33. Location-Specific Applicable and Relevant and Appropriate Requirements and To-Be Considered Guidance (TBC)

Location	Requirements	Prerequisite	Citation
Presence of wetlands	Shall take action to minimize the destruction, loss or degradation of wetlands and to preserve and enhance beneficial values of wetlands.	Federal actions that involve potential impacts to, or take place within, wetlands – **TBC**	Executive Order 11990 – *Protection of Wetlands* Section 1.(a)
	Shall avoid undertaking construction located in wetlands unless: (1) there is no practicable alternative to such construction, and (2) that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use.		Executive Order 11990, Section 2.(a) *Protection of Wetlands*
Coastal Areas			
Location encompassing coastal zone, as defined by 16 U.S.C. § 1453(1)	Each Federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone shall be carried out in a manner which is consistent to the maximum extent practicable with the enforceable policies of approved State management programs.	Federal actions within coastal zones – **relevant and appropriate**	16 U.S.C. § 1456(c)(1)(A)
Discharge of Dredge and/or Fill Material into Waters of the United States and/or State of Alabama			
Location encompassing aquatic ecosystem as defined in 40 C.F.R. § 230.3(c)	No discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.	Action that involves discharge of dredged or fill material into waters of the United States, including wetlands – **relevant and appropriate**	40 C.F.R. § 230.10(a) Clean Water Act Regulations – Section 404(b) Guidelines

Table 33. Location-Specific Applicable and Relevant and Appropriate Requirements and To-Be Considered Guidance (TBC)

Location	Requirements	Prerequisite	Citation
Location encompassing aquatic ecosystem as defined in 40 C.F.R. § 230.3(c) *con't*	No discharge of dredged or fill material shall be permitted if it: • Causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard; • Violates any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act; • Jeopardizes the continued existence of species listed as endangered or threatened under the Endangered Species Act of 1973, or results in the likelihood of the destruction or adverse modification of critical habitat; • Violates any requirement imposed by the Secretary of Commerce to protect any marine sanctuary designated under title III of the Marine Protection, Research, and Sanctuaries Act of 1972.	Action that involves discharge of dredged or fill material into waters of the United States, including wetlands – **relevant and appropriate**	40 C.F.R. § 230.10(b) Clean Water Act Regulations – Section 404(b) Guidelines
	No discharge of dredged or fill material shall be permitted which will cause or contribute to significant degradation of the waters of the United States		40 C.F.R. § 230.10(c) Clean Water Act Regulations – Section 404(b) Guidelines
	No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem.		40 C.F.R. § 230.10(d) Clean Water Act Regulations – Section 404(b) Guidelines

Table 33. Location-Specific Applicable and Relevant and Appropriate Requirements and To-Be Considered Guidance (TBC)

Location	Requirements	Prerequisite	Citation
Presence of State waterbottoms or adjacent wetlands, as defined by ADEM Admin. Code r. 335-8-1-.02(a)	Dredging and/or filling of State waterbottoms or adjacent wetlands may be permitted provided that: • There will be no dredging or filling in close proximity to existing submersed grassbeds; • Dredging, filling or trenching methods and techniques are such that reasonable assurance is provided that applicable water quality standards will be met; and no alternative project site or design is feasible and the adverse impacts to coastal resources have been reduced to the greatest extent practicable.	Dredging and/or filling of a State waterbottom or adjacent wetland – **relevant and appropriate**	ADEM Admin. Code r. 335-8-2-.02(1)(c) & (d)
	Dredging, filling, or trenching resulting in a temporary disturbance may be permitted provided that all areas are returned to preproject elevations and all wetland areas are revegetated and the requirements of ADEM Admin. Code r. 335-8-2-.02(1)(b) thru (d) are met.		ADEM Admin. Code r. 335-8-2-.02(2)
	Any fill material placed on State waterbottoms or in wetlands shall be free to toxic pollutants in toxic amounts and shall be devoid of sludge and/or solid waste.		ADEM Admin. Code r. 335-8-2-.02(5)
	The salinity of return waters from dredge disposal sites shall be similar to that of the receiving waters and reasonable assurance provided that applicable water quality standards met.		ADEM Admin. Code r. 335-8-2-.02(8)

Table 33. Location-Specific Applicable and Relevant and Appropriate Requirements and To-Be Considered Guidance (TBC)

Location	Requirements	Prerequisite	Citation
Presence of non-adjacent wetlands, as defined by ADEM Admin. Code r. 335-8-1-.02(nnn)	Dredging or filling of non-adjacent wetlands may be permitted provided that: • No alternative project sites or designs which avoid the dredging or filling are feasible and the adverse impacts have been reduced to the greatest extent possible; and • The non-adjacent wetlands to be dredged or filled have a limited functional value.	Dredging and/or filling of non-adjacent wetland – **relevant and appropriate**	ADEM Admin. Code r. 335-8—2-.02(3)
Drainage of Waterbodies			
Presence of any stream or other body of water proposed to be impounded, diverted, controlled, or modified for drainage	Department or agency of the United States, first shall consult with the United States Fish and Wildlife Service, Department of the Interior, and with the head of the agency exercising administration over the wildlife resources of the particular State wherein the impoundment, diversion, or other control facility is to be constructed, with a view to the conservation of wildlife resources by preventing loss of and damage to such resources as well as providing for the development and improvement thereof in connection with such water-resource development.	Federal actions that propose to impound, divert, control, or modify waters of any stream or body of water greater than 10 acres – **relevant and appropriate**	16 U.S.C. § 662(a) Fish and Wildlife Coordination Act

ADEM = Alabama Department of Environmental Management
ADPH = Alabama Department of Public Health
ARAR = applicable or relevant and appropriate requirement
AWPCA = Alabama Water Pollution Control Act
C.F.R. = *Code of Federal Regulations*
CWA = Clean Water Act
DOI = U.S. Department of the Interior

> = greater than
< = less than
≥ = greater than or equal to
≤ = less than or equal to
TBC = To Be Considered
U.S.C. = U.S. Code

FIGURES

NOTICE

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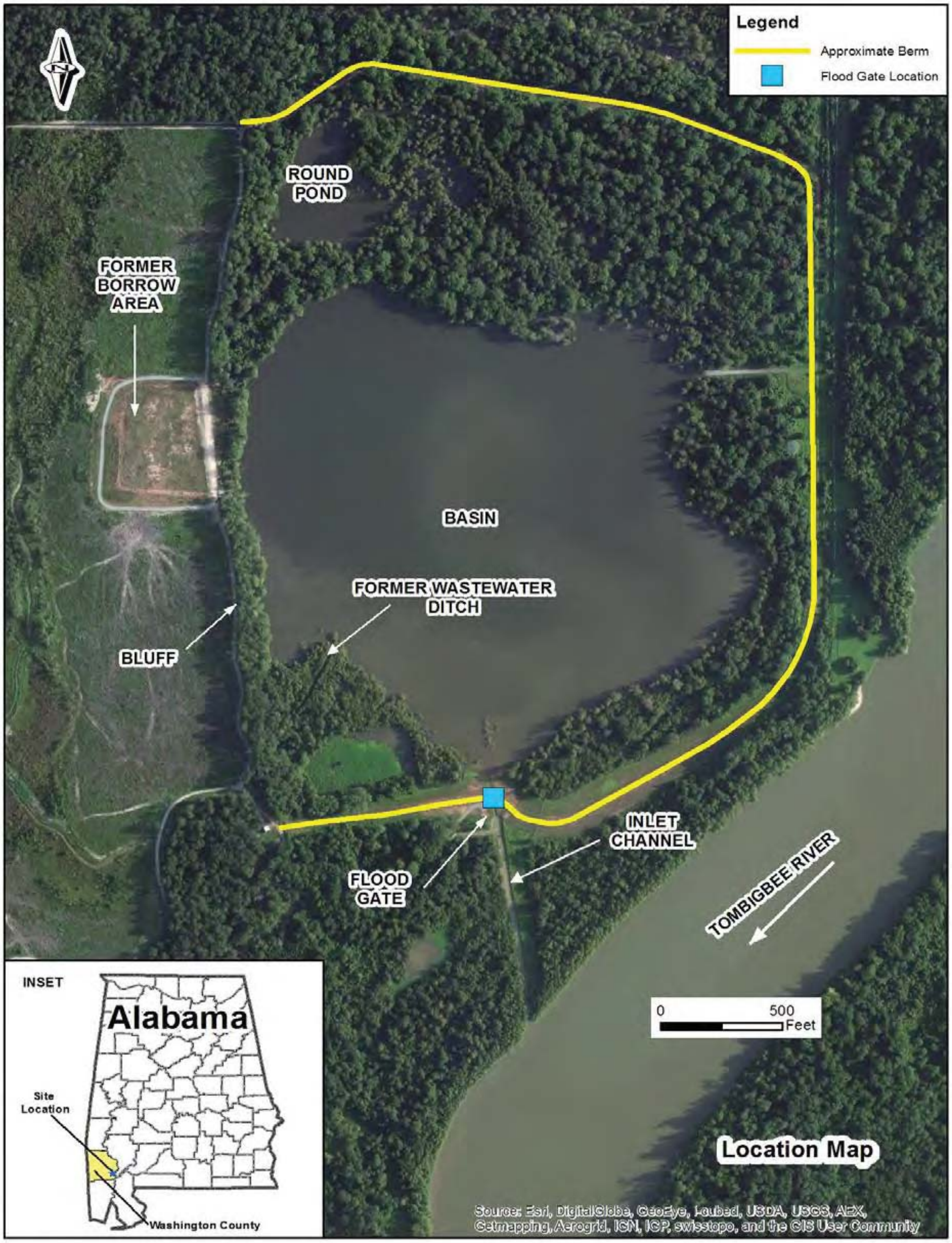


Figure 1. Olin McIntosh OU2 Location Map

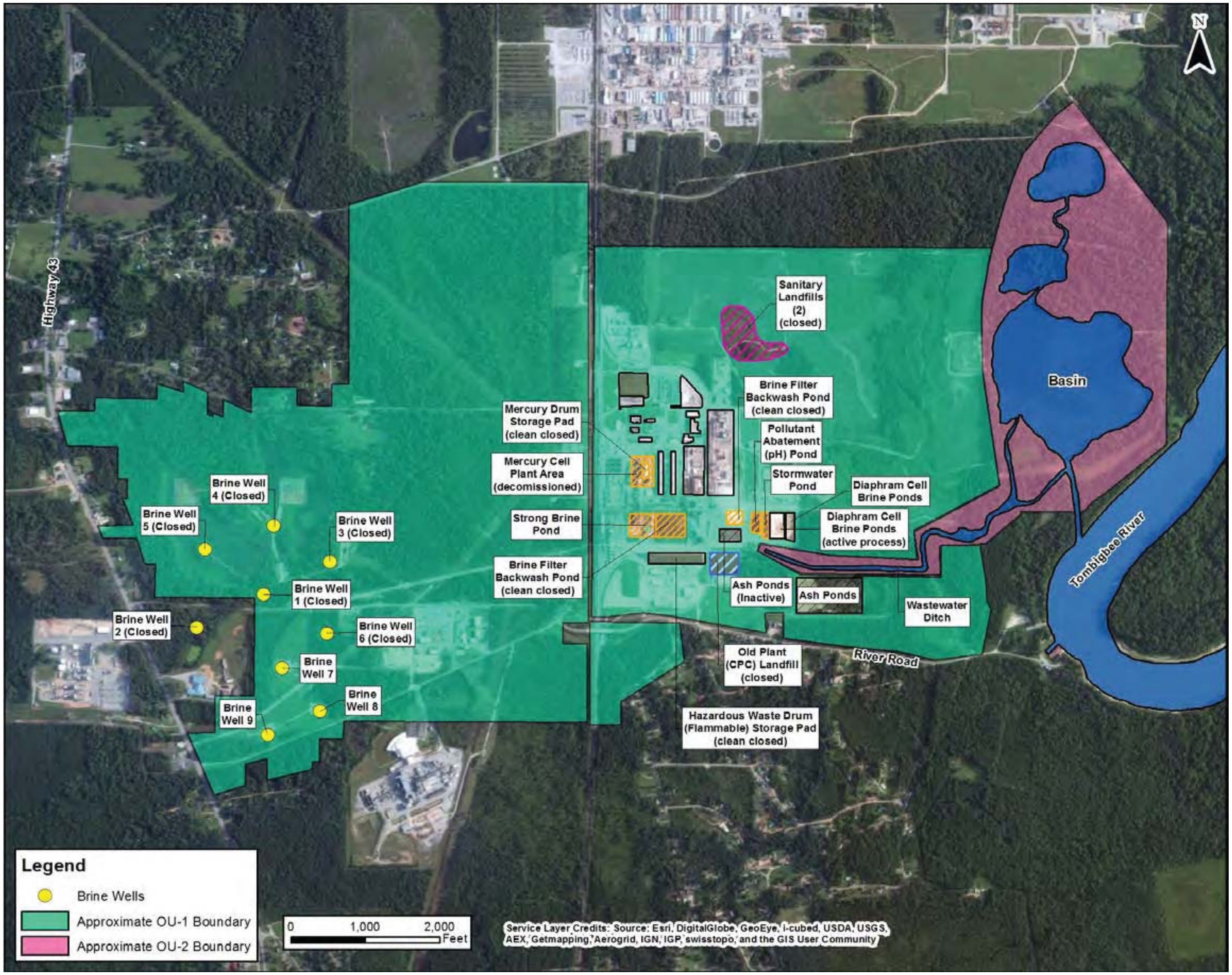


Figure 2. Operable Unit Locations

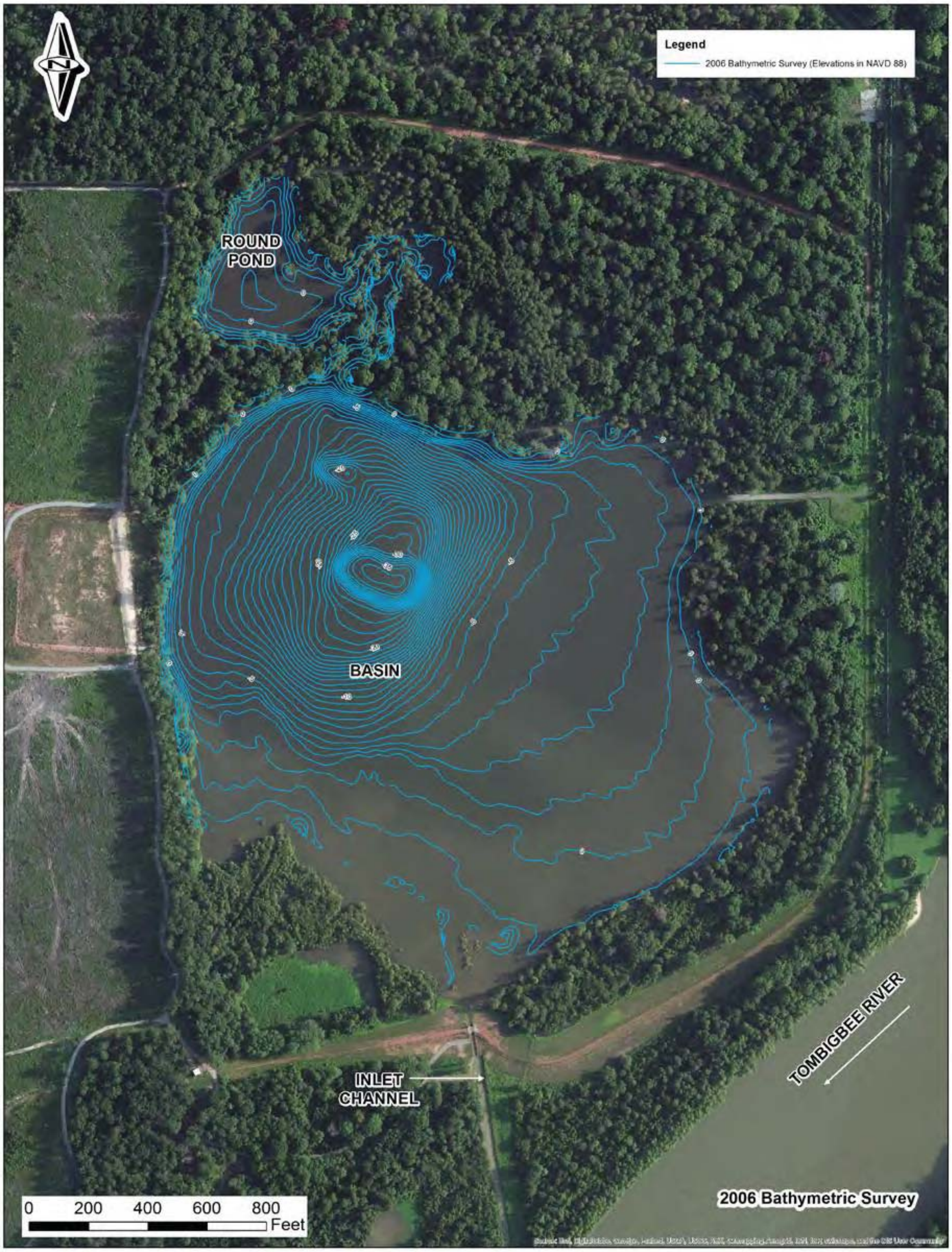


Figure 3. Olin McIntosh OU 2 2006 Bathymetric Survey

Figure 4. Cross Section Locations

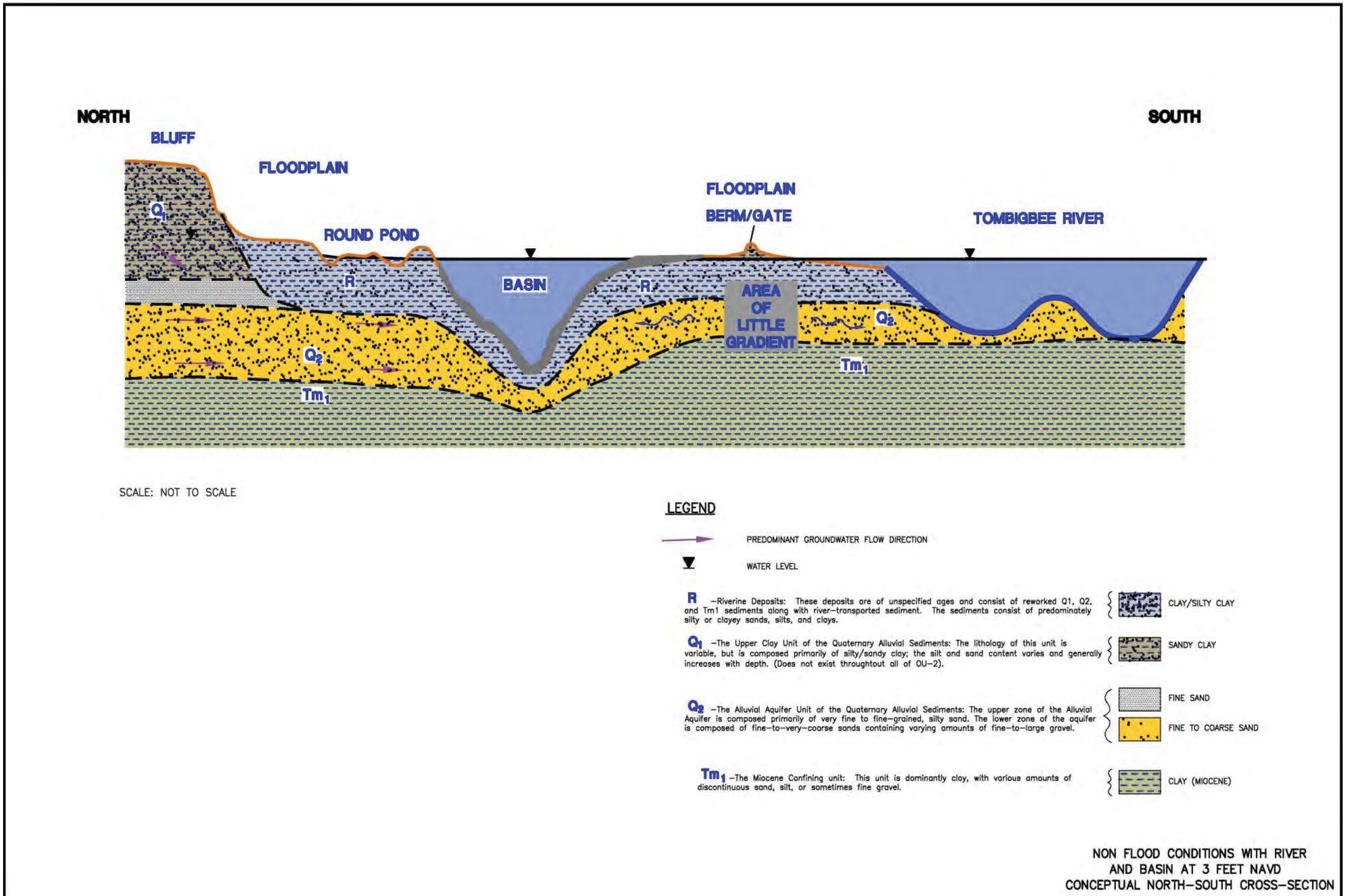


Figure 5. Conceptual Cross Section Diagram (North-South)

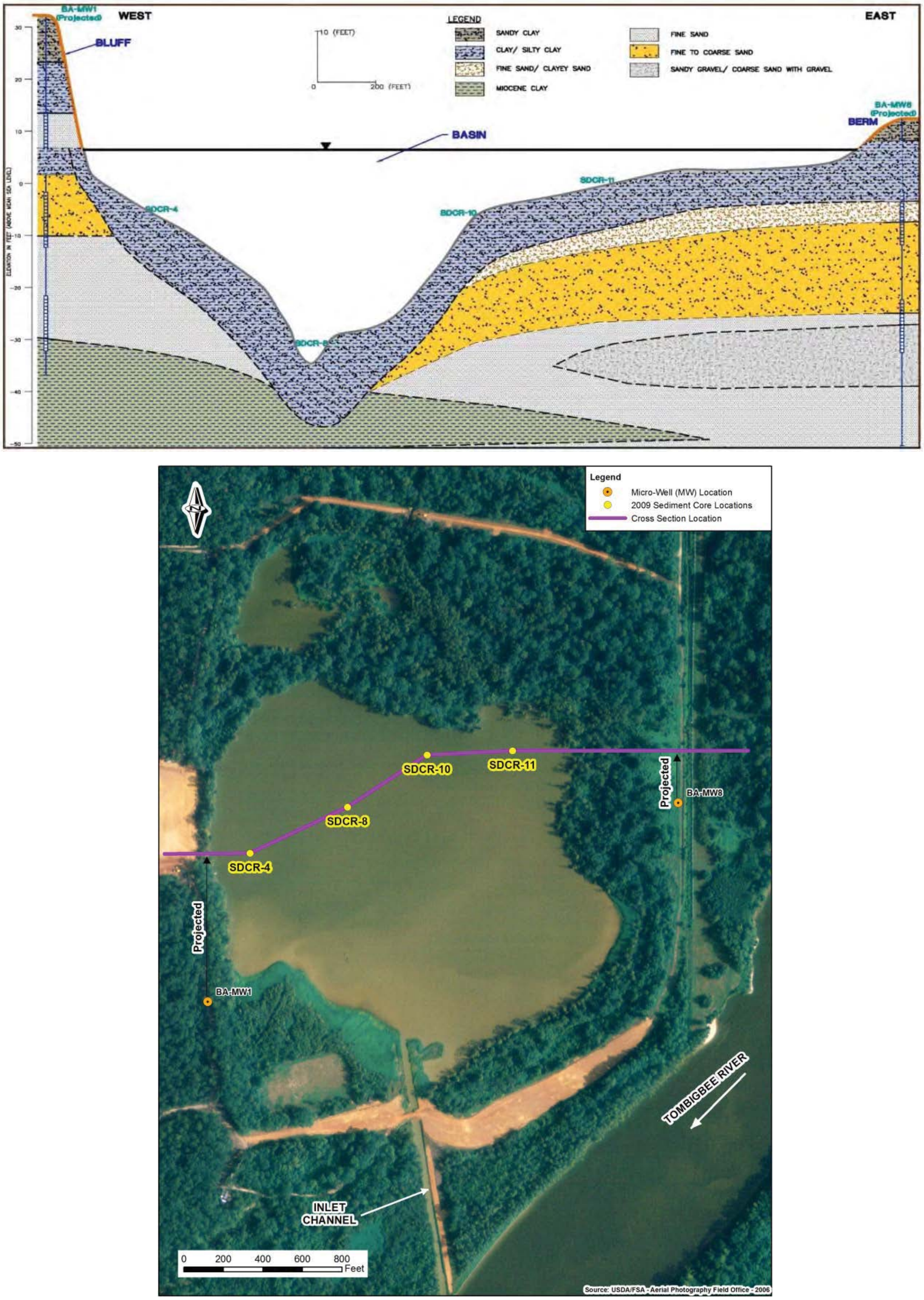


Figure 6. Geologic Cross-Section (West-East) of Olin Basin (top) and Section Locations (Bottom)

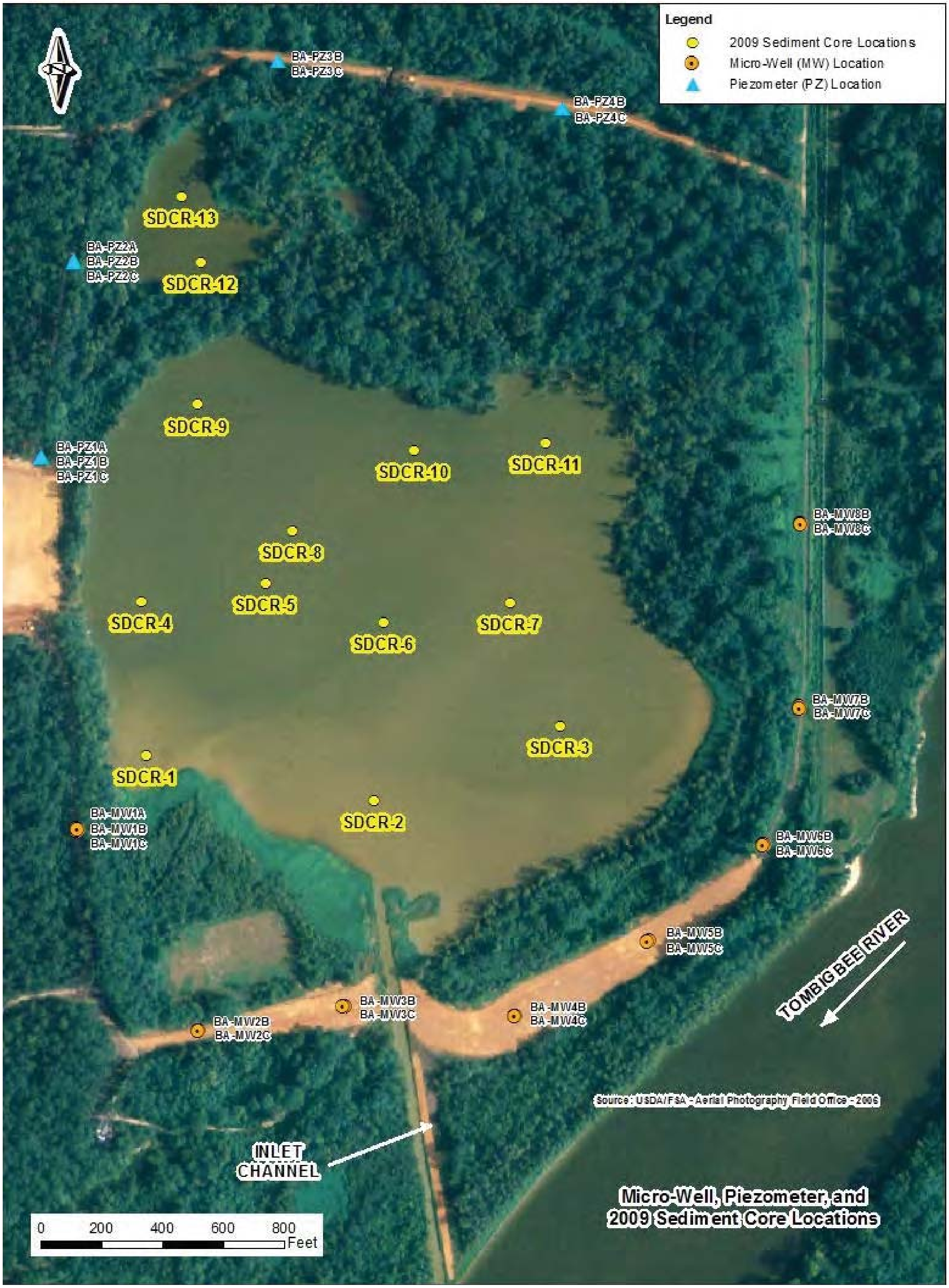


Figure 7. Micro-well, Piezometer, and 2009 Sediment Core Locations

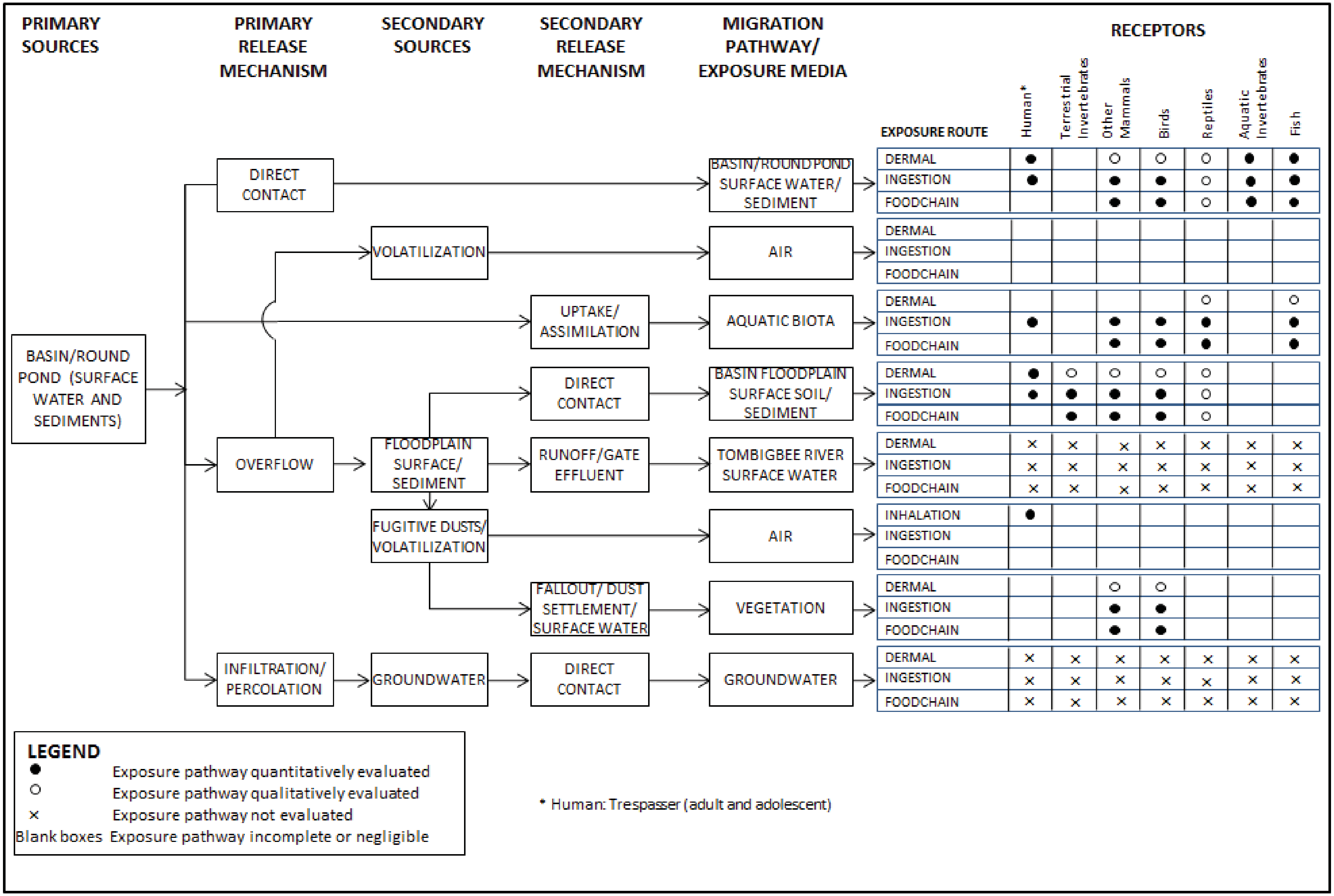


Figure 8. Site Conceptual Exposure Model OU-2

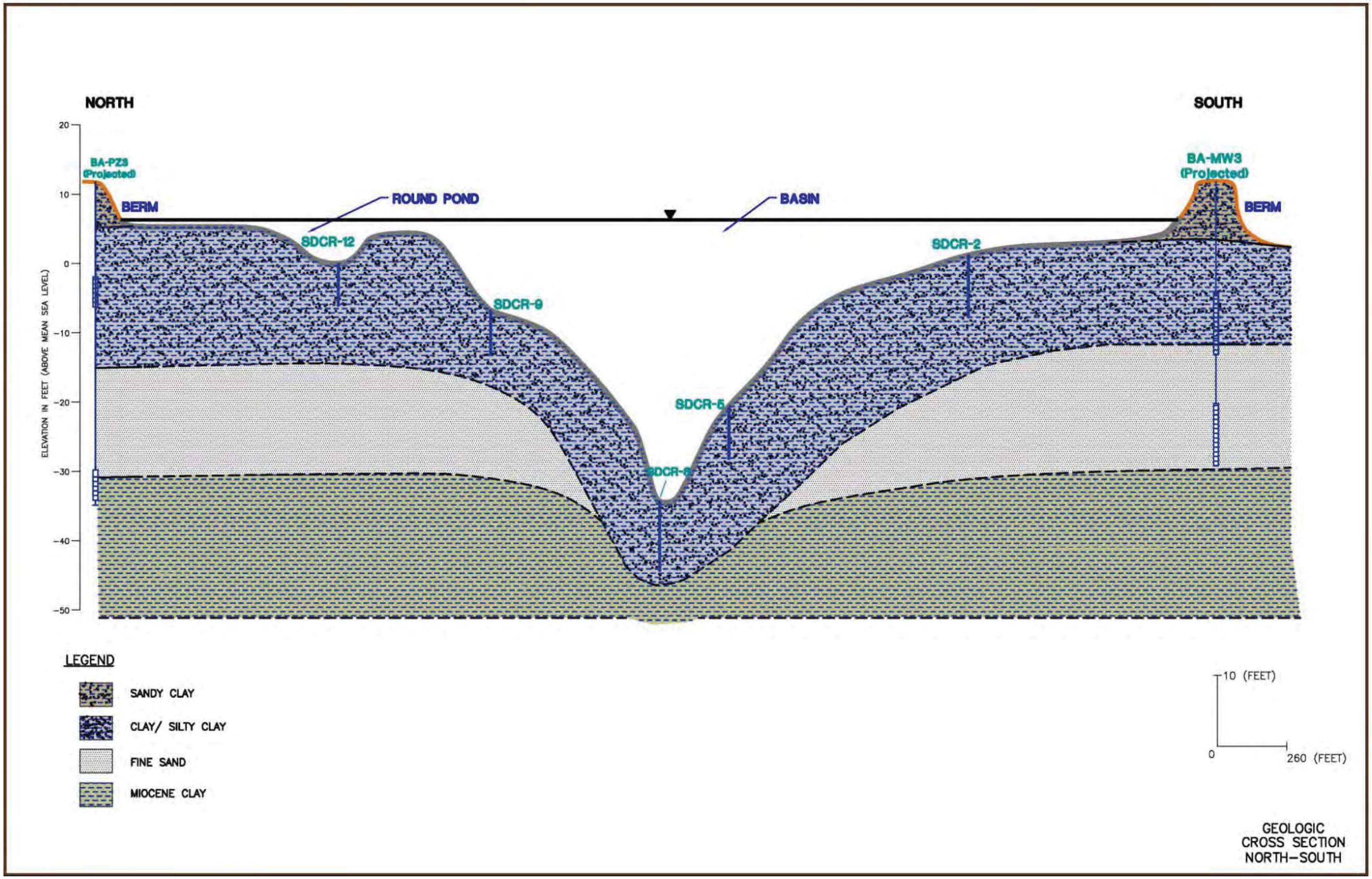


Figure 9. Conceptual Cross Section Diagram (North-South) with Sediment Cores

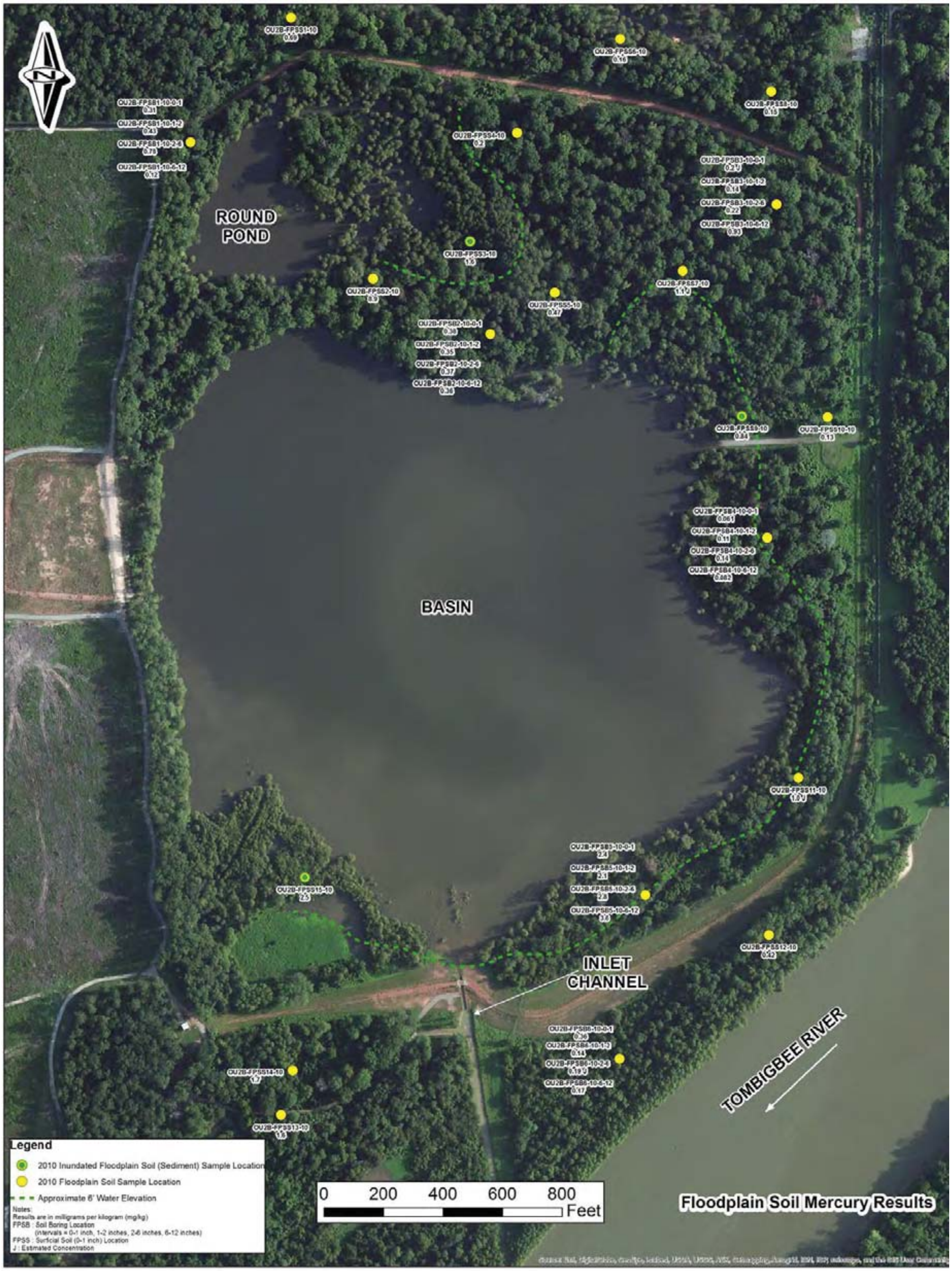


Figure 10. Locations of Mercury Samples in Floodplain Soil

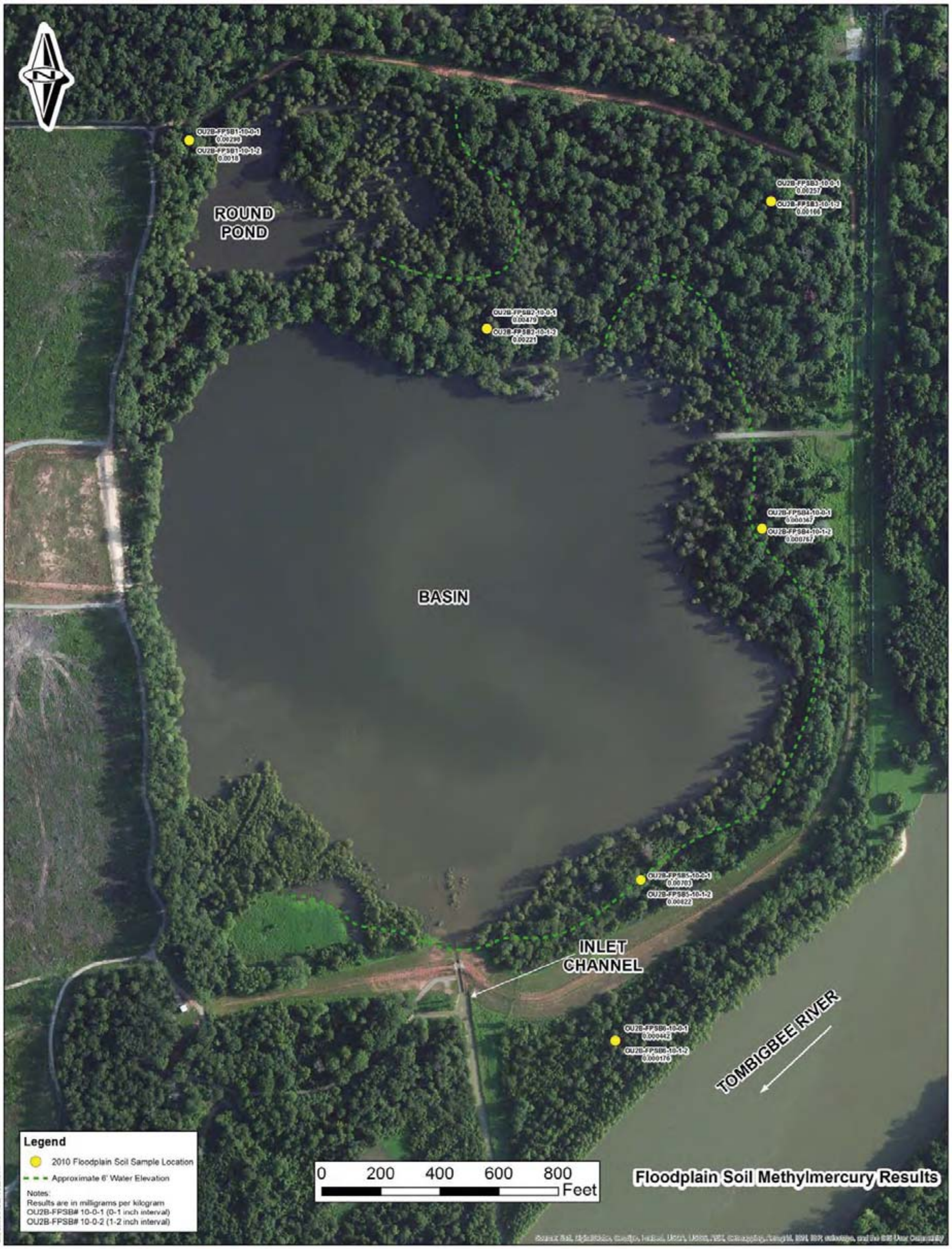


Figure 11. Locations of Methylmercury Samples in Floodplain Soil

Figure 12. Locations of HCB Samples in Floodplain Soil

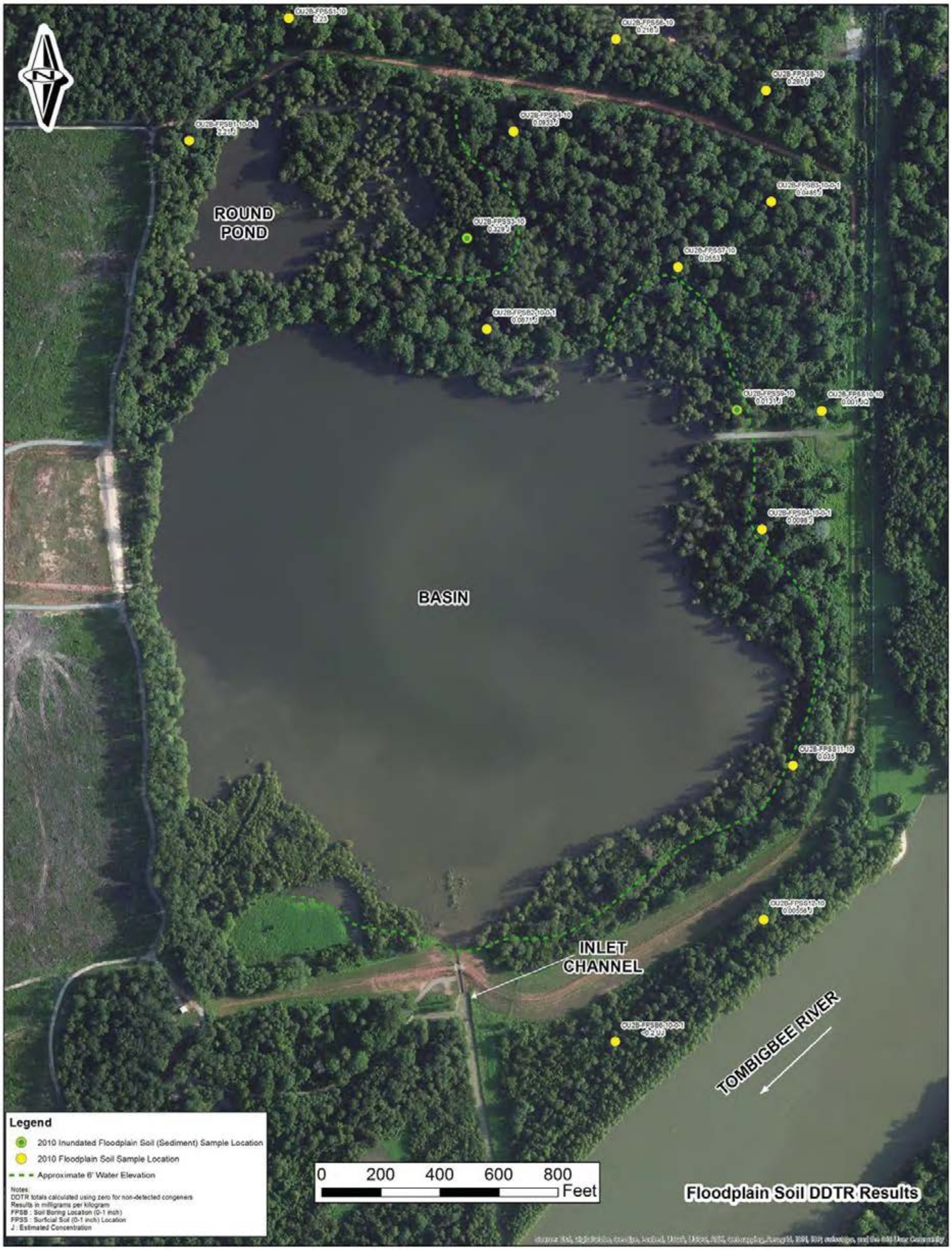


Figure 13. Locations of DDTR Samples in Floodplain Soil

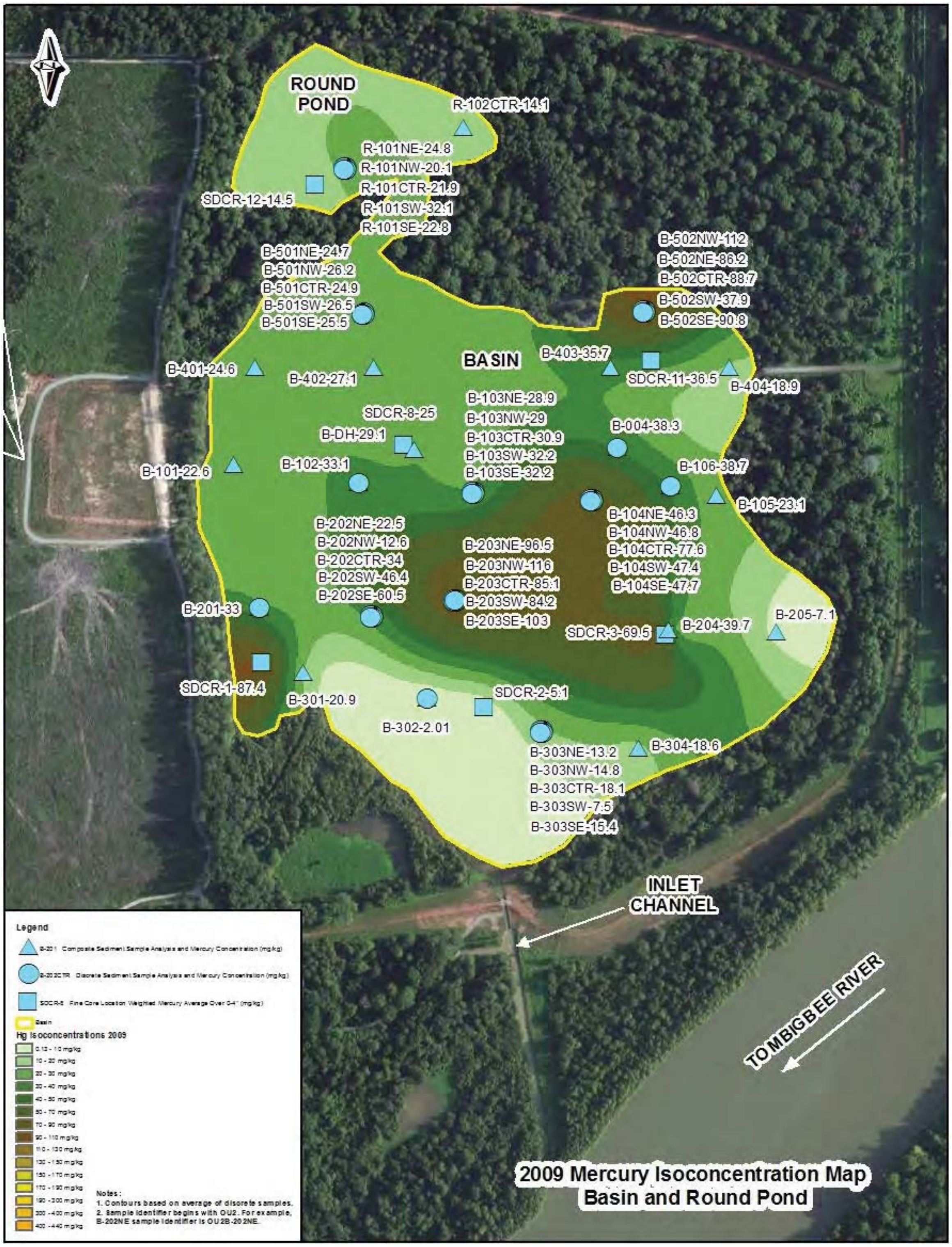


Figure 14. Mercury Isoconcentration Map in 2009: Basin and Round Pond

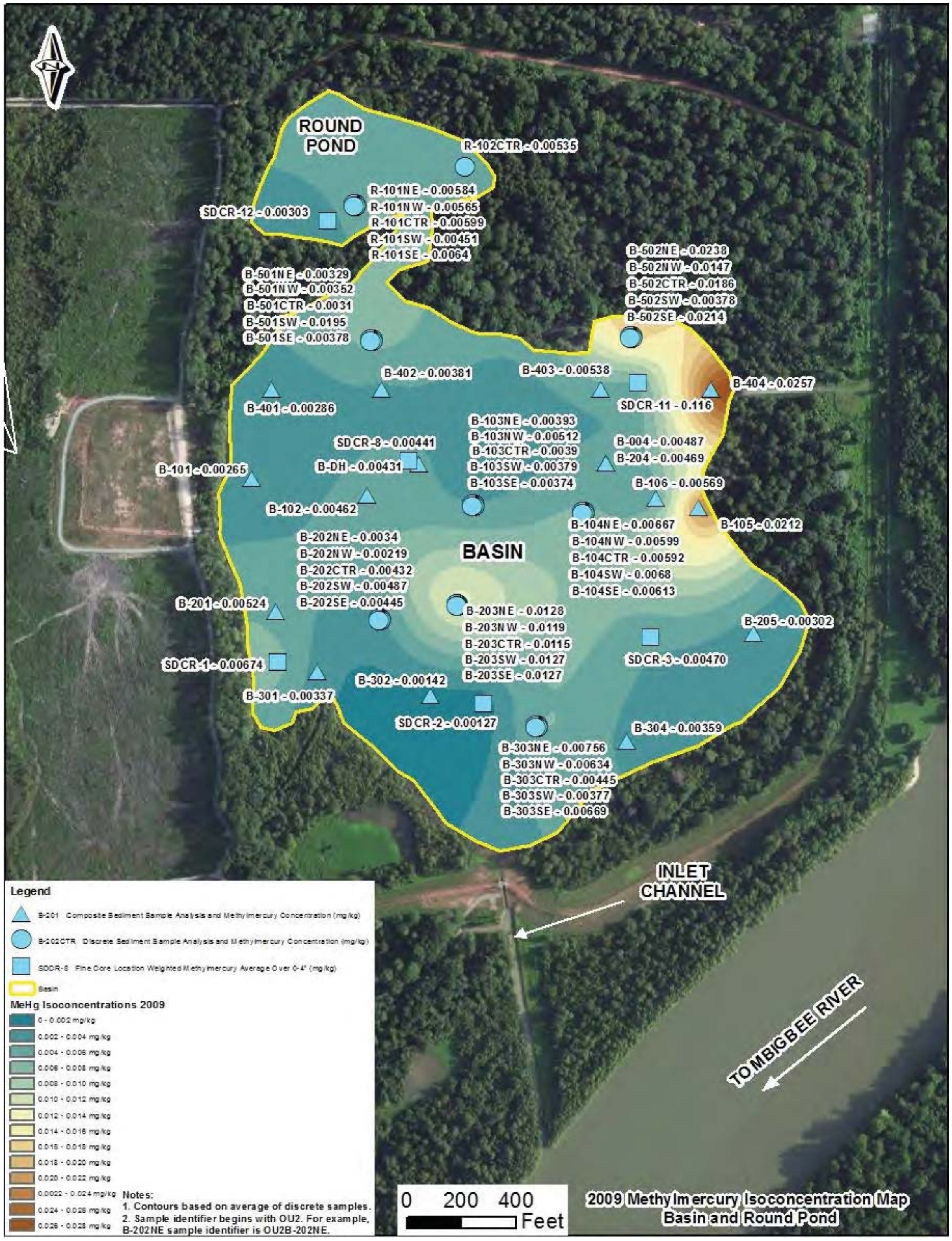


Figure 15. Methylmercury Isoconcentration Map: Basin and Round Pond

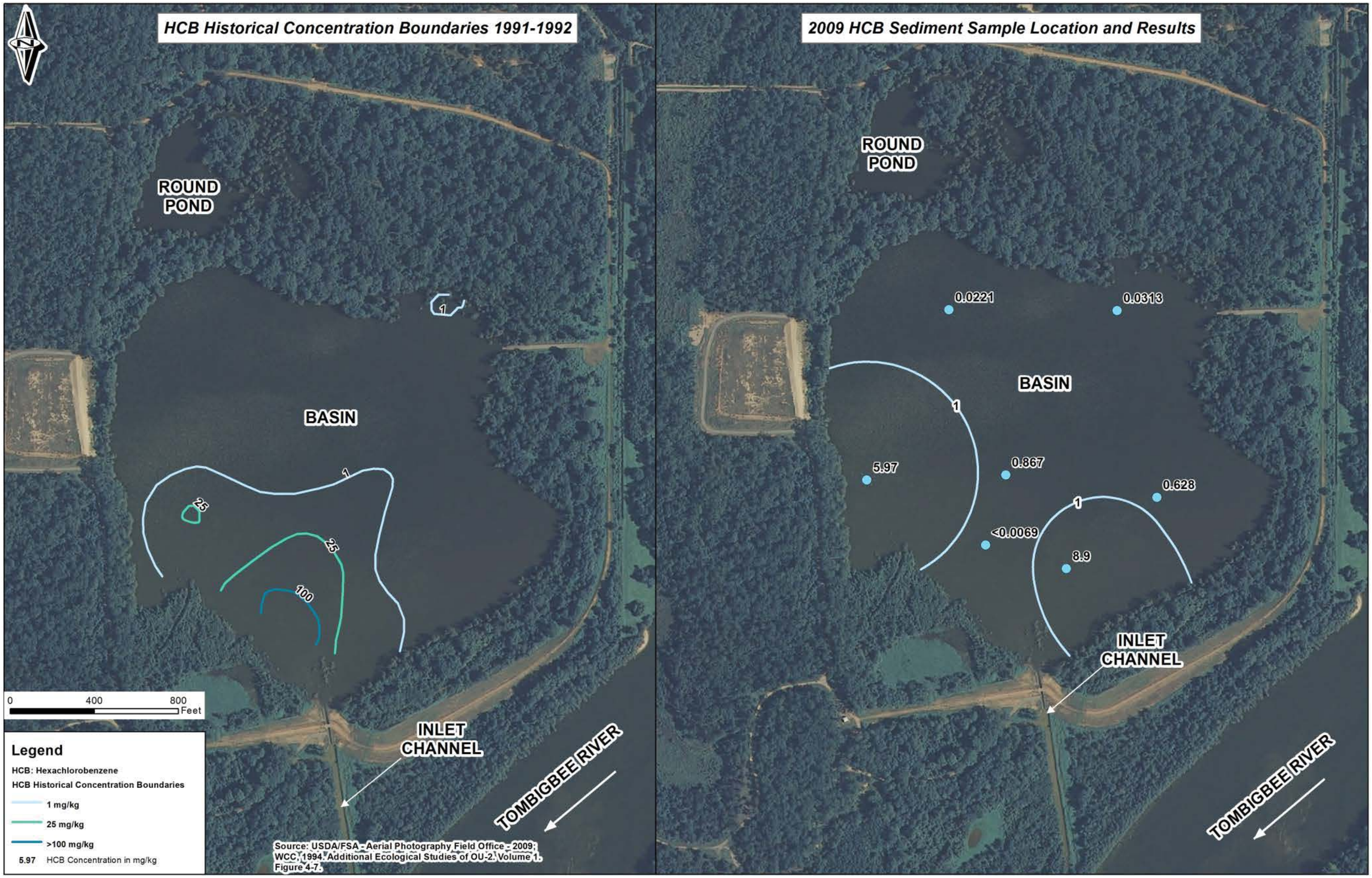


Figure 16. Sediment Sample Locations and HCB Results: Comparison of 2009 to Historical Results

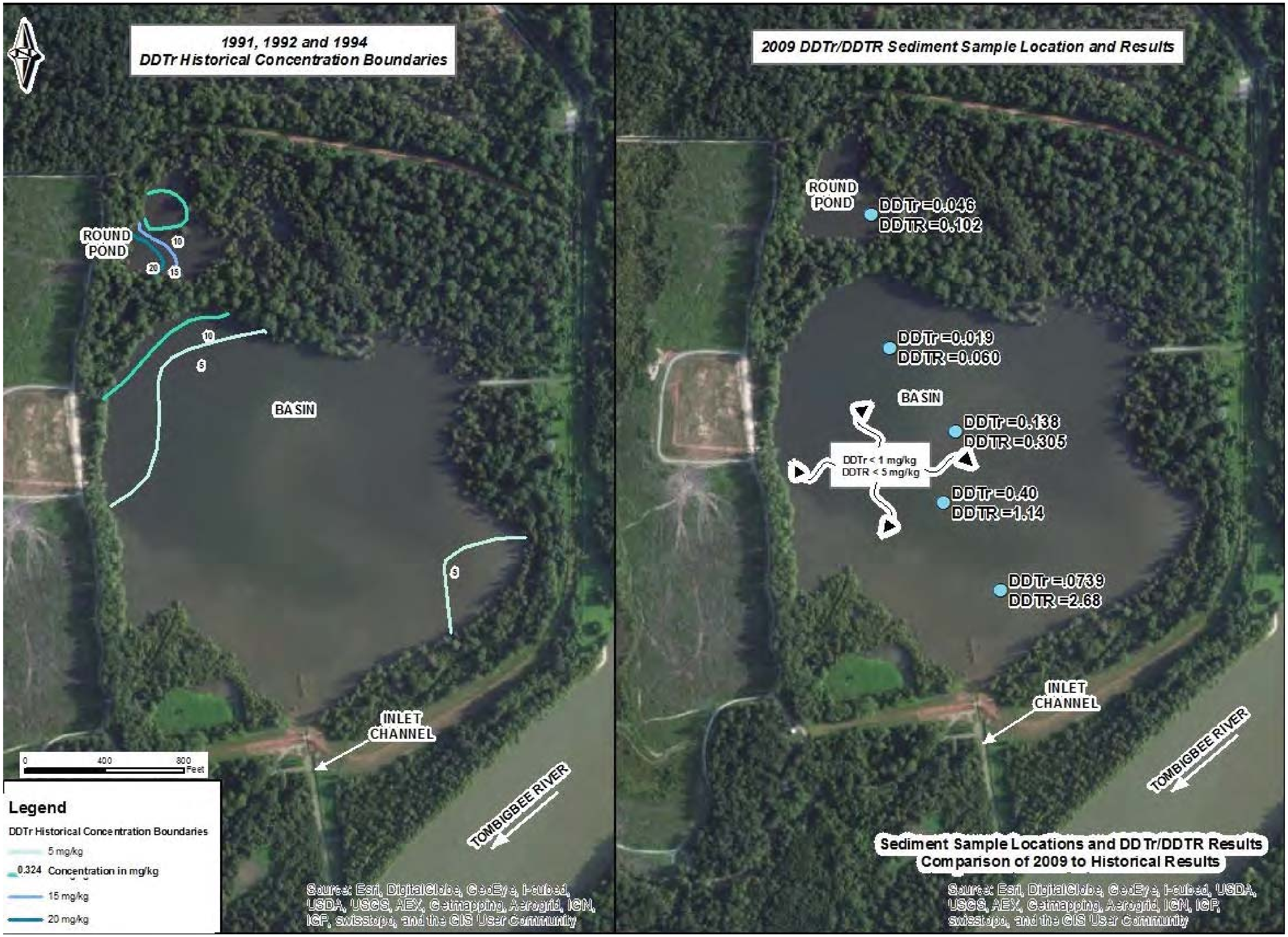


Figure 17. Sediment Sample Locations and DDTr/DDTR Results: Comparison of 2009 to Historical Results

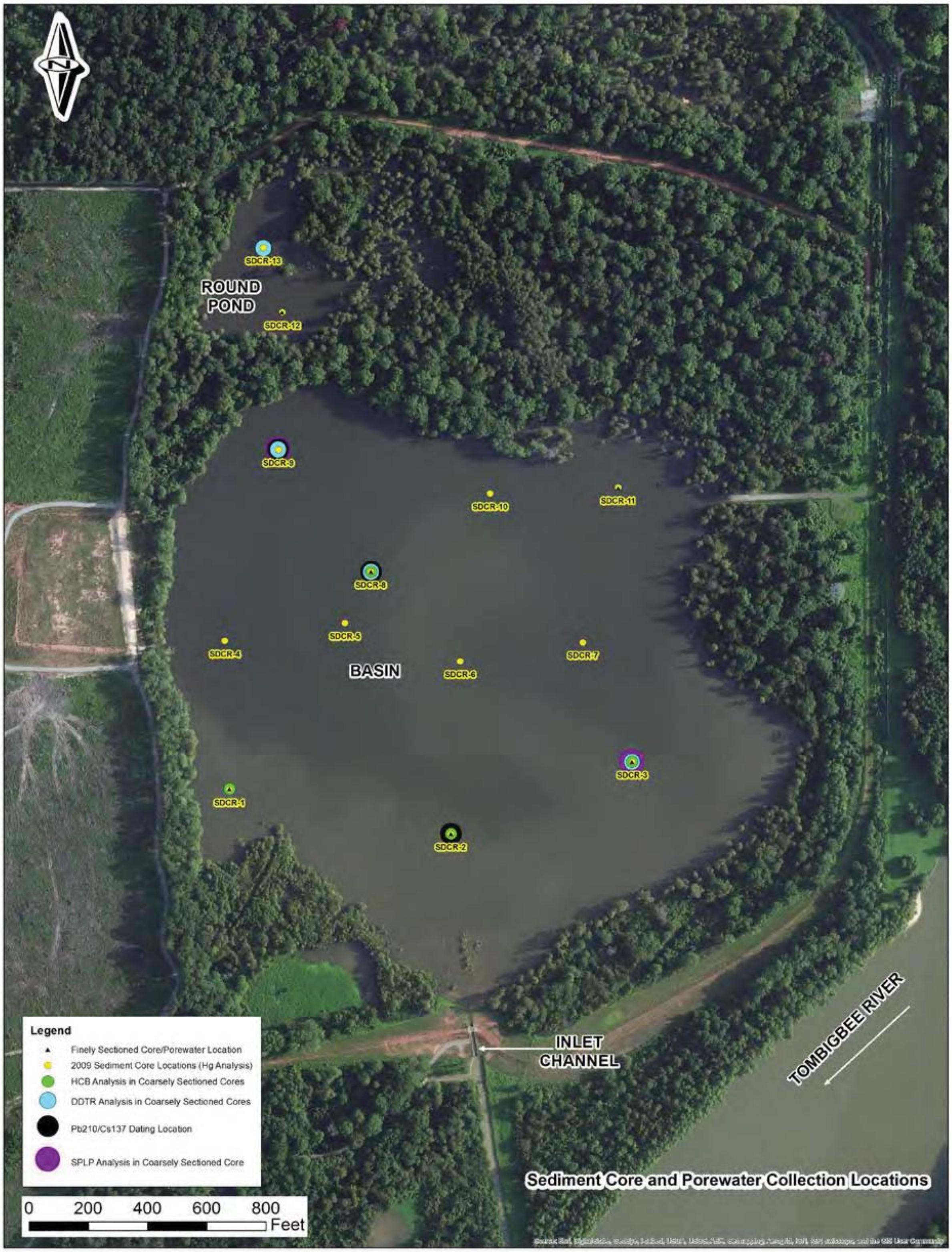


Figure 18. Sediment Core and Porewater Sample Collection Locations

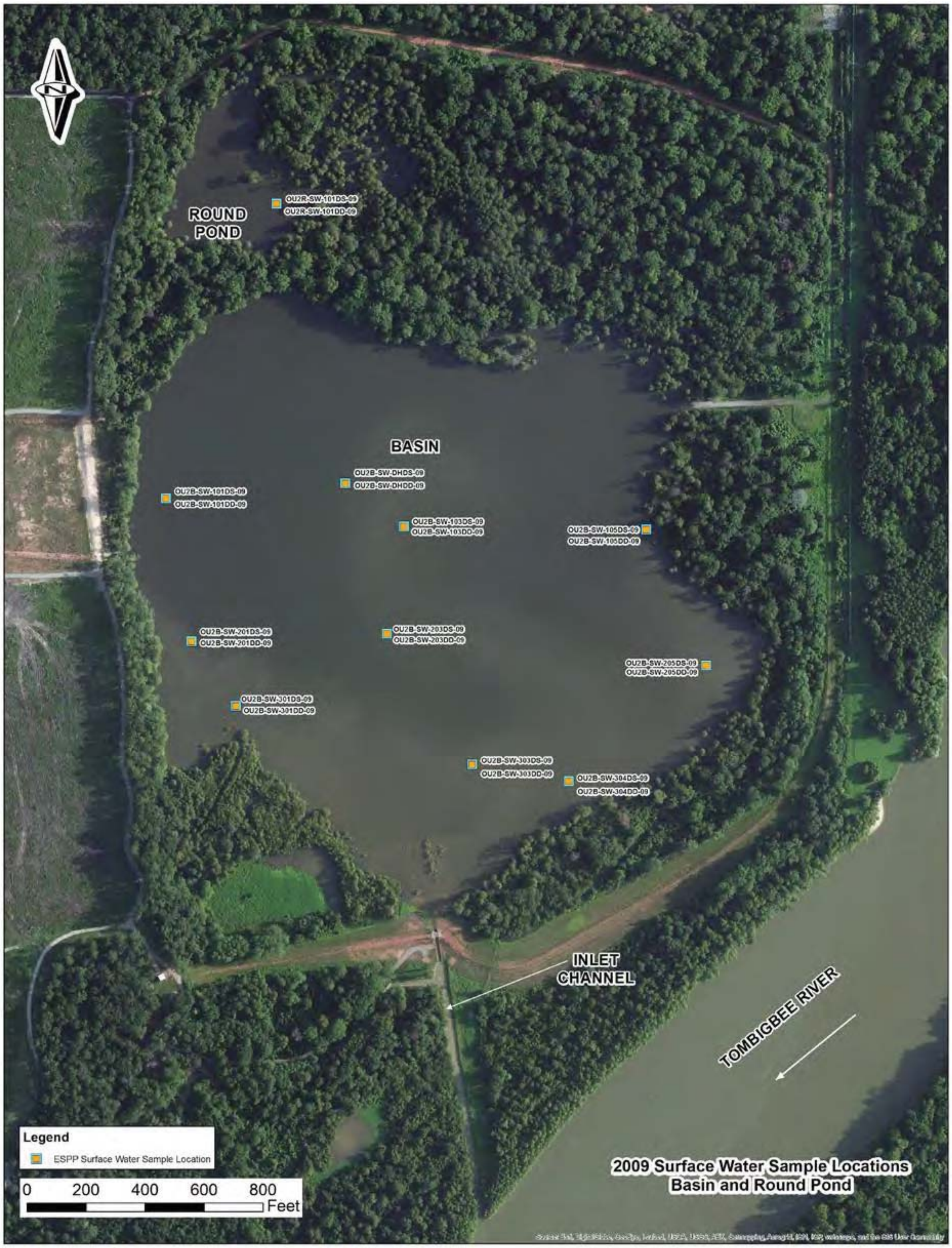


Figure 19. Surface Water Sample Locations in 2009: Basin and Round Pond

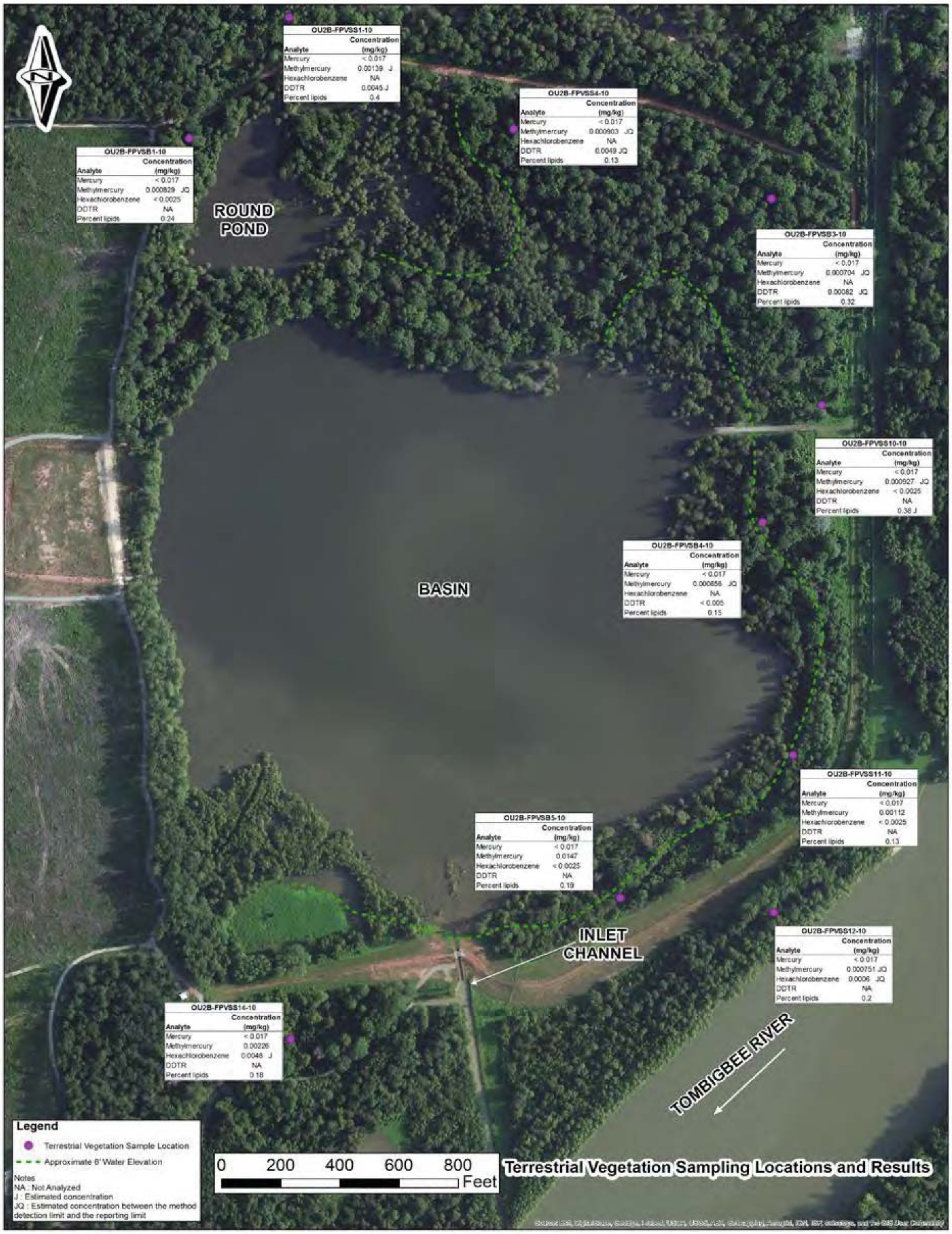


Figure 20. Terrestrial Vegetation Sampling Locations and COC Concentrations

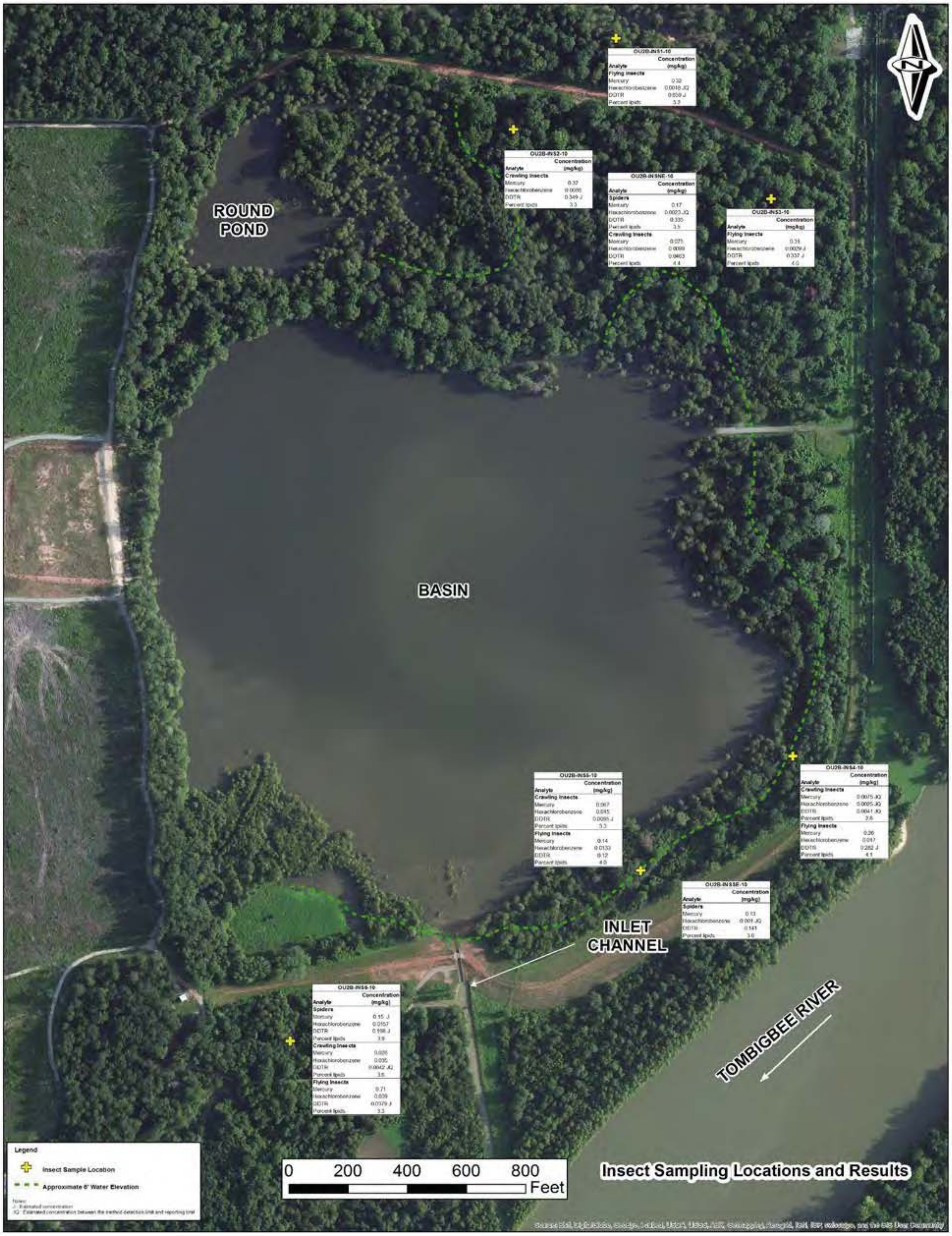


Figure 21. Insect Sampling Locations and COC Concentrations

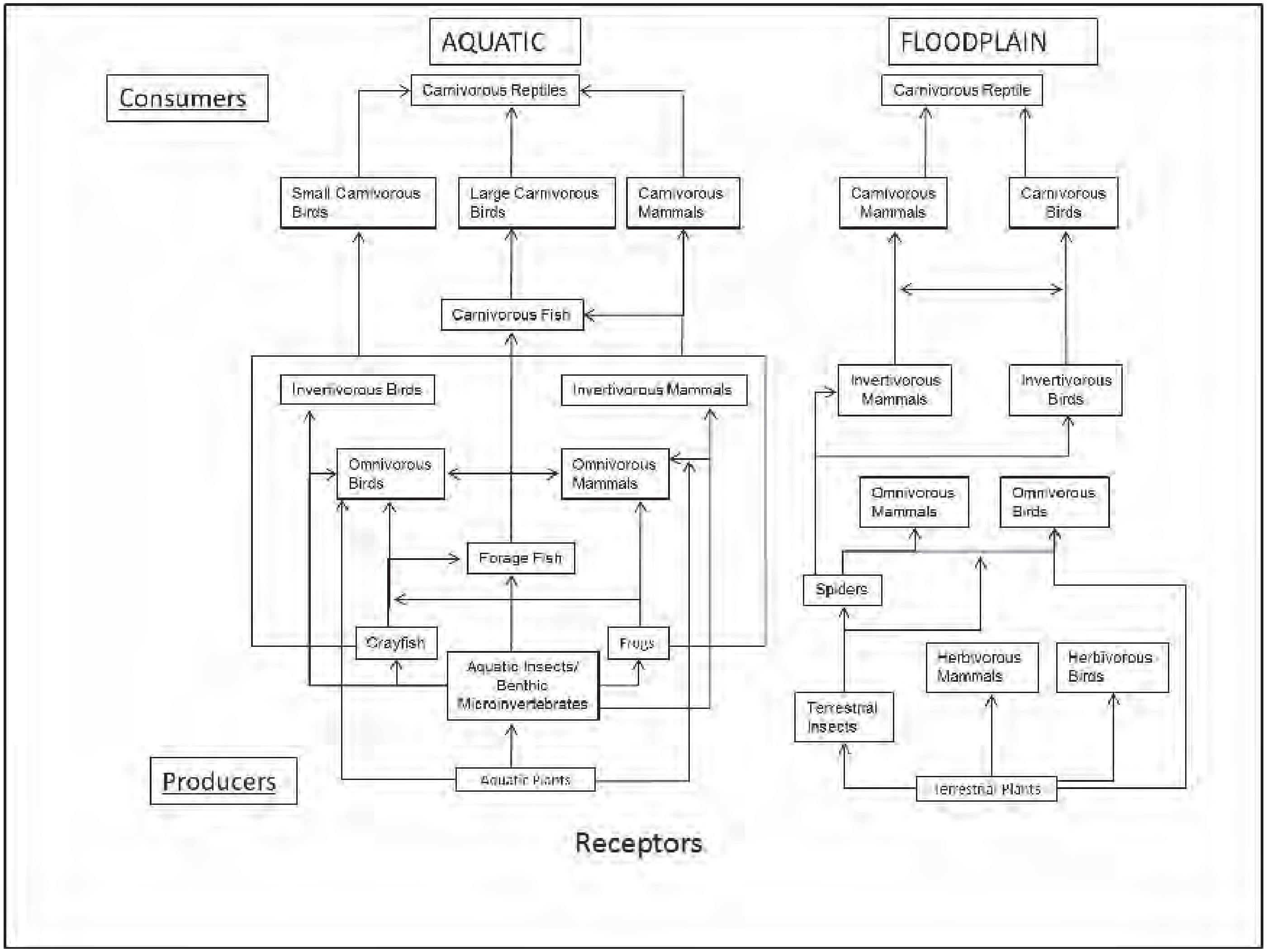
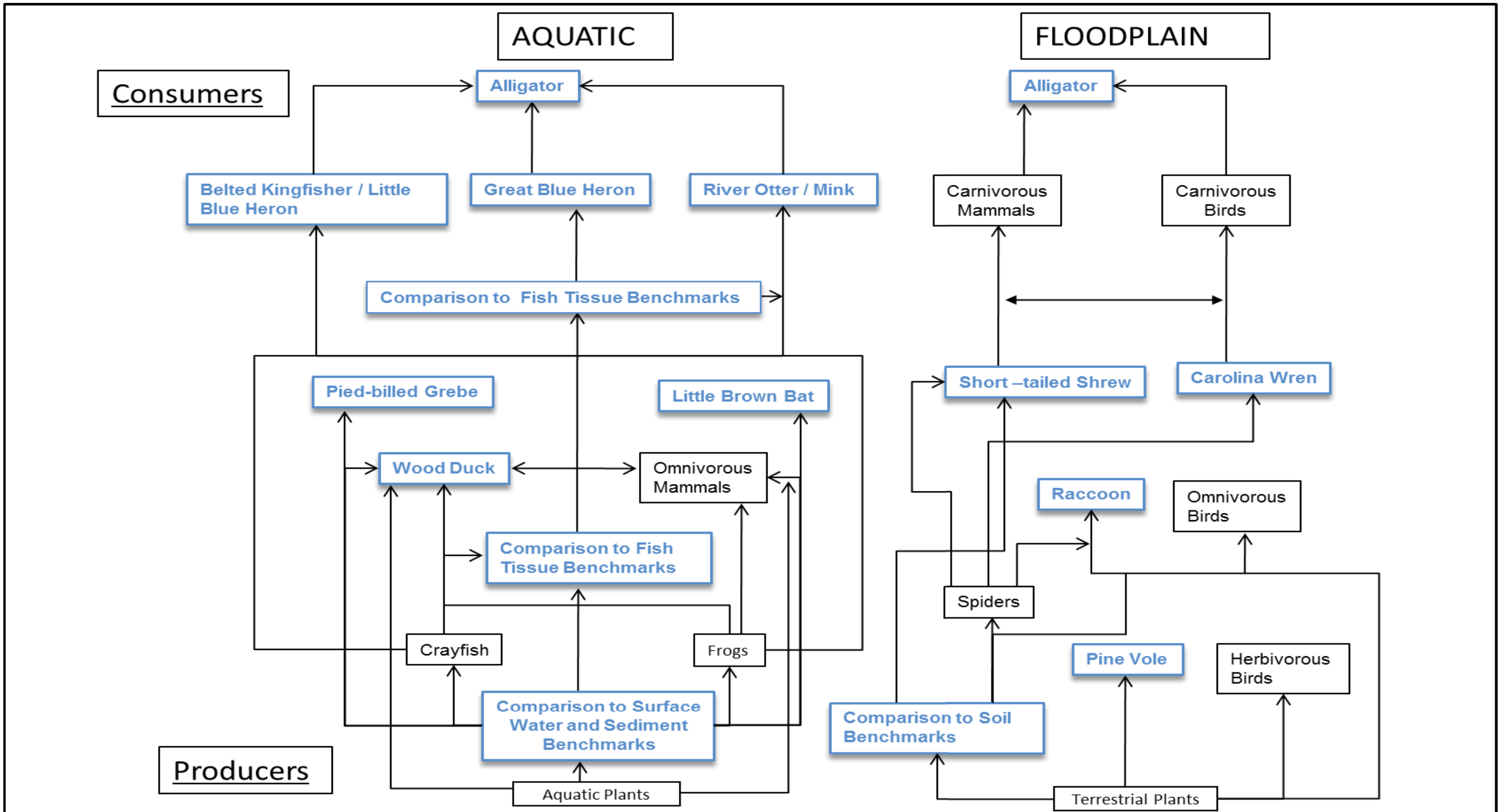


Figure 22. Generalized Food Web Model



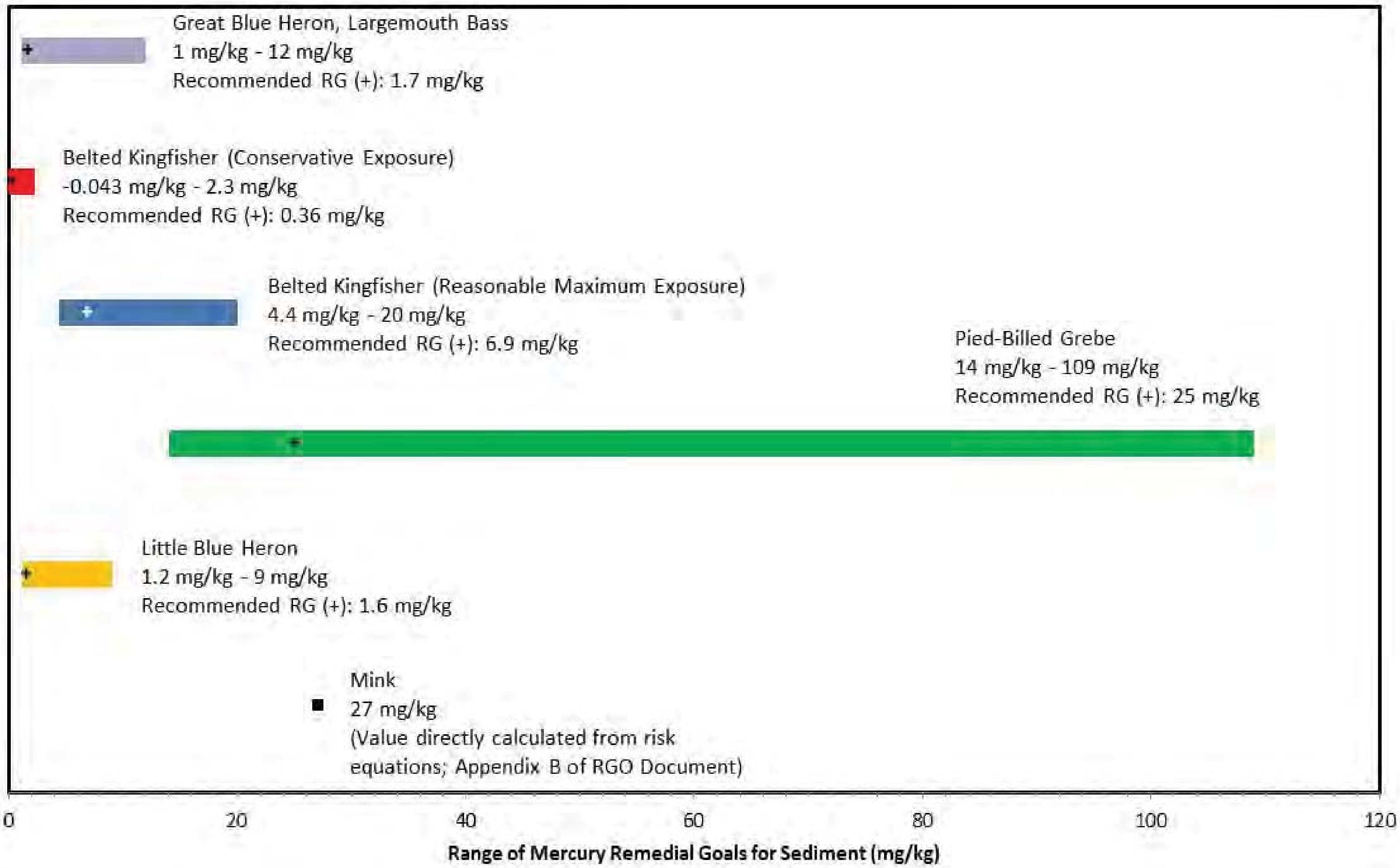
Source: Modified from the December 2009 EPA McIntosh Presentation

Note:

Comparison to Benchmarks

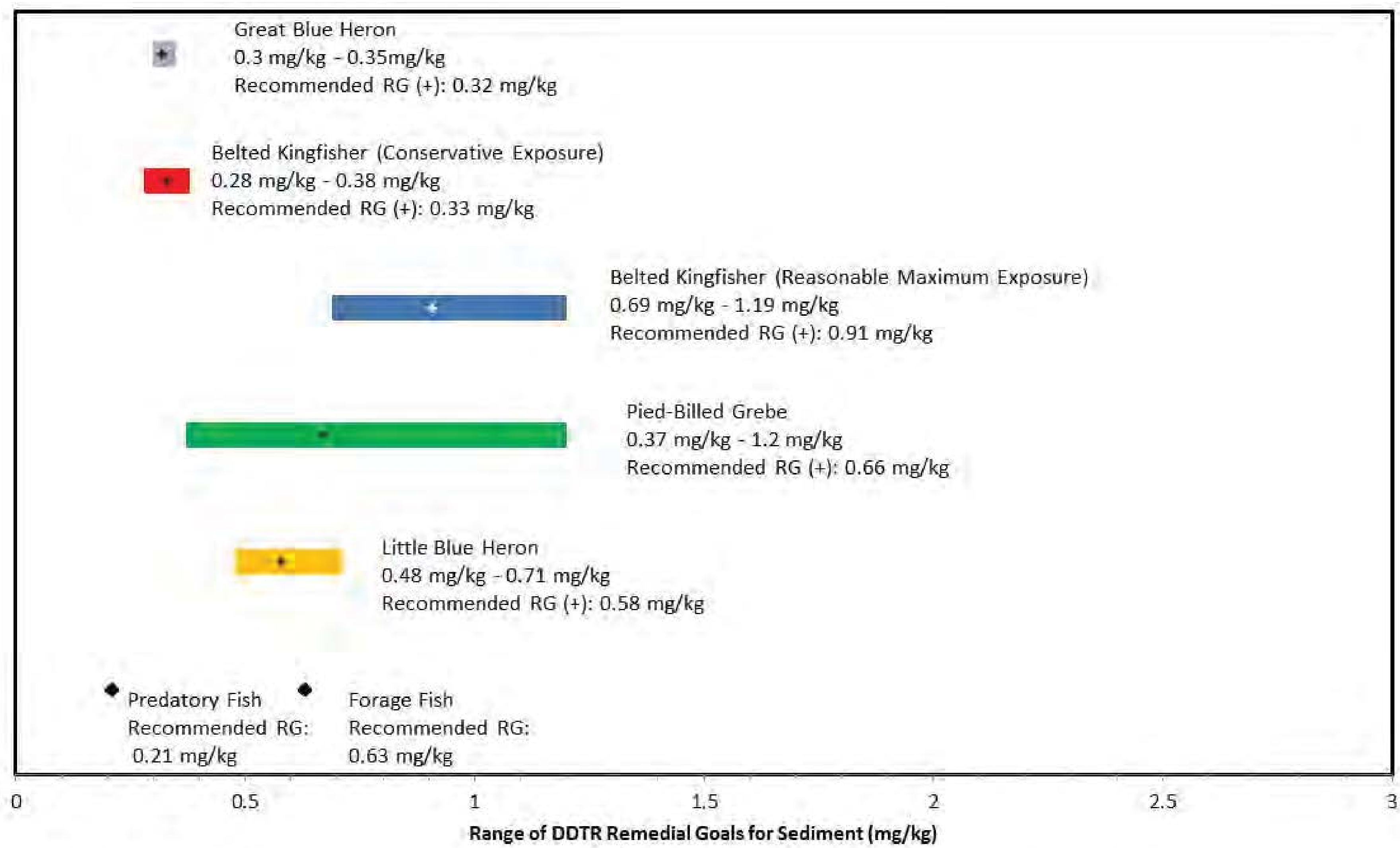
– Media risk evaluated by comparison to benchmarks instead of food chain modeling

Figure 23. Site Specific Food Web Model



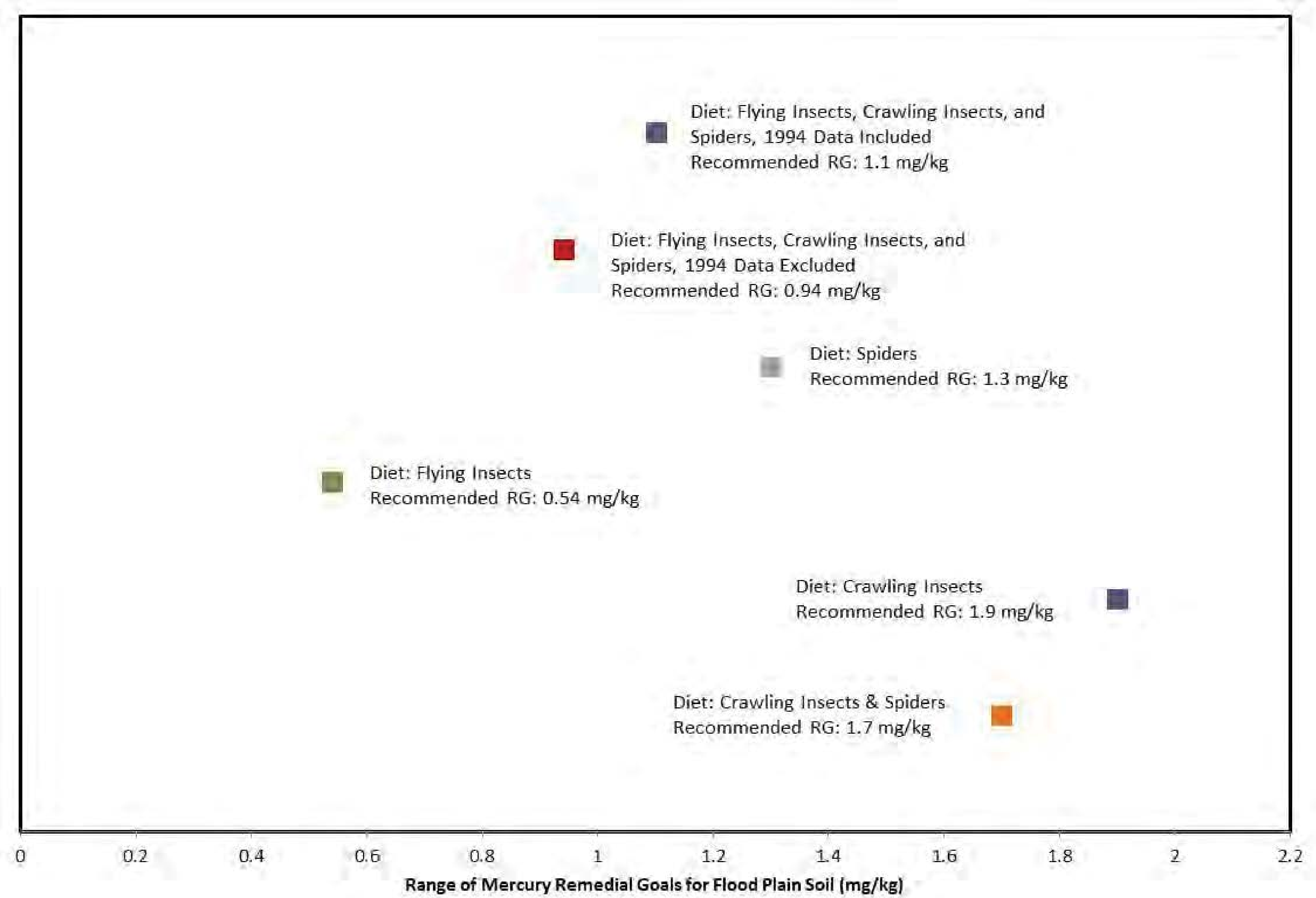
+ Indicates the Remedial Goal for the receptor using the combined forage fish dataset.

Figure 24. Mercury Target Sediment Concentrations Protective of Receptor Based on Risk from Forage and Predatory Fish



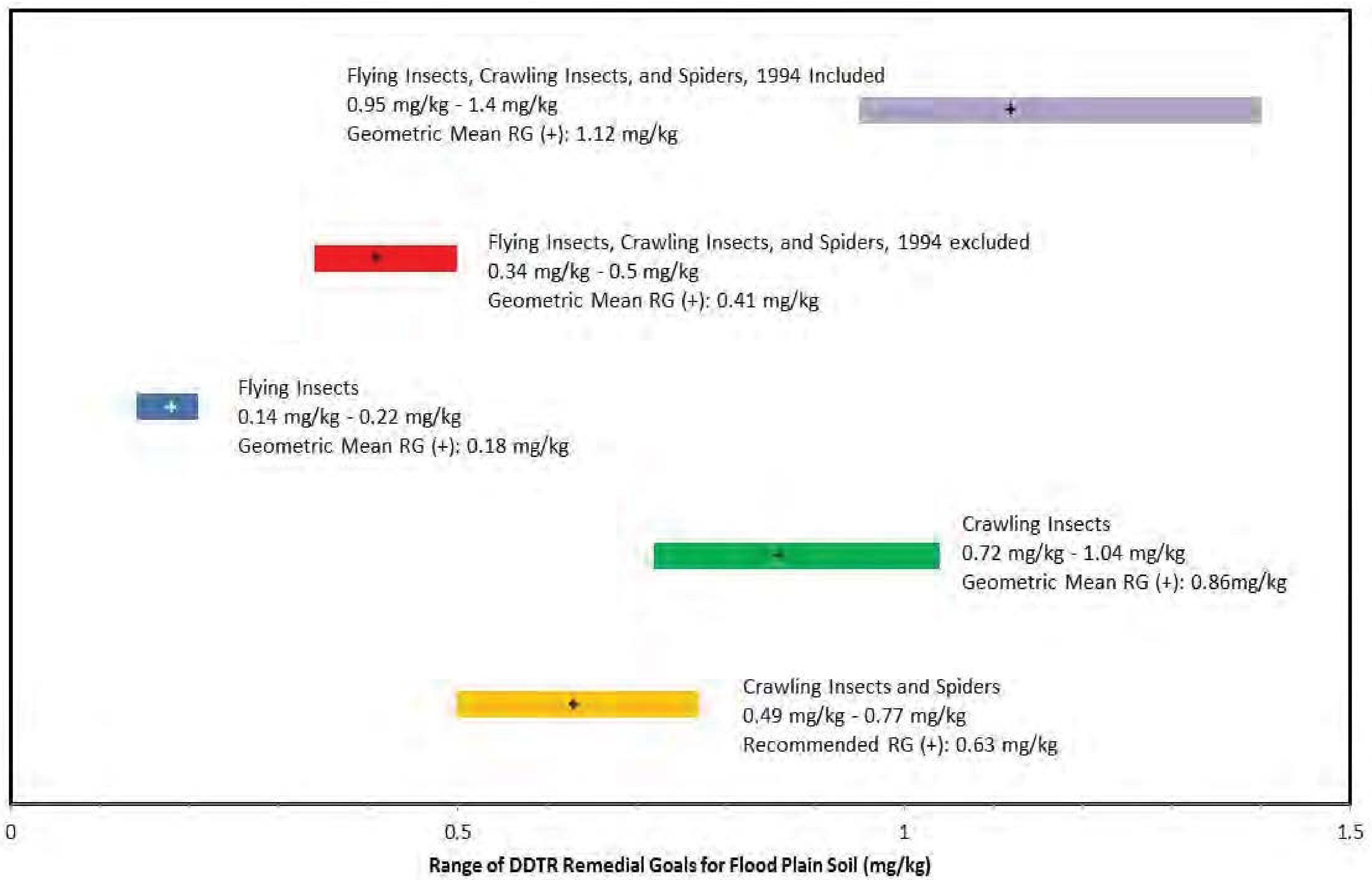
+ Indicates the Remedial Goal for the receptor using the combined forage fish dataset (forage fish + predatory fish for Great Blue Heron).
◆ Indicates the sediment Remedial Goal for fish based on bioaccumulation into fish tissue

Figure 25. DDTR Target Sediment Concentrations Protective of Receptor Based on Risk from Forage and Predatory Fish



Note: Values represent NOAEL, LOAEL, and geometric mean Remedial Goals.

Figure 26. Mercury Target Soil Concentrations Protective of Carolina Wren



+ Indicates the geometric mean Remedial Goal for the invertebrate grouping.

Figure 27. DDTR Target Soil Concentrations Protective of the Carolina Wren

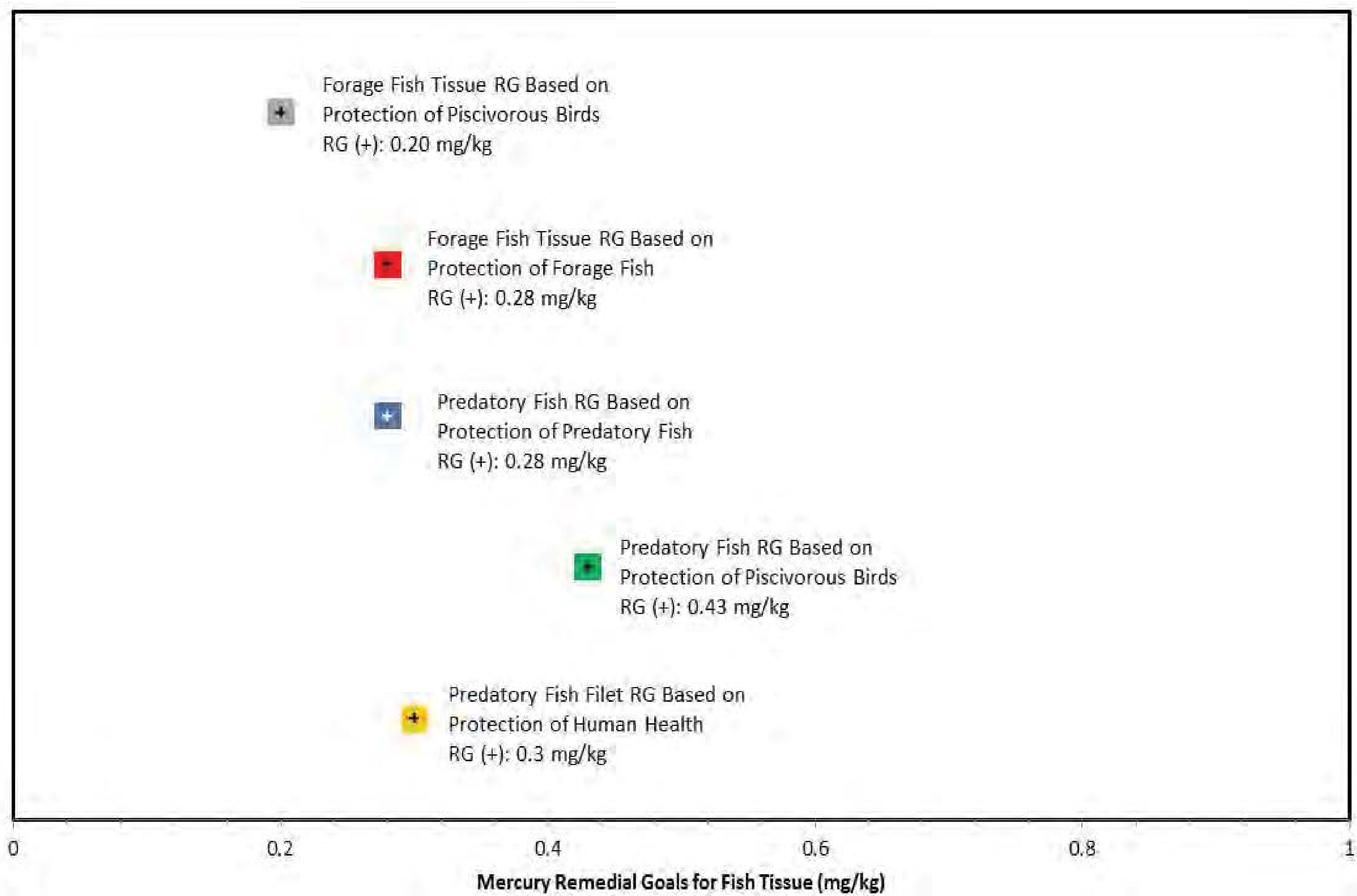


Figure 28. Mercury Target Fish Concentrations Protective of Fish, Piscivorous Birds, and Humans

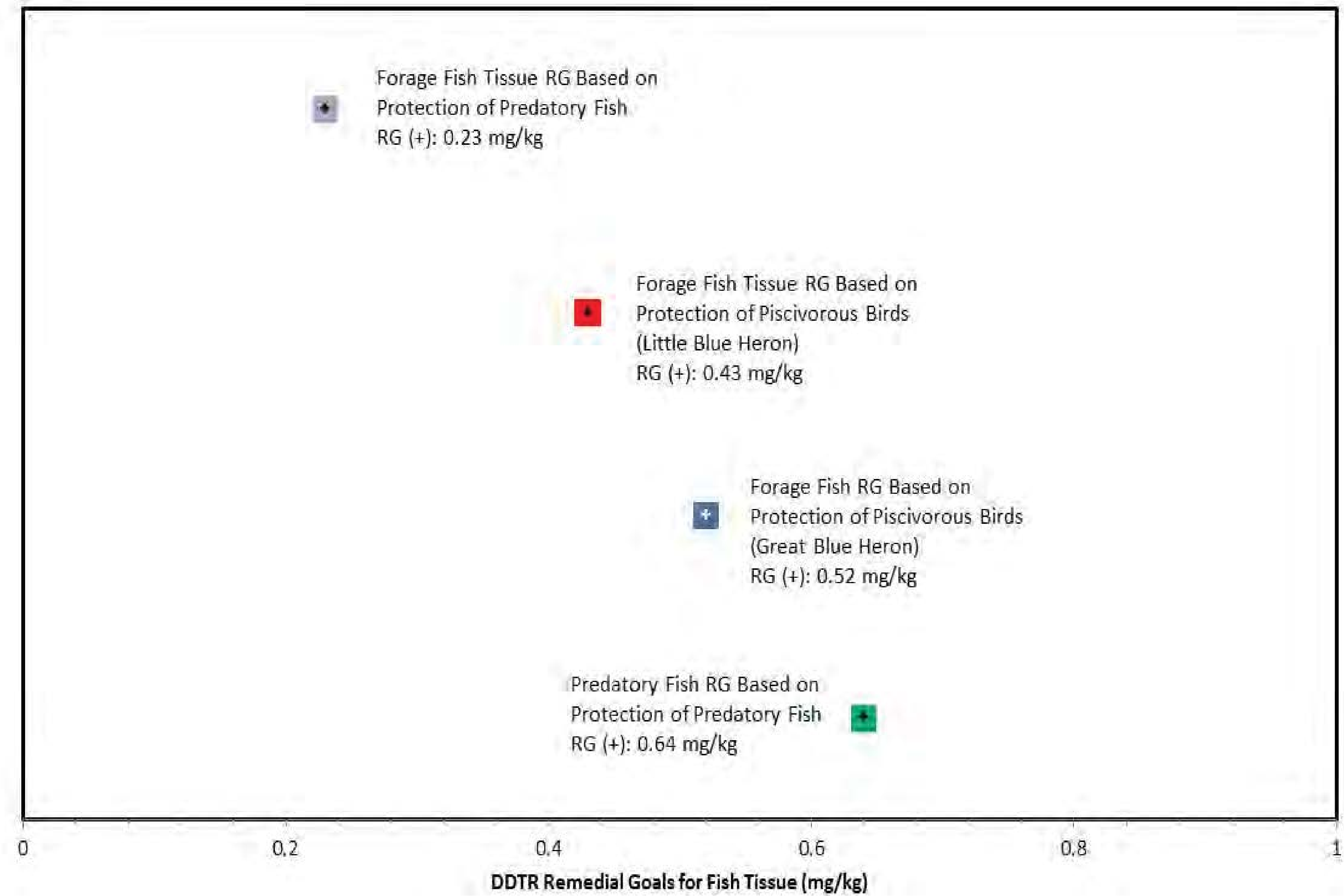


Figure 29. DDTR Target Fish Concentrations Protective of Fish and Piscivorous Birds

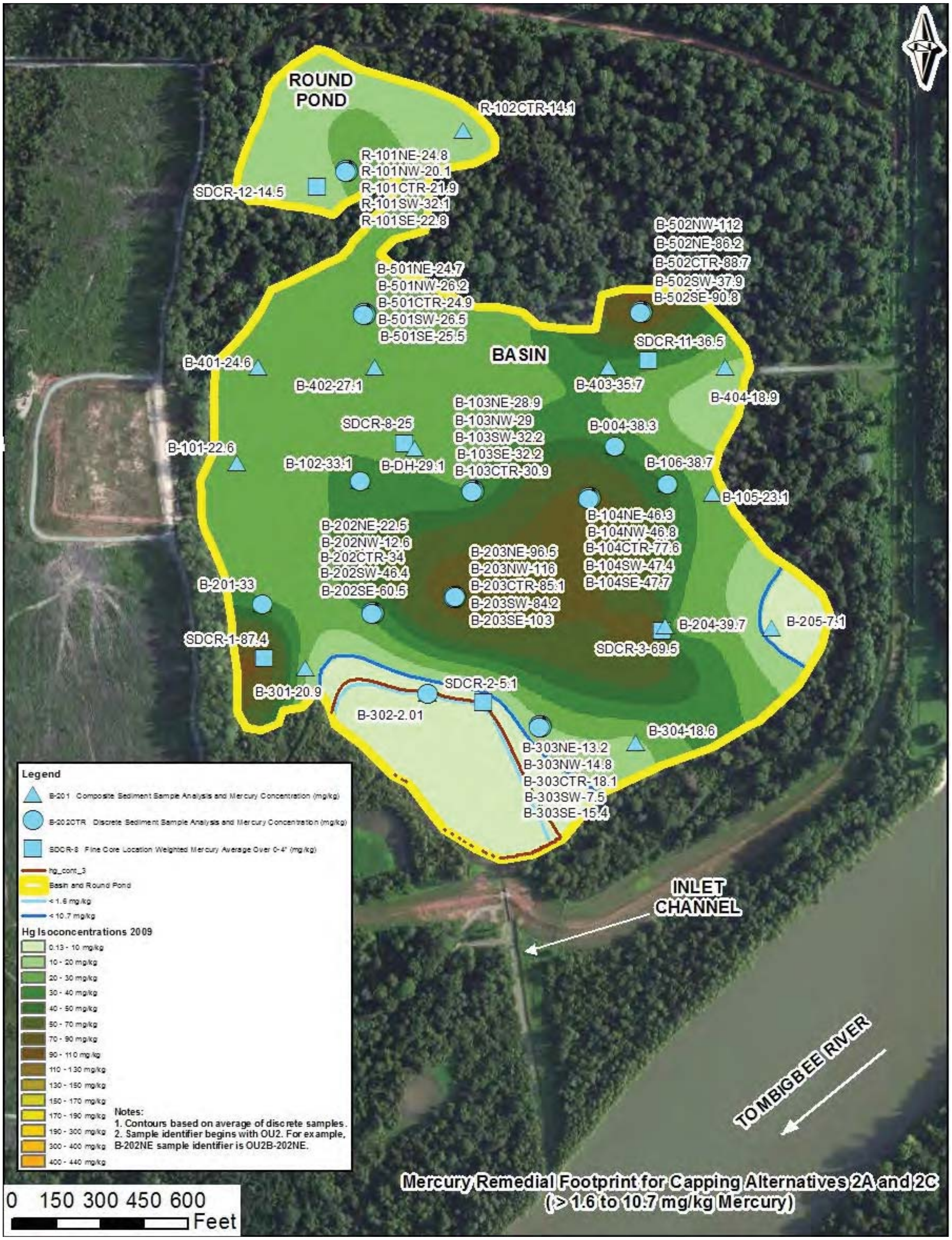


Figure 30. Mercury Remedial Footprint for Capping Alternatives 2A and 2C (> 1.6 to 10.7 mg/kg Mercury)

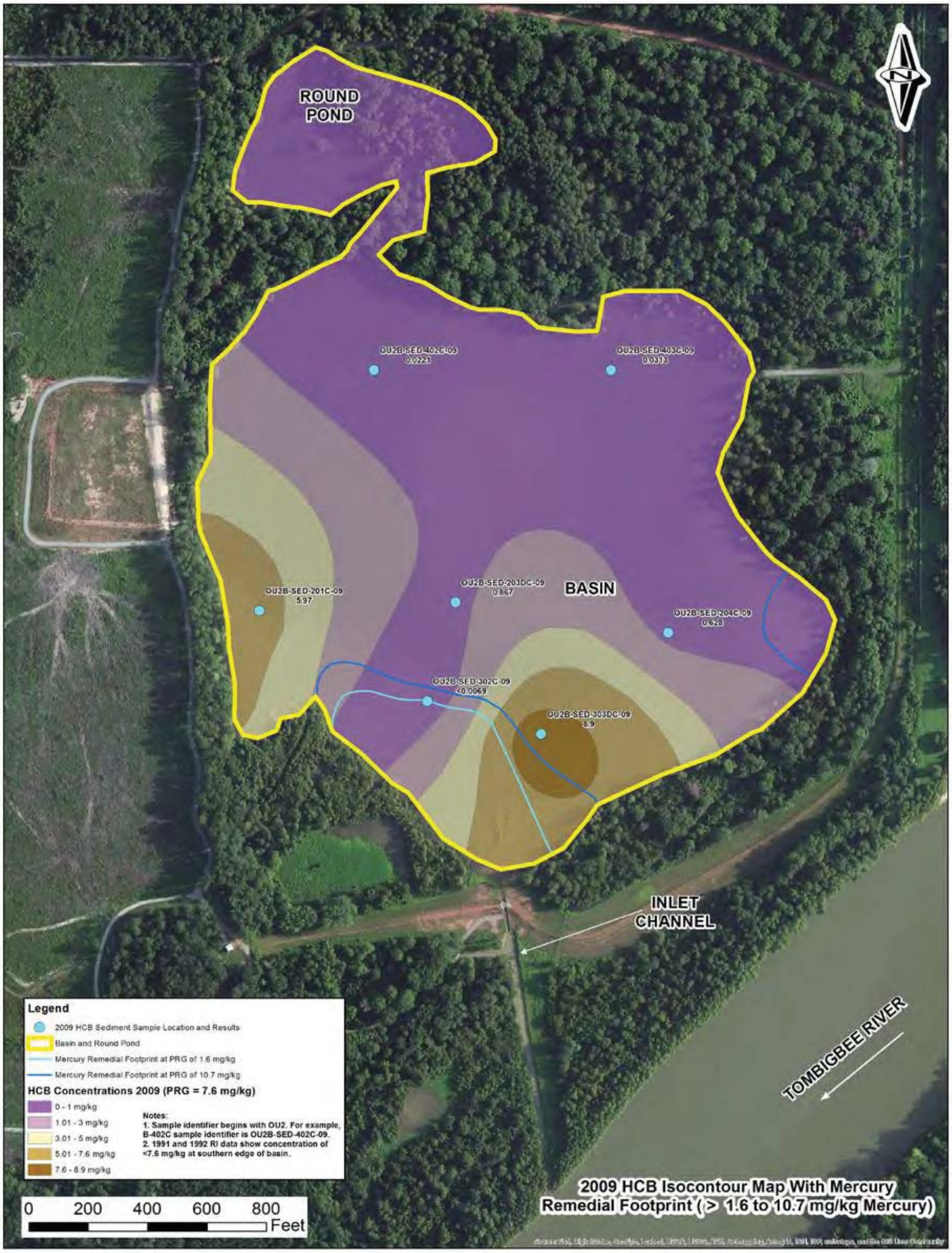


Figure 31. HCB (2009) Isocontour Map with Mercury Remedial Footprint (>1.6 to 10.7 mg/kg Mercury)

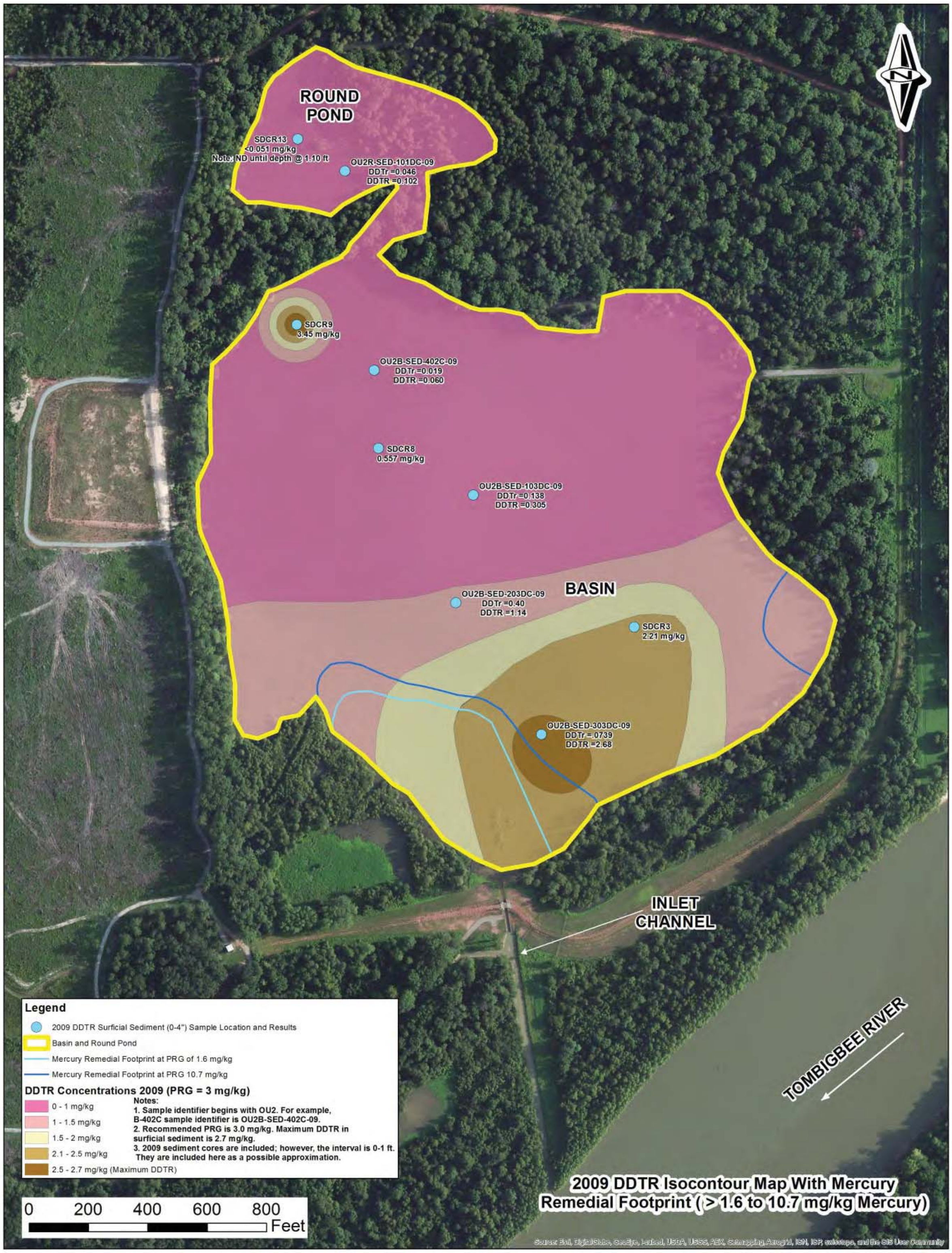


Figure 32. DDTR (2009) Isocontour Map with Mercury Remedial Footprint (>1.6 to 10.7 mg/kg Mercury)

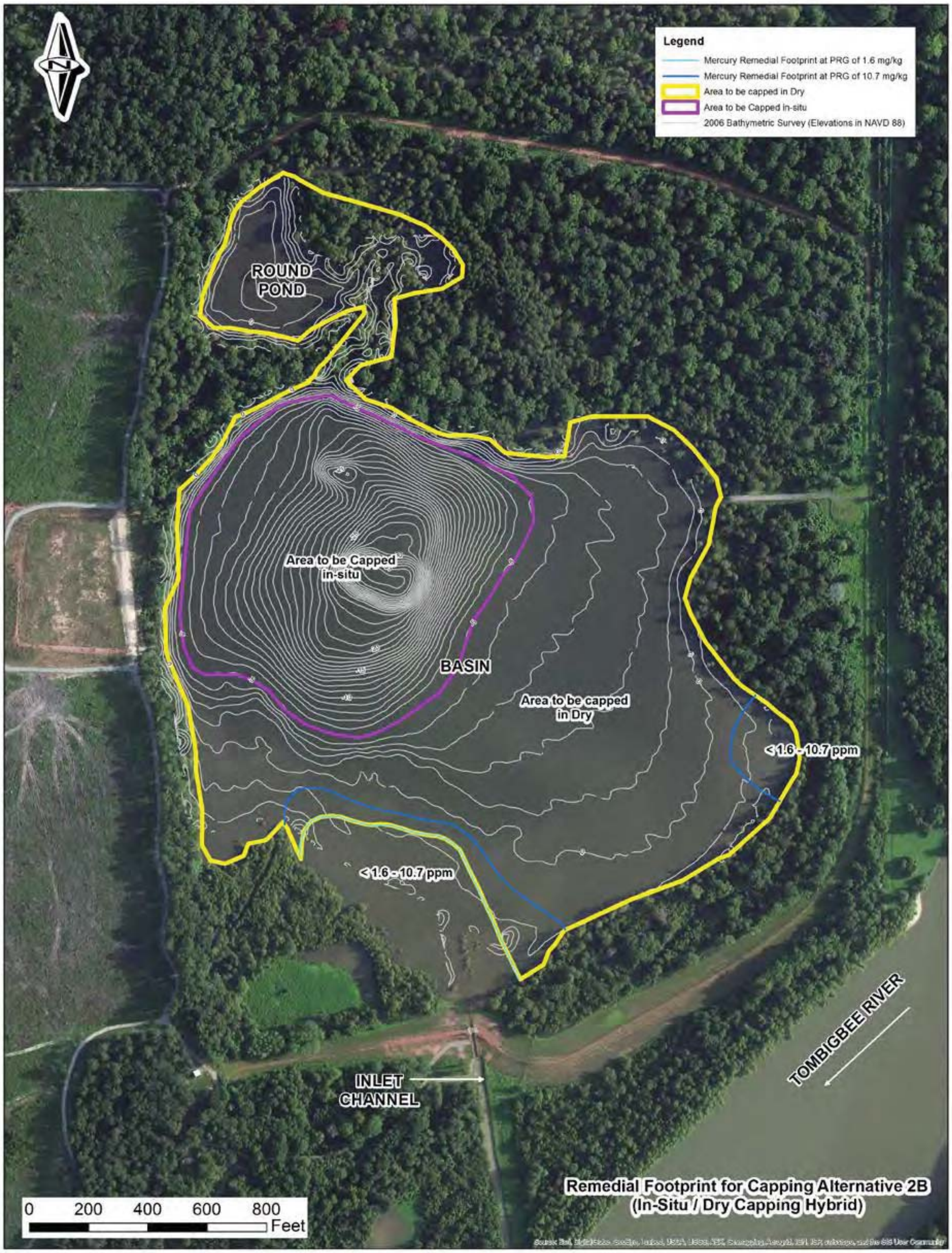


Figure 33. Remedial Footprint for Capping Alternative 2B (In-Situ/Dry Capping Hybrid)

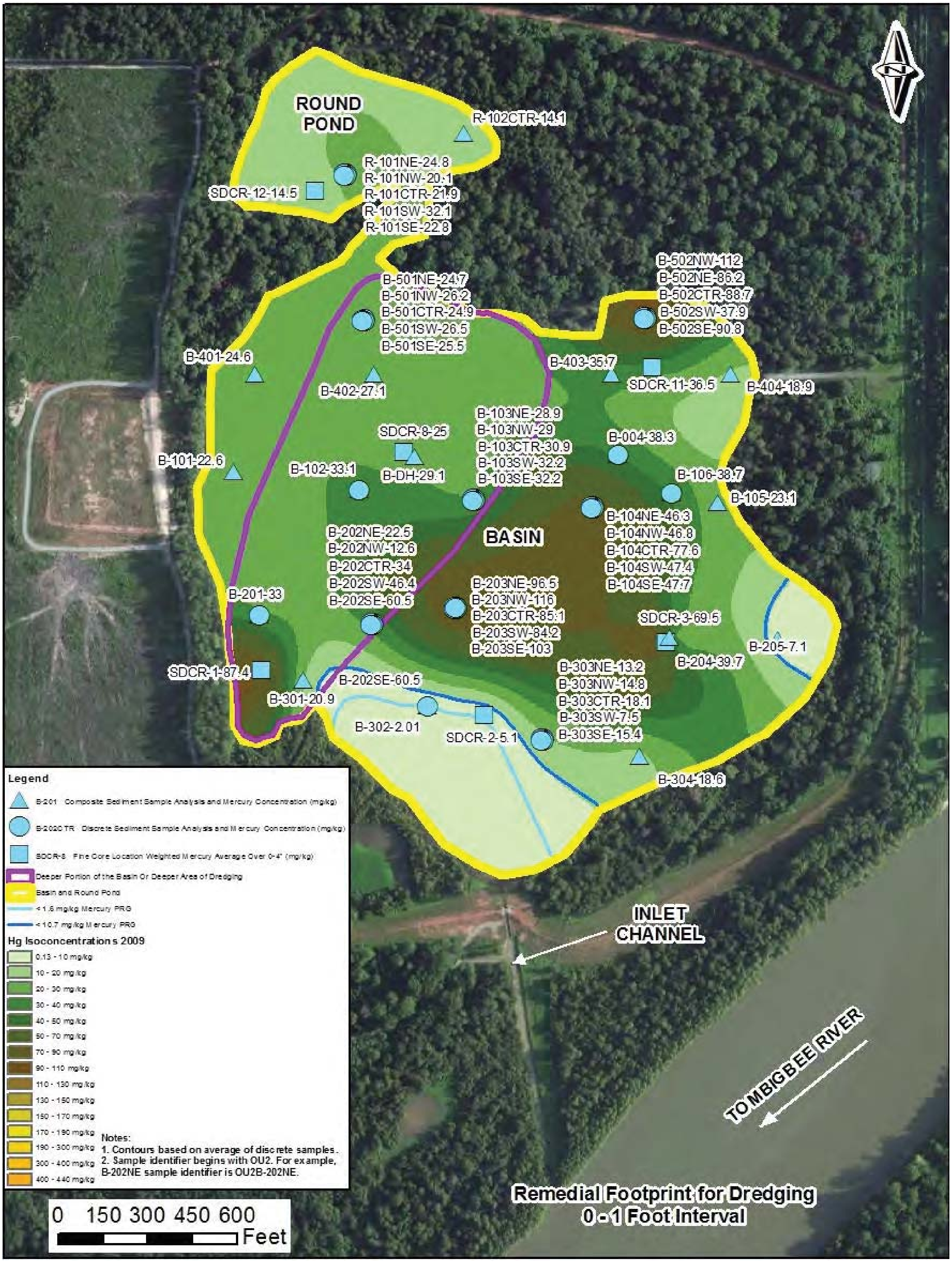


Figure 34. Remedial Footprint for Dredging: 0 – 1 Foot Interval

Figure 35. Remedial Footprint for Dredging (Alternative 3): 1 – 2 Foot Interval

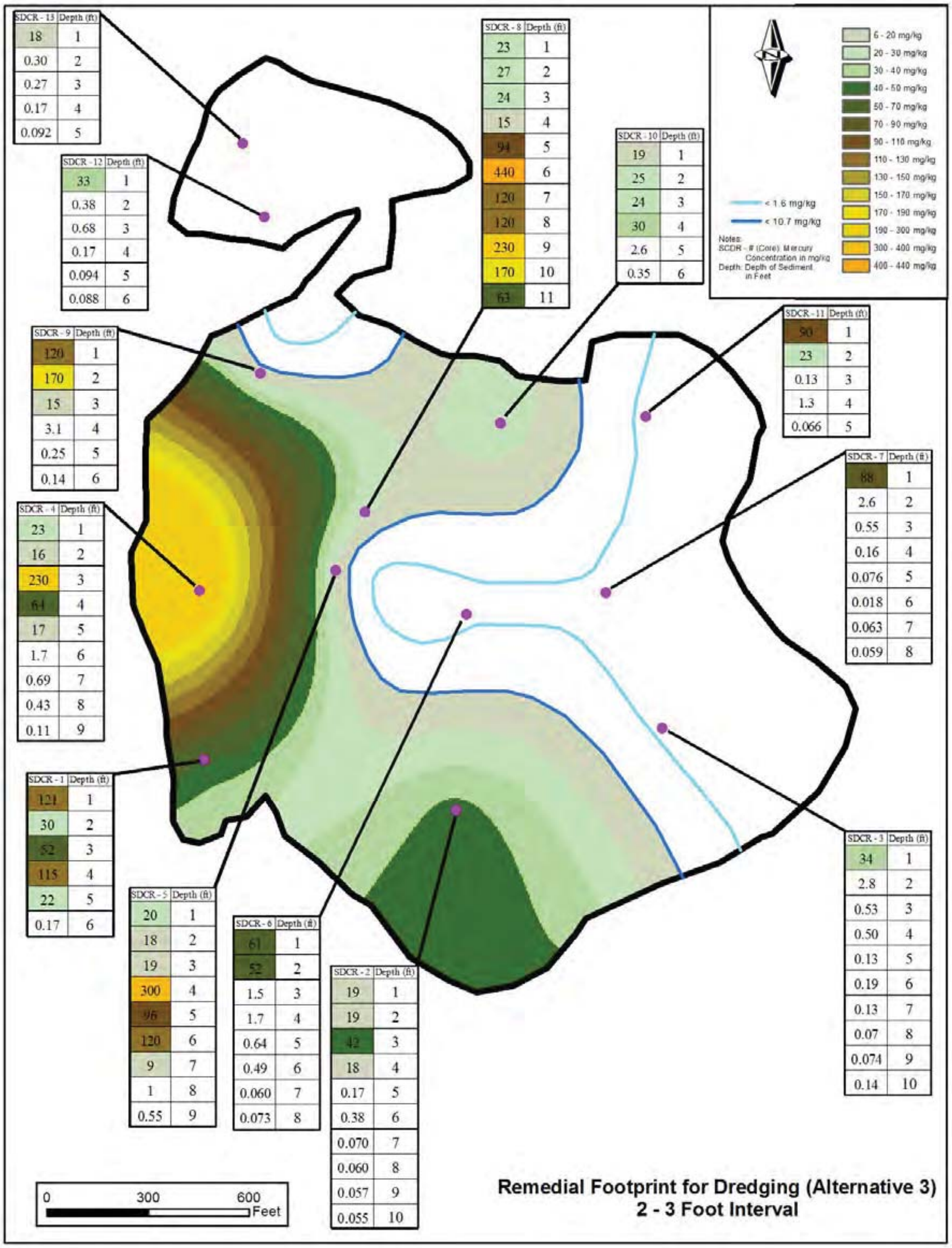


Figure 36. Remedial Footprint for Dredging (Alternative 3): 2 – 3 Foot Interval

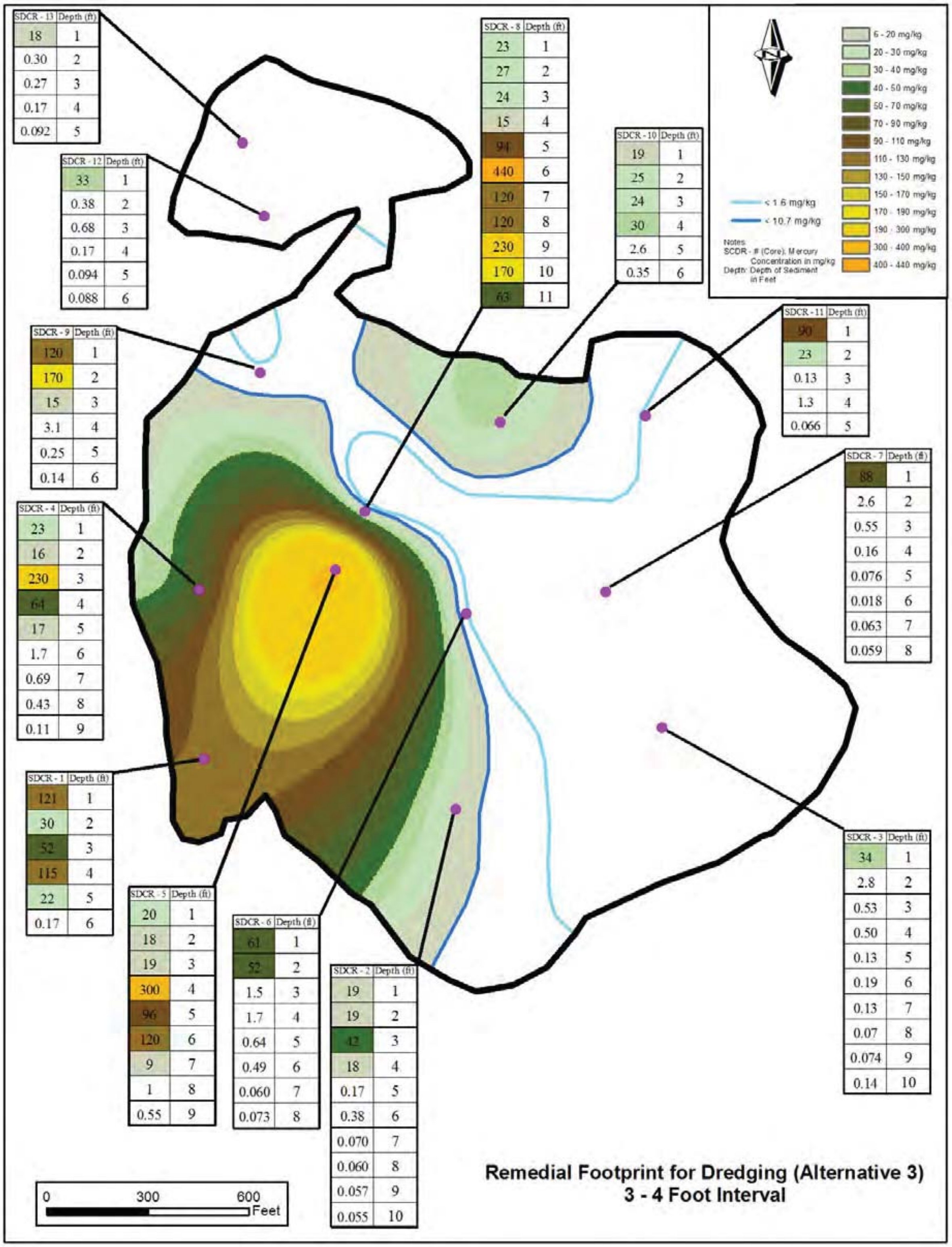


Figure 37. Remedial Footprint for Dredging (Alternative 3): 3 – 4 Foot Interval

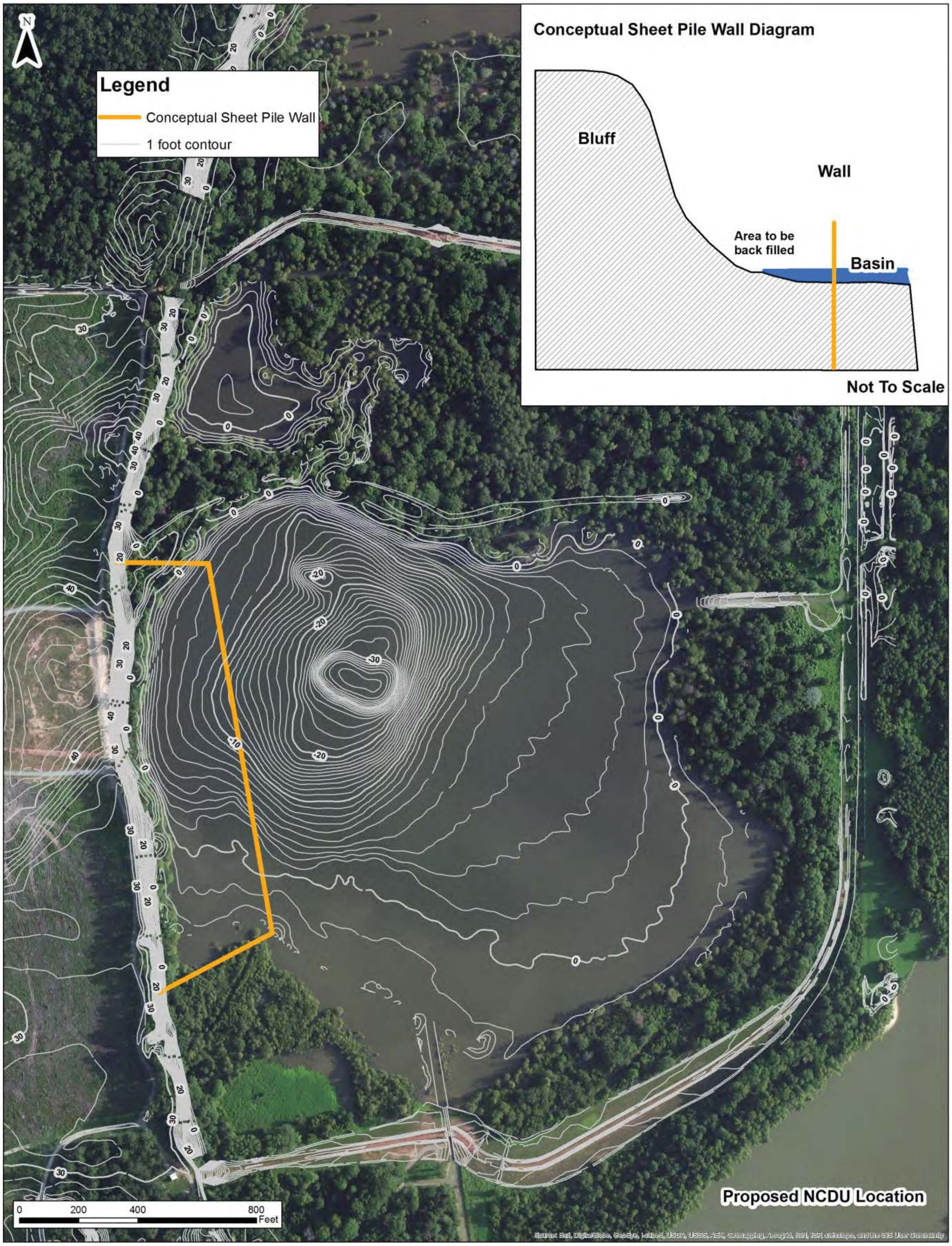


Figure 38. Conceptual Sheet Pile Wall and Locations

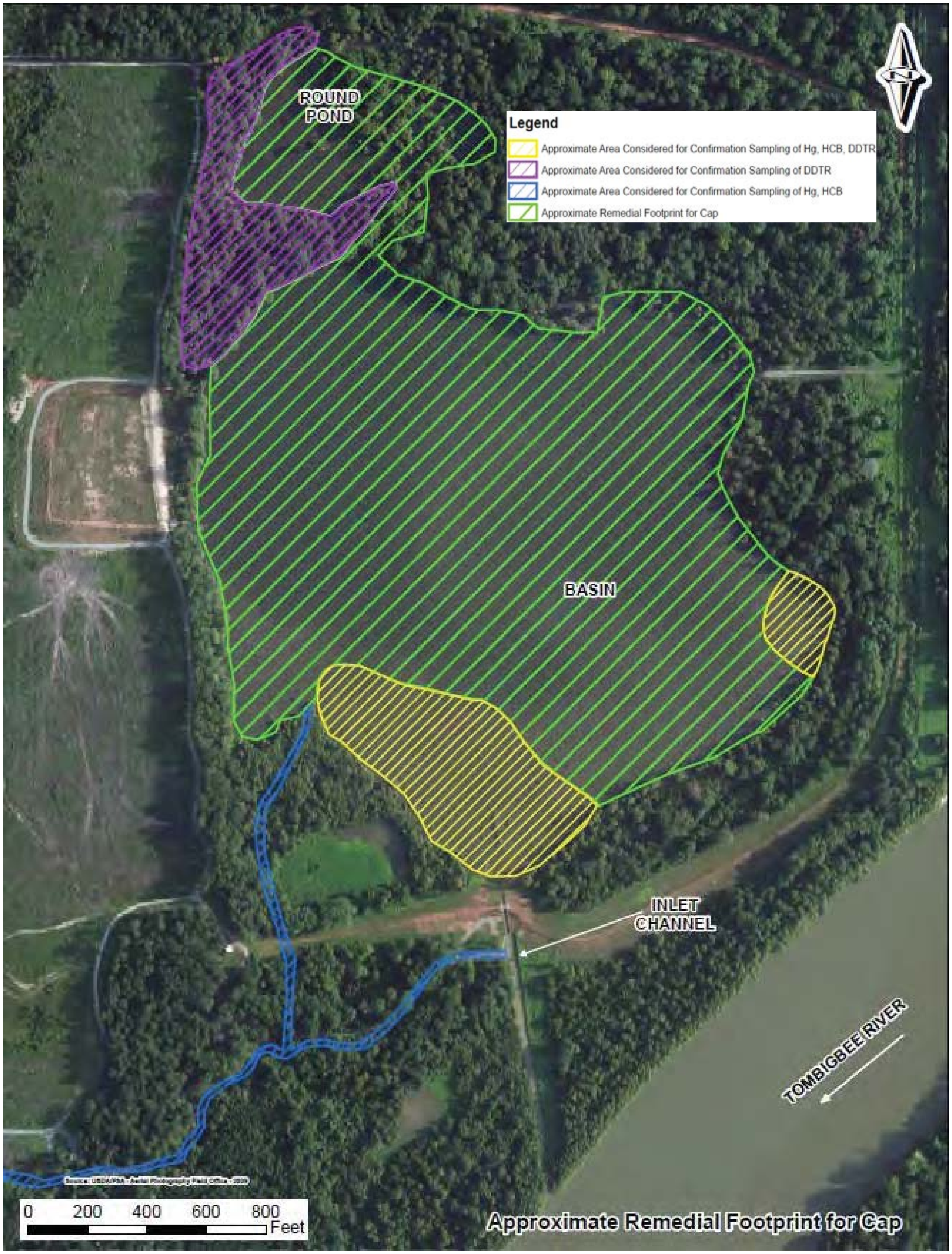


Figure 39. Remediation Footprint

APPENDIX 1: EXPLANATION OF REMEDIAL GOAL DERIVATIONS AND MODIFICATIONS

Explanation of Remedial Goal Derivations and Modifications

INTRODUCTION

This Appendix provides technical information for remedial goal (RG) development for receptors and exposure pathways that were not presented in the OU-2 Remedial Goal Option (RGO) report for development of remedial goals (MACTEC 2010b). The information provided in this memorandum updates that provided in the 2012 RGO report in cases where expanded information was used to derive cleanup levels (CULs) for the OU-2 ROD. The memorandum documents RG development or changes for the following topics:

- Derivation of fish-tissue-residue RGs and sediment RGs to protect fish for mercury and DDTR,
- Derivation of sediment RGs to meet fish fillet TBC criteria for human health
- Changes to the floodplain-soil RGs to protect insectivorous birds exposed to DDTR in floodplain soils,
- Changes to the sediment RG for DDTR to protect piscivorous birds feeding on predatory fish, and
- Modification of DDTR RGs based upon OU-2 total organic carbon (TOC) concentrations.

Derivation of Fish-tissue-residue RGs to Protect Predatory Fish

The RGO Report for OU-2 (AMEC, 2012) developed remedial goals for a variety of piscivorous wildlife to reduce their risk from exposure to chemicals of concern through ingestion of contaminated media. The RGO report did not develop remedial goals to protect fish from the chemicals of concern they passively accumulate in their bodies through bioaccumulation. RGs to protect fish can be expressed as either concentrations in the fish, referred to here as fish-tissue-residue RGs, or concentrations in the sediment, referred to here as sediment RGs to protect fish, depending on whether the RG will be compared to the fish tissue concentration (also referred to as the body burden) or the sediment concentration. Fish tissue concentrations are normally expressed in wet weight. Hence the units on the fish-tissue-residue RGs are in terms of wet weight in contrast to sediment RGs, which are always expressed in terms of concentrations in sediment in dry weight. Fish-tissue-residue RGs can be developed to protect wildlife receptors that consume fish, this section however, pertains to the derivation of fish-tissue-residue RGs relative to the assessment endpoint for protection of fish populations.

Fish-tissue-residue RGs to protect fish at OU-2 are based on fish-tissue-residue effects levels published by Beckvar and others (2005). No site-specific toxicity testing was performed on OU-2 fish in relation to their body burdens of mercury or DDTR. Risk to fish was assessed in the OU-2 risk assessment by comparing fish tissue body burdens to fish-tissue-residue effects levels published in the literature. The Beckvar *et al.* paper evaluated paired no-effects and low-effects tissue residue data derived from experimental studies published in primary literature. From there they derived protective fish-tissue-residue effects levels for mercury and DDTR using four analytical methods–simple ranking, empirical percentiles, tissue threshold-effect levels (t-TELs), and cumulative distribution functions (CDFs). In their evaluation of the four methods, the authors found that both the t-TEL and the empirical percentile approach 10th percentile low effects range (LER) provided reasonable results for fish-tissue-residue effects levels. EPA used the greater of the t-TEL and the 10th percentile low LER as fish-tissue-residue RGs to protect fish at OU-2 (Table 1). The selected fish-tissue-residue RG to protect fish for mercury (0.28 mg/kg wet weight) was based on the 10th percentile LER for adult fish. The selected fish-tissue-residue RG to protect fish for DDTR (0.64 mg/kg wet weight) was based on the t-TEL for adult fish. Beckvar *et al.* (2005) identified the fish tissue effects levels for DDTR as preliminary, noting that some of the data used to derive the benchmarks represented mortality endpoints instead of preferred chronic endpoints, such as reproductive effects.

Table 1. Fish-tissue-residue Effects Levels (from Beckvar *et al.*, 2005)

	10th Percentile LER (mg/kg wet wt.)	t-TEL (mg/kg wet wt.)
Hg (adult fish)	**0.28**	0.21
Hg (early life stage)	NA	NA
DDTR (adult fish)	0.50	**0.64**
DDTR (early life stage)	0.89	0.70

NA = not applicable. Data were insufficient to derive empirical percentiles or t-TEL.
Shading indicates EPA's choice of the remedial goal to protect fish as a whole-body concentration.

EPA augmented the fish-tissue-residue effects levels in Beckvar *et al.* (2005) with studies of DDTR compiled by EPA Region 10. Region 10 compiled the studies to support development of a fish-tissue-residue RG to protect fish for the Portland Harbor Superfund site. The Portland Harbor Superfund site is using a fish-tissue-residue RG of 0.63 mg/kg to protect fish, based on studies Region 9 compiled from the primary literature. Several of the fish species compiled by Region 9 reside in the Southeastern U.S. (Table 2). The studies on Southeastern U.S. species in Table 2 provide additional information on the toxicity of DDTR to fish that was not reported by Beckvar and others (2005). The studies on these additional species support EPA's adoption of the 0.64 mg/kg fish-tissue-residue RG for protection of fish. A study by Gakstatter and Weiss (1967) reported DDTR effects on the behavior of goldfish and bluegill. The behavioral effects (equilibrium loss and convulsions) are normally not used to develop fish-tissue-residue effects levels. Region 9 provided evidence to link the behavioral effects observed in the Gakstatter and Weiss (1967) study to adverse effects at the population level. The Crawford and Guarino (1976) paper was not used to derive the Portland Harbor fish-tissue-residue RG for DDTR because it appeared to be inconsistent in discussion of o,p′-DDT or p,p-DDT and reported egg residues for only one exposure concentration.

Table 2. Fish-tissue-residue Effects Levels from EPA Region 9 Compilation of Studies Considered with Emphasis on Southeastern U.S. Species.

Species	Endpoint	Endpoint Effect	Whole Body Conc., mg/kg wet weight	Final Whole Body Conc., mg/kg wet weight*	Exposure Route	Duration	Studies Considered
Carassius auratus (goldfish)	Behavior linked to mortality	Equilibrium loss and convulsions	5.1	0.61	water	6 hours (32-d recovery)	Gakstatter and Weiss 1967
Lepomis macrochirus (bluegill)	Behavior linked to mortality	Equilibrium loss and convulsions	4.2	0.51	water	5 hours (32-d	Gakstatter and Weiss 1967
Fundulus heteroclitus (killifish)	Mortality	25% Mortality	5.2	0.63	water	24 hours	Crawford and Guarino 1976

*An acute to chronic ratio (ACR) was applied to toxicity studies where behavior leading to mortality or mortality was the test endpoint when the exposure duration was less than 30 days. The ACR used was 8.3 after Raimondo *et al.* 2007. Chronic endpoints, such as growth or reproduction are typically measured in studies having an exposure duration greater than 30 days and do not require an ACR adjustment.

The DDTR fish-tissue-residue effects levels apply to both forage fish and predatory fish. However, as illustrated in Figure 1, the concentrations of DDTR in largemouth bass are approximately three times greater than the concentration of DDTR in forage fish. Greater body burdens of DDTR in largemouth bass (a predatory fish) compared to lesser body burdens of DDTR in mosquitofish and brook silversides is a consequence of biomagnification. On average, the concentrations of DDTR in largemouth bass tissues are about three times greater than the concentrations of DDTR in forage fish (Table 3). Hence, forage fish will need to reduce their body burden of DDTR to approximately 0.23 mg/kg in order for predatory fish to achieve the fish-tissue-residue RG of 0.64 mg/kg. The recommended fish-tissue-residue (in forage fish) RG of 0.23 mg/kg for DDTR is predicted to protect predatory fish.

Table 3. Biomagnification of DDTR in Largemouth Bass and Bluegill Sunfish from DDTR Concentrations in Mosquitofish or Brook Silversides.

Area/Year	Largemouth Bass (mg/kg)	Bluegill Sunfish (mg/kg)	Mosquitofish or Silversides (mg/kg)
NE Basin 1994	12.9	-	4.39
Round Pond 1994	48.12	-	14.96
NE Basin 2001	5.71	-	1.38
NW Basin 2001	19.89	-	1.77
SE Basin 2001	14.37	-	1.27
Round Pond 2001	25.02	-	10.24
N Basin 2010	5.3	1.92	0.93
S Basin 2010	3.13	1.73	1.39

All concentrations in Table 3 are reported in units of mg/kg wet weight.

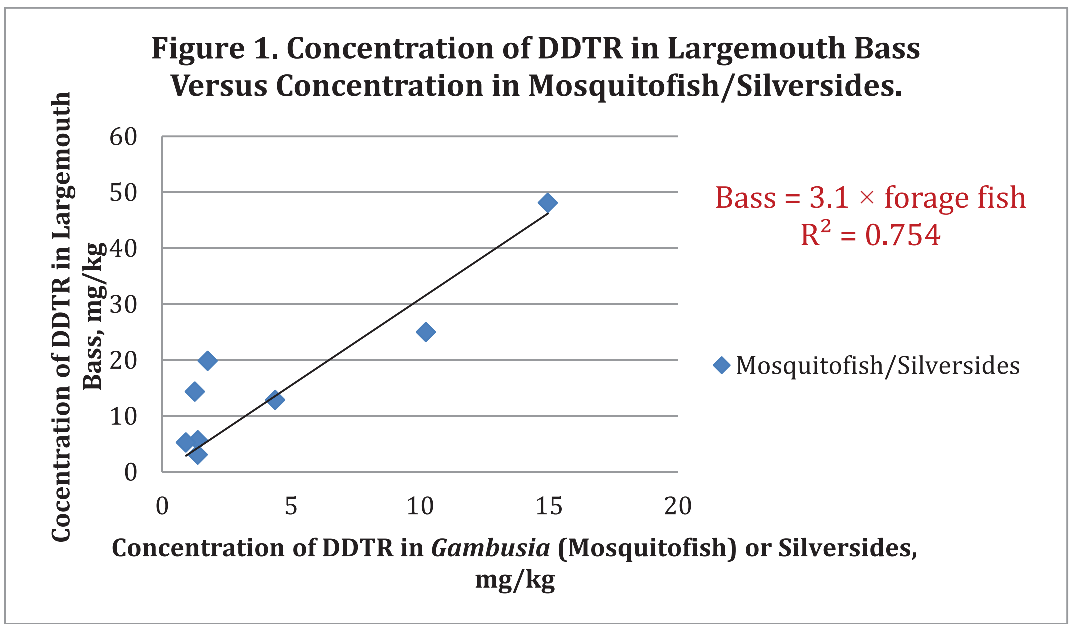


Figure 1. Concentration of DDTR in Largemouth Bass Versus Concentration in Mosquitofish/Silversides.

The mercury fish-tissue-residue effects level to protect fish of 0.28 mg/kg (Table 1) applies to both forage fish and predatory fish, and represents the whole body concentration. A matrix comparing the mercury concentrations in paired observations of forage fishes and predatory fish revealed a lesser degree of biomagnification of mercury than observed for DDTR (Table 4). The concentration of mercury in largemouth bass was on average approximately 2.4 times greater than the concentration of mercury in mosquitofish. The concentration of mercury in largemouth bass was on average approximately 1.9 times greater than the concentration of mercury in brook silversides.

Table 4. Biomagnification of Mercury in Largemouth Bass from Bluegill Sunfish, Mosquitofish, and Brook Silversides.

Area/Year	Predatory Largemouth Bass (mg/kg)	Forage Fishes		
		Bluegill Sunfish (mg/kg)	Mosquitofish (mg/kg)	Brook Silversides (mg/kg)
NE Basin 1991/1994	0.86	-	0.45	-
NE Basin 2001	0.70	-	0.46	-
SE Basin 2001	1.3	-	0.38	-
NW Basin 2001	1.5	-	0.47	-
Round Pond 2001	0.86	-	0.41	-
NE Basin 2008	1.5	0.70	-	0.9
SE Basin 2008	1.5	0.66	-	0.82
NW Basin 2008	1.5	0.68	-	0.82
SW Basin 2008	1.7	0.78	-	0.74

Concentrations in fish are whole-body concentrations in wet weight.

Derivation of Sediment RGs to Protect Predatory Fish

The OU-2 RGO report for development of remedial goals evaluated bioaccumulation of mercury from sediment to fish using three methods: power analysis, linear regression, and ratio estimators. Substituting the fish-tissue-residue RGs for mercury concentrations in either forage fish or predatory fish (y) into their respective bioaccumulation equations and solving for the sediment concentration (x), the mercury sediment RGs for protection of predatory fish range from 0.48 – 6.3 mg/kg (Table 5). Predatory fish are important, because they have higher concentrations of mercury and DDTR in their bodies by biomagnification.

Table 5. Range of Mercury Sediment RGs for Protection of Predatory Fish

	Bioaccumulation Equation (from RGO Document)	Target Fish Level (mg/kg wet wt.)	Sediment Level at Target Fish Level (mg/kg dry wt.)
Forage Fish			
Power Analysis	$y = 0.1646x^{0.3904}$	0.135	0.6
Linear Regression	$y = 0.0135x + 0.0786$	0.135	4.2
Ratio Estimator	$y = 0.0236x$	0.135	5.7
Predatory Fish			
Power Analysis	$y = 0.3642x^{0.3307}$	0.28	0.48
Linear Regression	$y = 0.0368x + 0.2297$	0.28	1.6
Ratio Estimator	$y = 0.0441x$	0.28	6.3

Notes: x = mercury concentration in sediment
y = mercury concentration in whole body fish tissue

An analysis of DDTR bioaccumulation in forage fish using a combined Olin and Ciba dataset (Table 6) shows that a simple bioaccumulation factor (BAF) of 1.1 can be derived by pairing sediment and forage fish tissue data from the areas of fish collection (Figure 2). This simple BAF can be used to back-calculate a sediment RG for protection of fish by dividing the fish-tissue-residue (in forage fish) RG of 0.23 mg/kg by the BAF of 1.1, yielding a sediment RG for protection of fish of 0.21 mg/kg DDTR in sediment (dry weight).

Table 6. Paired Forage Fish and Sediment Data Used to Derive DDTR BAF, Olin and Ciba Data

	Location	Gambusia/ Silversides	Silversides	Sediment	Area of Feature, acres
2008	Cypress Swamp Focus Area	21	--	43	
2010	Cypress Swamp Focus Area	1.7	--	2.3	20
2011	Cypress Swamp Focus Area	3.5	--	2.3	
2001	Round Pond	8.44	--	6.63	
2010	Round Pond	0.8	--	0.26	4
2011	Round Pond	0.7	--	0.26	
1994	Olin Basin	4.39	--	3.29	
2001	SE Olin Basin	1.31	--	1.27	
2001	NW Olin Basin	2.67	--	1.77	
2001	NE Olin basin	1.42	--	4.03	
2010	Olin Basin	1.14	1.14	0.46	76

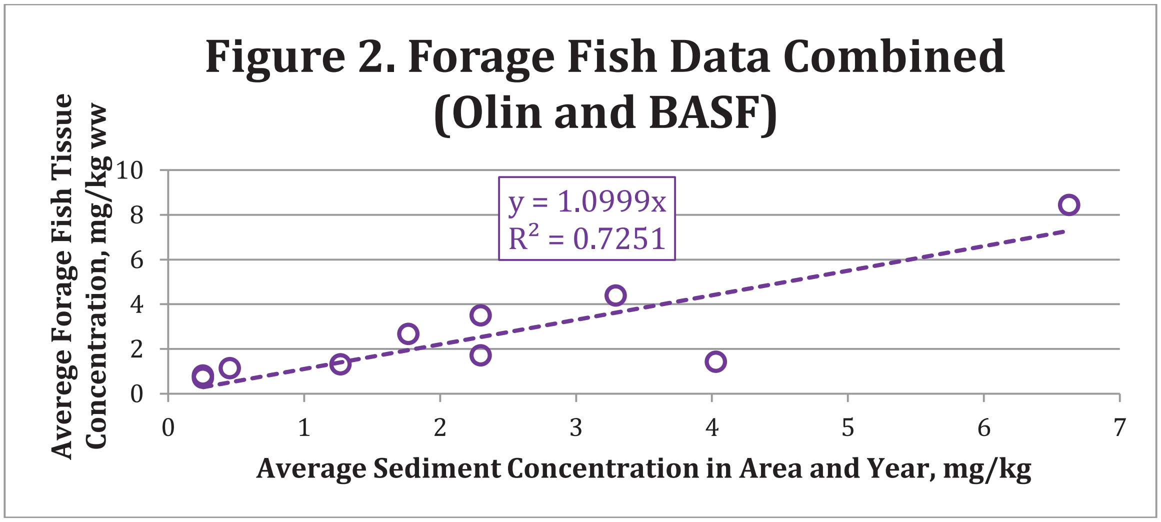


Figure 2. Derivation of Sediment to Forage Fish BAF for DDTR Using Combined Olin and Ciba Data.

Derivation of Sediment RGs to Meet Fish Fillet TBC Criteria

Sediment concentrations recommended to meet the human health "To Be Considered" criteria of 0.3 mg/kg mercury in fish fillets were calculated by converting mercury fillet concentrations to whole body concentrations, and back-calculating sediment goals using the bioaccumulation equations for predatory fish presented in the RGO document. Mercury concentrations in whole body bass average approximately 1.5 times higher than fillet concentrations, therefore 0.3 mg/kg in largemouth bass fillets is equivalent to 0.2 mg/kg in whole body bass. Based on the uncertainty in identifying fish exposure areas for largemouth bass, bioaccumulation into bass was calculated three ways (power analysis, linear regression, ratio estimators) using paired sediment and fish tissue data to arrive at a range of sediment concentrations required to meet the TBC concentration of 0.3 mg/kg. Equations for the three methods are detailed in Table 5 above. Based on the analysis, the recommended sediment RG range expected to meet the "To Be Considered" criteria of 0.3 mg/kg mercury in fish fillets is 0.16 to 4.5 mg/kg of mercury in sediment.

Changes to Floodplain-soil DDTR Remedial Goal for Insectivorous Birds

The RGO report derived RGs for floodplain soil based on risk to insectivorous birds, as represented by Carolina wren. Toxicity Reference Values (TRVs) used to derive RGs for the wren were selected from the information presented in the EPA Eco-SSL guidance for DDTR (EPA, 2007), and were the same TRVs used to derive RGs for piscivorus birds at OU-2. The TRVs selected for evaluation of piscivorous birds were based on analysis of data considering all toxicological endpoints, including egg-shell thinning. However, egg-shell thinning does not appear to be an important mechanism for reproductive impairment in terrestrial birds other than raptors, so use of this as a toxicological endpoint for RG development for terrestrial songbirds is not appropriate. The Eco-SSL NOAEL TRV of 0.227 mg/kg-d, which was used at OU-2 to derive the RG for piscivorous birds, was derived from Table 5.1 of the Eco-SSL guidance (EPA, 2007). The guidance procedure was to take the geometric mean of the NOAEL values, which was 4.66 mg/kg-d, and compare it with the lowest LOAEL value for survival, growth, or reproduction. The lowest LOAEL was 0.281 mg/kg-d from Carlisle et al. (1986) for eggshell thickness. The NOAEL of 0.227 mg/kg-d (Cecil *et al.* 1978) was selected as the highest NOAEL lower than the lowest LOAEL.

For terrestrial birds at OU-2, if eggshell thinning endpoints are not considered, then the lowest LOAEL less than 4.66 and NOT associated with an eggshell endpoint would be selected from Table 5.1 in the guidance. The first bounded reproduction study with a LOAEL less than 4.66 that did not have an eggshell endpoint, was Davison et al. 1976, who reported mortality in Japanese quail at a dose of 1.3 mg/kg-d. The NOAEL would then be selected as the highest NOAEL less than 1.3 mg/kg-d that was not an eggshell study. The study of mortality in the white-throated sparrow (Mahoney, 1975) reported a NOAEL of 1.04 mg/kg-d. Therefore, 1.04 mg/kg-d was selected as the NOAEL TRV for insectivorous terrestrial birds, and 1.3 mg/kg-d was selected as the LOAEL TRV for insectivorous terrestrial birds at OU-2.

Floodplain soil RGs for protection of the Carolina wren were revised based on use of the updated TRVs using the same equations presented in the RGO Report. Carolina wren was modeled in the RGO Report using current and historical insect and spider data in various combinations (see ROD Figure 23). The floodplain soil RGs for DDTR based on the geometric mean of the NOAEL and LOAEL ranged from 0.18 mg/kg – 1.12 mg/kg, depending on data used to represent the Carolina wren's diet. Preferred data for use in OU-2 floodplain is crawling insects and spiders. Based on the crawling insect and spider data, the recalculated NOAEL to LOAEL floodplain soil RG range was 0.49 mg/kg – 0.77 mg/kg with a geometric mean of 0.63 mg/kg. Therefore, 0.63 mg/kg in floodplain soil is the concentration selected as the RG for DDTR at OU-2 to protect the insectivorous bird.

Changes to DDTR RG for Piscivorous Birds whose Diet Includes Predatory Fish

The RGO document assumed that forage fish were the predominant exposure pathway to aquatic-dependent wildlife at OU-2. EPA raised the concern that DDTR can biomagnify in predatory fish. RGs designed to protect forage fish and wildlife that feed on smaller fish may not be sufficiently protective of predatory fish and the wildlife that feed on larger fish, such as the great blue heron, osprey, and bald eagle. DDTR is known to biomagnify in predatory fish at the top of the food chain. For greater mathematical precision, and to incorporate the diet of the great blue heron as including 35% predatory fish, EPA recalculated the sediment RG for great blue heron using the food chain ingestion assumptions exactly as presented in the OU-2 ecological risk assessment. Olin measured DDTR in fish tissue and sediment in 2010. At the time, this data was not available for inclusion in the risk assessment and RGO reports. Data pairings used to derive the largemouth bass BSAF, including the 2010 data, are shown in Table 7. The BSAF for DDTR accumulation in predatory fish uses the data for DDTR concentrations in largemouth bass collected in 1994, 2001, and 2010. In 1991 whole bodies of largemouth bass were analyzed for DDTr (i.e. 4,4’- congeners of DDD, DDE, and DDT). In 2001 filets and offal of largemouth bass were analyzed for DDTR. The concentration of DDTR in whole body fish was as reported in the RGO Support Sampling Report (URS Corp. 2002). In 2010, whole bodies and filets of largemouth bass were analyzed for DDTR. The whole body data is preferred for ecological risk assessments because the biota will utilize the entire fish in their diets. For DDTr a conversion based on the site-specific data was used to predict the DDTR concentration based on the ratios of DDTr to DDTR observed in sediment samples and fish tissue samples. The data for predatory fish tissue DDTR concentrations and sediment concentrations was paired up by year and by location within OU-2 (Table 7). Data from the Ciba site investigation was available for largemouth bass collected from within the Olin Basin in 1991. This data was obtained from Ciba’s BERA and included in Table 7 of the paired data for DDTR in predatory fish and sediment.

Average concentrations and lipid- and TOC-normalized concentrations were computed for generating the bioaccumulation plots for DDTR accumulation predatory fish. In 1991 the concentrations were measured as DDTr in both fish and sediment. Concentrations of DDTr were converted to DDTR in Table 8. The BSAF for DDTR accumulation into largemouth bass was estimated by the ratio method because the regression through the plot of lipid-normalized largemouth bass and TOC-normalized sediment produced an r^2 value of 0.3. The non-normalized data for DDTR accumulation in largemouth bass plotted with less scatter than the normalized sediment and tissue concentrations. The recommended BSAF of 5.0 was estimated as the average, average largemouth bass tissue concentration divided by the average, average sediment concentration among the sampling years and locations summarized in Table 8.

Table 7. Data Pairings for Derivation of Largemouth Bass BSAF

Location	Sediment Conc., mg/kg dw	Sediment Sample ID	TOC, mg/kg	TOC Sample	Tissue Conc., mg/kg ww	% Lipids	Tissue Sample ID
NE Basin	4.748	ODG0301-0694	16000	ODG0303-0694	8.76	1.66	OLE0108-0694
1994	5.283	ODG0302-0694	33300	SGG08-081391	11.75	5.9	OLE0105-0694
	6.178	ODG0303-0694	30900	SGG09-081091	14.3	6.38	OLE0107-0694
			29800	SGH08-081391	16.79	4.52	OLE0109-0694
			80500	SGI10-081391			
			39400	SGJ06-081391			
			36900	SGJ07-081391			
W Basin	0.494	SGJ06-081191	29800	SGH08-081391	15.47	1.33	LB-E1-02-WB-1191
1991	1.03	SGG09-080991	80500	SGI10-081391	20.66	0.67	LB-E1-03-WB-1191
	1.3	SGG08-081191	39400	SGJ06-081391			
	1.36	SGH08-081191	36900	SGJ07-081391			
	1.65	SGJ07-081191					
	2.16	SGI10-081191					
W Basin 1991, 1994	0.74	SGF07-081191	39000	SGC10-080991	76.7	7.85	OLE0103-0694
	1.46	SGC06-081191	28100	SGC06-081391	11.2	2.72	CIBA-LB-D1-1991
	1.59	SGD10-080891	43500	SGD10-080991	21.7	11.2	CIBA-LB-D2-1991
	1.64	SGC06DUP-081191	34800	SGD06-081391	30.7	5.58	CIBA-LB-D3-1991
	1.73	SGC10-080891	26900	SGF07-081391	24.3	5.93	CIBA-LB-D4-1991
	2.44	SGD06-081191			44.8	7.17	CIBA-LB-D5-1991
					44.3	9.23	CIBA-LB-D6-1991

Table 7 (continued). Data Pairings for Derivation of Large Mouth Bass BSAF

Location	Sediment Conc., mg/kg dw	Sediment Sample ID	TOC, mg/kg	TOC Sample	Tissue Conc., mg/kg ww	% Lipids	Tissue Sample ID
W Basin	0.494	SGJ06-081191	39000	SGC10-080991	7	4.67	LB-E3-25-WB-1191
1991, 1994	0.74	SGF07-081191	36500	SGC06DUP-081391	9.3	2.67	LB-E5-32-WB-1191
(Continued)	1.03	SGG09-080991	28100	SGC06-081391	14.2	6.67	LB-E5-30-WB-1191
	1.3	SGG08-081191	43500	SGD10-080991	20.4	2	LB-E6-34-WB-1191
	1.36	SGH08-081191	34800	SGD06-081391	21.2	N.A.	LB-E3-23-WB-1191
	1.46	SGC06-081191	26900	SGF07-081391	22.7	0.33	LB-E5-28-WB-1191
	1.59	SGD10-080891	16000	ODG0303-0694	27.5	1.33	LB-E3-21-WB-1191
	1.65	SGJ07-081191	33300	SGG08-081391	46.89	1.67	LB-G1-37-WB-1191
	1.73	SGC10-080891	30900	SGG09-081091			
	2.16	SGI10-081191	29800	SGH08-081391			
	2.44	SGD06-081191	80500	SGI10-081391			
	4.75	ODG0301-0694	39400	SGJ06-081391			
	5.28	ODG0302-0694	36900	SGJ07-081391			
	6.18	ODG0303-0694					
SW Basin	0.272	SGC05-081391	36500	SGC06DUP-081391	26.14	9.37	OLE0102-0694
1991, 1994	1.41	ODG0102-0694	28100	SGC06-081391			
	1.43	ODG0101-0694	34800	SGD06-081391			
	2.01	ODG0103-0694	4450	ODG0101-0694			
	1.46	SGC06-081191	16000	ODG0202-0694			
	1.64	SGC06DUP-081191					
	2.44	SGD06-081191					
Round Pond	5.86	ODG0502-0694	16000	ODG0404-0694	18.3	5.28	OLE0206-0694
1994	5.99	ODG0501-0694	16000	ODG0410-081894	19.67	7.09	OLE0201-0694
	7.14	ODG0503-0694	16000	ODG0505-0694	106.4	8.14	OLE0204-0694
			16000	ODG0511-081894			

Table 7 (continued). Data Pairings for Derivation of Large Mouth Bass BSAF

Location	Sediment Conc., mg/kg dw	Sediment Sample ID	TOC, mg/kg	TOC Sample	Tissue Conc., mg/kg ww	% Lipids	Tissue Sample ID
NE Basin	3.21	SE-B1-101101-01	84000	SE-B1-101101-01C	4.52	0.82	BF-B2-100101-01
2001	2.54	SE-B1-101101-02	140000	SE-B2-101101-01C	3.25	0.88	BF-B3-100101-01
	3.15	SE-B1-101101-03	170000	SE-B3-101101-01C	13.98	1.42	BF-B4-100101-01
	7.5	SE-B2-101101-01	130000	SE-B4-101101-01C	1.08	0.73	BF-B1-100101-01
	6.14	SE-B2-101101-02	12000	SE-H6-0901			
	5.16	SE-B2-101101-03	15000	SE-H8-0901			
	4.04	SE-B3-101101-01	24000	SE-I10-0901			
	5.18	SE-B3-101101-02	15000	SE-J6-0901			
	5.09	SE-B3-101101-03	17000	SE-B4-0901			
	4.55	SE-B4-101101-01					
	8.86	SE-B4-101101-02					
	5.98	SE-B4-101101-03					
	0.737	SE-H6-0901					
	0.63	SE-H8-0901					
	0.635	SE-I10-0901					
	1.078	SE-J6-0901					
NW Basin	0.32	SE-B10-101101-06	9400	SE-B5-0901	7.99	0.82	BF-B10-100201-01
2001	0.35	SE-C6-0901	65000	SE-B10-101101-01C	31.79	0.81	BF-B5-100201-01
	0.63	SE-B5-101101-01	32000	SE-B10-101101-04			
	0.78	SE-B10-101101-01	55000	SE-B5-101101-01C			
	1.01	SE-F7-0901	20000	SE-C6-0901			
	1.15	SE-B5-101101-03	29000	SE-D10-0901			
	1.17	SE-B10-101101-02	23000	SE-F7-0901			
	1.71	SE-B5-101101-02					
	1.91	SE-B10-101101-03					
	2.49	SE-B10-101101-04					
	2.98	SE-B10-101101-05					

	4.4	SE-D10-0901					

Table 7 (continued). Data Pairings for Derivation of Large Mouth Bass BSAF

Location	Sediment Conc., mg/kg dw	Sediment Sample ID	TOC, mg/kg	TOC Sample	Tissue Conc., mg/kg ww	% Lipids	Tissue Sample ID
SE Basin	0.0921	SE-G3-0901	3200	SE-G3-0901	14.37	1.01	BF-B6-100201-01-F
2001	0.57	SE-B6-101101-03	7300	SE-K4-0901			
	0.7	SE-B6-101101-06	10000	SE-K5-0901			
	0.7	SE-B6-101101-04	11000	SE-J3-0901			
	0.76	SE-B6-101101-01	14000	SE-H4-0901			
	0.77	SE-H4-0901	24000	SE-B6-101101-04			
	0.868	SE-B6-101101-02	28000	SE-H2-0901			
	1.14	SE-B6-101101-05					
	1.24	SE-K5-0901					
	1.696	SE-J3-0901					
	1.821	SE-H2-0901					
	3.48	SE-K4-0901					
Round Pond	10.18	SE-R1-101101-05	110000	SE-R1-101101-04	19.32	0.76	BF-R8-100201-01-F
2001	14.43	SE-R1-101101-06	120000	SE-R1-101101-01C	26.74	0.93	BF-R9-100201-01-F
	25.94	SE-R1-101101-04	25000	SE-R2-101101-01C	29.01	1.01	BF-R7-100201-01-F
			23000	SE-R7-101101-01C			

Table 7 (continued). Data Pairings for Derivation of Large Mouth Bass BSAF

Location	Sediment Conc., mg/kg dw	Sediment Sample ID	TOC, mg/kg	TOC Sample	Tissue Conc., mg/kg ww	% Lipids	Tissue Sample ID
N Basin	0.0763	OU2B-SED-103C-10	23400	OU2B-SED-103C-10	2.1861	1.5	MCI 0001-10-WB-NE
2010	0.0591	OU2B-SED-402C-10	25500	OU2B-SED-402C-10	1.6559	0.81	MCI 0002-10-WB-NE
					1.9815	0.92	MCI 0003-10-WB-NE
					2.4289	2.8	MCI 0004-10-WB-NE
					3.5657	2.0	MCI 0005-10-WB-NE
					2.2756	2.5	MCI 0006-10-WB-NE
					2.7505	3.2	MCI 0007-10-WB-NE
					3.5902	2.7	MCI 0008-10-WB-NE
					2.4834	2.3	MCI 0009-10-WB-NE
					3.844	5.5	MCI 0015-10-WB-NE
					0.6911	0.77	MCI 0022-10-WB-NW
					3.73	3.5	MCI 0023-10-WB-NW
					3.2596	5.3	MCI 0024-10-WB-NW
					3.215	2.4	MCI 0025-10-WB-NW
					4.102	4.8	MCI 0026-10-WB-NW
					5.114	4.6	MCI 0027-10-WB-NW
					4.883	6.3	MCI 0028-10-WB-NW
					39.179	4.6	MCI 0029-10-WB-NW
					9.846	3.0	MCI 0030-10-WB-NW

Table 7 (continued). Data Pairings for Derivation of Large Mouth Bass BSAF

Location	Sediment Conc., mg/kg dw	Sediment Sample ID	TOC, mg/kg	TOC Sample	Tissue Conc., mg/kg ww	% Lipids	Tissue Sample ID
S Basin	453.5	OU2B-SED-203DC-10	10900	OU2B-SED-203DC-10	1.2515	0.81	MCI 0043-10-WB-SW
2010	1231.4	OU2B-SED-303C-10	6980	OU2B-SED-303C-10	2.3571	1.8	MCI 0044-10-WB-SW
	458.8	OU2B-SED-DUP05C-10	7590	OU2B-SED-DUP05C-10	2.6183	3.8	MCI 0045-10-WB-SW
					2.1639	2.9	MCI 0046-10-WB-SW
					4.3586	5.5	MCI 0047-10-WB-SW
					3.7509	1.6	MCI 0048-10-WB-SW
					9.3606	6.9	MCI 0049-10-WB-SW
					4.066	4.9	MCI 0050-10-WB-SW
					4.383	7.4	MCI 0051-10-WB-SW
					4.4658	5.8	MCI 0052-10-WB-SW
					1.4861	1.5	MCI 0064-10-WB-SE
					0.7539	0.8	MCI 0065-10-WB-SE
					3.597	4.5	MCI 0066-10-WB-SE
					2.008	1.7	MCI 0067-10-WB-SE
					3.6704	6.1	MCI 0068-10-WB-SE
					1.5909	1.1	MCI 0069-10-WB-SE
					0.6714	0.53	MCI 0070-10-WB-SE
					3.5797	9.2	MCI 0071-10-WB-SE
					3.6847	4.8	MCI 0072-10-WB-SE
					2.856	2.6	MCI 0073-10-WB-SE

Table 8. Pairing Data for Estimating the Biota to Sediment Accumulation Factor for DDTR in Largemouth Bass with DDTR to DDTR Conversion.

Location/-Year	Average DDTr Sediment Concentration mg/kg	Average DDTR Sediment Concentratio nmg/kg[1]	Average DDTr Tissue Concentration in Whole Body, mg/kg wet weight	Average DDTR Tissue Concentration in Filet, mg/kg wet weight	Average DDTR Tissue Concentration in Whole Body, mg/kg wet weight[2]
NE Basin 1994	--	5.40	--	--	12.9
W Basin 1991	1.33	4.32	18.07	--	21.64
W Basin 1991, 1994	1.61	5.19	36.23	2.12	41.23
W Basin 1991, 1994 (Ciba Data)	2.25	4.88	21.15	4.75	25.34
SW Basin 1991, 1994	1.52	3.39	--	--	26.14
Round Pond 1994	--	6.33	--	--	48.12
NE Basin 2001	--	4.03	--	0.44	5.71
NW Basin 2001	--	3.21	--	0.72	19.89
SE Basin 2001	--	1.15	--	0.85	14.37
Round Pond 2001	--	10.1	--	2.10	25.02
N Basin 2010	--	0.0667	--	0.16	5.30
S Basin 2010	--	0.71	--	0.17	3.13

1 – Average DDTR concentration in sediment was estimated from the average DDTR concentration in sediment by multiplying by 3.24.
2 – Average DDTR concentration in whole-body largemouth bass tissue was estimated from the DDTr concentration in whole-body largemouth bass by multiplying by 1.20.

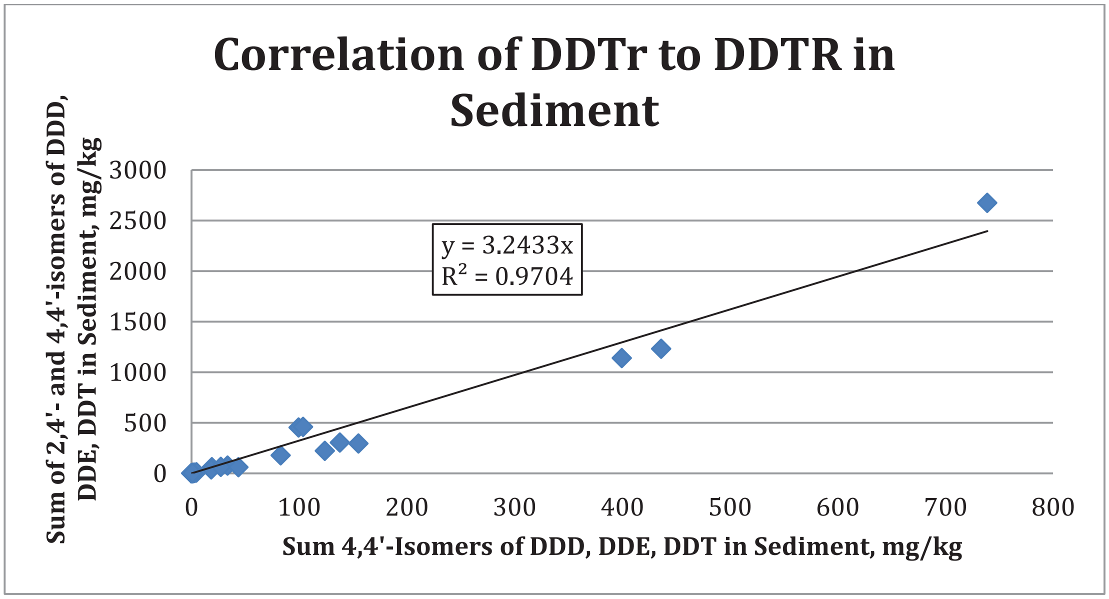


Figure 3. Correlation between DDTR and DDTr Concentrations in OU-2 sediment.

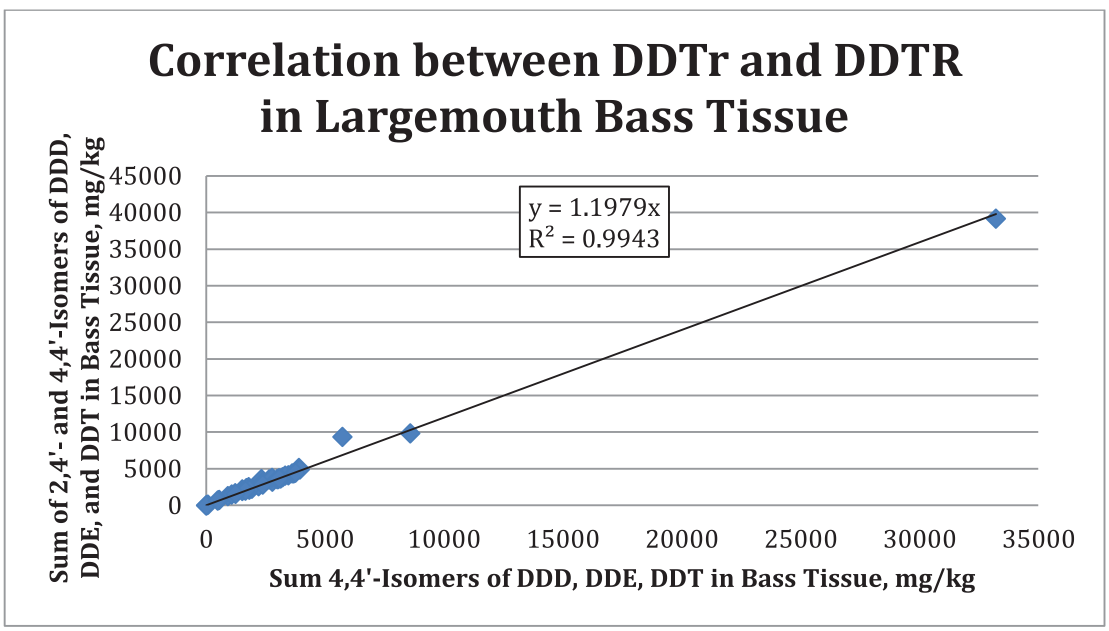


Figure 5. Correlation between DDTr and DDTR Concentrations in Largemouth Bass Tissue.

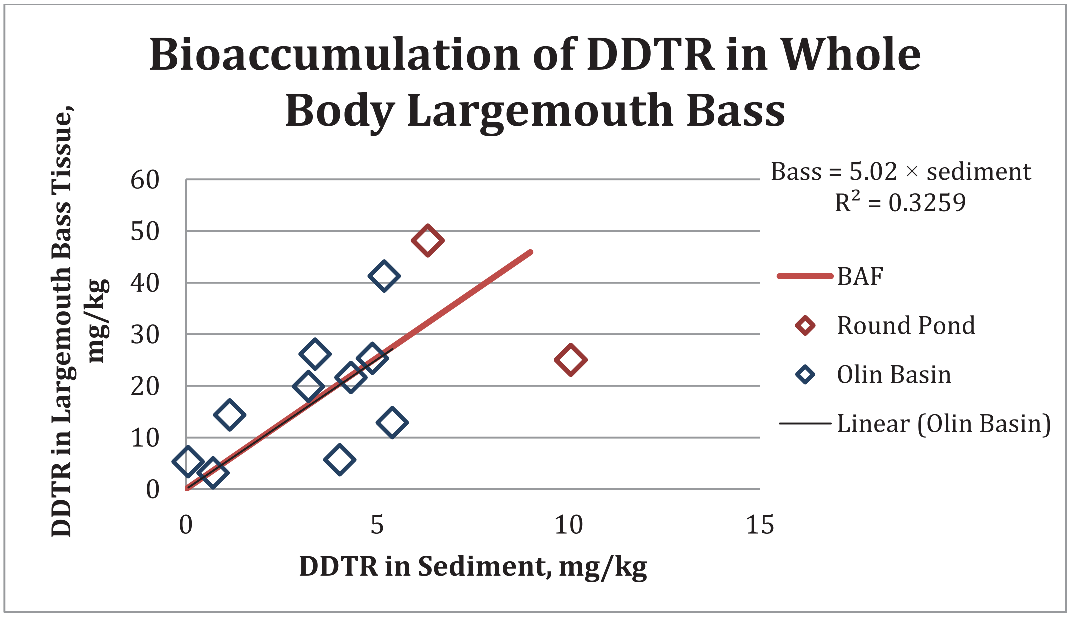


Figure 4. Bioaccumulation of DDTR in Largemouth Bass Showing the Biota-to-Sediment Accumulation Factor Estimated by the Ratio Method (solid red line).

Use of the largemouth bass BSAF together with the forage fish BSAF results in a sediment NOAEL remedial goal for great blue heron of 0.30 mg/kg, and a sediment LOAEL remedial goal of 0.35 mg/kg. These remedial goals are lower than the remedial goals for great blue heron calculated using forage fish alone.

Modification of DDTR RGs Based on OU-2 Total Organic Carbon (TOC) Concentrations

Remedial goals for DDTR were calculated based on site-specific bioaccumulation estimates obtained from sediment and fish tissue data in OU-2. Bioaccumulation rates for lipophilic organic contaminants such as DDTR are represented in the form of a BSAF, where sediment concentrations are normalized to TOC concentration, and fish tissue is normalized to lipid content. The equation for the normalized regression can be converted to an equation for non-normalized sediment concentrations by incorporating the average lipid content in the forage fish and the average TOC concentration in the sediment. This conversion was done in the RGO document to simplify the back-calculation of the DDTR concentration in sediment that is protective of fish-eating wildlife. The equation presented in the RGO document for bioaccumulation of DDTR in forage fish was:

$$y = 1.3305x^{0.9395},$$

where *y* is the tissue concentration and *x* is the sediment concentration. This equation assumed an average TOC in sediment of 5.5%, which is characteristic of the northern shorelines of the Olin Basin where forage fish were collected but was not representative of the Olin Basin and Round Pond as a whole. The average OU-2 wide concentration of TOC in the sediment was 2.24%. If the equation is recalculated using the OU-2 wide average TOC and lipid concentrations, the revised equation is:

$$y = 2.056x^{0.7252}$$

Thus, the sediment RG for DDTR at OU-2 is sensitive to the TOC concentration in the sediment. If lipid content is held constant, lower sediment TOC concentrations equate to a higher BSAF, and therefore a lower remedial goal. Since the RGO equation assumed an average TOC concentration that was more than twice the site-wide average, it is likely that the RG for DDTR would be lower in areas with lower TOC concentrations. At the very least, remedial alternatives should recognize the importance of TOC in achieving appropriate levels of risk reduction in OU-2.

The RGO document also assumed that forage fish were the predominant exposure pathway to aquatic-dependent wildlife at the site. EPA raised the concern that DDTR can biomagnify in predatory fish. A RG designed to protect forage fish and wildlife that feed on smaller fish may not be sufficiently protective of predatory fish and the wildlife that feed on larger fish, such as the great blue heron, osprey, and bald eagle. DDTR is known to biomagnify in predatory fish at the top of the food chain. For greater mathematical precision, and to incorporate the diet of the receptors as they appeared in the BERA (MACTEC 2010a) instead of using a short cut that focused on the forage fish portion of the diet as was done in the RGO document, EPA calculated RGs using the dietary compositions as reported in the BERA repeated here as (Table 9). To incorporate all dietary items, BSAFs were developed by EPA for DDTR accumulation in predatory fish, aquatic insects, crayfish, and frogs. Crayfish and frogs were lesser components of the diets and made generally made less difference to the calculations, which is why the RGO document did not include these. However, bioaccumulation estimates based on historical aquatic insect data showed relatively high bioaccumulation of DDTR into these organisms, which is potentially important to organisms such as little blue heron and pied-billed grebe, whose diets were assumed to be comprised of 25% or more aquatic insects.

Table 9. Dietary Fractions of Receptors used in Food-chain Model Calculations to Estimate RGOs.

Receptor	Fraction Aquatic Insects	Fraction Forage Fish	Fraction Predatory Fish	Fraction Crayfish	Fraction Frogs	Terr. Insect fraction
Pied-billed grebe	0.6	0.2	0	0.2	0	0
Belted kingfisher	0	1	0	0	0	0
Belted kingfisher Omnivore	0.19	0.51	0	0.05	0.25	0
Little blue heron	0.25	0.75	0	0	0	0
Great blue heron	0.05	0.5	0.35	0	0.1	0
Carolina wren	0	0	0	0	0	1

The BSAFs for DDTR accumulation in forage fish and terrestrial insects are the same as developed in the RGO document. Table 10 summarizes the BSAFs that were used in the food-chain models to develop the RGOs presented in this technical memorandum.

Table 10. Biota-to-Sediment Accumulation Factors Used in Remedial Goal Option Calculations.

Prey Item	Average Lipid Content, %	Normalized Regression Eqn.	Non-normalized Regression Equation*	Source
Forage Fish	3.78	$y = 3.4605x^{0.7252}$	$y = 2.056x^{0.7252}$	RGO Document
Predatory Fish (bass)	N.A.	N.A.	y = 5x	This document
Aquatic Insects	3.94	$y = 4.76x^{0.981}$	$y = 7.79x^{0.981}$	This document
Crayfish	N.A.	N.A.	y = 0.88x	This document
Frogs	1.60	y = 0.50x	y = 0.36x	This document
Terrestrial Insects	3.64	y = 1.46x to y=5.03x	y = 2.35x to y=8.08x	RGO Document

*If a normalized regression equation appears in the table, the non-normalized regression equation was computed assuming an average total organic carbon content for OU-2 of 2.24%.

The BSAF for DDTR accumulation in predatory fish was discussed in the previous section, using the data presented in Tables 7 and 8, and Figures 3, 4, and 5.

The bioaccumulation of DDTR in aquatic insects was developed by EPA because it was not included in the RGO Development Report (MACTEC 2010b). Aquatic insects were collected and analyzed for DDTR in 1994 and 2001 (Table 11). The average concentrations in aquatic insects normalized by lipids and TOC were plotted in Figure 6.

Frogs were analyzed for DDTR in 1994 (Table 12). Figure 7 shows the frog BSAF curve fit to normalized frog data. Because the plot of normalized frog data had an r^2 of 0.6 the BSAF for frogs was estimated by the ratio approach, which resulted in a normalized BSAF of 0.5 for DDTR accumulation in frogs. If the normalized BSAF for DDTR in frogs was adjusted by the average lipid content in frogs and the average TOC in sediments the non-normalized BSAF was approximated as 0.36.

Crayfish were collected in 1994 and analyzed for DDTr. Sediment data collected in 1994 for DDTr and 1991 sediment data, which was only analyzed for DDTr, was paired. Crayfish were collected from the west basin and from the Olin Ditch. The data for crayfish used the ratio method to estimate a BSAF for crayfish (Table 14). The BSAF for crayfish was calculated by the ratio method as the average of the average tissue concentrations of DDTr divided by the average of the average DDTr sediment concentrations. The estimated BSAF for DDTR in crayfish was estimated as 0.88 for DDTr by this approach.

Use of the expanded dietary compositions for each receptor together with the lower TOC concentration represented by the OU-2 wide average results in lower RGs compared to those derived in the RGO document (Table 15). However, EPA recognizes that there is uncertainty with the aquatic insect and crayfish BSAFs due to their small sample sizes. It is expected that remediation of sediments to the clean-up levels presented in Table 30 of the ROD will reduce average concentrations across OU-2 to a level where average exposures are less than even the conservative levels represented by the adjusted RGs presented in Table 15. Therefore, EPA is not specifying the adjusted RGs as clean-up levels for OU-2.

Table 11. Data Pairing for Evaluation of Bioaccumulation of DDTR in Aquatic Insects.

Location	Sediment Conc., mg/kg dw	Sediment Sample ID	Total Organic Carbon (TOC)	Fraction Organic Carbon	TOC Norm. Sediment Concentration (mg/kg TOC)	Tissue Conc., mg/kg ww	Tissue Sample ID	Fraction Lipids	Lipid Norm. Aquatic Insect Tissue Concentration (mg/kg lipid)
SE Basin AI-1	0.77	SE-B6-101101-01	25000	0.025	31.4	11.06	AI-1-060101	0.0466	237
	0.76	SE-B6-101101-02	24000	0.024	31.0	11.026	AI-1 (0700)-070201	0.051	216
	0.57	SE-B6-101101-03			23.3	10.71	AI-1 (0715)-070201	0.0528	203
	0.7	SE-B6-101101-04			28.6				
	1.14	SE-B6-101101-05			46.5				
	0.7	SE-B6-101101-06			28.6				
Averages	0.77				31.6	10.9			219
NE Basin	0.635	SE-I10-0901	24000	0.024	26.5	5.1	AI-2-060101	0.0417	122
AI-2	7.5	SE-B2-101101-01	140000	0.14	53.6	4.43	AI-2 (0800)-070201	0.0499	89
	6.14	SE-B2-101101-02			43.9	4.186	AI-2 (0815)-070201	0.038	110
	5.16	SE-B2-101101-03			36.9				

Averages	4.86				40.2	4.57			107

Table 11. Data Pairing for Evaluation of Bioaccumulation of DDTR in Aquatic Insects (Continued).

Location	Sediment Conc., mg/kg dw	Sediment Sample ID	Total Organic Carbon (TOC)	Fraction Organic Carbon	TOC Norm. Sediment Concentration (mg/kg TOC)	Tissue Conc., mg/kg ww	Tissue Sample ID	Fraction Lipids	Lipid Norm. Aquatic Insect Tissue Concentration (mg/kg lipid)
SW Basin AI-6	0.411	SE-B4-0901	17000	0.017	24.2	12.74	AI-6-060101	0.0369	345
						8.74	AI-6 (0915)-070201	0.0444	197
Averages	0.41				24.2	10.7			271
Round Pond AI-4	10.18	SE-R1-101101-01	120000	0.12	88.5	13.092	AI-4 (0900)-070201	0.0527	248
	20.55	SE-R1-101101-02	110000	0.11	178.7	17.69	AI-4-060101	0.0519	341
	13.79	SE-R1-101101-03		119.9					
	26.03	SE-R1-101101-04		226.3					
	10.28	SE-R1-101101-05		89.4					
	14.66	SE-R1-101101-06		127.5					
Averages	15.9				138.4	15.4			295

Table 11. Data Pairing for Evaluation of Bioaccumulation of DDTR in Aquatic Insects (Continued).

Location	Sediment Conc., mg/kg dw	Sediment Sample ID	Total Organic Carbon (TOC)	Fraction Organic Carbon	TOC Norm. Sediment Concentration (mg/kg TOC)	Tissue Conc., mg/kg ww	Tissue Sample ID	Fraction Lipids	Lipid Norm. Aquatic Insect Tissue Concentration (mg/kg lipid)
Round Pond AI-3	2.8	SE-R7-101101-01	23000	0.023	122	27.3	AI-3-060101	0.0436	626
	2.7	SE-R7-101101-02			117				
	2.2	SE-R7-101101-03			96				
	2.4	SE-R2-101101-01	25000	0.025	96				
	2.2	SE-R2-101101-02			88				
	3	SE-R2-101101-03			120				
	10.18	SE-R1-101101-01	120000	0.12	88.5				
	20.55	SE-R1-101101-02	110000	0.11	178.7				
	13.79	SE-R1-101101-03			119.9				
	26.03	SE-R1-101101-04			226.3				
	10.28	SE-R1-101101-05			89.4				
	14.66	SE-R1-101101-06			127.5				
Averages	9.75				122	27.3			626

Table 11. Data Pairing for Evaluation of Bioaccumulation of DDTR in Aquatic Insects (Continued).

Location	Sediment Conc., mg/kg dw	Sediment Sample ID	Total Organic Carbon (TOC)	Fraction Organic Carbon	TOC Norm. Sediment Concentration (mg/kg TOC)	Tissue Conc., mg/kg ww	Tissue Sample ID	Fraction Lipids	Lipid Norm. Aquatic Insect Tissue Concentration (mg/kg lipid)
Reference 1994	0.00101	RDG0201-0694	16000	0.16	0.0631	0.048	RIN0613-0794	0.0228	2.11
	0.00501	RDG0202-0694	16000	0.16	0.3131				
	0.003465	RDG0203-0694	16000	0.16	0.2166				
	0.003165	RDG0301-0694	16000	0.16	0.1978				
	0.003035	RDG0302-0694	985	0.0099	3.0812				
	0.001775	RDG0303-0694	9470	0.095	0.1874				
	0.00319	RDG0401-0694	5880	0.059	0.5425				
	0.00417	RDG0402-0694	3510	0.035	1.1880				
	0.00283	RDG0403-0694	13300	0.13	0.2128				
	0.00189	RDG0601-0694	16000	0.16	0.1181				
	0.00473	RDG0602-0694	8540	0.085	0.5539				
	0.00473	RDG0603-0694	11100	0.11	0.4261				
Averages	0.00325				0.592	0.048			2.11

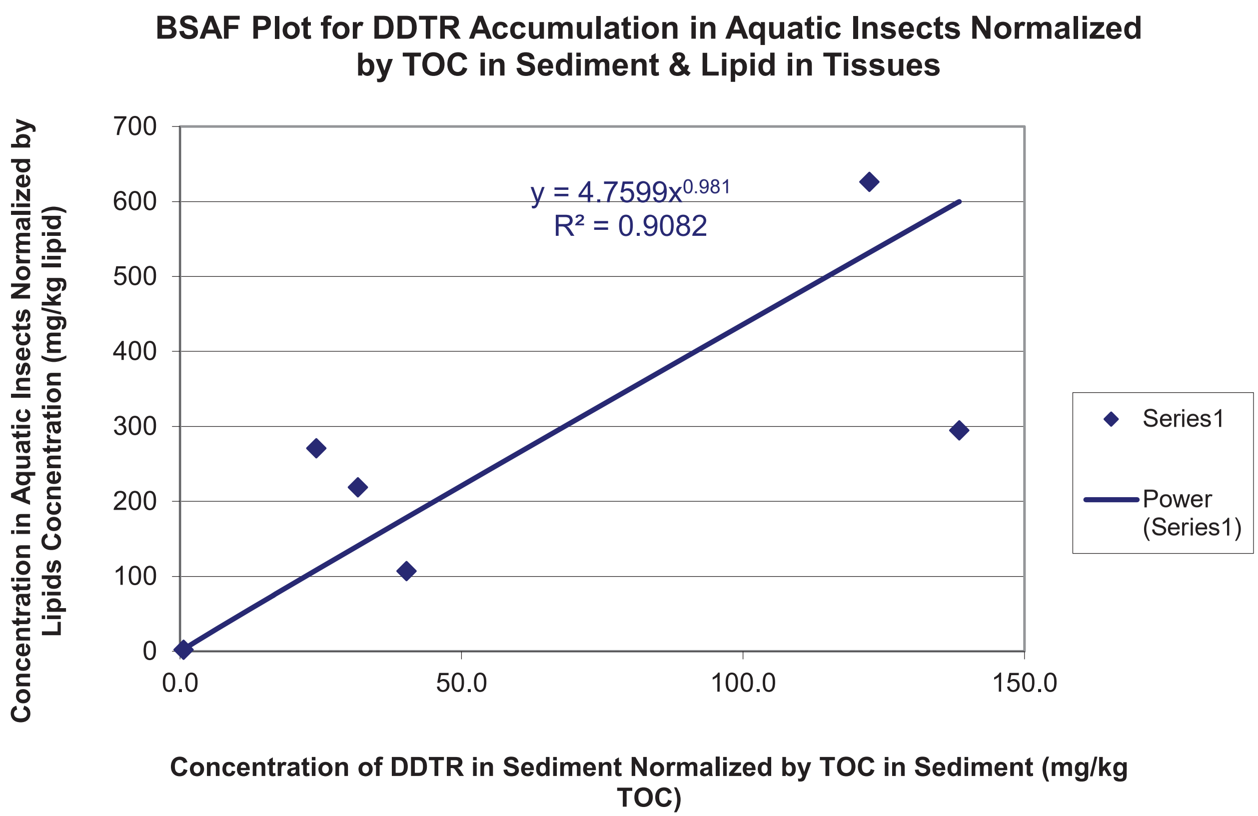


Figure 6. TOC and Lipid Normalized Bioaccumulation in Aquatic Insects.

Table 12. Data Pairing for Frog Samples.

Location	DDTR Sediment Conc., mg/kg dw	Sediment Sample ID	Total Organic Carbon (TOC), mg/kg	TOC Norm. Sediment Concentration (mg/kg TOC)	DDTR Tissue Conc., mg/kg ww	Tissue Sample ID	Percent Lipids	Norm. Aquatic Insect Tissue Concentration (mg/kg lipid)
NE Basin	0.635	SE-I10-0901	24000		0.54	OBFXX09-0894	2.95	18.31
1994	7.5	SE-B2-101101-01	140000		0.188	OBFXX08-0894	1.43	13.15
	6.14	SE-B2-101101-02						
	5.16	SE-B2-101101-03						
Averages	4.86		82000	59.25	0.364			15.73
NW Basin	1.59	SGD10-080891	43500		0.12	OBFXX12-0894	0.71	16.90
1994	1.73	SGC10-080891	39000		0.982	OBFXX11-0894	1.75	56.11
					1.166	OBFXX02-0794	1.74	67.01
					1.019	OBFXX10-0894	3.26	31.26
Averages	1.66		41250	40.24	0.82			42.82
SE Basin 1994	0.77	SE-B6-101101-01	25000		0.023	OBFXX07-0894	0.51	4.51
	0.76	SE-B6-101101-02	24000		0.402	OBFXX06-0894	2.27	17.71
	0.57	SE-B6-101101-03						
	0.7	SE-B6-101101-04						
	1.14	SE-B6-101101-05						
	0.7	SE-B6-101101-06						
Averages	0.77		24500	31.56	0.2125			11.11
Round Pond 1994	10.18	SE-R1-101101-01	120000		0.315	OBNXX01-0794	1.45	21.72
	20.55	SE-R1-101101-02	110000		0.4	OBFXX05-0794	1.44	27.78
	13.79	SE-R1-101101-03			2.785	OBFXX04-0794	1.55	179.68
	26.03	SE-R1-101101-04			0.307	OBFXX03-0794	0.99	31.01
	10.28	SE-R1-101101-05						
	14.66	SE-R1-101101-06						
Averages	15.91		115000	138.39	0.952			65.05

Table 13. Data Pairing and Normalization for Frog Tissue.

Location	Average DDTR Concentration in Sediment, mg/kg	Average DDTR Concentration in Frogs, mg/kg	Average TOC-Normalized Sediment Conc., mg/kg TOC	Average Lipid-Normalized Frog Tissue Conc., mg/kg-lipid
NE Basin	4.86	0.364	59.25	15.73
NW Basin	1.66	0.82	40.24	42.82
SE Basin	0.77	0.2125	31.56	11.11
Round Pond	15.91	0.95175	138.39	65.05

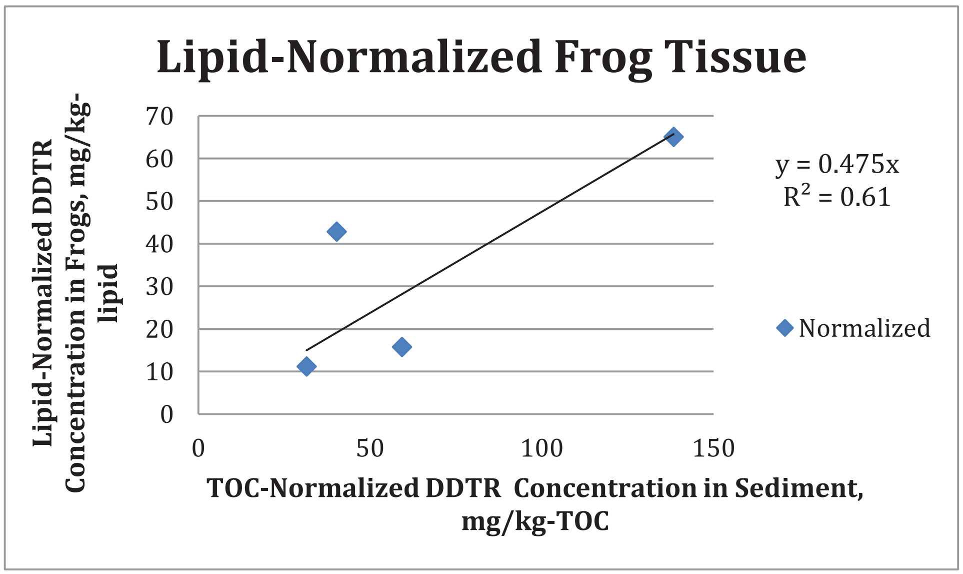


Figure 7. Lipid-normalized DDTr concentration in bullfrogs plotted against TOC-normalized DDTR concentration in sediment showing correlation coefficient.

Table 14 Data Pairing for Crayfish Tissues.

Location	DDTr Sediment Conc., mg/kg dw	Sediment Sample ID	Total Organic Carbon (TOC), mg/kg	TOC Norm. Sediment Concentration (mg/kg TOC)	DDTr Tissue Conc., mg/kg ww	Tissue Sample ID	Percent Lipids	Norm. Aquatic Insect Tissue Concentration (mg/kg lipid)
Wastewater Ditch 1994	0.73	SGBD05-082091	29400	24.83	0.969	OCS0102-0694	1.34	72.31
	0.304	SGBD06-082091	32700	9.30	0.425	OCS0103-0694	1.04	40.87
					0.437	OCS0103-0694 dup		
					0.494	OCS0104-0694	1.26	39.21
					0.688	OCS0105-0694	1.56	44.10
					1.637	OCS0106-0694	3.03	54.03
					0.522	OCS0107-0694	1.4	37.29
					1.161	OCS0108-0694	2.75	42.22
					1.448	OCS0109-0694	3.15	45.97
					0.548	OCS0110-0694	1.58	34.68
Averages	0.517			17.06	0.833			45.63
W Basin	1.73	SGC10-080891	39000	44.36	0.677	OCTXX01-0694	2.6	26.04
1994	1.46	SGC06-081191	28100	51.96				
	1.64	SGC06DUP-081191	36500	44.93				
	0.705	ODG0101-0694	4450	158.43				
	0.67	ODG0102-0694						
	0.986	ODG0103-0694						
Averages	1.20			47.08	0.677			26.04

Table 15. Summary of Sediment Remedial Goals for DDTR Assuming 2.24% Total Organic Carbon in Sediments and Comparing with RGO Document.

	RGO Document			This Document		
Receptor	NOAEL	LOAEL	Geometric Mean	NOAEL	LOAEL	Geometric Mean
Pied-billed grebe	0.37	1.2	0.66	0.096	0.12	0.11
Belted Kingfisher	0.69	1.2	0.91	0.105	0.14	0.12
Belted Kingfisher Omnivore Diet	0.28	0.38	0.33	0.111	0.144	0.13
Little Blue Heron	0.48	0.71	0.58	0.107	0.138	0.12
Great Blue Heron	1.3	2.1	1.7	0.265	0.337	0.30

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APPENDIX 2: STATE CONCURRENCE LETTER

LANCE R. LEFLEUR
DIRECTOR

ADEM

Alabama Department of Environmental Management
adem.alabama.gov
1400 Coliseum Blvd. 36110-2400 ■ Post Office Box 301463
Montgomery, Alabama 36130-1463
(334) 271-7700 ■ FAX (334) 271-7950

ROBERT J. BENTLEY
GOVERNOR

September 18, 2013

CERTIFIED MAIL # 91 7199 9991 7030 3429 6219

Ms. Beth Walden
Remedial Project Manager
U.S. Environmental Protection Agency
Atlanta Federal Center
61 Forsyth Street
Atlanta, GA 30303-8960

RE: ADEM Review and Concurrence:
Draft Record of Decision for OU2 dated September 2013

Dear Ms. Walden:

The Department has reviewed the draft submittal of the ROD for Olin Corporation's McIntosh facility. Based on our review, the Department concurs with the selected remedy, in-situ capping, with the following notifications:

1. The Department has concerns with the preliminary remedial goal (PRG) for the contaminant of concern (COC) DDTr. The value, outlined in the ROD, differs from the PRG currently established for portions of the floodplain previously designated as protective in OU-2. ADEM recommends establishing a consistent cleanup standard for the entire floodplain.

2. The proposed PRG for DDTr in the draft ROD for the Olin facility may not be appropriately calculated due to the use of the historical data applied to generate the remediation values. The use of historical data that does not account for remedial actions completed that improve the bioavailable concentration of DDTr may yield a remediation value that is not accurately calculated.

Please note that on September 16, 2013, the Department provided additional comments on the ROD electronically to address general grammatical concerns. If you have any questions concerning this matter, please contact Mrs. Sonja B Favors at 334-279-3067.

Sincerely,

Phillip D. Davis, Chief
Land Division

PDD/SBF/nbf

Birmingham Branch
110 Vulcan Road
Birmingham, AL 35209-4702
(205) 942-6168
(205) 941-1603 (FAX)

Decatur Branch
2715 Sandlin Road, S. W.
Decatur, AL 35603-1333
(256) 353-1713
(256) 340-9359 (FAX)

Mobile Branch
2204 Perimeter Road
Mobile, AL 36615-1131
(251) 450-3400
(251) 479-2593 (FAX)

Mobile-Coastal
4171 Commanders Drive
Mobile, AL 36615-1421
(251) 432-6533
(251) 432-6598 (FAX)

APPENDIX 3: RESPONSIVENESS SUMMARY

Table of Contents

Responsiveness Summary

INTRODUCTION

This responsiveness summary provides a summary of the significant comments and criticisms submitted by the public on the U.S. Environmental Protection Agency's (EPA's) May 2013 Proposed Plan for the Olin McIntosh Operable Unit 2 Superfund Site, and the EPA's responses to those comments and concerns. A responsiveness summary is required by the National Oil and Hazardous Substances Pollution Contingency Plan at 40 C.F.R. § 300.430(f)(3)(F). All comments summarized in this document have been considered in the EPA's final decision in the selection of a remedy to address the contamination at the Site.

SUMMARY OF COMMUNITY RELATIONS ACTIVITES

The May 2013 Proposed Plan, which identified the EPA's preferred remedy and the basis for that preference, including supporting analyses and information, was made available to the public in the administrative record file at the EPA Region 4 Records Center in its' Atlanta office, the McIntosh Town Hall, and an EPA Region 4 webpage.

The notice of availability of the above-referenced documents and the announcements of a public meeting date were published in the Washington County News and the Call News Newspapers on May 15 and 17, 2013, respectively. A news release announcing the Proposed Plan, which included the public meeting date and location was issued to various media outlets on the same dates. In addition, the EPA presented the schedule for the upcoming Proposed Plan and a brief description of the proposed remedy in a February 12, 2013 town hall meeting.

A public comment period was open from May 22, 2013 to June 21, 2013. The EPA's response to the comments received during this period is included in the

Responsiveness Summary, which is part of this Record of Decision.

On May 22, 2013, the EPA conducted a public meeting in the evening at the McIntosh Town Hall to inform local officials and interested citizens about the Superfund process, to review current and planned remedial activities at the Site, to discuss the Proposed Plan, and to listen to and respond to questions and comments from the area residents and interested parties. A total of less than 15 people attended the public meeting, including one resident, one media representative, representatives of Olin Corp. and BASF, and state officials.

OVERVIEW

The EPA's selected remedy includes, in-situ capping consisting of a multi-layered engineered cap. In habitat areas, the uppermost layers of the cap will be designed using suitable habitat materials. Reactive materials, containing sequestering materials, may be used to reduce the potential for contaminants to migrate through the cap. The institutional controls, including deed and use restrictions currently in place as a result of OU-1 will be amended to include the OU-2 remedial footprint; the engineering controls, including the berm and gate system, signs, fencing, and security monitoring, will be employed long enough to limit risks to human receptors. Long-term monitoring will include cap maintenance; topographic surveys; sediments samples, surface water and porewater monitoring; fish tissue and other biota monitoring. Because this alternative will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a CERCLA statutory review will be conducted every five years after the completion of the remediation to ensure that the remedy is, or will be, protective of human health and the environment. Additional sampling will be performed in the channel connecting Round Pond to the Basin and the perimeter floodplain soils that are often inundated; and the former wastewater and discharge ditch to further refine the remedial footprint.

While the public who commented, supported the preferred remedy, all of the public who commented, either disagreed or had concerns with the DDTR remedial goals for sediment, soil, and fish tissue.

SUMMARY OF COMMENTS AND RESPONSES

Three letters were received via U.S. mail during the comment period from May 22, 2013 to June 21, 2013. Copies of the comments letters are provided in Appendix 3. A copy of the comment letters received after the comment period ended is also provided as a separate attachment to this Record of Decision, see Appendix 3.2. The EPA in its discretion has decided to respond to them (to the extent that they comments are not already addressed in other comment response and where practicable) despite the fact that they were submitted after the comment period closed. A summary of the comments contained in the letters and the response to those comments are below.

A copy of the transcript from the public meeting is provided as an attachment to this Record of Decision and is available in the Administrative Record, which is available at the following information repositories:

McIntosh Town Hall

206 Commerce Street

McIntosh, AL 36553

(251) 944-2428

USEPA Region 4 Records Center

61 Forsyth Street

Atlanta, GA 30303

(404) 562-8946

Electronic documents are posted at the EPA Region 4 webpage:
http://www.epa.gov/region4/foiapgs/readingroom/index.htm

Commenters on the Proposed Plan included Olin Corporation, BASF Corporation, and Alabama Department of Environmental Management. Numerous comments were similar, and the comments were focused on a limited number of topics. In addition, it was recognized that the comments required comprehensive responses.
Rather than respond to each comment individually (which would have resulted in repetitive responses), or respond by referring back to the first comment /response on a particular topic (which would have resulted in undue emphasis on that first comment or response), comments were grouped into three subjects – 1) consistency with the Ciba Geigy OU-3 Superfund Site remedy which shares the same floodplain as the Olin OU-2 Superfund Site; 2) technical and scientific basis in developing the DDTR clean up levels and whether they can be achieved; 3) potential for recontamination of the in-situ cap. Many of these subjects are interrelated and readers are urged to review the Responsiveness Summary in its entirety. In addition, in a very limited number of cases a comment which seemed best suited to more than one category was included in other appropriate categories.

For ease of reading, the comments received are presented in normal text and the EPA's responses are in italics.

<u>Consistency with Ciba-Giegy OU-3 Remedy</u>:

Comments:

- **EPA management has consistently upheld the remedy chosen for the floodplain remediation and performance goal set for DDTr. (BASF)**
- **In the proposed plan for the Olin site, EPA has recommended a set of DDTR remedial goals for OU-2 that differ from BASF's OU-3 even within this overlapping area. This inconsistency is troubling given that the existing remedy not only was developed with input and approval from EPA,**

ADEM and the NRD trustees, but has proven to be successful and protective. (BASF)

- **The Department has concerns with the DDTR remedial goal because it differs from the remedial goal previously designated for portions of the floodplain. ADEM recommends a consistent cleanup standard. (ADEM)**

EPA Response:
The evaluation and analysis in both the Ciba and Olin ecological risk assessments concluded that the DDTR remedial goals for soils and sediments should be <1 mg/kg (ppm) in order to be protective of the environment and certain species effected by DDTR contamination. The 15 ppm cleanup level for DDTR in soils/sediments selected in the Ciba OU- 3 July 1995 ROD was a risk-management decision based not on the level determined to be protective (<1 mg/kg), but upon a concern that "…remediating to 1 ppm is not practical because this would require extensive excavation and destruction of the bottom land hardwood forrest and the cypress tuepelo swamp". The EPA also issued an ESD for the Ciba OU-3 in October of 2008. Though the cleanup level for DDTR was not changed, this ESD did require additional actions (placement of a sand cover in ecologically sensitive areas and monitoring with natural recovery). It was determined that an application of a sand cover could be performed in ecologically sensitive areas without destroying the habitat. The monitoring requires that, in addition to the 15 ppm DDTR sediment cleanup level, tissue concentrations in the mosquitofish (gambusia affinis) be used as a measure of protectiveness of piscivorous birds that feed on mosquitofish. A performance standard of 0.3-1.5 ppm DDTR in tissue is being used, but has not been achieved. It is still possible that additional remedial action, beyond natural recovery, will be necessary at Ciba OU-3.

One of the significant differences between the habitats at Olin OU-2 and Ciba OU-3 is that at Olin the habitat includes larger basins of open water which supports a more extensive fishery than at the Ciba Site. It is noteworthy that in 2010, fish samples were collected from the Olin Basin . The forage fish samples ranged from 0.878 to 1.82 *mg/kg in brook silversides and 0.557 to 5.46 mg/kg in bluegill; the predatory (largemouth bass) fish samples ranged from 0.674 to 39.2 mg/kg.*

Scientific and Technical Issues

Comment:

- **EPA has chosen to propose DDTR remedial goals for Olin's OU-2 that are so low they may be technically impracticable to achieve. (BASF)**

EPA Response:

Success indicated by the 2013 monitoring data at BASF has proven that caps containing organic carbon are capable of reducing surface sediment concentrations, sequestering contamination, and decreasing exposure to fish. The EPA has selected cleanup levels at other Sites for DDTR at or below the levels in the OU-2 ROD. Based upon experience in implementing those other remedial actions and anticipated successfulness of capping at the Olin, the EPA is confident that the DDTR cleanup level can be attained and over time the environment can be restored to a state protective of human health and the environment.

Comment:

- **BASF strongly believes that the Proposed Plan for the Olin OU-2, and specifically the proposed DDTr remedial goals, must be based on sound scientific and technical principles, and consistent with prior agency management decisions. The proposed DDTR remedial goals for Olin fall short of this mark. (BASF)**

EPA Response:

The preliminary remedial goals (PRGs) described in the FS and PP documents are based upon current technical and scientific literature and have a strong scientific backing as explained in both the Olin and Ciba ecological risk assessments. An explanation of the calculation of the remedial goals is presented in the Remedial Goal Option Report and in Appendix 1 to this ROD.

Comment:

- **The proposed PRG for DDTR may not be appropriately calculated due to the use of historical data applied to generate remediation values. (ADEM)**

EPA Response*:*

Remedial goals for DDTR for piscivorous birds were derived by Olin in the RGO report using forage fish tissue data and sediment data from 1994 and 2001. Sediment and fish tissue data from each of those years were paired to derive Biota-Sediment Accumulation Factors (BSAF) for DDTR. The RGO report utilized food chain dose equations from the ecological risk assessment to identify fish tissue concentrations that trigger risk to piscivorous birds and mammals. The BSAFs were then used to back-calculate sediment concentrations that through bioaccumulation result in fish tissue concentrations triggering risk. BSAFs are derived from regression equations of paired sediment and fish tissue data, in which sediment DDTR concentrations are normalized to organic carbon content, and fish tissue concentrations are normalized to lipid content. While DDTR concentrations in site sediment and fish tissue in OU-2 may have decreased since the data were originally collected, the BSAF, which defines the relationship between sediment and tissue concentrations, is not expected to vary significantly over time. Therefore, the remedial goal does not change over time. As sediment concentrations decrease, fish tissue concentrations decrease, but the relationship between sediment and fish tissue remains relatively constant, provided that there is reasonable certainty in the data pairings used to derive the BSAF. In addition, fish tissue data collected in 2010 and analyzed for DDTR subsequent to the RGO report confirm the BSAF relationship observed in the historical data. Refer to Appendix 1 in the ROD for details of how the preliminary remedial goals were calculated.

In summary, the BSAF represents the relationship between sediment and fish tissue concentrations. The BSAF is not expected to vary greatly over time. As sediment concentrations decrease, fish tissue concentrations decrease, but the relationship *between sediment and fish tissue remains relatively constant, provided that there is reasonable certainty in the data pairings used to derive the BSAF. Historical data from the Ciba BERA was added. The measurement of DDTr instead of DDTR in historical data was accounted for by the ratio observed in the data. Refer to Appendix 1 in the ROD for details of how the preliminary remedial goals were calculated.*

Ciba-Geigy as an Upgradient Source

Comments:

- **The DDTR PRG may not be achievable as a result of upgradient, background sources of DDTR at the Ciba-Geigy Superfund Site. (Olin)**
- **The DDTR PRG for forage fish may not be achievable because of potential migration of DDTR from the BASF facility. (Olin)**

EPA Response:

Based upon an evaluation consistent with Agency policy and guidance on determining background levels of contamination, the DDTR remedial goals are above background in the Mobile/Tensas River basin – by an order of magnitude. Data collected by BASF as part of the 2008 Ciba-OU-3 ESD indicated that the DDTr footprint in the sediments is stable and consistent with past investigations; natural recovery is occurring; sediment transport to the Tombigbee River is likely not occurring, and transport is minimal and localized within the ecologically sensitive areas that were not remediated in the initial cleanup phase conducted in1998.

Figure 1 in Appendix 1 shows that DDTR concentrations in Round Pond were 0.102 mg/kg in 2009. If contaminant migration were occurring from the property to the north, the DDTR concentrations in the northern portion of OU-2 would be in the parts per million range. Moreover, the DDTR concentrations in sediments in the northern portion of the Olin Basin have declined over time. The DDTR concentrations in sediments of the southern portion of the Olin Basin have shown a slower rate of decline. Any past or ongoing source of DDTR to the Olin Basin are diffuse in nature and are occurring at a lower concentration than the concentrations in the sediments on the Ciba-Geigy

Superfund Site. Hydrodynamic modeling indicated that the current velocities through the floodplain are insufficient to erode floodplain soils. The most recent sampling events in the Olin floodplain and Basin have shown that DDTR concentrations are in the ppb – well below the cleanup goal. There is no evidence of Ciba-contaminated sediments appreciably accumulating in the Basin under current conditions.

APPENDIX 3.1 – COMMENT LETTERS DURING PUBLIC COMMENT PERIOD

Olin
3855 North Ocoee Street, Suite 200, Cleveland, TN 37312
(423) 336-4600 FAX: (423) 336-4166

June 19, 2013

Ms. Beth Walden
Remedial Project Manager
U.S. Environmental Protection Agency
Atlanta Federal Center
61 Forsyth Avenue
Atlanta, Georgia 30303-8960

Re: **Submittal of Comments on the May 2013 USEPA Proposed Plan for Olin McIntosh Operable Unit 2**
McIntosh, Alabama

Dear Ms. Walden:

Olin Corporation (Olin) submits the attached comments on the May 2013 *Proposed Remedial Action Plan for the Olin McIntosh Operable Unit 2*, located in McIntosh, Alabama. Please let me know if you have any questions. I can be reached at (423) 336-4388 or via e-mail (kdroberts@olin.com).

Sincerely,

OLIN CORPORATION

Keith D Roberts

Keith D. Roberts
Director, Environmental Remediation

cc: C. A. Hunt – Olin
T. E. Stroth – Olin
L. D. O'Brien – Olin
C. E. Draper – AMEC

June 19, 2013

COMMENTS ON THE USEPA PROPOSED PLAN FOR
OLIN McINTOSH OPERABLE UNIT 2
Washington County, Alabama

1. USEPA's Proposed Plan for Olin McIntosh Operable Unit 2 (OU-2) recommends in-situ capping as the preferred alternative for remediation of sediments. Olin Corporation supports the selection of USEPA's preferred alternative as a cost effective remedy that will provide short and long term protectiveness of human health and the environment.

2. Page 6 – The DDTR preliminary remediation goal (PRG) for OU-2 sediments is stated as 0.33 to 1.7 mg/kg. The DDTR PRG for OU-2 floodplain soils is stated as 0.039 to 0.25 mg/kg. These PRGs for sediment and soil may not be achievable as a result of upgradient, background sources of DDTR at the Ciba-Geigy Superfund site immediately north of OU-2. DDTR concentrations at the Ciba-Geigy Superfund site of 1 to 3 mg/kg did not require remediation. The OU-2 sediment and soil PRGs should be revised to be consistent with upgradient, background conditions of 1 to 3 mg/kg that may migrate from the Ciba-Geigy Superfund site. Olin recommends that USEPA revise the sediment and soil DDTR PRGs to range from 1 to 3 mg/kg.

3. Page 6 – The DDTR PRG for forage fish tissue proposed by USEPA is 0.64 mg/kg. This goal may not be achievable because of potential migration of DDTR from the BASF facility immediately north of OU-2. Olin recommends a range of DDTR from 1.05 to 2.33 mg/kg in forage fish tissue which is consistent with the biota-sediment accumulation relation with upgradient, background soil concentrations of DDTR of 1 to 3 mg/kg. The DDTR fish tissue PRG of 0.64 mg/kg for OU-2 is also not consistent with the Ciba-Geigy Remedial Goal of 1.5 mg/kg.

4. Page 6 – A PRG of 0.64 for DDTR in forage fish tissue proposed by USEPA is based on a summary paper (Beckvar, et al., 2005) that uses fish species that are not native to the southeastern United States. The PRG should be revised using species that are expected to occur at OU-2, be consistent with background DDTR contributions, and be consistent with the Remedial Goal for the upgradient Ciba-Geigy Superfund site. Olin recommends a forage fish tissue remedial goal of 1.05 to 2.33 mg/kg and a soil/sediment remedial goal of 1 to 3 mg/kg to be consistent with upgradient, background conditions.

5. Page 6 – USEPA provides a Remedial Action Objective for restoration of surface water to meet water quality standards. The ambient water quality criterion (AWQC) for mercury is 0.012 µg/L. Olin notes that compliance with the surface water AWQC will be applied to filtered surface water at the point of discharge at the gate. The USEPA-approved Feasibility Study (FS) for OU-2 indicates that the confirmation point for this RAO is at the gate overflow. Overflow at the gate is representative of exposure concentrations within OU-2; it also represents the quality of water exiting OU-2.

6. Page 13 – Olin acknowledges USEPA's position on designating OU-2 sediments as "not readily classifiable as principle threat wastes". However, it is Olin's position that the mercury in sediment at OU-2 is a low level threat waste for the following reasons.

   - OU-2 sediment containing mercury can be reliably contained via an in-situ cap.
   - OU-2 sediment presents a low risk in the event of a release.
   - OU-2 sediment exhibits low mobility.
   - OU-2 sediment is near health-based levels.

   A more detailed explanation for classification of the sediments at OU-2 as a low level threat waste was submitted to USEPA in a letter dated August 24, 2012.

7. Page 13 – Olin concurs with USEPA's decision to determine the selected cap materials, cap thickness, and the potential use of reactive materials during the remedial design.

References:

Beckvar, N., T.M. Dillon, and L.B. Read, 2005. *Approaches for linking whole-body fish tissue residues of mercury or DDT to biological effects thresholds.* Environ Toxicol Chem. 24(8): 2094-2105.

BASF
The Chemical Company

June 20, 2013

Via Certified and Electronic Mail
Ms. Beth Walden
Superfund Remedial Branch
U.S. Environmental Protection Agency
61 Forsyth Street
Atlanta, Georgia 30303

RE: Comments to Proposed Plan for Olin McIntosh Operable Unit 2

Dear Ms. Walden:

BASF Corporation submits the following comments to the U.S. Environmental Protection Agency's (EPA) Proposed Plan for Olin McIntosh's Operable Unit 2 (OU-2). Specifically, BASF opposes the proposed remedial goals for DDTr in OU-2.

BASF operates at the property adjacent and to the north of the Olin McIntosh site. Under the oversight of EPA and the Alabama Department of Environmental Management (ADEM), BASF has been performing DDTr remediation work in the floodplain (BASF OU-3) since 1995. The OU-3 remediation includes activities on both BASF and Olin floodplain property. Beginning with the original Record of Decision through three consecutive 5-year reviews, EPA management has consistently upheld the remedy chosen for the floodplain remediation and the performance goal set for DDTr.

Over forty percent (approximately 89 acres) of Olin's OU-2 overlaps with BASF's OU-3. Consistency in addressing DDTr is therefore necessary and critical to achieving a sound remedy. However, in the Proposed Plan for the Olin site, EPA has recommended a set of DDTr remedial goals for OU-2 that differ from BASF's OU-3 even within this overlapping area. This inconsistency is troubling given that the existing remedy not only was developed with input and approval from EPA, ADEM, and the NRD trustees, but has proven to be successful and protective.

In addition, the Olin goals appear not to consider DDTr data collected during the process of BASF's remediation. Instead, EPA has chosen to propose DDTr remedial goals for Olin's OU-2 that are so low they may be technically impracticable to achieve.

In closing, the protection of health, safety and the environment is BASF's most important responsibility. We care about our employees and we care about the communities in which we operate. For this reason, BASF strongly believes that the Proposed Plan for the Olin McIntosh Operable Unit 2, and specifically the proposed DDTr remedial goals, must be

BASF Corporation
227 Oak Ridge Parkway
Toms River, NJ 08755
Tel. 732.914.2542
Steve.havlik@basf.com

BASF
The Chemical Company

Ms. Beth Walden, USEPA
June 20, 2013
Page 2

based on sound scientific and technical principles, and consistent with prior agency management decisions. The proposed DDTr remedial goals for Olin fall short of this mark.

BASF appreciates the opportunity to provide these comments. In addition, BASF requests a meeting with EPA to discuss this letter. We will be in contact with the agency shortly to schedule such meeting.

Sincerely,

Stephen K. Havlik
Senior Remediation Specialist

CC: Franklin Hill (USEPA)
Richard Campbell (USEPA)
Carol Monell (USEPA)
Charles King (USEPA)
Sonja Favors (ADEM)

BASF Corporation
227 Oak Ridge Parkway
Toms River, NJ 08755
Tel. 732.914.2542
Steve.havlik@basf.com

3855 North Ocoee Street, Suite 200, Cleveland, TN 37312
(423) 336-4600 FAX: (423) 336-4166

June 19, 2013

Ms. Beth Walden
Remedial Project Manager
U.S. Environmental Protection Agency
Atlanta Federal Center
61 Forsyth Avenue
Atlanta, Georgia 30303-8960

Re: **Submittal of DDTR in Abiotic and Biotic Media**
McIntosh, Alabama

Dear Ms. Walden:

Olin Corporation (Olin) herein submits *DDTR in Abiotic and Biotic Media*, for the Olin McIntosh Plant Operable Unit 2 (OU-2), located in McIntosh, Alabama. This document summarizes DDT concentrations over time at OU-2 and describes how preliminary remediation goals (PRGs) were calculated for sediment, soil, and fish tissue. Analytical results and PRG calculation methods are based on the information provided in the Remedial Investigation Addendum (AMEC, 2011a), the Updated Ecological Risk Assessment (ERA; AMEC, 2011b), and the Remedial Goal Options (RGO) report (AMEC, 2012) for OU-2. This document also provides recommendations for PRGs.

Please let me know if you have any questions. I can be reached at (423) 336-4388 or via e-mail (kdroberts@olin.com).

Sincerely,

OLIN CORPORATION

Keith D Roberts

Keith D. Roberts
Director, Environmental Remediation

cc: S. Favors – ADEM
C. A. Hunt – Olin
T. E. Stroth – Olin
L. D. O'Brien – Olin
C. E. Draper – AMEC

June 19, 2013

OLIN MCINTOSH OPERABLE UNIT 2 (OU-2)
DDTR IN ABIOTIC AND BIOTIC MEDIA

The purpose of this document is to present changes in DDT concentrations over time at Olin McIntosh OU-2 and describe how preliminary remediation goals (PRGs) were calculated for sediment, soil, and fish tissue. Analytical results and PRG calculation methods are based on the information provided in the Remedial Investigation (RI) Addendum (AMEC, 2011a), the Updated Ecological Risk Assessment (ERA; AMEC, 2011b), and the Remedial Goal Options (RGO) report (AMEC, 2012). This document also provides recommendations for PRGs.

DDT concentrations are reported as DDTr or DDTR. DDTr is a combination of the 4,4'-isomers of DDT, DDE, and DDD. DDTr was analyzed in 1991 as part of the RI and in 2008. DDTR, which is the total of the 2,4'- and 4,4'-isomers of DDD, DDE, and DDT, was analyzed in subsequent investigations in the 1990s, and in 2001 and 2009. The presence of DDTR is likely a result of indirect discharges from the Ciba-Geigy Corporation (McIntosh Plant) Superfund site, (currently BASF property) located immediately north of OU-2. Olin did not manufacture DDT or intermediate daughter products associated with DDTR.

DDTR CONCENTRATIONS AT OU-2 SEDIMENT, SOILS, AND WATER

Sediment

DDTr/DDTR concentrations in surficial sediment (0" to 6") are presented in Table 1A and Figure 1. Figure 1 also provides non-surficial sediment core data.

1991/1994: DDTr was analyzed in surficial sediment collected in 1991 and 1994. The 1991 and 1994 DDTr concentrations ranged from 0.272 to 63.5 milligrams per kilogram (mg/kg). Generally, higher DDTr concentrations were detected in Round Pond. DDTr concentrations decreased from north to south for these early RI data. DDTR ranged from 0.536 to 177 mg/kg based on the known ratio of DDTr to DDTR. A 95% upper confidence limit (UCL) of 5.84 mg/kg was estimated for surficial sediment in the Basin and >177 mg/kg in Round Pond.

2001: DDTR concentrations ranged from 0.0893 to 64.8 mg/kg in the Basin and 2.20 to 26.0 mg/kg in Round Pond. The 95% UCL was 6.14 mg/kg for surficial sediment in the Basin and 19.5 mg/kg in Round Pond. Generally, higher concentrations were detected in Round Pond and concentrations decreased from north to south.

2008/2009: DDTR concentrations ranged from 0.0144 to 2.72 mg/kg in surficial sediment in 2008/2009 in the Basin and from 0.117 to 0.226 mg/kg for the one location sampled in Round Pond in 2008 and 2009. The DDTR concentrations in OU-2 decreased notably from 1991 to 2008/2009. The higher concentrations of DDTr/DDTR were detected in the southern portion of the Basin in 2008 and 2009. This distribution represents a change from the DDTr distribution in 1991 and 2001. The current distribution of DDTR in sediment is depicted in Figure 2.

Floodplain Soils

DDTr/DDTR concentrations in floodplain soils are presented in Table 1B.

1994/2001: DDTR concentrations ranged from 0.739 to 155 mg/kg with a 95% UCL of >155 mg/kg in 1994 based on 8 samples and a result of 15.1 mg/kg in 2001 for the one sample location.

2010: DDTR was collected from locations throughout the OU-2 floodplain in 2010. DDTR concentrations in surficial floodplain soils ranged from 0.00375 to 2.23 mg/kg with a 95% UCL of 1.2 mg/kg. Concentrations decreased from north to south, with the highest concentrations in the northwest portion of the floodplain, immediately adjacent to Ciba-Geigy Corporation (McIntosh Plant) Superfund site. DDTR concentrations in the northwest are notably higher than those in the eastern and southern portion of the floodplain. DDTR floodplain soil data from 2010 are presented in Figure 3.

Surface Water and Groundwater

DDTR was not detected in surface water collected from OU-2 in 1991. It was also not detected in groundwater in 2008. DDTR is not a constituent of concern in surface water or groundwater.

DDTR CONCENTRATIONS AT OU-2 IN FISH TISSUE

Fish species present at OU-2 can be divided into two categories based on their function in the ecosystem: forage fish and predatory fish.

Forage Fish

DDTR whole body concentrations in forage fish are presented in Table 2. This table lists the DDTR concentrations in mosquitofish (*Gambusia affinis*) collected in 2001 and brook silversides (*Labidesthes sicculus*) and bluegill (*Lepomis macrochirus*) collected in 2010. Mosquitofish concentrations were higher in Round Pond than in the Basin during the 2001 sample collection. Fish tissue collection was based on the available fish species at the time of collection. DDTR in the 2010 forage fish samples ranged from 0.878 to 1.82 mg/kg in brook silversides and 0.557 to 5.46 mg/kg in bluegill.

Predatory Fish

Predatory fish at OU-2 are represented by largemouth bass (*Micropterus salmoides*). Largemouth bass DDTR tissue concentrations are presented in Table 3. Largemouth bass filet concentrations ranged from 0.15 to 2.76 mg/kg. The DDTR mean in the Basin was 0.741 mg/kg and DDTR mean in Round Pond was 2.22 mg/kg in 2001. Largemouth bass filet concentrations ranged from 0.094 to 0.367 mg/kg with a mean of 0.166 mg/kg in 2010 in the Basin, a decrease since 2001. Largemouth bass whole body concentrations ranged from 0.674 to 39.2 mg/kg with a mean of 4.2 mg/kg in 2010 in the Basin. Forage fish and predatory fish were not collected in Round Pond in 2010 due to low water levels. Comparisons cannot be made for DDTR from 2001 to 2010 for Round Pond, as a result.

June 19, 2013

SEDIMENT DDTR PRG CALCULATION USING BSAF AND RATIO METHODS

Sediment BSAF/Ratio Methods

Aquatic insect and forage fish consumption was identified as the ecological risk driver for DDTR for the little blue heron, belted kingfisher, and pied-billed grebe. The dietary composition of the little blue heron, belted kingfisher, and pied-billed grebe includes a substantial component of forage fish and aquatic insects. Preliminary remediation goals (PRGs) were calculated for DDTR at OU-2 using the biota-sediment accumulation factor (BSAF) method.

DDTR is a lipophilic compound. The reported fish tissue DDTR concentrations were lipid-normalized by dividing the reported DDTR concentrations by the fraction of lipids for each sample. Sediment DDTR concentrations were also normalized by dividing the reported DDTR concentrations by the average fraction of organic carbon (FOC) for the sediment samples.

Data pairing of fish and sediment samples is the first step in BSAF development. Guidance in calculating the BSAF recommends that sediment samples across a typical foraging range be collected and analyzed, and that the sediment samples should be representative of the organism's immediate life history (Burkhard, 2009). Thus, appropriate tissue and sediment sample pairs are collected within a narrow timeframe (i.e., the same year). The use of sediment and tissue data across multiple years includes a time lapse between the exposed tissue and the medium in which the tissue was exposed. Fish may have also lived in various areas of the Basin during different life stages (i.e., juvenile vs. adult). Inclusion of data across multiple years increases the uncertainty associated with the data pairing. The data pairings used for the PRG development were generally for sediment and fish tissue samples collected within the same year, with the exception of including 1991 data with the 1994 data. This deviation in the general data pairing methodology was made because the coefficient of determination (R^2) values obtained during linear regression analysis increased with inclusion of the older sediment data. Paired observations in each dataset were made by matching fish samples either with collocated sediment samples or with sediment samples within a typical home range for each fish type. The data pairings are summarized below:

- Pairing 1991 and 1994 sediment with fish collected in 1991 and 1994
- Pairing 2001 sediments with fish collected in 2001
- Pairing 2008 sediments with fish collected in 2008

Analytical results for sediments within the foraging range of the organism were averaged in the data pairings to determine a representative concentration. Sediment core samples in the 0 to 6 inch depth interval were treated as individual samples when averaging sediments at a location. Analytical results for fish tissue were averaged within a sample station if multiple samples were collected from a single location or area within the same year.

Predatory fish home ranges were assumed to be a quadrant of the Basin or the entirety of Round Pond. Forage fish home ranges were assumed to be a circle with a radius of 400 feet and centered on a sample station (AMEC, 2012). The 400-foot-radius circle was selected because it provided coverage in all directions and accounted for the uncertainty associated with the fish sample collection area in relation to the overall home range. All sediment data from

Round Pond were paired with the forage fish data in Round Pond instead of using a 400-foot radius.

Sediments in each reference area were averaged to generate one representative concentration for the reference sediments. The average sediment concentration was paired with the average fish concentration for each reference area to generate one data point for each reference area. The reference areas were limited to one data pairing so that the OU-2 BSAF analysis would be representative of conditions in OU-2, rather than areas outside OU-2.

PRGs were also calculated using the ratio method. PRGs were calculated by dividing the average fish tissue concentration by the average sediment concentration. Home ranges were not considered in the ratio method. The results of the BSAF and ratio analysis indicated that the BSAF method was more appropriate than the ratio method for calculating sediment PRGs for OU-2 (AMEC, 2012).

Sediment PRG Analysis

The DDTR sediment-fish data pairs were plotted in Microsoft® Excel. Average sediment concentrations were plotted along the x-axis, and the associated average fish concentrations were plotted along the y-axis. A regression trend line, a R^2 value, and a p-value were calculated by Excel and placed on each graph. The goal was to find a model equation with an R^2 value greater than 0.7 and a p-value less than 0.05. Multiple regression models were generated for DDTR in forage fish. Separate regression analyses were conducted for DDTR in forage fish using normalized and non-normalized data. The R^2 values ranged from 0.44 to 0.78 with p-values ranging from 0.0001 to 0.02 for DDTR in sediment. Regression results which produced R^2 and p-values that met the goals were carried forward in the PRG calculation process.

Normalization of the data resulted in higher R^2 values and lower p-values than use of the non-normalized data. The power curve generated from the normalized data was the only DDTR regression equation that met the USEPA R^2 goal of 0.7 with a R^2 of 0.78 and an acceptable p-value of 0.0001. The power equation using normalized data was the only model included in the DDTR PRG development. The linear model and the non-normalized data model did not meet the USEPA R^2 goal of 0.7. The use of a regression equation for normalized DDTR requires that fish data be normalized using the average lipid fraction for all samples, and the resulting sediment concentrations be de-normalized. De-normalization of sediments was accomplished by multiplying the normalized sediment concentration by the average FOC of all samples.

The ratio method was also used to calculate DDTR PRGs to provide a range of sediment PRGs for each receptor. The ratio method is not dependent on R^2 values or p-values, and can be used for PRG development when regression analysis does not indicate a strong correlation between the sediment and tissue data (as is indicated by R^2 values less than 0.7 and p-values greater than 0.05). R^2 values and p-values for the ratio method were not generated because the meaning of these two statistical terms for best fit lines is not equivalent to the meaning of these two terms for the ratio method. The ratio method was not carried forward in the PRG development for DDTR in sediment because the power model in the BSAF regression analysis met the USEPA goal for the R^2 and p values.

Sediment PRGs

The range of DDTR PRGs developed to be protective of ecological receptors ingesting forage fish in OU-2 is summarized below. This PRG range comprises the NOAEL- to LOAEL-based risks for DDTR in sediment. The PRGs based on the geometric mean of the NOAEL- and LOAEL-based risks for DDTR in sediment are also discussed below.

DDTR Sediment PRGs Protective of Ecological Receptors Ingesting Forage Fish (Figure 4):

- 0.69 mg/kg dw (NOAEL) to 1.19 mg/kg dw (LOAEL) for the belted kingfisher (RME; assuming a diet consisting of fish and other dietary items and an area use factor of 50%);
- 0.28 mg/kg dw (NOAEL) to 0.38 mg/kg dw (LOAEL) for the belted kingfisher (assuming a highly conservative diet of 100% fish and an area use factor of 100%);
- 0.37 mg/kg dw (NOAEL) to 1.2 mg/kg dw (LOAEL) for the pied-billed grebe;
- 0.48 mg/kg dw (NOAEL) to 0.71 mg/kg dw (LOAEL) for the little blue heron; and
- 1.33 mg/kg dw (NOAEL) to 2.07 mg/kg dw (LOAEL) for the great blue heron.

The belted kingfisher and the little blue heron are the most sensitive receptors to DDTR in sediments. The geometric mean DDTR sediment PRGs are as follows:

- 0.91 mg/kg dw for the belted kingfisher (RME; assuming a diet consisting of fish and other dietary items and an area use factor of 50%):
- 0.33 mg/kg dw for the belted kingfisher (assuming a highly conservative diet of 100% fish and an area use factor of 100%);
- 0.58 mg/kg dw for the little blue heron;
- 0.66 mg/kg dw for the pied-billed grebe; and
- 1.7 mg/kg dw for the great blue heron.

A Remedial Action Objective was developed for DDTR in only forage fish because ecological receptors associated with risk from DDTR have a diet consisting mostly of forage fish. The ecological receptors exposed to DDTR in fish do not typically consume predatory fish.

SOIL DDTR PRG CALCULATION USING BAF AND RATIO METHODS

Soil BAF/Ratio Methods

The development of soil PRGs has been designed to be protective of insectivorous birds that may forage in the OU-2 floodplains. The Carolina wren was selected as the receptor for the evaluation of risk to insectivorous birds at OU-2 (AMEC, 2011b). The dietary consumption of the wren was assumed to consist exclusively of invertebrates. The bioaccumulation factor (BAF) method was used to pair insect tissue samples with associated floodplain soil samples for DDTR. The BAF approach is similar to the BSAF approach used in the sediment PRG evaluation. Data pairs were established by matching invertebrate samples with floodplain soil samples within 400 feet of the invertebrate collection site. Invertebrate tissue concentrations were graphed against average floodplain soil concentrations, and site-specific regression equations relating the tissue concentrations to surface soil concentrations were developed. The target invertebrate tissue concentration was then determined by back calculation of terrestrial risk equations. The target invertebrate tissue concentration was entered into the site-specific regression equation to obtain a corresponding PRG for soil.

The ratio method was also used to provide a range of soil PRGs for OU-2. PRGs were calculated by dividing the average invertebrate tissue concentration by the average floodplain soil concentration. Home ranges were not considered in the ratio method.

The results of the BAF and ratio analysis indicated that the ratio method was more appropriate than the BAF regression analysis for calculating soil PRGs for DDTR for OU-2, as discussed below.

Soil PRG Analysis

DDTR floodplain soil PRGs were evaluated using the ratio method with normalized and non-normalized data and this method was selected as the most representative. Floodplain soil PRGs for DDTR were also estimated using the linear and power regression equations for the BAF regression analysis using normalized and non-normalized data for informational purposes only to document the evaluation. The BAF linear and power regression analysis was not used to estimate PRGs because it did not produce acceptable R^2 and p values. The PRGs were estimated by back-calculating to a target DDTR invertebrate tissue concentration associated with a hazard index (HI) of 1 for insectivorous avian receptors using the ratio method.

Soil PRGs

DDTR floodplain soil PRGs were evaluated using the ratio method with lipid normalized data. Data groupings of different combinations of insect types (flying insects, crawling insects, and spiders) were used to provide a range of potential soil DDTR PRGs (Figure 5). The soil PRGs using normalized data were:

- 0.032 mg/kg dw (NOAEL) to 0.047 mg/kg dw (LOAEL) for flying insects.
- 0.076 mg/kg dw (NOAEL) to 0.11 mg/kg dw (LOAEL) for flying insects, crawling insects, and spiders (1994 data excluded).
- 0.11 mg/kg dw (NOAEL) to 0.17 mg/kg dw (LOAEL) for crawling insects and spiders.
- 0.16 mg/kg dw (NOAEL) to 0.23 mg/kg dw (LOAEL) for crawling insects.

- 0.21 mg/kg dw (NOAEL) to 0.31 mg/kg dw (LOAEL) for flying insects, crawling insects, and spiders (1994 data included).

DDTR soil PRGs protective of insectivorous birds ranged from 0.032 mg/kg dw (NOAEL) to 0.31 mg/kg dw (LOAEL) for the Carolina wren. The geometric mean soil PRG range is 0.039 mg/kg dw to 0.25 mg/kg dw for the Carolina wren.

The DDTR PRG for floodplain soils was developed using highly conservative exposure assumptions. The DDTR LOAEL HI for the Carolina wren was 1.4 in the updated ERA (AMEC, 2011b), which is slightly above the target of 1. The conservative nature of the risk equations would indicate the DDTR HI of 1.4 is likely overestimated for the Carolina wren. This adds to the level of uncertainty for the need for a DDTR PRG for floodplain soils.

USEPA'S DDTR PRG RECOMMENDATIONS

USEPA recommends a DDTR PRG for OU-2 sediments of 0.33 to 1.7 mg/kg in the Proposed Remedial Action Plan (PRAP; USEPA, 2013). The USEPA proposed DDTR PRG for OU-2 floodplain soils is stated in the PRAP as 0.039 to 0.25 mg/kg (USEPA, 2013). The DDTR PRG for forage fish tissue proposed in the PRAP is 0.64 mg/kg (USEPA, 2013).

The PRGs for sediment and soil may not be achievable as a result of upgradient, background sources of DDTR at the Ciba-Geigy Corporation (McIntosh Plant) site immediately north of OU-2. Residual DDTR concentrations at the Ciba-Geigy Corporation (McIntosh Plant) site of 1 to 3 mg/kg did not require additional remediation by USEPA. The likelihood exists that upgradient, background conditions of 1 to 3 mg/kg may migrate from the Ciba-Geigy Corporation (McIntosh Plant) site. Sediment and soil samples collected from OU-2 in 2009 and 2010 show that the DDTR concentrations at OU-2 are also within this same range (1 to 3 mg/kg).

The DDTR fish tissue PRG of 0.64 mg/kg for OU-2 is based on a literature summary paper (Beckvar, et al., 2005). The PRG proposed by USEPA is the lower end of the range of values presented in the paper for a variety of fish species. This variety of fish species contains several that are not native to the southeastern United States. This PRG is also not consistent with the Ciba-Geigy Corporation (McIntosh Plant) goal of 1.5 mg/kg (USEPA, 2006). The forage fish tissue PRG proposed by USEPA also may not be achievable because of potential migration of DDTR from the Ciba-Geigy Corporation (McIntosh Plant) site immediately north of OU-2. The PRG should be revised using species that are expected to occur at OU-2, be consistent with background DDTR contributions, and be consistent with the Remedial Goal for the upgradient Ciba-Geigy Superfund site. USEPA typically allows for background concentrations to be considered in selection of a PRG.

CONCLUSION AND RECOMMENDATIONS

DDTR is a unique constituent of concern at OU-2 because its source does not originate from within the Olin Property. Manufacturing activities at the Olin Plant did not include DDTR. The primary release mechanism for DDTR is migration of sediments and soils containing DDTR from the Ciba-Geigy Corporation (McIntosh Plant) Superfund site located immediately north of OU-2. Floodplain soil and sediment collected from the 1990s at OU-2 show a distinct DDTR migration pattern. These data provide evidence that DDTR migrated south from the Ciba-Geigy Corporation (McIntosh Plant) property onto OU-2.

June 19, 2013

The Ciba-Geigy Corporation (McIntosh Plant) property has released DDTR to OU-2 in the past and has the potential to continue to release DDTR at residual concentrations of 1 to 3 mg/kg. The site-specific, "background" concentration for OU-2, as a result, is 1 to 3 mg/kg. USEPA typically uses site-specific background as a consideration in the selection of PRGs. USEPA should consider the PRG selected for fish tissue at the Ciba-Geigy site of 1.5 mg/kg for DDTR. Conditions in the floodplain immediately north of OU-2 are very similar to those at OU-2 such that a different and more stringent PRG for OU-2 soils in comparison to the Ciba-Geigy Superfund site is not justifiable.

Olin recommends that USEPA revise the sediment and soil DDTR PRGs to range from 1 to 3 mg/kg. Olin also recommends a forage fish tissue DDTR PRG range of 1.05 to 2.33 mg/kg, which is consistent with the biota-sediment accumulation relationship with upgradient, background sediment/soil concentrations of DDTR of 1 to 3 mg/kg. This fish tissue PRG range is also consistent with the PRG selected for the Ciba-Geigy Superfund Site.

REFERENCES

AMEC, 2011a, *Part 1 Remedial Investigation Addendum and Enhanced Sedimentation Pilot Project Annual Report, Year 2 Results. Revision 2.* Operable Unit 2, McIntosh, Alabama. November 14,

AMEC, 2011b, *Part 2 Updated Ecological Risk Assessment. Revision 2*. Operable Unit 2, McIntosh, Alabama. November 14.

AMEC, 2012. *Remedial Goal Option Report for the Development of Preliminary Remediation Goals in Sediment and Floodplain Soils, Revision 3.* Operable Unit 2, McIntosh, Alabama. July 6.

Beckvar, N., T.M. Dillon, and L.B. Read, 2005. *Approaches for linking whole-body fish tissue residues of mercury or DDT to biological effects thresholds.* Environ Toxicol Chem. 24(8): 2094-2105.

Burkhard, L. 2009. *Estimation of Biota Sediment Accumulation Factor (BSAF) from Paired Observations of Chemical Concentrations in Biota and Sediment*. U.S. Environmental Protection Agency, Ecological Risk Assessment Support Center, Cincinnati, OH. EPA/600/R-06/047.

USEPA, 2006. *Second Five-Year Review Report for Cibay-Geigy Chemical Superfund Site, McIntosh, Washington County, Alabama.* USEPA Region 4 Science and Ecosystem Division. September.

USEPA, 2013. *Proposed Plan Olin McIntosh Operable Unit 2, Washington County, Alabama.* May 22.

Table 1A. DDTR Concentrations in Surficial Sediment

	Basin					Round Pond			
	1991	1994	2001	2008	2009	1994	2001	2008	2009
n	15	6	45	4	4	6	12	1	1
Minimum Concentration (mg/kg)	0.536	1.41	0.0893	0.0144	0.0784	5.86	2.20	0.117	0.226
Maximum Concentration (mg/kg)	12.2	6.18	64.8	0.639	2.72	177	26.0	0.117	0.226
95% UCL	5.84		6.14	1.16		>177	19.5	0.226	

Table 1B. DDTR Concentrations in Floodplain Soil

	1994	2001	2010
n	8	1	21
Minimum Concentration (mg/kg)	0.739	15.1	0.00375
Maximum Concentration (mg/kg)	155	15.1	2.23
95% UCL	>155	--	1.2

<u>Notes:</u>
DDTR - sum of 2,4'- and 4,4'-DDD, DDE, and DDT. One-half the reporting limit is used in the summary calculations for non-detects.
mg/kg - milligram per kilogram
n - number of samples
95% UCL - 95 percent upper confidence limit
-- - 95% UCL not calculated for one sample

Table 2. Forage Fish Tissue DDTR Concentrations.

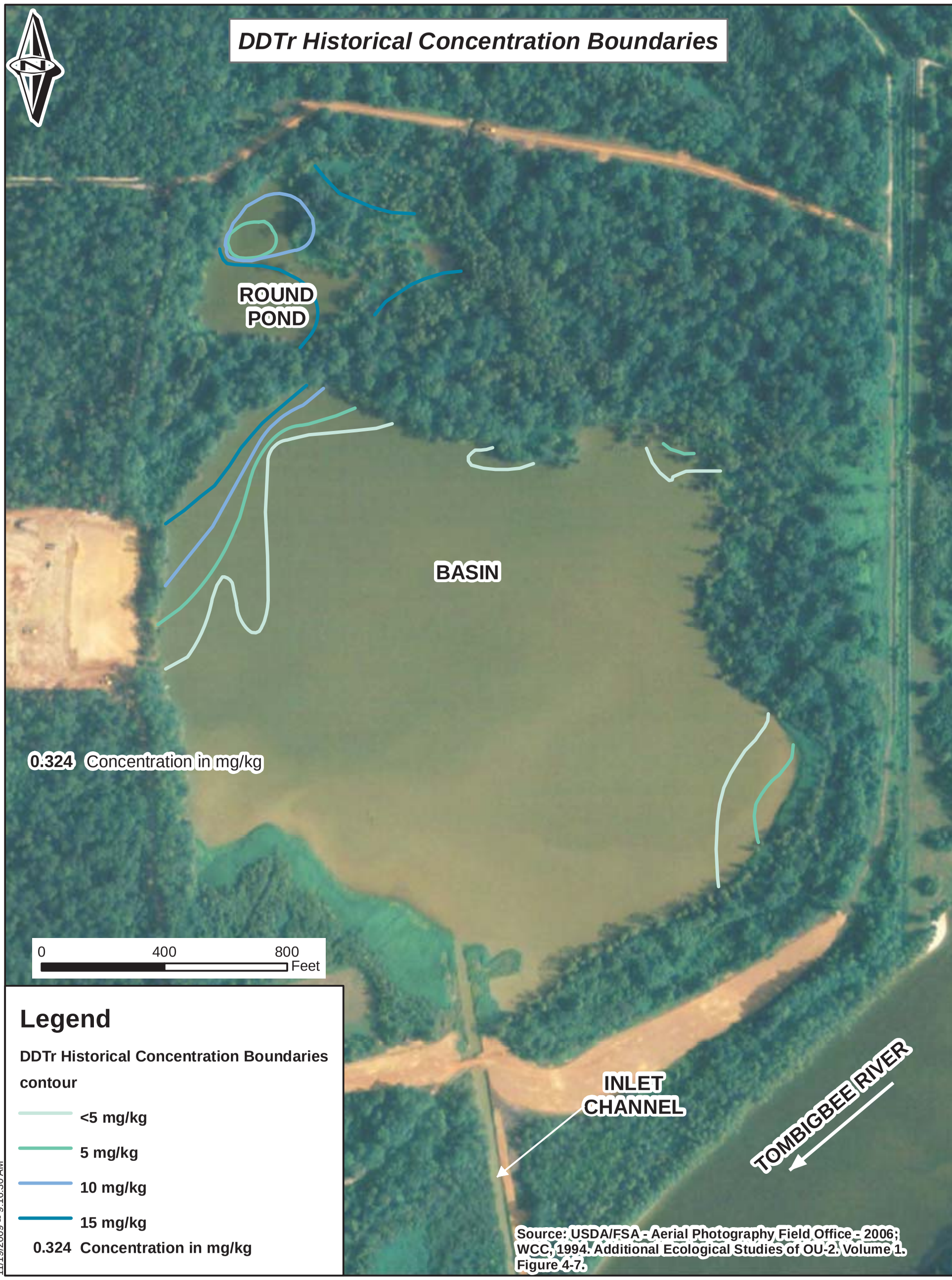
		Basin by Quadrant											
		NW Quadrant		NE Quadrant		SW Quadrant		SE Quadrant		Basin		Round Pond	
		2001	2010	2001	2010	2001	2010	2001	2010	2001	2010	2001	2010
Mosquitofish[1]	n	3	--	9	--	--	--	3	--	15	--	6	--
	Minimum Concentration (mg/kg)	1.65	--	0.99	--	--	--	1.29	--	0.99	--	6.54	--
	Maximum Concentration (mg/kg)	1.88	--	2.05	--	--	--	1.44	--	2.05	--	10.8	--
	Average Concentration (mg/kg)	1.77	--	1.38	--	--	--	1.34	--	1.45	--	8.44	--
Brook Silversides[1]	n	--	1	--	1	--	1	--	1	--	4	--	--
	Minimum Concentration (mg/kg)	--	0.878	--	1.0	--	1.82	--	0.907	--	0.878	--	--
	Maximum Concentration (mg/kg)	--	0.878	--	1.0	--	1.82	--	0.907	--	1.82	--	--
	Average Concentration (mg/kg)	--	0.878	--	1.0	--	1.82	--	0.907	--	1.15	--	--
Bluegill[2]	n	--	5	--	5	--	5	--	5	--	20	--	--
	Minimum Concentration (mg/kg)	--	1.01	--	0.557	--	0.625	--	0.675	--	0.557	--	--
	Maximum Concentration (mg/kg)	--	2.16	--	4.44	--	2.64	--	5.46	--	5.46	--	--
	Average Concentration (mg/kg)	--	1.74	--	2.1	--	1.69	--	1.86	--	1.85	--	--

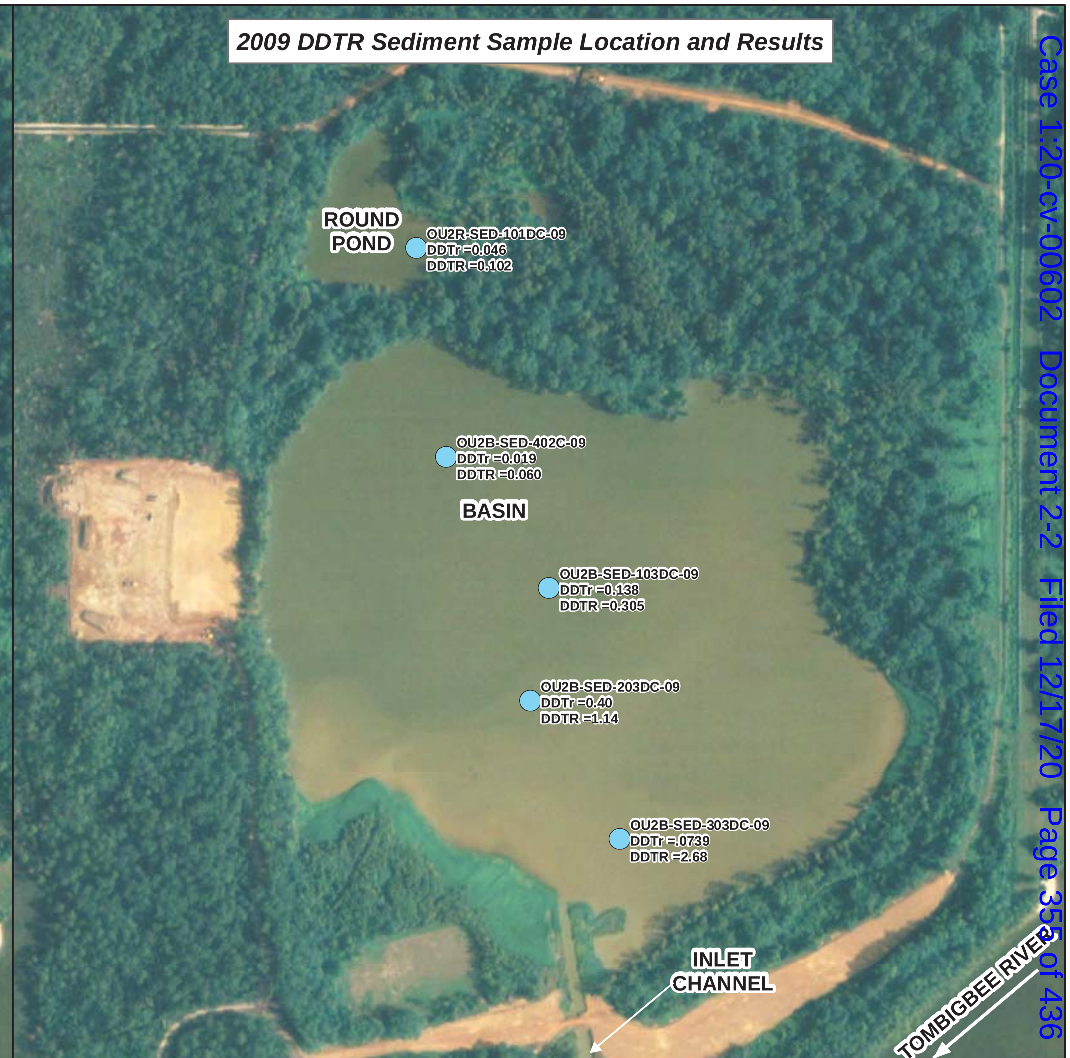
Notes:
DDTR - sum of 2,4'- and 4,4'-DDD, DDE, and DDT. One-half the reporting limit is used in the summary calculations for non-detects.
mg/kg - milligram per kilogram
n - number of samples
NE - northeast
NW - northwest
SE - southeast
SW - southwest
-- - not collected
[1] whole body, composite samples
[2] whole body, individual samples

Table 3. Predatory Fish Tissue DDTR Concentrations.

		Basin by Quadrant																	
		NW Quadrant			NE Quadrant			SW Quadrant			SE Quadrant			Basin			Round Pond		
		2001	2010		2001	2010		2001	2010		2001	2010		2001	2010		2001	2010	
		Filet	Filet	WB	Filet	Filet	WB	Filet	Filet	WB	Filet	Filet	WB	Filet	Filet	WB	Filet	Filet	WB
Largemouth Bass	n	2	5	10	4	5	10	--	5	10	1	5	10	7	20	40	3	--	--
	Minimum Concentration (mg/kg)	0.715	0.159	0.696	<0.05	0.0968	1.66	--	0.0937	1.25	0.927	0.095	0.674	0.15	0.094	0.674	1.38	--	--
	Maximum Concentration (mg/kg)	1.42	0.346	39.2	1.43	0.154	3.85	--	0.253	9.37	0.927	0.367	3.68	1.43	0.367	39.2	2.76	--	--
	Average Concentration (mg/kg)	1.07	0.203	8.24	0.5	0.121	2.68	--	0.16	3.88	0.927	0.182	2.39	0.741	0.166	4.2	2.22	--	--

Notes:
DDTR - sum of 2,4'- and 4,4'-DDD, DDE, and DDT. One-half the reporting limit is used in the summary calculations for non-detects.
mg/kg - milligram per kilogram
n - number of samples
NE - northeast
NW - northwest
SE - southeast
SW - southwest
WB - whole body
-- - not collected



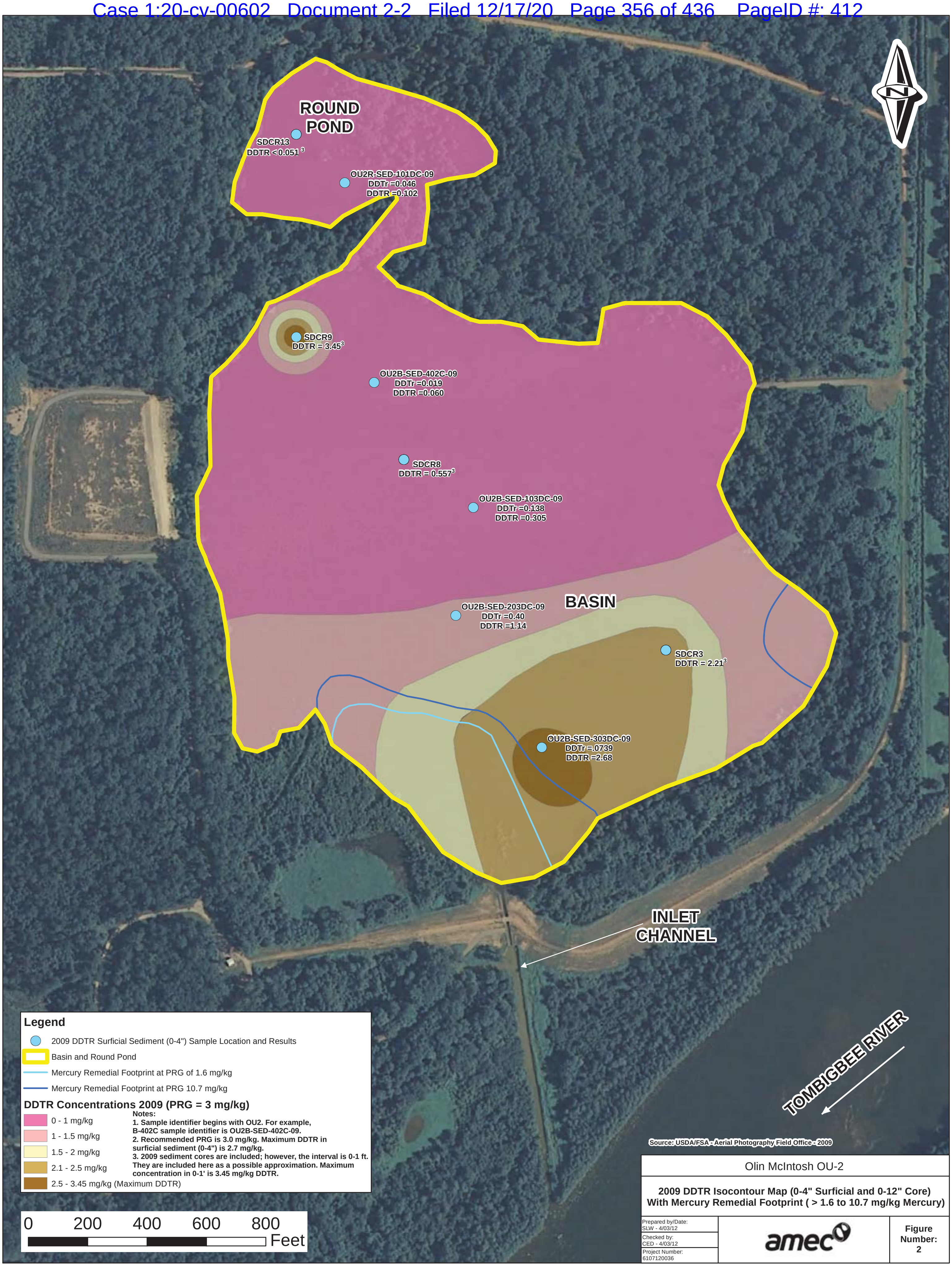


Olin McIntosh OU 2

2009 Sediment Sample Locations and DDTR Results Comparison to Historical Results

Prepared by/Date: BWH - 11/06/09	amec	Figure Number: 1
Checked by/Date: CED - 11/06/09		
Project Number: 6107090035		

Map Document: (G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\ESPP Baseline report\2009\mxds\Figure4_6_Historic_Contour.mxd)
11/19/2009 -- 9:16:30 AM



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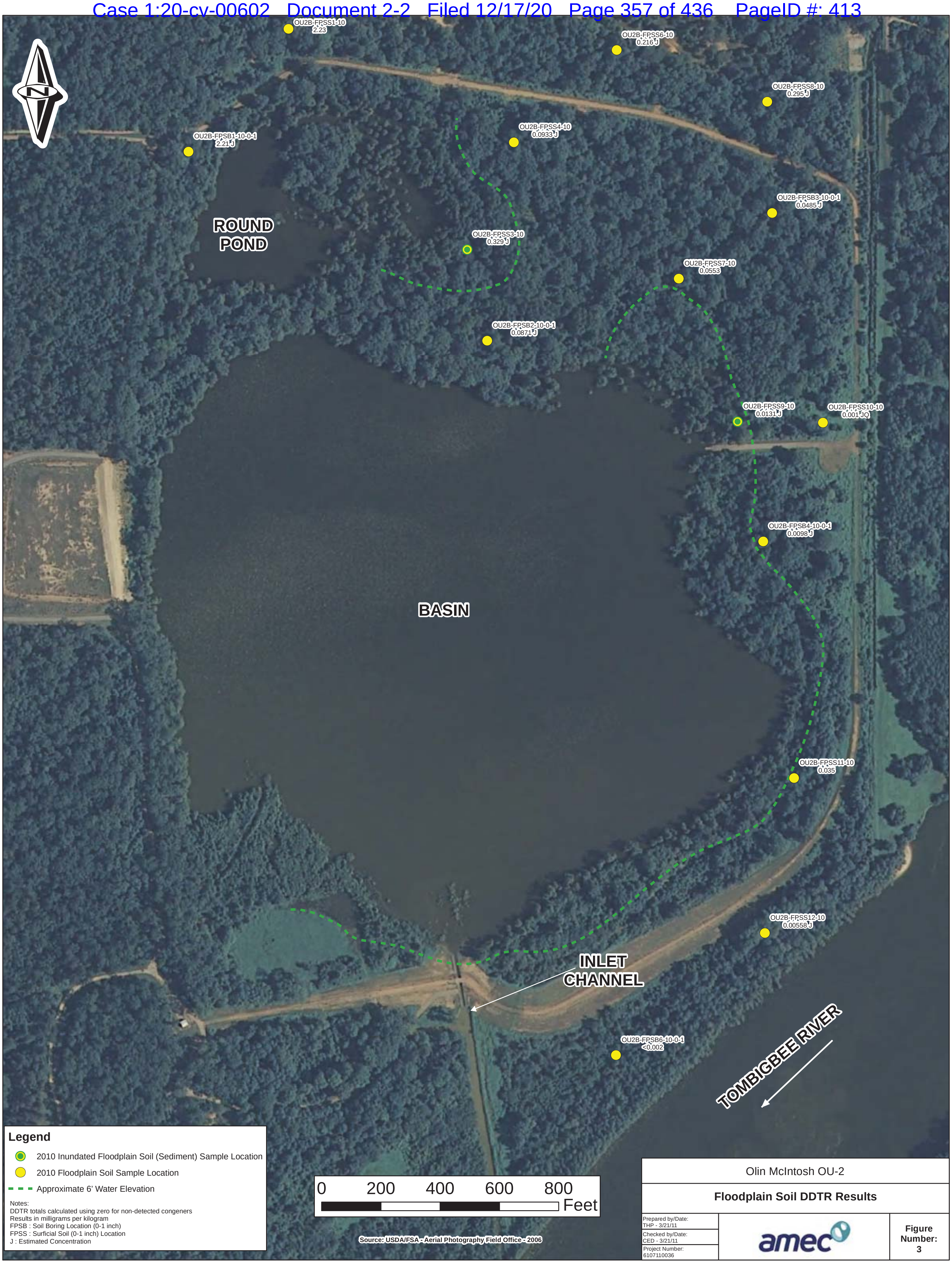

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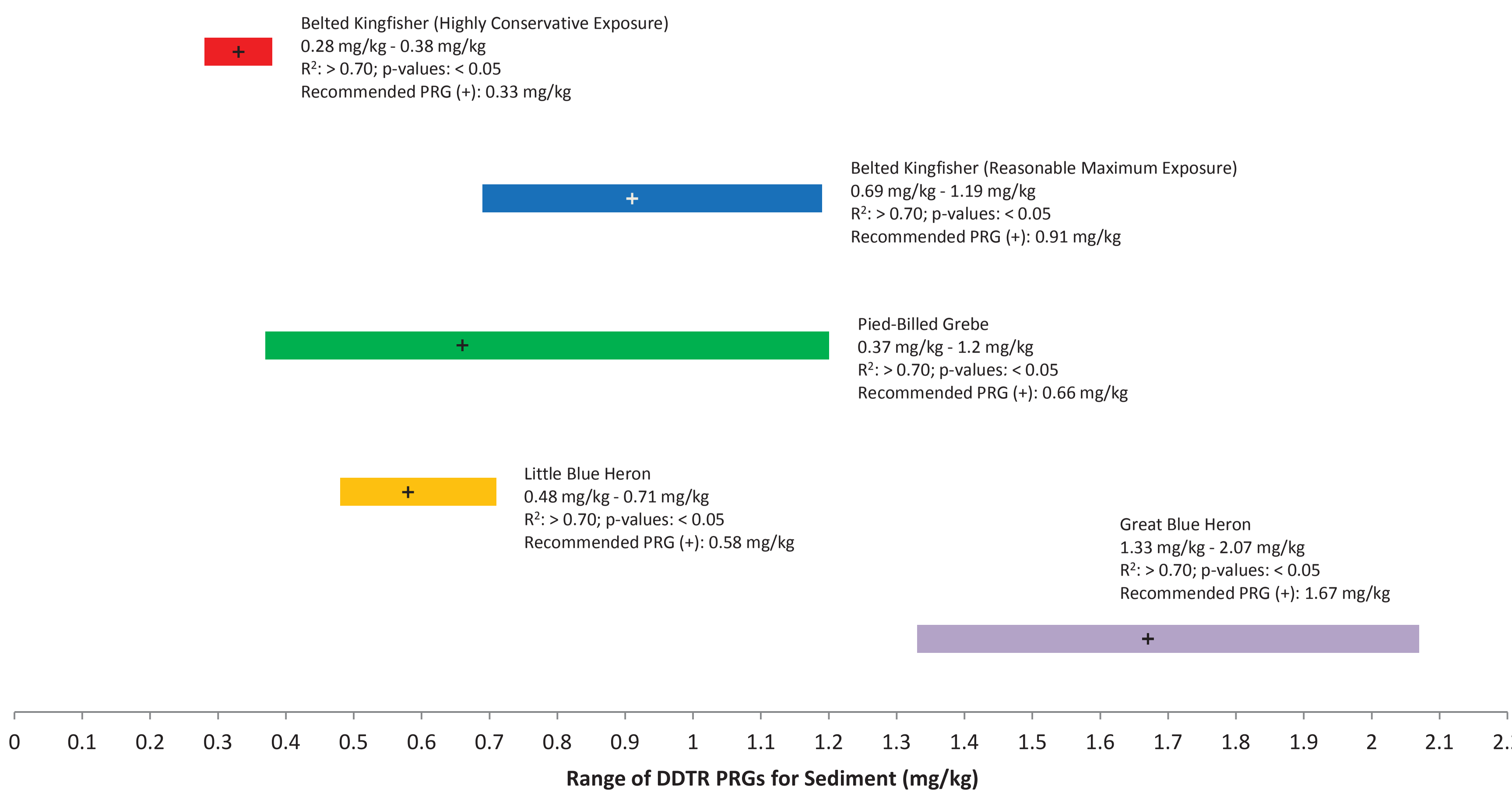
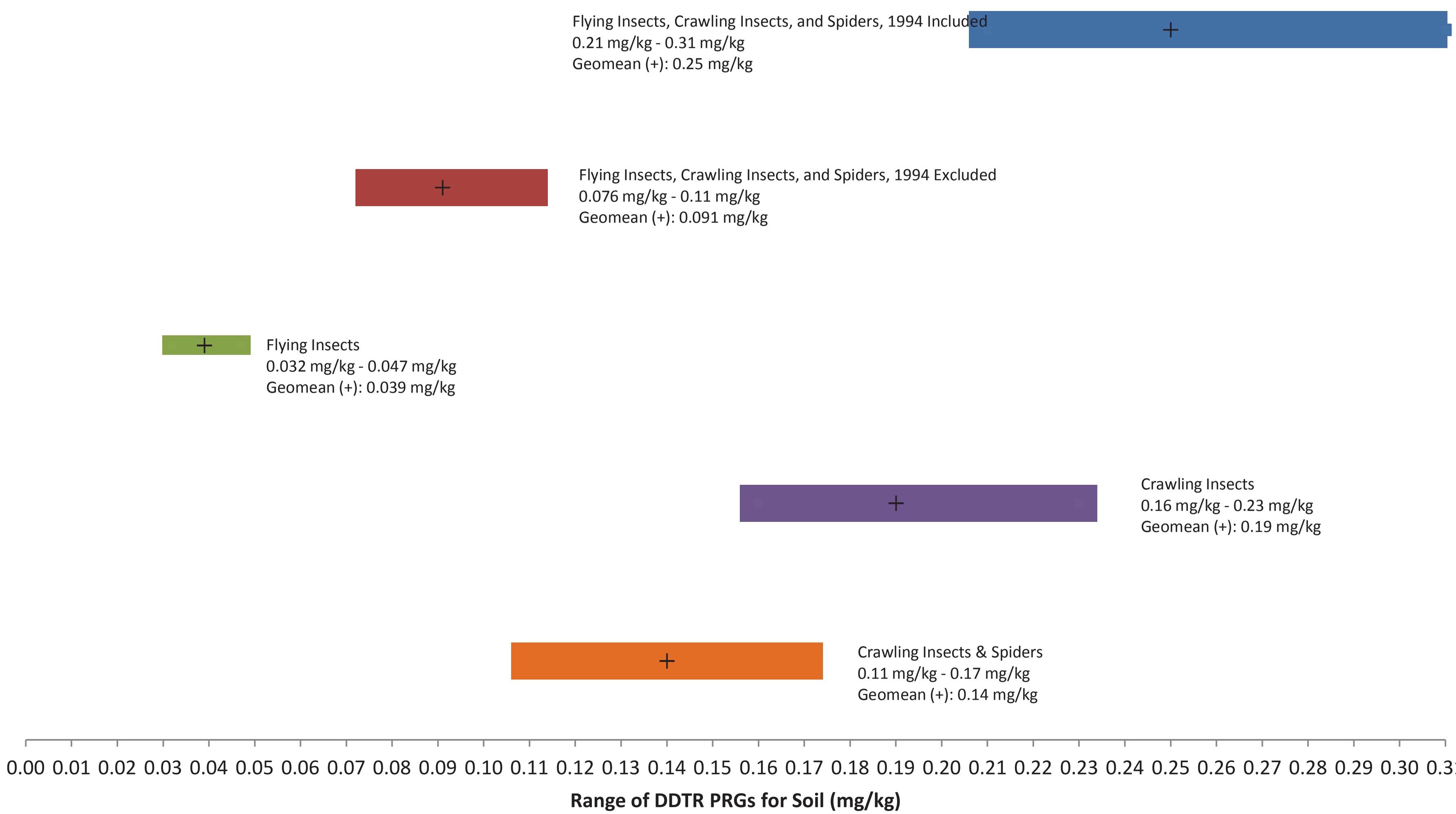
Figure 4
DDTR Target Sediment Concentrations Protective of Receptor Based on Risk from Forage Fish



+ Indicates the geometric mean PRG for the receptor.

PREPARED BY/DATE: MKB 3/28/12
CHECKED BY/DATE: EFC 3/28/12

FIGURE 5
DDTR Target Soil Concentrations Protective of the Carolina Wren (Normalized Data)



+ Indicates the geometric mean PRG for the invertebrate grouping (Table 4-6).

Prepared By: NSR 4/16/12
Checked By: EFC 4/16/12

APPENDIX 3.2 – COMMENT LETTERS AFTER PUBLIC COMMENT PERIOD

LANCE R. LEFLEUR
DIRECTOR

ADEM

Alabama Department of Environmental Management
adem.alabama.gov
1400 Coliseum Blvd. 36110-2400 ■ Post Office Box 301463
Montgomery, Alabama 36130-1463
(334) 271-7700 ■ FAX (334) 271-7950

ROBERT J. BENTLEY
GOVERNOR

September 18, 2013

CERTIFIED MAIL # 91 7199 9991 7030 3429 6219

Ms. Beth Walden
Remedial Project Manager
U.S. Environmental Protection Agency
Atlanta Federal Center
61 Forsyth Street
Atlanta, GA 30303-8960

RE: ADEM Review and Concurrence:
Draft Record of Decision for OU2 dated September 2013

Dear Ms. Walden:

The Department has reviewed the draft submittal of the ROD for Olin Corporation's McIntosh facility. Based on our review, the Department concurs with the selected remedy, in-situ capping, with the following notifications:

1. The Department has concerns with the preliminary remedial goal (PRG) for the contaminant of concern (COC) DDTr. The value, outlined in the ROD, differs from the PRG currently established for portions of the floodplain previously designated as protective in OU-2. ADEM recommends establishing a consistent cleanup standard for the entire floodplain.

2. The proposed PRG for DDTr in the draft ROD for the Olin facility may not be appropriately calculated due to the use of the historical data applied to generate the remediation values. The use of historical data that does not account for remedial actions completed that improve the bioavailable concentration of DDTr may yield a remediation value that is not accurately calculated.

Please note that on September 16, 2013, the Department provided additional comments on the ROD electronically to address general grammatical concerns. If you have any questions concerning this matter, please contact Mrs. Sonja B Favors at 334-279-3067.

Sincerely,

Phillip D. Davis, Chief
Land Division

PDD/SBF/nbf

Olin
3855 North Ocoee Street
Suite 200
Cleveland, TN 37312
(423) 336-4007
cmrichards@olin.com

Curt M. Richards
Corporate Vice President,
Environment, Health & Safety

Mr. A. Stanley Meiberg
Acting Regional Administrator
Region 4
U.S. Environmental Protection Agency
Atlanta Federal Center
61 Forsyth Avenue
Atlanta, Georgia 30303-8960

Re: **USEPA's Proposed Remediation Goals for DDTR**
Olin McIntosh Operable Unit (OU) 2, McIntosh, Alabama

Dear Mr. Meiberg:

Olin Corporation (Olin) has tried to understand the rationale regarding the proposed remediation goals for the 2,4'- and 4,4'-isomers of DDT, DDE, and DDD (collectively, DDTR) for the McIntosh OU-2 Superfund Site in McIntosh, Alabama. Our requests to meet with USEPA Region 4 Agency officials prior to the issuance of the Record of Decision (ROD) to discuss this issue have not been successful. DDTR is a unique Chemical of Concern (COC) at OU-2 because its source does not originate from within the Olin property. The primary release mechanism for DDTR is migration of sediments and soils containing DDTR from the Ciba-Geigy Corporation (McIntosh Plant) Superfund Site (currently BASF property) located immediately north of OU-2. Historic and current DDTR data provide evidence that DDTR migrated south from the Ciba-Geigy site onto OU-2.

Off-site, upgradient concentrations were not considered in the selection of DDTR remedial goals for OU-2. (This information is summarized in the attached DDTR Summary). Olin has concerns that soil and sediment runoff containing DDTR will re-contaminate the in-situ cap specified in the Proposed Remedial Action Plan so that remedial goals at OU-2 are not achievable. The Alabama Department of Environmental Management has also expressed concerns about the preliminary remedial goal in their letter to Beth Walden, USEPA Remedial Project Manager, dated September 18, 2013. (This letter is attached). Olin requests that USEPA explain how activities at the Ciba-Geigy Superfund Site will affect meeting the remedial goals at Olin's OU-2 prior to the issuance of the ROD.

Please let me know if you have any questions; I am available to discuss this concern at your convenience. I can be reached at (423) 336-4007 or via e-mail (cmrichards@olin.com).

Sincerely,

OLIN CORPORATION

Curtis M Richards

Curtis M. Richards
Vice President, Environmental Health and Safety

Enclosures (2)

POSITION PAPER FOR FUTURE DISCUSSION
DDTR GOALS AT OU-2

The purpose of this document is to state Olin Corporation's (Olin's) opposition to the proposed remedial goal for the 2,4'- and 4,4'-isomers of DDT, DDE, and DDD (collectively, DDTR) in floodplain soil, sediment, and forage fish at the McIntosh OU-2 Superfund Site, in McIntosh Alabama. The U.S. Environmental Protection Agency (USEPA) prepared the *Proposed Remedial Action Plan [PRAP] for the Olin McIntosh Operable Unit 2* (OU-2) and identified the primary site-related constituents of concern (COCs) as mercury and hexachlorobenzene (HCB). The PRAP proposed remediation goals for DDTR, in addition to proposing remediation goals for mercury and HCB. Olin provided comments on the PRAP requesting revision of the DDTR remediation goals to consider site-specific background, as provided in the USEPA-approved OU-2 *Feasibility Study* (November 2012) and *Remedial Goal Option Report for the Development of Preliminary Remediation Goals in Sediment and Floodplain Soils* (July 2012). USEPA indicated that the DDTR remediation goals for these media would not be revised. Olin takes exception to the implementation of these risk-based DDTR remediation goals without consideration of site-specific background concentrations and cites inconsistencies with goals provided for an adjacent site, as discussed below.

DDTR is a unique COC at OU-2 because its source does not originate from within the Olin property. Manufacturing activities at the Olin McIntosh Plant did not include DDT or intermediate daughter products associated with DDTR. The primary release mechanism for DDTR is migration of sediments and soils containing DDTR from the Ciba-Geigy Corporation (McIntosh Plant) Superfund site (currently BASF property) located immediately north of OU-2. Historic and current DDTR data provide evidence that DDTR migrated south from the Ciba-Geigy site onto OU-2. The Ciba-Geigy site represents the site-specific background for OU-2 and has the potential to continue to release DDTR at residual concentrations of 1 to 3 mg/kg, which is above the USEPA proposed goals for OU-2. The site-specific, background concentration for OU-2, as a result, is 1 to 3 mg/kg.

USEPA's PRAP for OU-2 recommends remedial goals based solely on conservative risk-based calculations and does not consider background or goals for the adjacent site. USEPA's selected remedial goal ranges are 0.33 to 1.7 mg/kg for sediment, 0.039 to 0.25 mg/kg for floodplain soil, and 0.64 mg/kg for fish tissue. USEPA has also indicated that the preferred remedial alternative, in-situ capping, will require the design of a cap that effectively isolates both mercury (primary COC) and DDTR.

USEPA typically uses site-specific background as a consideration in the selection of remediation goals. However, site-specific background is not considered in the PRAP. The remedial goals are less than the site-specific background concentration of 1 to 3 mg/kg DDTR in sediments and floodplain soils and the Ciba-Geigy remedial goal selected for forage fish tissue (1.5 mg/kg). Conditions in the floodplain immediately north of OU-2 are very similar to those at OU-2. Migration of background DDTR at the Ciba-Geigy site onto a cap at OU-2 has the potential to re-contaminate the cap, once placed.

Olin recommends the following options, in combination or separately, to address the DDTR remediation goals at OU-2:

1. Select remedial goals for floodplain soils/sediments that are consistent with the USEPA-approved *Remedial Goal Option Report for the Development of Preliminary Remediation Goals in Sediment and Floodplain Soils* and *Feasibility Study*. The remedial goal range recommended in the report and approved by USEPA was 1 to 3 mg/kg for sediments and floodplain soils. Select a remedial goal for forage fish that is consistent with that for the Ciba-Geigy site (i.e., 1.5 mg/kg).

2. Acknowledge that the preferred alternative, in-situ capping, in addition to addressing site-specific COCs (mercury and HCB), will also be effective for DDTR in OU-2 sediment. Cap performance and effectiveness would be based on mercury and HCB, not DDTR.

Olin is prepared to proceed with remediation activities as described in the PRAP with the implementation of the above option(s).

LANCE R. LEFLEUR
DIRECTOR

ADEM

Alabama Department of Environmental Management
adem.alabama.gov
1400 Coliseum Blvd. 36110-2400 ■ Post Office Box 301463
Montgomery, Alabama 36130-1463
(334) 271-7700 ■ FAX (334) 271-7950

ROBERT J. BENTLEY
GOVERNOR

September 18, 2013

CERTIFIED MAIL # 91 7199 9991 7030 3429 6219

Ms. Beth Walden
Remedial Project Manager
U.S. Environmental Protection Agency
Atlanta Federal Center
61 Forsyth Street
Atlanta, GA 30303-8960

RE: ADEM Review and Concurrence:
Draft Record of Decision for OU2 dated September 2013

Dear Ms. Walden:

The Department has reviewed the draft submittal of the ROD for Olin Corporation's McIntosh facility. Based on our review, the Department concurs with the selected remedy, in-situ capping, with the following notifications:

1. The Department has concerns with the preliminary remedial goal (PRG) for the contaminant of concern (COC) DDTr. The value, outlined in the ROD, differs from the PRG currently established for portions of the floodplain previously designated as protective in OU-2. ADEM recommends establishing a consistent cleanup standard for the entire floodplain.

2. The proposed PRG for DDTr in the draft ROD for the Olin facility may not be appropriately calculated due to the use of the historical data applied to generate the remediation values. The use of historical data that does not account for remedial actions completed that improve the bioavailable concentration of DDTr may yield a remediation value that is not accurately calculated.

Please note that on September 16, 2013, the Department provided additional comments on the ROD electronically to address general grammatical concerns. If you have any questions concerning this matter, please contact Mrs. Sonja B Favors at 334-279-3067.

Sincerely,

Phillip D. Davis, Chief
Land Division

PDD/SBF/nbf

APPENDIX 3.3 – PUBLIC MEETING TRANSCRIPT MAY 22, 2013

U.S. ENVIRONMENTAL PROTECTION AGENCY

PROPOSED PLAN

OLIN McINTOSH OPERABLE UNIT 2

PUBLIC MEETING

WASHINGTON COUNTY, ALABAMA

MAY 22, 2013

U.S. ENVIRONMENTAL PROTECTION AGENCY

PROPOSED PLAN

PUBLIC MEETING

OLIN McINTOSH OPERABLE UNIT 2

WASHINGTON COUNTY, ALABAMA

MAY 22, 2013

INTRODUCTION:

KYLE BRYANT, COMMUNITIES INVOLVEMENT
COORDINATOR ENVIRONMENTAL
PROTECTION AGENCY, REGION 4

PRESENTER:

BETH WALDEN, PROJECT MANAGER
ENVIRONMENTAL PROTECTION AGENCY
WASTE MANAGEMENT DIVISION

INTRODUCTION

MR. BRYANT: First I'd like to say welcome this evening. My name is Kyle Bryant. I am the Communities Involvement Coordinator from the Environmental Protection Agency, Region 4, out of Atlanta assigned to the Olin McIntosh site.

The first order of business, I hope everyone who comes in has signed our sign-in sheet in the back. If you have not, please take a moment to do so before you leave. It's right there on the left corner of that table. So we can keep in touch with you for future correspondence.

The occasion this evening is for a proposed plan public meeting to discuss Operable Unit 2. And you will hear a presentation by the Regional Project Manager, Beth Walden, who is seated right here to my right.

And we have other people from the agency, from EPA, Region 4, here in the audience with us this evening as well as our colleagues from the state, if you have any subsequent questions about what you're going to hear about tonight.

Just a brief word on this process. We have business cards on the back table so if you want to grab a couple of them and an ink pen that we've also provided back there, you can jot down your questions related to the presentation or the Proposed Plan. And make sure they get in my hands before you leave at the end of the day so that we can compile them and give those to the Project Manager so she can respond to those in a timely manner.

This is the beginning of our 30-day comment period on the Proposed Plan so it officially starts this evening. So, even if it takes you a little bit longer to formulate your questions or you want to review the documents further, please take a copy of the Proposed Plan on the back table with you. And she has a business card on the table and I'll also provide my contact information so you can get in touch with either of us to forward your comments or questions. Okay?

We also have a court reporter here. We're required by the National Contingency Plan to have a court reporter record the meeting proceeds. So would you like to introduce yourself?

COURT REPORTER: I'm Patricia Taylor with Freedom Court Reporting.

MR. BRYANT: With that, I'll introduce our Remedial Project Manager, Beth Walden. You may begin.

PRESENTATION

MS. WALDEN: Good evening. Thanks for coming out tonight. I have been working on the Olin OU-2 site for about six or seven years and we have reached a point in our Superfund process where we are recommending a cleanup action for the basin. So, tonight we're going to go over some background for the site, the studies we've done to date, what the contaminants of concern are, the process we use to figure out what is driving the cleanup, the different cleanup alternatives that we've taken a look at and then EPA's preferred remedy.

So the site is divided into two operable units. And if you want to take a look in your Proposed Plan it might be a little easier to see.

Operable Unit 1. When a site is complex or we're ready to make a decision on one part of the site, we will divide the site up organizationally, administratively, to deal with the existing environmental problems. So the plant area is what we call Operable Unit 1.

Operable Unit 2 is actually the basin; the floodplain and the old waste water ditch that went from the facility to Olin basin. So here's an aerial photo of the plant area, which I'm sure most of you in the room are familiar with. The waste water ditch used to drain here and go into the Olin basin. And this is obviously the Tombigbee River.

So just to highlight some of the features. In 2006, Olin built a berm around much of the floodplain, which is about two hundred acres. The basin is about a 70-acre lake. In the middle of the lake is about a 40-foot depth from where the old Tombigbee River channel used to cut through the floodplain. So, the facility is up here in what we call the uplands. This is Round Pond. And Olin built a gate that they used to manage the water level in the lake.

So, EPA and Olin have been involved in the site for a number of years; began the investigations in 1990. And in 1994, they actually came up with a remedy for OU-1, which involved treatment of the groundwater. They upgraded a landfill cover. And under their active plant management they've actually closed a number of units that either had solid waste or hazardous waste in them. That actually was completed in about 2001. All the construction for what we call Operable Unit 1.

And then from 2001 to present we've been looking at Operable Unit 2 or focusing on Operable Unit 2.

We actually in 1994 when we made the selection for the OU-1 remedy there were investigations going on in OU-2 and they were primarily ecological data collection. And as I said, in 2001 construction of OU-1 was finished.

In 2004-2005, Olin took the initiative and built a berm, as I showed you earlier, and it has a gate structure and it's around 100-150 acres or so of the floodplain.

And between 2006-2010, we collected at lot more data.

And in 2011-12, we finalized the Remedial Investigation and Feasibility Study Reports.

So just to give you an idea of the type of work that we were doing over the last ten, fifteen years: There has been sediment collection, surface water; measurement of how much sediment was coming into the system with the berm in place; a debris survey to take a look at fallen trees and what was on the bottom of the lake bed; ground water investigation. In fact, to take a look at the sediment deposition in the lake you had to have OSHA-trained divers to dive down into the bottom of the lake and take a look at the sediment pens. We've had CLAMS out there to take a look at mercury uptake into the CLAMS. We've taken cores of the bottom of the basin; pore water sampling, which is between the sediment and the water; and we also took a look at how old the contamination was, at what depth, and tried to figure out and correlate how many inches a year sediment were getting into the system.

Wind suspension in the lake. You have winds obviously that come across the top of the lake that cause water movement, which we believe may be causing some of the sediment from not settling out. We took samples of the floodplain soils. We've looked at mercury specifically because mercury is unique in that it has a biological influence that causes the mercury to stay in the biota and stay mobile within the sediment column.

We've taken samples of fish, insects, monthly surface water sampling to take a look at the influences of the wind, as well as the -- the sediment transport modeling. Took a look at when the sediment comes into the system, does it stay in the system. And what we have found is we have three primary contaminants of concern: That is mercury, hexachlorobenzene, and what we refer to as DDTR. And it is the result of the waste water from the Olin plant into the OU-2 basin, and floodwaters coming in and mixing the contamination around and it's moving across the floodplains. DDTR also is a contaminant of concern from indirect discharges from BASF, or used to be known as CIBA.

What we have found is that there is no current risk because Olin has site security measures in place. If there were no security measures in place there would be an unacceptable risk to people eating the fish. There is also an ecological risk to fish-eating birds, insect-eating birds, from both the sediment and the soil.

The green, the larger area, represents the footprint that will need to be addressed with any type of remedy.

The lighter green hatched area represents an area that we need to take some additional soil samples primarily for DDT because we haven't sampled this area in a very long time.

The orange cross-hatched area represents an area that we want to do further sampling in, primarily for the hexachlorobenzene. These two areas will be addressed by whatever the remediation is that we choose. And EPA is recommending the capping alternative. So those areas would be evaluated as part of the capping.

So we looked at a number of different remedial technologies and decided for mercury-contaminated sites, the most obvious technologies are capping, dredging and basically doing nothing and letting the contamination over time become more dilute or to actually degrade. The no-action alternative is actually an EPA-required alternative to look at.

The difference in alternative 2A, 2B and 2C is really whether or not you de-water the basin and cap on dry land or apply a subaqueous cap within the lake. And, so, we dealt with different ways of looking at the number of acres to see if it made sense to de-water it.

And lastly, we looked at dredging. Which is basically removing all the contaminated sediment and either placing it onsite in a landfill or shipping it offsite.

Capping would basically involve placing the material all over the bottom of the basin as well any parts of the flood-plain that need to be addressed. A capping material like a sand or a clay or some other type of amendment to go with the sand or native soil. And then a habitat layer that you want to jump start. Once you cap something you want to jump start the biological activity again.

So the cost for capping for 2A is about 15 million. 2B is 15.6. 2C is 17 million.

If you dredge, you're looking at a cost of about 55 million to 70 million, depending on whether you leave it onsite or ship it offsite.

When we compare the alternatives we look at nine criteria and you could probably see them better in your handout.

The first two are what we call the threshold criteria. The remedy has to be protective of human health in the environment and it has to comply with federal or state regulations.

The next five criteria are what we call the balancing criteria. We look at the long-term effectiveness. Meaning in the long term, in a hundred years, is this still going to be a remedy that's going to work? We try to reduce the toxicity mobility, or volume.

Short-term effectiveness: When you actually apply the remedy are there any short-term risks that -- like for instance, with dredging, obviously if you dredge, the short-term risks are you're removing all of the sediment and habitat for, you know, the critters, so the speak, or the fish. So

that has an immediate short-term impact.
Capping has an impact, not as severe; because as you're placing the material, it's not killing everything that you're putting material on because they can move through the water columns.
And then we look at cost. We compare the cost and the benefit of one alternative compared to another.
And the last two are the State acceptance and community acceptance. And those are the two things that we take a look at in the next thirty days based on the comments we get.
EPA is recommending Alternative 2A because we feel it is the best balance of the five balancing criteria. It does meet protection of human health in the environment. We expect that the fish should recover in the next ten years after the cap is implemented and we consider it more cost effective than the dredging alternative.

And that is an example of the barge that is one of the techniques for placing the material over the contaminated sediment.

So, we're at the Proposed Plan and Remedy Selection Stage. So as Kyle mentioned earlier, we're going to take a look at the comments we receive. We're going to write a Record of Decision that basically outlines the remedy selection, what I've just walked you through. But I have to write a responsiveness summary so if I receive comments during that period I have to technically respond to those and those also go in the Record of Decision.

After the Record of Decision, we will basically negotiate -- In this case we have one potentially responsible party and that's Olin. We actually have potentially CIBA as well for the DDT. So we will send a letter out and say "are you guys going to do the work?" They'll say yes or no. We write an administrative order; it's lodged in the court. And from that point on we're back into the technical world of remedial design documents where they lay out their plans for how they're actually going to build the cap. We're going to talk about the frequency of monitoring. Because once you leave a hazardous substance in place like mercury, we will be doing 5-year reviews for as long as it does not allow for unrestricted access.

So, basically, we'll be out here for a very long time monitoring to see whether the work that we have done is effective.

And that concludes the formal part of this presentation. If you guys have any questions I'm more than happy to answer them. And we'll stick around also if you're more comfortable asking questions when we're done. That's it. Thank you for coming out tonight.

END OF PROCEEDINGS

C E R T I F I C A T E

STATE OF ALABAMA)
COUNTY OF CONECUH)

I hereby certify that the above and foregoing transcript of proceedings was taken down by me in machine shorthand, and the questions and answers thereto were transcribed by means of computer-aided transcription, and that the foregoing represents a true and correct transcript of the proceedings given by said witness upon said hearing.

I further certify that I am neither of counsel nor of kin to the parties to the action, nor am I in anywise interested in the result of said cause.

I further certify that I am duly licensed by the Alabama Board of Court Reporting as a Certified Court Reporter as evidenced by the ACCR number following my name below.

____

PATRICIA L. TAYLOR, CCR.
CCR# 363, Expires 9/30/13
Commissioner for the.
State of Alabama at Large.
My Commission Expires: 12/31/16

WORD INDEX

REMEDIAL DESIGN/REMEDIAL ACTION

STATEMENT OF WORK

OPERABLE UNIT 2

OLIN CORP. (MCINTOSH PLANT) SUPERFUND SITE

McIntosh, Washington County, State of Alabama

EPA Region 4

July 2020

TABLE OF CONTENTS

1. INTRODUCTION

1.1 **Purpose of the SOW**. This Statement of Work (SOW) sets forth the procedures and requirements for implementing the Work.

1.2 **Structure of the SOW**

- Section 2 (Community Involvement) sets forth EPA's and Settling Defendants' (SDs) responsibilities for community involvement.
- Section 3 (Remedial Design) sets forth the process for developing the RD, which includes the submission of specified primary deliverables.
- Section 4 (Remedial Action) sets forth requirements regarding the completion of the RA, including primary deliverables related to completion of the RA.
- Section 5 (Reporting) sets forth SDs' reporting obligations.
- Section 6 (Deliverables) describes the content of the supporting deliverables and the general requirements regarding SDs' submission of, and EPA's review of, approval of, comment on, and/or modification of, the deliverables.
- Section 7 (Schedules) sets forth the schedule for submitting the primary deliverables, specifies the supporting deliverables that must accompany each primary deliverable, and sets forth the schedule of milestones regarding the completion of the RA.
- Section 8 (State Participation) addresses State participation.
- Section 9 (References) provides a list of references, including URLs.

1.3 The Scope of the Remedy includes the actions described in Section 1.4 of the ROD, including:

Multi-layered Cap. A multi-layered cap applied in-situ over approximately 80 acres of sediment exceeding the sediment cleanup levels. The cap will consist of three layers: 1) a mixing zone, 2) an effective cap layer, and 3) a habitat layer. The capping materials and their thicknesses will be determined during remedial design. These capping materials will be physically and chemically compatible with the environment in which they are placed. Geotechnical parameters will be evaluated to ensure compatibility among cap components, native sediment, and surface water. The placement method will minimize short-term risk from the release of contaminated pore water and resuspension of contaminated sediment during cap placement. Reactive materials may be used to reduce the potential for contaminants to migrate through the cap.

Additional Sampling and Analyses. Additional sampling and analyses will be performed in the channel connecting Round Pond to the Olin Basin and the perimeter of the Round Pond floodplain soils that are often inundated, as well as the former wastewater and discharge ditch, to further refine the remedial footprint. Depending on the results of this characterization, these floodplain soil areas may require installation of a cap.

Institutional Controls. The institutional controls (deed and restrictive covenant) that are currently in place as a result of OU-1 (Operable Unit 1) will be amended to include the OU-2 remedial footprint and use restrictions. Also, engineering controls, such as warning signs, including fish advisory signage, fencing, and security monitoring will be implemented to restrict access and prevent exposures to human receptors.

Construction Monitoring. Construction monitoring for capping will be designed to ensure that the design plans and specifications are followed in the placement of the cap and to monitor the extent of any contaminant releases during cap placement. Construction monitoring will likely include interim and post-construction cap material placement surveys, sediment cores, sediment profiling camera, and chemical resuspension monitoring for contaminants. In the initial period following cap construction, sediment samples will be taken to confirm that cleanup levels were achieved and benthic community assessments will be performed to evaluate restoration efforts.

Maintenance. Maintenance of the in-situ cap will include the repair and replenishment of the layers where necessary to prevent releases of contaminants.

Long-Term Monitoring. Long-term monitoring will include physical, chemical, and biological measurements in various media to evaluate long-term remedy effectiveness in achieving remedial action objectives (RAOs), attaining cleanup levels, and in reducing human health and environmental risk. In addition, long-term monitoring data is needed to complete the five-year review process.

1.4 The terms used in this SOW that are defined in CERCLA, in regulations promulgated under CERCLA, or in the Consent Decree (CD), have the meanings assigned to them in CERCLA, in such regulations, or in the CD, except that the term "Paragraph" or "¶" means a paragraph of the SOW, and the term "Section" means a section of the SOW, unless otherwise stated.

2. COMMUNITY INVOLVEMENT

2.1 Community Involvement Responsibilities

(a) EPA has the lead responsibility for developing and implementing community involvement activities at the Site. Previously during the RI/FS phase, EPA developed a Community Involvement Plan (CIP) for the Site. Pursuant to 40 C.F.R. § 300.435(c), EPA shall review the existing CIP and determine whether it should be revised to describe further public involvement activities during the Work that are not already addressed or provided for in the existing CIP.

(b) If requested by EPA, SDs shall participate in community involvement activities, including participation in (1) the preparation of information regarding the Work for dissemination to the public, with consideration given to including mass media and/or Internet notification, and (2) public meetings that may be held or sponsored by EPA to explain activities at or relating to the Site. SDs' support of EPA's community involvement activities may include providing online access to initial submissions and updates of deliverables to (1) any Community Advisory Groups, (2) any Technical Assistance Grant recipients and their advisors, and (3) other entities to provide them with a reasonable opportunity for review and comment. EPA may describe in its CIP SDs' responsibilities for community involvement activities. All community involvement activities conducted by SDs at EPA's request are subject to EPA's oversight.

(c) **SDs' CI Coordinator**. If requested by EPA, SDs shall, within 30 days, designate and notify EPA of SDs' Community Involvement Coordinator (SDs' CI Coordinator). SDs may hire a contractor for this purpose. SDs' notice must include the name, title, and qualifications of the SDs' CI Coordinator. SDs' CI Coordinator is responsible for providing support regarding EPA's community involvement activities, including coordinating with EPA's CI Coordinator regarding responses to the public's inquiries about the Site.

3. REMEDIAL DESIGN

3.1 RD Work Plan. SDs shall submit a Remedial Design (RD) Work Plan (RDWP) for EPA approval. The RDWP must include:

(a) Plans for implementing all RD activities identified in this SOW, in the RDWP, or required by EPA to be conducted to develop the RD;

(b) A description of the overall management strategy for performing the RD, including a proposal for phasing of design and construction, if applicable;

(c) A description of the proposed general approach to contracting, construction, operation, maintenance, and monitoring of the Remedial Action (RA) as necessary to implement the Work;

(d) A description of the responsibility and authority of all organizations and key personnel involved with the development of the RD;

(e) Descriptions of any areas requiring clarification and/or anticipated problems (e.g., data gaps);

(f) Description of any proposed pre-design investigation;

(g) Description of any proposed treatability study;

(h) Descriptions of any applicable permitting requirements and other regulatory requirements;

(i) Description of plans for obtaining access in connection with the Work, such as property acquisition, property leases, and/or easements; and

(j) The following supporting deliverables described in ¶ 6.7 (Supporting Deliverables): Health and Safety Plan; Emergency Response Plan, Field Sampling Plan, and Quality Assurance Project Plan.

3.2 SDs shall meet regularly with EPA to discuss design issues as necessary, as directed or determined by EPA.

3.3 **Pre-Design Investigation**. The purpose of the Pre-Design Investigation (PDI) is to address data gaps by conducting additional field investigations. The PDI will include geotechnical and chemical sampling of media in OU2 to support a proper and effective design of the sediment cap as needed to fill data gaps identified in the PDI work plan**.**

(a) **PDI Work Plan**. SDs shall submit a PDI Work Plan (PDIWP) for EPA approval. The PDIWP must include:

(1) An evaluation and summary of existing data and description of data gaps;

(2) A sampling plan including media to be sampled, contaminants or parameters for which sampling will be conducted, location (areal extent and depths), and number of samples; and

(3) Cross references to quality assurance/quality control (QA/QC) requirements set forth in the Quality Assurance Project Plan (QAPP) as described in ¶ 6.7(d).

(b) Following the PDI, SDs shall submit a PDI Evaluation Report. This report must include:

(1) Summary of the investigations performed;

(2) Summary of investigation results;

(3) Summary of validated data (i.e., tables and graphics);

(4) Data validation reports and laboratory data reports;

(5) Narrative interpretation of data and results;

(6) Results of statistical and modeling analyses, if performed; and

(7) Photographs documenting the work conducted; and

(8) Conclusions and recommendations for RD, including design parameters and criteria.

(c) EPA may require SDs to supplement the PDI Evaluation Report and/or to perform additional pre-design studies.

3.4 Treatability Study

(a) SDs shall submit to EPA their analysis and recommendation of the need to perform a Treatability Study (TS) for the purpose of evaluating capping materials, geotechnical parameters, and placement methods.

(b) If EPA determines a TS is needed, SDs shall submit a TS Work Plan (TSWP) for EPA approval. SDs shall prepare the TSWP in accordance with EPA's *Guide for Conducting Treatability Studies under CERCLA, Final* (Oct. 1992), as supplemented for RD by the *Remedial Design/Remedial Action Handbook*, EPA 540/R-95/059 (June 1995).

(c) Following completion of the TS, SDs shall submit a TS Evaluation Report for EPA comment.

(d) EPA may require SDs to supplement the TS Evaluation Report and/or to perform additional treatability studies.

3.5 Preliminary (30%) RD. SDs shall submit a Preliminary (30%) RD for EPA's comment. The Preliminary RD must include:

(a) A design criteria report, as described in the *Remedial Design/Remedial Action Handbook*, EPA 540/R-95/059 (June 1995);

(b) Preliminary drawings and specifications;

(c) Descriptions of permit requirements, if applicable;

(d) A description of how the RA will be implemented in a manner that minimizes environmental impacts in accordance with EPA's *Principles for Greener Cleanups* (Aug. 2009);

(e) A description of monitoring and control measures to protect human health and the environment, such as air monitoring and dust suppression, during the RA;

(f) Any proposed revisions to the RA Schedule that is set forth in ¶ 7.3 (RA Schedule); and OU2 Long Term Monitoring Plan; Construction Quality Assurance/Quality Control Plan; Transportation and Off-Site Disposal Plan; O&M Plan; O&M Manual; and Institutional Controls Implementation and Assurance Plan.

3.6 Pre-Final (95%) RD. SDs shall submit the Pre-final (95%) RD for EPA's comment. The Pre-final RD must be a continuation and expansion of the previous design submittal and must address EPA's comments regarding the Preliminary RD. The Pre-final RD will serve as the approved Final (100%) RD if EPA approves the Pre-final RD without comments. The Pre-final RD must include:

(a) A complete set of construction drawings and specifications that are: (1) certified by a registered professional engineer; (2) suitable for procurement; and (3) follow the Construction Specifications Institute's Master Format 2018 Edition.

(b) A survey and engineering drawings showing existing Site features, such as elements, property borders, easements, and Site conditions;

(c) Pre-Final versions of the same elements and deliverables as are required for the Preliminary RD;

(d) A specification for photographic documentation of the RA; and

(e) Pre-Final Operation and Maintenance (O&M) Plan and O&M Manual; and

(f) Updates of all supporting deliverables required to accompany the Preliminary (30%) RD.

3.7 **Final (100%) RD**. SDs shall submit the Final (100%) RD for EPA approval. The Final RD must address EPA's comments on the Pre-final RD and must include final versions of all Pre-final RD deliverables.

4. REMEDIAL ACTION

4.1 **RA Work Plan**. SDs shall submit a RA Work Plan (RAWP) for EPA approval that includes:

(a) A proposed RA Construction Schedule;

(b) An updated health and safety plan that covers activities during the RA; and

(c) Plans for satisfying permitting requirements, including obtaining permits for off-site activity and for satisfying substantive requirements of permits for on-site activity.

4.2 **Independent Quality Assurance Team**. SDs shall notify EPA of SDs' designated Independent Quality Assurance Team (IQAT). The IQAT will be independent of the Remedial Action Constructor. SDs may hire a third party for this purpose. SDs' notice must include the names, titles, contact information, and qualifications of the members of the IQAT. The IQAT will have the responsibility to determine whether Work is of expected quality and conforms to applicable plans and specifications. The IQAT will have the responsibilities as described in Section 2.1.3 of the *Guidance on EPA Oversight of Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties*, EPA/540/G-90/001 (Apr. 1990).

4.3 Meetings and Inspections

(a) **Preconstruction Conference**. SDs shall hold a preconstruction conference with EPA and others as directed or approved by EPA and as described in the *Remedial Design/Remedial Action Handbook*, EPA 540/R-95/059 (June 1995). SDs shall prepare minutes of the conference and shall distribute the minutes to all Parties.

(b) **Periodic Meetings**. During the construction portion of the RA (RA Construction), SDs shall meet regularly with EPA, and others as directed or determined by EPA, to discuss construction issues. The meetings may be in person or via teleconference. SDs shall distribute an agenda and list of attendees to all Parties prior to each meeting. SDs shall prepare minutes of the meetings and shall distribute the minutes to all Parties.

(c) **Inspections**

(1) EPA or its representative shall conduct periodic inspections of or have an on-site presence during the Work. At EPA's request, the Supervising Contractor or other designee shall accompany EPA or its representative during inspections.

(2) SDs shall provide on-site office space for EPA personnel to perform their oversight duties when requested. The minimum office requirements are an office desk with chair, access to reproduction, wireless internet access if feasible, and sanitation facilities.

(3) SDs shall provide personal protective equipment needed for EPA personnel and any oversight officials to perform their oversight duties.

(4) Upon notification by EPA of any deficiencies in the RA Construction, SDs shall take all necessary steps to correct the deficiencies and/or bring the RA Construction into compliance with the approved Final RD, any approved design changes, and/or the approved RAWP. If applicable, SDs shall comply with any schedule provided by EPA in its notice of deficiency.

4.4 Emergency Response and Reporting

(a) **Emergency Response and Reporting**. If any event occurs during performance of the Work that causes or threatens to cause a release of Waste Material on, at, or from the Site and that either constitutes an emergency situation or that may present an immediate threat to public health or welfare or the environment, SDs shall: (1) immediately take all appropriate action to prevent, abate, or minimize such release or threat of release; (2) immediately notify the authorized EPA officer (as specified in ¶ 4.4(c)) orally; and (3) take such actions in consultation with the authorized EPA officer and in accordance with all applicable provisions of the Health and Safety Plan, the Emergency Response Plan, and any other deliverable approved by EPA under the SOW.

(b) **Release Reporting**. Upon the occurrence of any event during performance of the Work that SDs are required to report pursuant to Section 103 of CERCLA, 42 U.S.C. § 9603, or Section 304 of the Emergency Planning and Community Right-to-know Act (EPCRA), 42 U.S.C. § 11004, SDs shall immediately notify the authorized EPA officer orally.

(c) The "authorized EPA officer" for purposes of immediate oral notifications and consultations under ¶ 4.4(a) and ¶ 4.4(b) is the EPA Project Coordinator, the EPA Alternate Project Coordinator (if the EPA Project Coordinator is unavailable), or the EPA [Emergency Response Unit], Region 4 (if neither EPA Project Coordinator is available).

(d) For any event covered by ¶ 4.4(a) and ¶ 4.4(b), SDs shall: (1) within [14] days after the onset of such event, submit a report to EPA describing the actions or events that occurred and the measures taken, and to be taken, in response thereto; and (2) within 30 days after the conclusion of such event, submit a report to EPA describing all actions taken in response to such event.

(e) The reporting requirements under ¶ 4.4 are in addition to the reporting required by CERCLA § 103 or EPCRA § 304.

4.5 Off-Site Shipments

(a) SDs may ship hazardous substances, pollutants, and contaminants from the Site to an off-Site facility only if they comply with Section 121(d)(3) of CERCLA, 42 U.S.C. § 9621(d)(3), and 40 C.F.R. § 300.440. SDs will be deemed to be in compliance with CERCLA § 121(d)(3) and 40 C.F.R. § 300.440 regarding a shipment if SDs obtain a prior determination from EPA that the proposed receiving facility for such shipment is acceptable under the criteria of 40 C.F.R. § 300.440(b).

(b) SDs may ship Waste Material from the Site to an out-of-state waste management facility only if, prior to any shipment, they provide notice to the appropriate state environmental official in the receiving facility's state and to the EPA Project Coordinator. This notice requirement will not apply to any off-Site shipments when the total quantity of all such shipments does not exceed 10 cubic yards. The notice must include the following information, if available: (1) the name and location of the receiving facility; (2) the type and quantity of Waste Material to be shipped; (3) the schedule for the shipment; and (4) the method of transportation. SDs also shall notify the state environmental official referenced above and the EPA Project Coordinator of any major changes in the shipment plan, such as a decision to ship the Waste Material to a different out-of-state facility. SDs shall provide the notice after the award of the contract for RA construction and before the Waste Material is shipped.

(c) SDs may ship Investigation Derived Waste (IDW) from the Site to an off-Site facility only if they comply with Section 121(d)(3) of CERCLA, 42 U.S.C.

§ 9621(d)(3), 40 C.F.R. § 300.440, *EPA's Guide to Management of Investigation Derived Waste*, OSWER 9345.3-03FS (Jan. 1992), and any IDW-specific requirements contained in the ROD. Wastes shipped off-Site to a laboratory for characterization, and RCRA hazardous wastes that meet the requirements for an exemption from RCRA under 40 CFR § 261.4(e) shipped off-site for treatability studies, are not subject to 40 C.F.R. § 300.440.

4.6 RA Construction Completion

(a) For purposes of this ¶ 4.6, "RA Construction" comprises, for any RA that involves the construction and operation of a system to achieve Performance Standards (for example, groundwater or surface water restoration remedies), the construction of such system and the performance of all activities necessary for the system to function properly and as designed.

(b) **Inspection of Constructed Remedy**. SDs shall schedule an inspection to review the construction and operation of the system and to review whether the system is functioning properly and as designed. The inspection must be attended by SDs and EPA and/or their representatives. A re-inspection must be conducted if requested by EPA.

(c) **RA Report**. SDs shall submit an "RA Report" requesting EPA's determination that RA Construction has been completed. The RA Report must: (1) include statements by a registered professional engineer and by SDs' Project Coordinator that construction of the system is complete and that the system is functioning properly and as designed; (2) include a demonstration, and supporting documentation, that construction of the system is complete and that the system is functioning properly and as designed; (3) include as-built drawings signed and stamped by a registered professional engineer; (4) be prepared in accordance with Chapter 2 (Remedial Action Completion) of EPA's *Close Out Procedures for NPL Sites* guidance (May 2011), as supplemented by *Guidance for Management of Superfund Remedies in Post Construction*, OLEM 9200.3-105 (Feb. 2017); and (5) be certified in accordance with ¶ 6.5 (Certification).

(d) If EPA determines that RA Construction is not complete, EPA shall so notify SDs. EPA's notice must include a description of, and schedule for, the activities that SDs must perform to complete RA Construction. EPA's notice may include a schedule for completion of such activities or may require SDs to submit a proposed schedule for EPA approval. SDs shall perform all activities described in the EPA notice in accordance with the schedule.

(e) If EPA determines, based on the initial or any subsequent RA Report, that RA Construction is complete, EPA shall so notify SDs.

4.7 RA Completion

(a) **RA Monitoring Report**. SDs shall submit a RA Monitoring Report to EPA. The report must: (1) include certifications by a registered professional engineer and by

SD's Project Coordinator that the RA is complete; (2) contain monitoring data to demonstrate that Performance Standards have been achieved; and (3) be certified in accordance with ¶ 6.5 (Certification).

(b) If EPA concludes that the RA is not Complete, EPA shall so notify SDs. EPA's notice must include a description of any deficiencies. EPA's notice may include a schedule for addressing such deficiencies or may require SDs to submit a schedule for EPA approval. SDs shall perform all activities described in the notice in accordance with the schedule.

(c) If EPA concludes, based on the initial or any subsequent RA Monitoring Report requesting Certification of Work Completion, that the Work is Complete, EPA shall so certify to SDs in accordance with ¶ 4.9.

4.8 Periodic Review Support Plan (PRSP). SDs shall submit the PRSP for EPA approval. The PRSP addresses the studies and investigations that SDs shall conduct to support EPA's reviews of whether the RA is protective of human health and the environment in accordance with Section 121(c) of CERCLA, 42 U.S.C. § 9621(c) (also known as "Five-year Reviews"). SDs shall develop the plan in accordance with *Comprehensive Five-year Review Guidance*, OSWER 9355.7-03B-P (June 2001), and any other relevant five-year review guidance.

4.9 Certification of Work Completion

(a) **Work Completion Inspection**. SDs shall schedule an inspection for the purpose of obtaining EPA's Certification of Work Completion. The inspection must be attended by SDs and EPA and/or their representatives.

(b) **Work Completion Report**. Following the inspection, SDs shall submit a report to EPA requesting EPA's Certification of Work Completion. The report must: (1) include certifications by a registered professional engineer and by SDs' Project Coordinator that the Work, including all O&M activities, is complete; and (2) be certified in accordance with ¶ 6.5 (Certification). If the RA Monitoring Report submitted under ¶ 4.7(a) includes all elements required under this ¶ 4.9(b), then the RA Monitoring Report/ suffices to satisfy all requirements under this ¶ 4.9(b).

(c) If EPA concludes that the Work is not complete, EPA shall so notify SDs. EPA's notice must include a description of the activities that SDs must perform to complete the Work. EPA's notice must include specifications and a schedule for such activities or must require SDs to submit specifications and a schedule for EPA approval. SDs shall perform all activities described in the notice or in the EPA-approved specifications and schedule.

(d) If EPA concludes, based on the initial or any subsequent report requesting Certification of Work Completion, that the Work is complete, EPA shall so certify in writing to SDs. Issuance of the Certification of Work Completion does not affect the following continuing obligations: (1) activities under the Periodic

Review Support Plan; (2) obligations under Sections VIII (Property Requirements), XXI (Retention of Records), and XVIII (Access to Information) of the CD; (3) Institutional Controls obligations as provided in the ICIAP; and (4) reimbursement of EPA's Future Response Costs under Section X (Payments for Response Costs) of the CD.

5. REPORTING

5.1 **Progress Reports**. Commencing with the month following lodging of the CD and until EPA approves the Work Completion, SDs shall submit progress reports to EPA on a monthly basis, or as otherwise requested by EPA. The reports must cover activities that took place during the prior reporting period, including:

(a) The actions that have been taken toward achieving compliance with the CD;

(b) A summary of all results of sampling, tests, and all other data received or generated by SDs;

(c) A summary of all deliverables that SDs submitted to EPA;

(d) A summary of all activities relating to RA Construction that are scheduled for the next six weeks;

(e) An updated RA Construction Schedule, together with information regarding completed items, delays encountered or anticipated that may affect the future schedule for implementation of the Work, and a summary of efforts made to mitigate those delays or anticipated delays;

(f) A summary of any modifications to the work plans or other schedules that SDs have proposed or that have been approved by EPA; and

(g) A summary of all activities undertaken in support of the Community Involvement Plan (CIP) during the reporting period and those to be undertaken in the next six weeks.

5.2 **Notice of Progress Report Schedule Changes**. If the schedule for an activity described in the Progress Reports, including activities required to be described under ¶ 5.1(d), changes, SDs shall notify EPA of such change at least 7 days before performance of the activity.

6. DELIVERABLES

6.1 **Applicability**. SDs shall submit deliverables for EPA approval or for EPA comment as specified in the SOW. If neither is specified, the deliverable does not require EPA's approval or comment. Paragraphs 6.2 (In Writing) through 6.4 (Technical Specifications) apply to all deliverables. Paragraph 6.5 (Certification) applies to any deliverable that is required to be certified. Paragraph 6.6 (Approval of Deliverables) applies to any deliverable that is required to be submitted for EPA approval.

6.2 **In Writing**. As provided in ¶ 87 of the CD, all deliverables under this SOW must be in writing unless otherwise specified.

6.3 **General Requirements for Deliverables.** All deliverables must be submitted by the deadlines in the RD Schedule or RA Schedule, as applicable. SDs shall submit all deliverables to EPA in electronic form. Technical specifications for sampling and monitoring data and spatial data are addressed in ¶ 6.4. All other deliverables shall be submitted to EPA in the electronic form specified by the EPA Project Coordinator. If any deliverable includes maps, drawings, or other exhibits that are larger than 8.5" by 11", SDs shall also provide EPA with paper copies of such exhibits.

6.4 **Technical Specifications**

(a) Sampling, monitoring and environmental data should be submitted in accordance with EPA Region 4 Superfund Environmental Data Submission Procedure (July2019). The standard Region 4 Electronic Data Deliverable (EDD) format is available at: https://www.epa.gov/superfund/region-4-superfund-electronic-data-submission. Other delivery methods may be allowed if electronic direct submission technology changes.

(b) Spatial data, including spatially-referenced data and geospatial data, should be submitted in accordance with EPA Region 4 Superfund Environmental Data Submission Procedure (July 2019). The standard Region 4 spatial format is available at: https://www.epa.gov/superfund/region-4-superfund-electronic-data-submission. Other delivery methods may be allowed if electronic direct submission technology changes. Spatial data submitted by SDs does not, and is not intended to, define the legal boundaries of the Site.

6.5 **Certification**. All deliverables that require compliance with this ¶ 6.5 must be signed by the SDs' Project Coordinator, or other responsible official of SDs, and must contain the following statement:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I have no personal knowledge that the information submitted is other than true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

6.6 **Approval of Deliverables**

(a) **Initial Submissions**

(1) After review of any deliverable that is required to be submitted for EPA approval under the CD or the SOW, EPA shall: (i) approve, in whole or in part, the submission; (ii) approve the submission upon specified conditions; (iii) disapprove, in whole or in part, the submission; or (iv) any combination of the foregoing.

(2) EPA also may modify the initial submission to cure deficiencies in the submission if: (i) EPA determines that disapproving the submission and awaiting a resubmission would cause substantial disruption to the Work; or (ii) previous submission(s) have been disapproved due to material defects and the deficiencies in the initial submission under consideration indicate a bad faith lack of effort to submit an acceptable deliverable.

(b) **Resubmissions**. Upon receipt of a notice of disapproval under ¶ 6.6(a) (Initial Submissions), or if required by a notice of approval upon specified conditions under ¶ 6.6(a), SDs shall, within 30 days or such longer time as specified by EPA in such notice, correct the deficiencies and resubmit the deliverable for approval. After review of the resubmitted deliverable, EPA may: (1) approve, in whole or in part, the resubmission; (2) approve the resubmission upon specified conditions; (3) modify the resubmission; (4) disapprove, in whole or in part, the resubmission, requiring SDs to correct the deficiencies; or (5) any combination of the foregoing.

(c) **Implementation**. Upon approval, approval upon conditions, or modification by EPA under ¶ 6.6(a) (Initial Submissions) or ¶ 6.6(b) (Resubmissions), of any deliverable, or any portion thereof: (1) such deliverable, or portion thereof, will be incorporated into and be enforceable under the CD; and (2) SDs shall take any action required by such deliverable, or portion thereof. The implementation of any non-deficient portion of a deliverable submitted or resubmitted under ¶ 6.6(a) or ¶ 6.6(b) does not relieve SDs of any liability for stipulated penalties under Section XIV (Stipulated Penalties) of the CD.

6.7 **Supporting Deliverables**. SDs shall submit each of the following supporting deliverables for EPA approval, except as specifically provided. SDs shall develop the deliverables in accordance with applicable regulations, guidance, and policies (see Section 9 (References)). SDs shall update each of these supporting deliverables as necessary or appropriate during the course of the Work, and/or as requested by EPA.

(a) **Health and Safety Plan**. The Health and Safety Plan (HASP) describes all activities to be performed to protect on site personnel and area residents from physical, chemical, and all other hazards posed by the Work. SDs shall develop the HASP in accordance with EPA's Emergency Responder Health and Safety and Occupational Safety and Health Administration (OSHA) requirements under 29 C.F.R. §§ 1910 and 1926. The HASP should cover RD activities and should be, as appropriate, updated to cover activities during the RA and updated to cover activities after RA completion. EPA does not approve the HASP, but will review it to ensure that all necessary elements are included and that the plan provides for the protection of human health and the environment.

(b) **Emergency Response Plan**. The Emergency Response Plan (ERP) must describe procedures to be used in the event of an accident or emergency at the Site (for example, power outages, water impoundment failure, treatment plant failure, slope failure, etc.). The ERP must include:

(1) Name of the person or entity responsible for responding in the event of an emergency incident;

(2) Plan for meeting(s) with the local community, including local, State, and federal agencies involved in the cleanup, as well as local emergency squads and hospitals;

(3) Spill Prevention, Control, and Countermeasures (SPCC) Plan (if applicable), consistent with the regulations under 40 C.F.R. Part 112, describing measures to prevent, and contingency plans for, spills and discharges;

(4) Notification activities in accordance with ¶ 4.4(b) (Release Reporting) in the event of a release of hazardous substances requiring reporting under Section 103 of CERCLA, 42 U.S.C. § 9603, or Section 304 of the Emergency Planning and Community Right-to-know Act (EPCRA), 42 U.S.C. § 11004; and

(5) A description of necessary actions to ensure compliance with Paragraph 11 (Emergencies and Releases) of the CD in the event of an occurrence during the performance of the Work that causes or threatens a release of Waste Material from the Site that constitutes an emergency or may present an immediate threat to public health or welfare or the environment.

(c) **Field Sampling Plan**. The Field Sampling Plan (FSP) addresses all sample collection activities. The FSP must be written so that a field sampling team unfamiliar with the project would be able to gather the samples and field information required. SDs shall develop the FSP in accordance with *Guidance for Conducting Remedial Investigations and Feasibility Studies*, EPA/540/G 89/004 (Oct. 1988).

(d) **Quality Assurance Project Plan**. The Quality Assurance Project Plan (QAPP) augments the FSP and addresses sample analysis and data handling regarding the Work. The QAPP must include a detailed explanation of SDs' quality assurance, quality control, and chain of custody procedures for all treatability, design, compliance, and monitoring samples. SDs shall develop the QAPP in accordance with *EPA Requirements for Quality Assurance Project Plans*, QA/R-5, EPA/240/B-01/003 (Mar. 2001, reissued May 2006); *Guidance for Quality Assurance Project Plans*, QA/G-5, EPA/240/R 02/009 (Dec. 2002); and *Uniform*

Federal Policy for Quality Assurance Project Plans, Parts 1-3, EPA/505/B-04/900A though 900C (Mar. 2005). The QAPP also must include procedures:

(1) To ensure that EPA and the State and their authorized representative have reasonable access to laboratories used by SDs in implementing the CD (SDs' Labs);

(2) To ensure that SDs' Labs analyze all samples submitted by EPA pursuant to the QAPP for quality assurance monitoring;

(3) To ensure that SDs' Labs perform all analyses using EPA-accepted methods (i.e., the methods documented in *USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis*, ILM05.4 (Dec. 2006); *USEPA Contract Laboratory Program Statement of Work for Organic Analysis*, SOM01.2 (amended Apr. 2007); and *USEPA Contract Laboratory Program Statement of Work for Inorganic Superfund Methods (Multi-Media, Multi-Concentration)*, ISM01.2 (Jan. 2010)) or other methods acceptable to EPA;

(4) To ensure that SDs' Labs participate in an EPA-accepted QA/QC program or other program QA/QC acceptable to EPA;

(5) For SDs to provide EPA and the State with notice at least 28 days prior to any sample collection activity; except if site conditions warrant, prior notice can be shortened to 14 days or less upon approval by EPA.

(6) For SDs to provide split samples and/or duplicate samples to EPA and the State upon request;

(7) For EPA and the State to take any additional samples that they deem necessary;

(8) For EPA and the State to provide to SDs, upon request, split samples and/or duplicate samples in connection with EPA's and the State's oversight sampling; and

(9) For SDs to submit to EPA and the State all sampling and tests results and other data in connection with the implementation of the CD.

(e) **OU-2 Long-Term Monitoring Plan**. The purpose of the OU2 Monitoring Plan (LTMP) is to obtain baseline information regarding the extent of contamination in affected media at the Site; to obtain information, through short- and long- term monitoring, about the movement of and changes in contamination throughout the Site, before and during implementation of the RA; to obtain information regarding contamination levels to determine whether Performance Standards (PS) are achieved; and to obtain information to determine whether to perform additional actions, including further Site monitoring. The OU2 LTMP must include:

(1) Description of the environmental media to be monitored;

(2) Description of the data collection parameters, including existing and proposed monitoring devices and locations, schedule and frequency of monitoring, analytical parameters to be monitored, and analytical methods employed;

(3) Description of how performance data will be analyzed, interpreted, and reported, and/or other Site-related requirements;

(4) Description of deliverables that will be generated in connection with monitoring, including sampling schedules, laboratory records, monitoring reports, and monthly and annual reports to EPA and State agencies; and

(5) Summary of potential additional monitoring and data collection actions (such as increases in frequency of monitoring, and/or installation of additional monitoring devices in the affected areas) in the event that results from monitoring devices indicate changed conditions (such as higher than expected concentrations of the contaminants of concern or groundwater contaminant plume movement).

(f) **Construction Quality Assurance/Quality Control Plan (CQA/QCP)**. The purpose of the Construction Quality Assurance Plan (CQAP) is to describe planned and systemic activities that provide confidence that the RA construction will satisfy final design plans, specifications, and related requirements, including quality objectives. The purpose of the Construction Quality Control Plan (CQCP) is to describe the activities to verify that RA construction has satisfied final design, specifications, and related requirements, including quality objectives. The CQA/QCP must:

(1) Identify, and describe the responsibilities of, the organizations and personnel implementing the CQA/QCP;

(2) Describe the PS required to be met to achieve Completion of the RA;

(3) Describe the activities to be performed: (i) to provide confidence that PS will be met; and (ii) to determine whether PS have been met;

(4) Describe verification activities, such as inspections, sampling, testing, monitoring, and production controls, under the CQA/QCP;

(5) Describe industry standards and technical specifications used in implementing the CQA/QCP;

(6) Describe procedures for tracking construction deficiencies from identification through corrective action;

(7) Describe procedures for documenting all CQA/QCP activities; and

(8) Describe procedures for retention of documents and for final storage of documents.

(g) **Transportation and Off-Site Disposal Plan**. The Transportation and Off-Site Disposal Plan (TODP) describes plans to ensure compliance with ¶ 4.5 (Off-Site Shipments). The TODP must include:

(1) Proposed routes for off-site shipment of Waste Material;

(2) Identification of communities affected by shipment of Waste Material; and

(3) Description of plans to minimize impacts on affected communities.

(h) **O&M Plan**. The O&M Plan describes the requirements for inspecting, operating, and maintaining the RA. SDs shall develop the O&M Plan in accordance with *Guidance for Management of Superfund Remedies in Post Construction*, OLEM 9200.3-105 (Feb. 2017). The O&M Plan must include the following additional requirements:

(1) Description of PS required to be met to implement the ROD;

(2) Description of activities to be performed: (i) to provide confidence that PS will be met; and (ii) to determine whether PS have been met;

(3) **O&M Reporting**. Description of records and reports that will be generated during O&M, such as daily operating logs, laboratory records, records of operating costs, reports regarding emergencies, personnel and maintenance records, monitoring reports, and monthly and annual reports to EPA and State agencies;

(4) Description of corrective action in case of systems failure, including: (i) alternative procedures to prevent the release or threatened release of Waste Material which may endanger public health and the environment or may cause a failure to achieve PS; (ii) analysis of vulnerability and additional resource requirements should a failure occur; (iii) notification and reporting requirements should O&M systems fail or be in danger of imminent failure; and (iv) community notification requirements; and

(5) Description of corrective action to be implemented in the event that PS are not achieved; and a schedule for implementing these corrective actions.

(i) **O&M Manual**. The O&M Manual serves as a guide to the purpose and function of the equipment and systems that make up the remedy. SDs shall develop the O&M Manual in accordance with *Guidance for Management of Superfund Remedies in Post Construction*, OLEM 9200.3-105 (Feb. 2017).

(j) **Institutional Controls Implementation and Assurance Plan**. The Institutional Controls Implementation and Assurance Plan (ICIAP) describes plans to implement, maintain, and enforce the Institutional Controls (ICs) at the Site. SDs shall develop the ICIAP in accordance with *Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites*, OSWER 9355.0-89, EPA/540/R-09/001 (Dec. 2012), and *Institutional Controls: A Guide to Preparing Institutional Controls Implementation and Assurance Plans at Contaminated Sites*, OSWER 9200.0-77, EPA/540/R-09/02 (Dec. 2012). The ICIAP must include the following additional requirements:

(1) Locations of recorded real property interests (e.g., easements, liens) and resource interests in the property that may affect ICs (e.g., surface, mineral, and water rights) including accurate mapping and geographic information system (GIS) coordinates of such interests; and

(2) Legal descriptions and survey maps that are prepared according to current American Land Title Association (ALTA) Survey guidelines and certified by a licensed surveyor.

7. SCHEDULES

7.1 Applicability and Revisions. All deliverables and tasks required under this SOW must be submitted or completed by the deadlines or within the time durations listed in the RD and RA Schedules set forth below. SDs may submit proposed revised RD Schedules or RA Schedules for EPA approval. Upon EPA's approval, the revised RD and/or RA Schedules supersede the RD and RA Schedules set forth below, and any previously-approved RD and/or RA Schedules.

7.2 RD Schedule

	Description of Deliverable, Task	¶ Ref.	Deadline
1	RDWP (Health & Safety Plan (6.7(a)), Emergency Response Plan (6.7(b)), Field Sampling Plan (6.7(c)),and Quality Assurance Project Plan (6.7(d))	3.1, 6.7(a), 6.7(b) 6.7(c), 6.7(d)	60 days after EPA's Authorization to Proceed regarding Supervising Contractor under CD ¶ 9.c
2	PDIWP	3.3(a)	60 days after EPA's Authorization to Proceed regarding Supervising Contractor under CD ¶ 9.c
3.	Treatability Study WP	3.4	90 days after EPA's Authorization to Proceed regarding Supervising Contractor under CD ¶ 9.c
4	Preliminary (30%) RD (PDI Evaluation Report 3.3(b)), Treatability Study Evaluation Report (3.4(c)), Preliminary Construction Quality Assurance/Quality Control Plan (6.7(f)), Preliminary Transportation and Off-Site Disposal Plan (6.7(g)), Preliminary O&M Plan (6.7(h)), and Preliminary Institutional Controls Implementation Plan (6.7(j))	3.5, 3.3(b) 3.4(c), 6.7(f), 6.7(g), 6.7(h), and 6.7(i)	180 days after EPA approval of Final RDWP (includes PDI Evaluation and Treatability Study Evaluation)
5	Pre-final (95%) RD Updates to deliverables required by Preliminary RD	3.6	60 days after EPA comments on Preliminary or Intermediate RD
6	Final (100%) RD Final versions of all deliverables described above	3.7	30 days after EPA comments on Pre-final RD

7.3 RA Schedule

	Description of Deliverable / Task	¶ Ref.	Deadline
1	Award RA contract		60 days after EPA Notice of Authorization to Proceed with RA
2	RAWP ((Health & Safety Plan (6.7(a)), Emergency Response Plan (6.7(b)), and Quality Assurance Project Plan (6.7(d))	4.1, 6.7(a), 6.7(b) 6.7(d)	90 days after EPA Notice of Authorization to Proceed with RA
3	OU2 Long-Term Monitoring Plan	6.7(e)	90 days after EPA Notice of Authorization to Proceed with RA
4	Designate IQAT	4.2	60 days after EPA's Authorization to Proceed regarding Supervising Contractor under CD ¶ 9.c
5	Pre-Construction Conference	4.3(a)	45 days after Approval of RAWP
6	Start of Construction		90 days after Approval of RAWP
7	RA Construction Pre-final Inspection	4.6(b)	30 days after completion of construction
8	RA Construction Pre-final Inspection Report	4.6(d)	15 days after completion of Pre-final Inspection
9	RA Construction Final Inspection	4.6(d)	30 days after Completion of Work identified in Pre-final Inspection Report
10	RA Construction Completion Report	4.6(d)	90 days after Final Inspection
11	RA Monitoring Report	4.7(a)	RA has been fully performed and the Performance Standards have been met.
12	Work Completion Report	4.9(b)	After O&M activities and Performance Standards have been met.
13	Periodic Review Support Plan ((Health & Safety Plan (6.7(a)), Emergency Response Plan (6.7(b)), and Quality Assurance Project Plan (6.7(d))	4.8, 6.7(a), 6.7(b) 6.7(d)	Five years after Completion of RA Construction

8. STATE PARTICIPATION

8.1 **Copies**. SDs shall, at any time they send a deliverable to EPA, send a copy of such deliverable to the State. EPA shall, at any time it sends a notice, authorization, approval, disapproval, or certification to SDs, send a copy of such document to the State.

8.2 **Review and Comment**. The State will have a reasonable opportunity for review and comment prior to:

(a) Any EPA approval or disapproval under ¶ 6.6 (Approval of Deliverables) of any deliverables that are required to be submitted for EPA approval; and

(b) Any approval or disapproval of the Construction Phase under ¶ 4.6 (RA Construction Completion), any disapproval of, or Certification of RA Completion under ¶ 4.7 (Certification of RA Completion), and any disapproval of, or Certification of Work Completion under ¶ 4.9 (Certification of Work Completion).

9. REFERENCES

9.1 The following regulations and guidance documents, among others, apply to the Work. Any item for which a specific URL is not provided below is available on one of the two EPA Web pages listed in ¶ 9.2:

(a) A Compendium of Superfund Field Operations Methods, OSWER 9355.0-14, EPA/540/P-87/001a (Aug. 1987).

(b) CERCLA Compliance with Other Laws Manual, Part I: Interim Final, OSWER 9234.1-01, EPA/540/G-89/006 (Aug. 1988).

(c) Guidance for Conducting Remedial Investigations and Feasibility Studies, OSWER 9355.3-01, EPA/540/G-89/004 (Oct. 1988).

(d) CERCLA Compliance with Other Laws Manual, Part II, OSWER 9234.1-02, EPA/540/G-89/009 (Aug. 1989).

(e) Guidance on EPA Oversight of Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties, OSWER 9355.5-01, EPA/540/G-90/001 (Apr.1990).

(f) Guidance on Expediting Remedial Design and Remedial Actions, OSWER 9355.5-02, EPA/540/G-90/006 (Aug. 1990).

(g) Guide to Management of Investigation-Derived Wastes, OSWER 9345.3-03FS (Jan. 1992).

(h) Permits and Permit Equivalency Processes for CERCLA On-Site Response Actions, OSWER 9355.7-03 (Feb. 1992).

(i) Guidance for Conducting Treatability Studies under CERCLA, OSWER 9380.3-10, EPA/540/R-92/071A (Nov. 1992).

(j) National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule, 40 C.F.R. Part 300 (Oct. 1994).

(k) Guidance for Scoping the Remedial Design, OSWER 9355.0-43, EPA/540/R-95/025 (Mar. 1995).

(l) Remedial Design/Remedial Action Handbook, OSWER 9355.0-04B, EPA/540/R-95/059 (June 1995).

(m) EPA Guidance for Data Quality Assessment, Practical Methods for Data Analysis, QA/G-9, EPA/600/R-96/084 (July 2000).

(n) Comprehensive Five-year Review Guidance, OSWER 9355.7-03B-P, 540-R-01-007 (June 2001).

(o) EPA Region 4 Superfund Environmental Data Submission, Interim Final, SEMDPROC-009-R0, (July 2019)

(p) Guidance for Quality Assurance Project Plans, QA/G-5, EPA/240/R-02/009 (Dec. 2002).

(q) Institutional Controls: Third Party Beneficiary Rights in Proprietary Controls (Apr. 2004).

(r) Quality management systems for environmental information and technology programs -- Requirements with guidance for use, ASQ/ANSI E4:2014 (American Society for Quality, February 2014).

(s) Uniform Federal Policy for Quality Assurance Project Plans, Parts 1-3, EPA/505/B-04/900A though 900C (Mar. 2005).

(t) Superfund Community Involvement Handbook, SEMS 100000070 (January 2016), https://www.epa.gov/superfund/community-involvement-tools-and-resources.

(u) EPA Guidance on Systematic Planning Using the Data Quality Objectives Process, QA/G-4, EPA/240/B-06/001 (Feb. 2006).

(v) EPA Requirements for Quality Assurance Project Plans, QA/R-5, EPA/240/B-01/003 (Mar. 2001, reissued May 2006).

(w) EPA Requirements for Quality Management Plans, QA/R-2, EPA/240/B-01/002 (Mar. 2001, reissued May 2006).

(x) USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis, ILM05.4 (Dec. 2006).

(y) USEPA Contract Laboratory Program Statement of Work for Organic Analysis, SOM01.2 (amended Apr. 2007).

(z) EPA National Geospatial Data Policy, CIO Policy Transmittal 05-002 (Aug. 2008), https://www.epa.gov/geospatial/geospatial-policies-and-standards and https://www.epa.gov/geospatial/epa-national-geospatial-data-policy.

(aa) Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration, OSWER 9283.1-33 (June 2009).

(bb) Principles for Greener Cleanups (Aug. 2009), https://www.epa.gov/greenercleanups/epa-principles-greener-cleanups.

(cc) USEPA Contract Laboratory Program Statement of Work for Inorganic Superfund Methods (Multi-Media, Multi-Concentration), ISM01.2 (Jan. 2010).

(dd) Close Out Procedures for National Priorities List Sites, OSWER 9320.2-22 (May 2011).

(ee) Groundwater Road Map: Recommended Process for Restoring Contaminated Groundwater at Superfund Sites, OSWER 9283.1-34 (July 2011).

(ff) Recommended Evaluation of Institutional Controls: Supplement to the "Comprehensive Five-Year Review Guidance," OSWER 9355.7-18 (Sep. 2011).

(gg) Construction Specifications Institute's MasterFormat 2018 Edition, available from https://www.csiresources.org/home.

(hh) Updated Superfund Response and Settlement Approach for Sites Using the Superfund Alternative Approach, OSWER 9200.2-125 (Sep. 2012)

(ii) Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites, OSWER 9355.0-89, EPA/540/R-09/001 (Dec. 2012).

(jj) Institutional Controls: A Guide to Preparing Institutional Controls Implementation and Assurance Plans at Contaminated Sites, OSWER 9200.0-77, EPA/540/R-09/02 (Dec. 2012).

(kk) EPA's Emergency Responder Health and Safety Manual, OSWER 9285.3-12 (July 2005 and updates), https://www.epaosc.org/_HealthSafetyManual/manual-index.htm.

(ll) Broader Application of Remedial Design and Remedial Action Pilot Project Lessons Learned, OSWER 9200.2-129 (Feb. 2013).

(mm) Guidance for Evaluating Completion of Groundwater Restoration Remedial Actions, OSWER 9355.0-129 (Nov. 2013).

(nn) Groundwater Remedy Completion Strategy: Moving Forward with the End in Mind, OSWER 9200.2-144 (May 2014).

(oo) Guidance for Management of Superfund Remedies in Post Construction, OLEM 9200.3-105 (Feb. 2017), https://www.epa.gov/superfund/superfund-post-construction-completion.

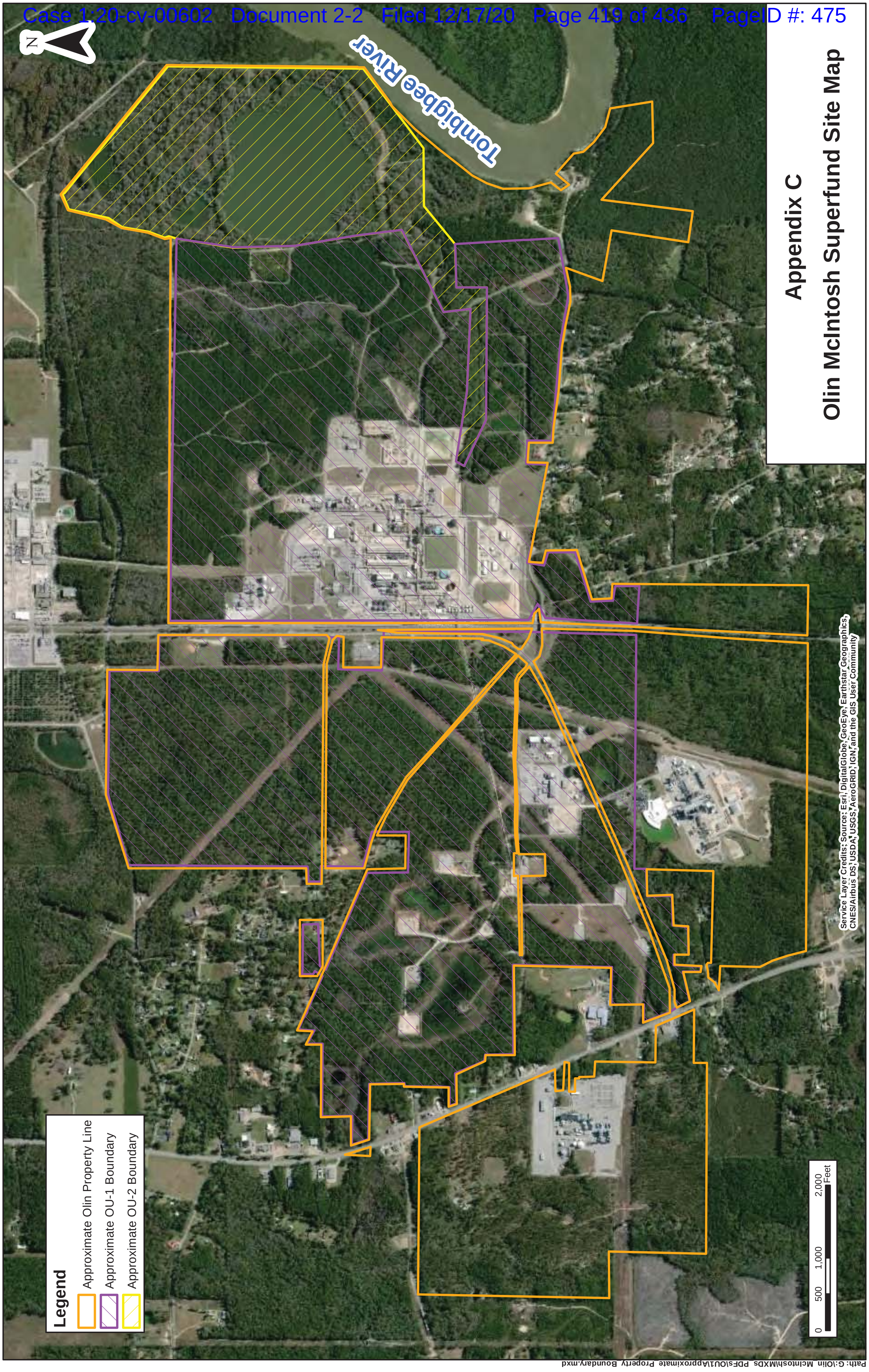
(pp) U.S. Environmental Protection Agency Region 4 Superfund Division, Environmental Data Submission, SFDPROC-009-R0 (January 27, 2017).

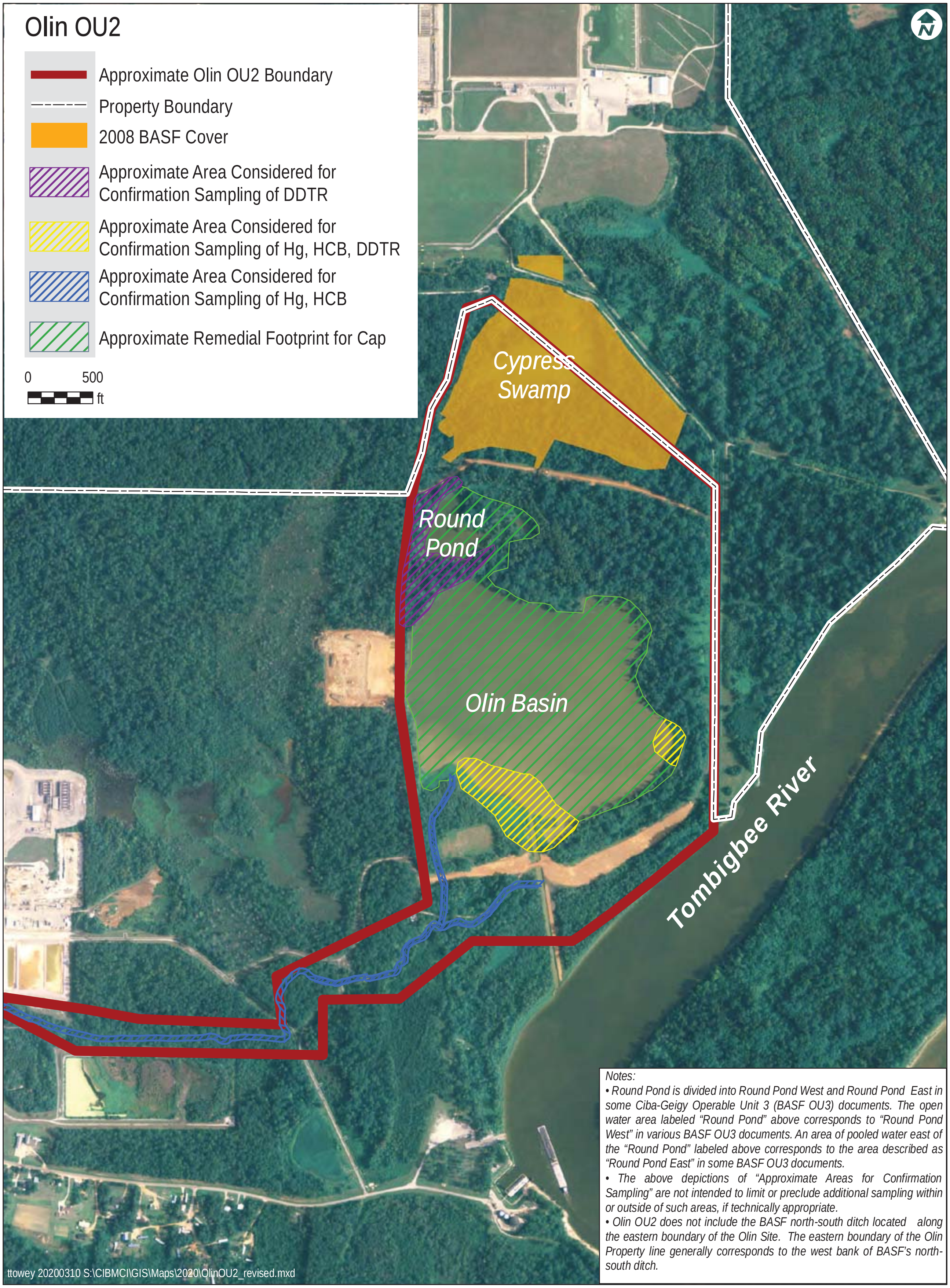
9.2 A more complete list may be found on the following EPA Web pages:

Laws, Policy, and Guidance: https://www.epa.gov/superfund/superfund-policy-guidance-and-laws

Test Methods Collections: https://www.epa.gov/measurements/collection-methods

9.3 For any regulation or guidance referenced in the CD or SOW, the reference will be read to include any subsequent modification, amendment, or replacement of such regulation or guidance. Such modifications, amendments, or replacements apply to the Work only after SDs receive notification from EPA of the modification, amendment, or replacement.


Appendix C
Olin McIntosh Superfund Site Map
N
Tombigbee River
Legend
Approximate Olin Property Line
Approximate OU-1 Boundary
Approximate OU-2 Boundary
0 500 1,000 2,000 Feet
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Path: G:\Olin McIntosh\MXDs_PDFs\OU1\Approximate Property Boundary.mxd



Notes:

• Round Pond is divided into Round Pond West and Round Pond East in some Ciba-Geigy Operable Unit 3 (BASF OU3) documents. The open water area labeled "Round Pond" above corresponds to "Round Pond West" in various BASF OU3 documents. An area of pooled water east of the "Round Pond" labeled above corresponds to the area described as "Round Pond East" in some BASF OU3 documents.

• The above depictions of "Approximate Areas for Confirmation Sampling" are not intended to limit or preclude additional sampling within or outside of such areas, if technically appropriate.

• Olin OU2 does not include the BASF north-south ditch located along the eastern boundary of the Olin Site. The eastern boundary of the Olin Property line generally corresponds to the west bank of BASF's north-south ditch.

ENVIRONMENTAL COVENANT

The NAME (hereinafter "Grantor") grants an Environmental Covenant (hereinafter "Covenant") this ___ day of _____________, 201X, to the following entities pursuant to The Alabama Uniform Environmental Covenants Act, Ala. Code §§ 35-19-1 to 35-19-14 (2014 Cum. Supp.) (hereinafter "the Act" or "Act"), and the regulations promulgated thereunder: the Alabama Department of Environmental Management and the identified holders or other applicable parties: HOLDER(S) NAME(S) IF APPLICABLE.

WHEREAS, the Grantor was the owner of certain real property located in the City of XXXXXXX, Alabama, identified as the former SITE NAME situated at PHYSICAL ADDRESS, in COUNTY NAME County, Alabama, (hereinafter "the Property"). The property which was conveyed to Grantor by deed dated DEED DATE, and recorded in the Office of the Judge of Probate for COUNTY NAME County, Alabama, in Deed Book XXX at Page XX;

WHEREAS, the Property is more particularly described as the following:

COMPLETE LEGAL SURVEY DEED DESCRIPTION OF AFFECTED AREA;

WHEREAS, this instrument is an Environmental Covenant developed and executed pursuant to the Act and the regulations promulgated thereunder;

WHEREAS, a release/disposal of hazardous substances, including, but not limited to, IDENTIFIED CONTAMINANT(S) AND MEDIA, occurred on the Property;

WHEREAS, the selected "remedial action" for the Property, which has now been implemented, providing in part, for the following actions:

DESCRIPTION OF REMEDIAL ACTION

WHEREAS, pursuant to the approved Remedial Action Plan, the Grantor and assignees agreed to perform operation and maintenance activities at the Property to address the effects of the release/disposal, which includes controlling exposure to the hazardous wastes, hazardous constituents, hazardous substances, pollutants, or contaminants;

WHEREAS, the Remedial Action Plan requires institutional controls to be implemented to address the effects of the release/disposal and to protect the remedy so that exposure to the hazardous waste, hazardous constituents, hazardous substances, pollutants, or contaminants is controlled by restricting the use of the Property and the activities on the Property;

WHEREAS, hazardous wastes, hazardous constituents, hazardous substances, pollutants, or other contaminants remain on the Property, specifically contamination has occurred in (LIST ENVIRONMENTAL MEDIA, SUCH AS GROUNDWATER, SURFACE SOILS, SUBSURFACE SOILS, SURFACE WATER, ETC.) and the following contaminant(s) remain at the site: (LIST ALL CONTAMINANTS REMAINING IN GROUNDWATER, SOIL, SEDIMENT, AND SURFACE WATERS);

WHEREAS, the purpose of this Covenant is to ensure protection of human health and the environment by placing restrictions on the Property to reduce the risk to human health to below the target risk levels for those hazardous wastes, hazardous constituents, hazardous substances, pollutants, or contaminants that remain on the Property;

WHEREAS, further information concerning the release/disposal and the activities to correct the effects of the release/disposal may be obtained by contacting Chief, Land Division, Alabama Department of Environmental Management (”ADEM”), or his or her designated representative, at 1400 Coliseum Boulevard, Montgomery, Alabama, 36110; and

WHEREAS, the Administrative Record concerning the Property is located at:

XXXXXXXXXXXXXX
XXXXXXXXXXXXXX
XXXXXXXXXXXXXX
XXXXXXXXXXXXXX

and

Alabama Department of Environmental Management
1400 Coliseum Boulevard
Montgomery, Alabama 36110

NOW, THEREFORE, Grantor hereby grants this Environmental Covenant to ADEM and the identified Holders, and declares that the Property shall hereinafter be bound by, held, sold, used, improved, occupied, leased, hypothecated, encumbered, and/or conveyed subject to the following requirements set forth in paragraphs 1 through 3 below:

1. **DEFINITIONS**

Owner. “Owner” means the GRANTOR, its successors and assigns in interest.

2. **USE RESTRICTIONS**

The following activity(ies) shall not take place on the identified Property without first obtaining written approval from ADEM through modification of this covenant:

EXAMPLE: Property is restricted to Industrial Use Only.

Use of groundwater for potable purposes.

3. **GENERAL PROVISIONS**

A. **Restrictions to Run with the Land.** This Environmental Covenant runs with the land pursuant to Ala. Code §35-19-5 (2014 Cum Supp.); is perpetual, unless modified or terminated pursuant to the terms of this Covenant pursuant to Ala. Code §35-19-9 (Cum Supp. 2014); is imposed upon the entire Property unless expressly stated as applicable only to a specific portion thereof; inures to the benefit of and passes with each and every portion of the Property; and binds the Owner, the Holders, all persons using the land, all persons, their heirs, successors and assigns having any right, title or interest in the Property, or any part thereof who have subordinated those interests to this Environmental Covenant, and all persons, their heirs, successors and assigns who obtain any right, title or interest in the Property, or any part thereof after the recordation of this Environmental Covenant.

B. **Notices Required.** In accordance with Ala. Code §35-19-4(b) (2014 Cum Supp.), the Owner shall send written notification, pursuant to Section J, below, following transfer of a specified interest in, or concerning proposed changes in use of, applications for building permits for, or proposals for any site work affecting the contamination on, the Property. Said notification shall be sent within fifteen (15) days of each event listed in this Section.

C. **Registry/Recordation of Environmental Covenant; Amendment; or Termination.** Pursuant to Ala. Code §35-19-12(b) (2014 Cum Supp.), this Environmental Covenant and any amendment or termination thereof, shall be contained in ADEM's registry for environmental covenants. After an environmental covenant, amendment, or termination is filed in the registry, a notice of the covenant, amendment, or termination may be recorded in the land records in lieu of recording the entire covenant in compliance with §35-19-12(b). Grantor shall be responsible for filing the Environmental Covenant within thirty (30) days of the final required signature upon this Environmental Covenant.

D. **Compliance Certification.** In accordance with Ala. Code §35-19-4(b) (2014 Cum Supp.), the Owner shall submit an annual report to the Director of the EPA Region 4 Superfund Division, and to the Chief of the ADEM Land Division, on the anniversary of the date this Covenant was signed by the Grantor. Said report shall detail the Owner's compliance, and any lack of compliance with the terms of the Covenant.

E. **Right of Access.** The Owner hereby grants ADEM; ADEM's agents, contractors and employees; the Owner's agents, contractors and employees; and any Holders the right of access to the Property for implementation or enforcement of this Environmental Covenant.

F. **ADEM Reservations.** Notwithstanding any other provision of this Environmental Covenant, ADEM retains all of its access authorities and rights, as well as all of its rights to require additional land/water use restrictions, including enforcement authorities related thereto.

G. **Representations and Warranties.** Grantor hereby represents and warrants to the other signatories hereto:

i) That the Grantor has the power and authority to enter into this Environmental Covenant, to grant the rights and interests herein provided and to carry out all obligations hereunder;

ii) That the Grantor is the sole owner of the Property and holds fee simple title which is free, clear and unencumbered;

iii) That ________________________has agreed to subordinate its interests in the Property to the Environmental Covenant, pursuant to Ala. Code §35-19-3(d) (2014 Cum. Supp.) in accordance with the subordination agreement *[attached hereto as Exhibit ____ or recorded at ______________________]*;

iv) That the Grantor has identified all other parties that hold any interest (e.g., encumbrance) in the Property and notified such parties of the Grantor's intention to enter into this Environmental Covenant;

v) That this Environmental Covenant will not materially violate, contravene, or constitute a material default under, any other agreement, document, or instrument to which Grantor is a party, by which Grantor may be bound or affected;

vi) That this Environmental Covenant will not materially violate or contravene any zoning law or other law regulating use of the Property;

vii) That this Environmental Covenant does not authorize a use of the Property which is otherwise prohibited by a recorded instrument that has priority over the Environmental Covenant.

H. **Compliance Enforcement.** In accordance with Ala. Code §35-19-11(b) (2014 Cum Supp.), the terms of the Environmental Covenant may be enforced by the parties to this Environmental Covenant; any person to whom this Covenant expressly grants power to enforce; any person whose interest in the real property or whose collateral or liability may be affected by the alleged violation of the Covenant; or a municipality or other unit of local government in which the real property subject to the Covenant is located, in accordance with applicable law. The parties hereto expressly agree that ADEM has the power to enforce this Environmental Covenant. Failure to timely enforce compliance with this Environmental Covenant or the use or activity limitations contained herein by any person shall not bar subsequent enforcement by such person and shall not be deemed a waiver of the person's right to take action to enforce any non-compliance. Nothing in this Environmental Covenant shall restrict ADEM, or the Grantor, from exercising any authority under applicable law.

I. **Modifications/Termination.** Any modifications or terminations to this Environmental Covenant must be made in accordance with Ala. Code §§35-19-9 and 35-19-10 (2014 Cum Supp.).

J. **Notices.** Any document or communication required to be sent pursuant to the terms of this Environmental Covenant shall be sent to the following persons:

ADEM

Chief, Land Division
Alabama Department of Environmental Management
1400 Coliseum Boulevard
Montgomery, AL 36110

Grantor

Responsible Party Name
Position
Company
Mailing Address,
City, Alabama ZIP

Holder(s) or Other Applicable Party(ies)

Name
Position
Company Name
Mailing Address
City, Alabama

K. **No Property Interest Created in ADEM.** This Environmental Covenant does not in any way create any interest by ADEM in the Property that is subject to the Environmental Covenant. Furthermore, the act of approving this Environmental Covenant does not in any way create any interest by ADEM in the Property in accordance with Ala. Code §35-19-3(b) (2014 Cum. Supp.).

L. **Severability.** If any provision of this Environmental Covenant is found to be unenforceable in any respect, the validity, legality, and enforceability of the remaining provisions shall not in any way be affected or impaired.

M. **Governing Law.** This Environmental Covenant shall be governed by and interpreted in accordance with the laws of the State of Alabama.

N. **Recordation.** In accordance with Ala. Code §35-19-8(a) (2014 Cum. Supp.), Grantor shall record this Environmental Covenant and any amendment or termination of the Environmental Covenant in every county in which any portion of the real property subject to this Environmental Covenant is located. Grantor agrees to record this Environmental Covenant within fifteen (15) days after the date of the final required signature upon this Environmental Covenant.

O. **Effective Date.** The effective date of this Environmental Covenant shall be the date upon which the fully executed Environmental Covenant has been recorded, in accordance with Ala. Code §35-19-8(a) (2014 Cum. Supp).

P. **Distribution of Environmental Covenant.** Within fifteen (15) days of filing this Environmental Covenant, the Grantor shall distribute a recorded and date stamped copy of the recorded Environmental Covenant in accordance with Ala. Code §35-19-7(a) (2014 Cum Supp.). However, the validity of this Environmental Covenant will not be affected by the failure to provide a copy of the Covenant as provided herein.

Q. **ADEM References.** All references to ADEM shall include successor agencies, departments, divisions, or other successor entities.

R. **Grantor References.** All references to the Grantor shall include successor agencies, departments, divisions, or other successor entities.

S. **Other Applicable Party(ies).** All references to Other Applicable Party(ies) shall include successor agencies, departments, divisions, or other successor entities.

Property owner has caused this Environmental Covenant to be executed pursuant to The Alabama Uniform Environmental Covenants Act, on this ___ day of __________, 201X.

IN TESTIMONY WHEREOF, the parties have hereunto set their hands this the day and year first above written.

NAME OF GRANTOR

This Environmental Covenant is hereby approved by the NAME OF GRANTOR, Alabama this ___ day of ________________, 201X.

By: ________________________________

Name & Title

Grantor

STATE OF __________)
)
COUNTY OF _________)

I, ______________, a _______________ in and for said County in said State or Commonwealth, hereby certify that ______________________, whose name as __________________ [title] of _________________________ [Grantor] is signed to the foregoing conveyance and who is known to me, acknowledged before me on this day that, being informed of the contents of the conveyance, (s)he, as such officer and with full authority executed the same voluntarily for and as the act of said corporation.

Given under my hand this the ____ day of ___________, 201X

Notary Public: ______________________

My Commission Expires: ______________

OTHER APPLICABLE PARTY(IES)

This Environmental Covenant is hereby approved by any OTHER APPLICABLE PARTY(IES)this ____ day of ____________________, 201X.

By: ____
Name & Title

Holder

STATE OF ____________)
)
COUNTY OF ___________)

I, _________________, a __________________ in and for said County in said State or Commonwealth, hereby certify that __________________________, whose name as ______________________ [title] of _______________________________ [Party] is signed to the foregoing conveyance and who is known to me, acknowledged before me on this day that, being informed of the contents of the conveyance, (s)he, as such officer and with full authority executed the same voluntarily for and as the act of said corporation.

Given under my hand this the _____ day of ____________, 201X

Notary Public: _________________________

My Commission Expires: ________________

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

This Environmental Covenant is hereby approved by the State of Alabama this ___ day of ___________, 201X.

By: ____

Phillip D. Davis
Chief, Land Division
Alabama Department of Environmental Management

State of Alabama}

Montgomery, County}

I, the undersigned Notary Public in and for said County and State, hereby certify that Phillip D. Davis, whose name as Chief, Land Division, Alabama Department of Environmental Management is signed to the foregoing conveyance, and who is known to me, acknowledged before me on this day that, being informed of the contents of the conveyance, he approved the same voluntarily on the day the same bears date and with full authority to do so.

Given under my hand and official seal this ____ day of ______________, 201X

____
Notary Public

My Commission Expires: _______________

STATE OF ALABAMA

COUNTY OF XXXXXXXXXXXX

I, ____, Clerk of the XXXX County Court, do certify that the foregoing Environmental Covenant *[and, if applicable, attached Subordination Agreement]* was lodged in my office for record, and that I have recorded it, this ___ day of ___________________, 201X in the Deed Recordation Book ### on Page ###.

____

County Clerk

This instrument prepared by:

GRANTOR
Mailing Address
City, Alabama ZIP

SUBORDINATION AGREEMENT

[Name of Interest Holder] (hereinafter "Subordinator of Interest"), of [address], [county], [State], is the holder of a [type of interest, lien, mortgage, easement, etc] granted by ____________________ to _____________________, dated ___________ and recorded with the ___________ County Clerks Office in [Deed, Lis Pendens, etc.] Book _______, Page ________.

[Name of Interest Holder] hereby assents to the grant of this Environmental Covenant granted by (Property Owner) to (Grantees i.e. Holders) and recorded with the ____________ County Clerk in Deed Book ________, Page________[to be filled in upon recordation simultaneously with filing of Environmental Covenant] [Or to the grant of the attached Environmental Covenant granted by (Grantor) to (Grantees, i.e. Holders)] and agrees that the [type of interest] shall be subject to said Environmental Covenant and to the rights, covenants, restrictions and easements created by and under said Environmental Covenant insofar as the interests created under the [type of interest] affect the Property or Impacted Area identified in the Environmental Covenant and as if for all purposes said Environmental Covenant had been executed, delivered and recorded prior to the execution, delivery and recordation and/or registration of the [type of interest].

The execution of this subordination agreement by [Name of Interest Holder] shall not subject such person to liability for environmental remediation pursuant to (Applicable Alabama Legal Authorities), provided that such person shall not otherwise be liable for environmental remediation under another provision of law.

The execution of this subordination agreement by [Name of Interest Holder] shall not be presumed to impose any affirmative obligation on the person with respect to said Environmental Covenant.

[Name of Interest Holder] act of subordinating his/her/its prior interest in the Property to said Environmental Covenant shall not affect the priority of that interest in relation to any other interests that exist in relation to the property.

[Name of Interest Holder] further assents specifically to the subsequent recordation and/or registration of a modification to the Environmental Covenant, in accordance with the terms as referenced in the Environmental Covenant and agrees that [type of interest] shall be subject to the Modified Environmental Covenant and to the rights, covenants, restrictions, and easements created thereby and there under insofar as the interests created under the [type of interest] affect the Property or Impacted Areas as so modified and as if for all purposes said Modified Environmental Covenant had been executed, delivered and recorded prior to the execution, delivery and recordation of the [type of interest].

[Name of Interest Holder] has caused this instrument to be executed this ___ day of _____________, 201X.

_________________________ _______________________
Name of Interest Holder Date

STATE OF ____________)
)
COUNTY OF ___________)

I, ________________, a _________________ in and for said County in said State or Commonwealth, hereby certify that _________________________, whose name as ____________________ [title] of _____________________________ [Party] is signed to the foregoing conveyance and who is known to me, acknowledged before me on this day that, being informed of the contents of the conveyance, (s)he, as such officer and with full authority executed the same voluntarily for and as the act of said corporation.

Given under my hand this the _____ day of ____________, 201X

Notary Public: _________________________

My Commission Expires: ________________

[To be added if not attached to the Covenant]

STATE OF ALABAMA

COUNTY OF _________________________________

I, ____, Clerk of the ___________________ County Court, do certify that the foregoing Subordination Agreement was lodged in my office for record, and that I have recorded it, and the certificate thereon, this ___ day of ___________________, 201X.

____
County Clerk

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

September 25, 2020

PRIVILEGED AND CONFIDENTIAL
ATTORNEY-CLIENT COMMUNICATION
ATTORNEY WORK PRODUCT

VIA EMAIL TO: EESCaseManangement.ENRD@usdoj.gov
The Honorable Jeffrey B. Clark
Assistant Attorney General
U.S. Department of Justice
Environment and Natural Resources Division
Post Office Box 7611
Washington, D.C. 20044-7611

Jonathan D. Brightbill
Principal Deputy Assistant Attorney General
U.S. Department of Justice
Environment and Natural Resources Division
Post Office Box 7611
Washington, D.C. 20044-7611

Re: CERCLA §§ 106 and 107 Consent Decree for Remedial Design / Remedial Action at Olin OU2 Superfund Site in McIntosh, Washington County, Alabama

Dear Mr. Clark and Mr. Brightbill:

The purpose of this letter is to refer the above-referenced matter for the filing of a Complaint and the lodging of the enclosed Consent Decree (CD) for entry in the U.S. District Court for the Southern District of Alabama. The CD provides for the performance of remedial design and remedial action at the Olin OU2 Superfund Site in McIntosh, Washington County, Alabama, along with payment of past and future oversight costs as defined in the CD. The CD has been executed by the Settling Defendants, Olin Corporation and BASF Corporation, and by EPA Region 4.

Enclosed with this letter are a copy of the CD and the EPA's "Ten-Point" Settlement Analysis assessing the proposed settlement. The originals of these documents will be sent to your staff.

Peter Krzywicki, of the Environmental Enforcement Section, is the DOJ trial attorney assigned to this case. The Region 4 attorney assigned to this case is Lisa Ellis. Ms. Ellis may be contacted at (404) 562-9541 or by email at ellis.lisa@epa.gov.

Sincerely,

MARY WALKER Digitally signed by MARY WALKER Date: 2020.09.29 16:01:57 -04'00'

Mary S. Walker
Regional Administrator

Enclosures (2)

cc: Lori Jonas, DOJ/EES (email w/pdf enclosures)
Peter Krzywicki, Trial Attorney, DOJ/EES (email w/pdf enclosures)
Cynthia L. Mackey, Director, EPA/OSRE (email w/pdf enclosures) Bruce
Kulpan, EPA/OSRE/RSD (email w/pdf enclosures)
Nicholas Sciretta, Regional Liaison, EPA/OSRE/RSD (email w/pdf enclosures)
Clarence Featherson, Regional Liaison, EPA/OSRE/RSD (email w/pdf enclosures)
Leif Palmer, EPA, Region 4, ORC (email w/pdf enclosures)
Maurice Horsey, EPA, Region 4, SECEB (email w/pdf enclosures)