# Feasibility Study
**Revision 1**

## Operable Unit 2, McIntosh, Alabama

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## ABBREVIATIONS AND ACRONYMS

| Acronym | Definition |
|---|---|
| ADEM | Alabama Department of Environmental Management |
| AMEC | AMEC Environment & Infrastructure, Inc. |
| Anchor QEA | Anchor QEA, LLC |
| AOC | Administrative Order of Consent |
| ARAR | Applicable or Relevant and Appropriate Requirements |
| AVS/SEM | Acid-Volatile Sulfide/Simultaneously-Extracted Metals |
| AWQC | Ambient Water Quality Criterion |
| BASF | BASF – The Chemical Company |
| BSAF | biota-sediment accumulation factor |
| Basin | Olin Basin |
| Battelle | Battelle Marine Sciences Laboratory |
| BHC | Bachmann-Hoyer-Canfield |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| cm/s | centimeter per second |
| COC | constituent of concern |
| COPC | constituent of potential concern |
| CRS | Congressional Research Service |
| CSM | Conceptual Site Model |
| CWA | Clean Water Act |
| cy | Cubic yard |
| DDD | Dichlorodiphenyldichloroethane |
| DDE | Dichlorodiphenyldichloroethylene |
| DDT | Dichlorodiphenyltrichloroethane |
| DDTr | 4,4'-isomers of DDD, DDE, and DDT |
| DDTR | 2,4'- and 4,4'-isomers of DDD, DDE, and DDT |
| DO | Dissolved Oxygen |
| DOC | Dissolved Organic Carbon |
| dw | Dry weight |
| ERA | Ecological Risk Assessment |

## ABBREVIATIONS AND ACRONYMS (Continued)

| Acronym | Definition |
|---|---|
| ESPP | Enhanced Sedimentation Pilot Project |
| GRA | General Response Action |
| HCB | Hexachlorobenzene |
| Hg | Mercury |
| αHgS | Alpha Mercuric Sulfide |
| βHgS | Beta Mercuric Sulfide |
| HHRA | Human Health Risk Assessment |
| HI | hazard index |
| HQ | hazard quotient |
| IC | Institutional Control |
| IEHH | Institute of Environmental and Human Health |
| J | Estimated concentration |
| JB | Estimated concentration due to blank contamination |
| JQ | Estimated concentration between the reporting limit and method detection limit |
| $K_d$ | partition coefficient |
| LOAEL | lowest observed adverse effect level |
| MACTEC | MACTEC Engineering and Consulting, Inc. |
| MDL | Method Detection Limit |
| µg/L | microgram per liter |
| mg/kg | milligram per kilogram |
| mg/L | milligram per liter |
| NAVD88 | North American Vertical Datum 1988 |
| NCP | National Contingency Plan |
| NOAEL | no observed adverse effect level |
| NPDES | National Pollutant Discharge Elimination System |
| NSR | net sedimentation rate |
| NTU | nephelometric turbidity unit |
| Olin | Olin Corporation |
| OM&M | operation, maintenance and monitoring |

## ABBREVIATIONS AND ACRONYMS (Continued)

| Acronym | Definition |
|---|---|
| ORD | Office of Research and Development |
| ORP | oxidation-reduction potential |
| OSHA | Occupational Safety and Health Administration |
| OU-1 | Operable Unit 1 |
| OU-2 | Operable Unit 2 |
| PPE | Personal Protective Equipment |
| PRG | Preliminary Remediation Goal |
| RAOs | Remedial Action Objectives |
| RCRA | Resource Conservation and Recovery Act |
| RGO | remedial goal option |
| RI/FS | Remedial Investigation/Feasibility Study |
| river | Tombigbee River |
| RL | Reporting Limit |
| RPM | Remedial Project Manager |
| site | Olin McIntosh Plant |
| SPLP | synthetic precipitation leaching procedure |
| SRB | sulfate-reducing bacteria |
| TBC | To Be Considered Criteria |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TMV | toxicity, mobility, and volume |
| TOC | total organic carbon |
| TSS | total suspended solids |
| URS | URS Corporation |
| USEPA | U.S. Environmental Protection Agency |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| WCC | Woodward-Clyde Consultants |

# 1.0 INTRODUCTION

Olin Corporation (Olin) is currently conducting a Remedial Investigation/Feasibility Study (RI/FS) for its McIntosh, Washington County, Alabama Plant Site (site) under the oversight of the U.S. Environmental Protection Agency (USEPA). The site is an active chemical production facility, located approximately 1 mile east-southeast of the town of McIntosh, Alabama (Figure 1-1). The site is listed on the National Priorities List of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Olin signed an Administrative Order of Consent (AOC), effective May 9, 1990, to satisfy the National Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] 300). The site is composed of two operable units. Operable Unit 1 (OU-1) comprises the Olin property, except OU-2 area, and includes the manufacturing process areas. OU-2 comprises the Olin Basin (Basin), Round Pond, surrounding wetlands on the Olin property, and the former wastewater ditch that discharged to the Basin from 1952 to 1974 (Figure 1-1).

The FS and implementation of the remedial action have been completed for OU-1 and are being monitored under the Resource Conservation and Recovery Act (RCRA). This FS addresses the evaluation of remedial alternatives for OU-2.

The Revised RI Addendum, Ecological Risk Assessment (ERA), and Human Health Risk Assessment (HHRA) were submitted to USEPA on November 14, 2011, and were approved by USEPA on November 16, 2011. These documents provide the results of the Enhanced Sedimentation Pilot Project (ESPP) monitoring and the results of sampling activities undertaken to address data gaps identified by USEPA and Olin during their evaluation of available historical data, including:

- ESPP bathymetric study (contours of sediment elevation) and debris evaluation
- Surface water profiles
- ESPP surface water sampling
- ESPP storm event sampling
- Gate overflow sampling
- ESPP surficial sediment sampling
- ESPP sediment trap sampling
- ESPP sediment pin measurements
- Sediment coring
- Sediment porewater sampling
- ESPP sedimentation rate estimation
- Background atmospheric deposition study
- Floodplain soil investigation
- Groundwater investigation

- Terrestrial vegetation study
- Insect study
- Fish tissue sampling
- ESPP annual bioaccumulation (*Corbicula*) studies

## 1.1 PURPOSE AND REPORT ORGANIZATION

This FS is prepared in accordance with the AOC between USEPA and Olin and includes the development, screening, and evaluation of remedial alternatives for OU-2. The FS has been prepared in accordance with USEPA Guidance (USEPA, 1988) and includes the following information:

- Remedial action objectives (RAOs) in accordance with Section 300.68 of the NCP for impacted media that require a remedial action based on the findings and risk assessments presented in the RI
- Identification and screening of remedial technologies
- Development of remedial alternatives for protection of human health and the environment
- Evaluation of remedial alternatives using the nine CERCLA criteria (USEPA, 1988) as well as the 11 Sediment Management Principles (USEPA, 2002)
- Comparison of remedial alternatives
- Recommendations

This document is organized into the following sections:

- Section 1.0 – Introduction
- Section 2.0 – Remedial Action Objectives/General Response Actions
- Section 3.0 – Development and Screening of Technologies
- Section 4.0 – Detailed Analysis of Alternatives
- Section 5.0 – Conclusions and Recommendations
- Section 6.0 – References

## 1.2 BACKGROUND

### 1.2.1 Site Description

The McIntosh OU-2 Basin is located between a bluff to the west and the Tombigbee River (the river) to the east. The bluff is approximately 20 to 30 feet higher in elevation than the floodplain area near the Basin. The Basin and Round Pond are thought to be part of a former natural oxbow lying within the floodplain of the river. The site location is depicted on Figure 1-1. The Basin and Round Pond cover approximately 76 and 4 acres, respectively, at a water elevation of 3 feet North American Vertical Datum 1988 (NAVD88). 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. OU-2 is mostly inundated from fall to the end of spring each year. The 2006 bathymetric study of the area is presented on Figure 1-2. OU-2 also includes the floodplains surrounding the Basin and Round Pond, the former discharge ditch to the Basin, and the wastewater ditch.

Construction of the berm and gate system around the Basin was initiated in June 2006 as part of the ESPP. The purpose of the constructed system is threefold: to enhance the capture of sediment-laden floodwater, increase hold time within the Basin (allowing floodwater sediment to be deposited therein), and reduce wind-driven resuspension of those sediments by maintaining a minimum water elevation.

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). During rising river water levels, up to 12 feet NAVD88, the gate is lowered to receive river water flowing from south to north from the river to the Basin through the inlet channel or spillway. When floodwaters reach 12 feet NAVD88 or above, they overtop the berm and enter the Basin from the north and east, flowing through the floodplain areas surrounding the Basin. The gate is closed in the upright position once water levels have crested. The floodwaters are then allowed to settle in the Basin over a longer period and with more quiescent conditions than would occur naturally, thus enhancing the sedimentation process. After the holding period, the gate is opened and waters are slowly decanted. The Basin water level is maintained at between 6 and 7 feet NAVD88 to reduce wind-driven resuspension of the deposited sediments.

### 1.2.2 Site History

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. USEPA has also requested the evaluation of other COCs, including hexachlorobenzene (HCB) and the 2,4′- and 4,4′-isomers of dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethylene (DDE), and dichlorodiphenyl-dichloroethane (DDD) (collectively, DDTR). The primary release mechanism for mercury and HCB to OU-2 was the discharge through the former wastewater ditch (Figure 1-1) from 1952 to 1974 (Woodward-Clyde Consultants [WCC], 1993). Site 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 National Pollutant Discharge Elimination System (NPDES). Current monitoring data show that the plant effluent and stormwater discharge meet the limits contained in the NPDES permit.

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)

Historical results are summarized in Table 1-1 of the November 14, 2011, RI Addendum (AMEC Environment and Infrastructure, Inc. [AMEC], 2011a). Summary data tables are also provided in Appendix A.

The wastewater ditch and former discharge ditch were investigated during the initial RI sampling activities in 1991/1992 and again in 2001. The wastewater ditch runs from the plant area in OU-1 to an area south of the Basin. The former discharge ditch received discharge from the wastewater ditch to the Basin between 1952 and 1974. Mercury and HCB results are summarized in Section 1.2.3.1 in the RI Addendum (AMEC, 2011a) and are presented on figures in Appendix B of this FS.

## 1.3 NATURE AND EXTENT OF CONTAMINATION

### 1.3.1 Groundwater

A groundwater investigation of OU-2 was performed to determine whether the OU-2 sediments act as a continuing source to groundwater and ultimately impact the river. Filtered mercury was not detected above screening levels in micro-wells installed in OU-2. Cores data collected within the Basin during the RI further supported that mercury in sediment in the Basin is not a continuing source to groundwater or the river via the groundwater pathway. The core results indicated the mercury did not fully penetrate the sediment deposits underlying the Basin and, therefore, a pathway for mercury transport between the Basin sediment and the underlying Alluvial Aquifer was not complete (WCC, 1993). The results from core samples collected in 2009 confirmed that mercury did not fully penetrate the sediment deposits. The groundwater analytical data, core data, and model results indicated that the OU-2 sediment is not a source of COCs to the Tombigbee River via the groundwater pathway. A mercury, HCB, or DDTR groundwater plume above the screening level at OU-2 was not evident. Groundwater beneath the Basin may contact and seep upward through the clayey sediments. Additional studies will be performed to estimate the groundwater seepage velocity as part of the remedial process.

### 1.3.2 Floodplain Soil

The analytical results for floodplain soils parameters, including mercury, methylmercury, HCB, and DDTR, are summarized below. Individual results are shown on Figures 1-3 through 1-6 and are provided in Table H-8 in Appendix H of the November 15, 2011, Revised RI Addendum (AMEC, 2011a). Floodplain soil results for COCs were reported in dry weight.

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 soil samples ranged from 15.1 to 28.7 percent. Total organic carbon (TOC) in surficial soils ranged from 15,900 milligram per kilogram (mg/kg) to 61,700 mg/kg. TOC decreased with depth in soil borings. TOC for these 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 1-3. 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. ProUCL was used to evaluate whether the maximum mercury concentration at FPSS2 was consistent with the floodplain soil data. ProUCL uses Dixon's Extreme Value test when the sample size is less than or equal to 25. Dixon's Extreme Value test indicated that the maximum concentration, at FPSS2, was not consistent with the floodplain soil data with 99 percent confidence. The range of mercury concentrations in surficial floodplain soils excluding this 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. It did not represent floodplain soils throughout OU-2.

Mercury concentrations in surficial floodplain soils generally decreased with increasing distance from the water's edges of the Basin and Round Pond. 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. The concentrations of mercury at these locations were within the range of concentrations of non-inundated floodplain soils.

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. Mercury concentrations in soil borings were low compared to sediment concentrations in the Basin (AMEC, 2011a).

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 1-4). 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. Soil methylmercury concentrations were four to five times less than that detected in 2009 surficial sediments (0-4 inches; AMEC, 2011a). 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 1-5. 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 1-6). The results for the six analyzed congeners were summed to obtain the DDTR value listed on Figure 1-6. 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. Summations were also calculated using one-half the reporting limit for non-detected concentrations at USEPA's request for evaluating uncertainty in non-detected concentrations. These summations resulted in concentrations ranging from 0.0038 JQ mg/kg (FPSS10) to 2.23 mg/kg (FPSS1). Concentrations decreased from north to south, with the highest concentrations 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.

### 1.3.3 Sediment

**Surficial Sediment**

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 1-7, which shows the distribution of mercury in surficial sediment using isoconcentration contours. Surficial sediment analytical results, including mercury, for 2006, 2008, and 1991/1992 are summarized in Appendix A; isoconcentration figures for these years are also provided in Appendix B. The area immediately north of the inlet channel (southern portion of the Basin) may represent a depositional area for incoming suspended river sediment during storm events based on lower mercury concentrations, grain size, and TOC results.

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 1-8 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. Surficial sediment analytical results for methylmercury for 2006 and 2008 are summarized in Appendix A; isoconcentration figures for these years are also provided in Appendix B.

HCB and DDTR were also identified as COCs for OU-2. A summary of HCB and DDTR concentrations and ranges by transect are provided in Appendix A. 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 the 2009 HCB concentrations in sediment with the 1991/1992 results is shown on Figure 1-9.

The 4,4′-isomers of DDT, DDE, and DDD (collectively, DDTr) were analyzed in 1991 as part of the RI and in 2008. DDTR was 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. 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. In 2009, DDTR detections were contained within the horizontal footprint of mercury. A comparison of DDTr/DDTR surficial sediment concentrations in 2009 and 1991/1992 is provided on Figure 1-10.

**Sediment Cores**

***Coarsely Sectioned Cores***

Coarsely sectioned core samples were collected at 13 locations throughout the Basin, as shown on Figure 1-11. Analytical results for the coarsely sectioned sediment cores are presented in Appendix A.

Relatively lower mercury concentrations were encountered near the sediment surface within 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 fine and coarse cores. Graphs of mercury concentration with depth were included in Appendix J of the RI Addendum (AMEC, 2011a). Groundwater seepage velocity and erosion/relocation during storm events may also affect migration of mercury if the magnitude of the groundwater seepage velocity and storm event is sufficient. Groundwater seepage will be evaluated during the remedial process.

This 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. The deeper portion of the Basin and the areas in the west central portion of the Basin near the deeper portion of the Basin are an exception to the wedge distribution pattern. Sediment accumulation may concentrate in the deeper portion of the Basin due to focusing.

Figures 1-12a and 1-13a, respectively, show cross sections A-A' and B-B' at no vertical exaggeration and 20 times exaggeration. Subsequent cross sections were presented using the 20 times vertical exaggeration of scale so that the distribution of mercury could be shown. The distribution of mercury with sediment sample intervals is shown on cross sections A-A' and B-B' on Figures 1-12b and c and 1-13b and c, respectively. These cross sections illustrate that relatively lower mercury concentrations are encountered in the top 1 foot of the sediment for some cores, and relatively higher concentrations of mercury are encountered in the top 1 foot of Basin sediment in other cores.

Analytical results for HCB and DDTR for the coarsely sectioned cores are given in Appendix A. These constituents were detected within the footprint of mercury (AMEC, 2011a).

Density, grain size, and percent solids of the coarsely sectioned sediment cores were also analyzed; the analytical results are presented in Appendix A. 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 (provided in Appendix E of AMEC, 2011a). Each sediment core terminated in a dense layer of clay, indicating no connection 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 1-11. 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 Appendix A. A detailed description of the fine core results are provided in the Revised RI

Addendum (AMEC, 2011a). Results were used as input to model transport of mercury through cap material in this FS.

### 1.3.4 Wind-Driven Resuspension Study and Model

Sediment traps were deployed in the Basin. Concentrations of mercury in the sediment traps in 2008 averaged 24 mg/kg. The sediment traps were designed to collect incoming sediments to evaluate enhanced sedimentation; however, a drought occurred in 2008 and there were no floods until August 2009. The presence of mercury-containing sediment in the traps may be due to the periodic resuspension of sediments that became entrained and concentrated in the traps. The sediment resuspension is potentially a result of stochastic wind events during low water levels associated with the drought conditions in 2007 and 2008.

Resuspension typically increases during drought and low water level conditions such as those experienced in 2007 and 2008, when water levels dropped below 3 feet NAVD88. Several models that estimate the effect of wind over a body of water were considered to further evaluate the potential for the reduction of resuspension. The U.S. Geological Survey (USGS) Bachmann-Hoyer-Canfield (BHC) model was selected because it is compatible with the physical features of OU-2, was presented in a peer-reviewed publication, and is commonly used to estimate the potential for resuspension in larger freshwater bodies (Bachmann et al., 2000). A decision was made in February 2009 to maintain at least 3 additional feet of water depth at the gate in an attempt to minimize the effect of wind on sediment resuspension based on the outcome of the BHC model.

### 1.3.5 Surface Water

A summary of surface water analytical results for 2006, 2008, and 2009 are provided in Appendix A. Surface water sampling locations are shown in Figure 1-14.

Mercury concentrations in surface water in 2009 ranged from 0.00731 microgram 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 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 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.

The historical data collection includes analysis of HCB and DDTr data collected in 1991, 1994, and 1995. Results for HCB, DDTr, and other parameters for surface water are presented in Appendix A.

### 1.3.6 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 Appendix A and graphically depicted in Appendix B. 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 Appendix A and graphically depicted in Appendix B. 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 the RL for non-detected concentrations at USEPA'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. The use of half the RL in the summations for the congeners that were not detected is also reported in Appendix A.

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***

Trends in fish tissue concentrations over time in the Basin are summarized as follows:

- Mercury concentrations in upper trophic level fish (largemouth bass) increased in 2007, while the middle and lower trophic level fish decreased. As the upper trophic level fish continue to feed on the middle and lower trophic level fish with lower tissue concentrations, the concentrations in upper trophic level fish could decrease.
- HCB concentrations in the upper and lower trophic level fish decreased over time. 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 decreased over time. No middle trophic level fish sampled from multiple years were available for historical trend comparison.
- The documented increases in fish tissue mercury concentrations without increases for HCB and DDTR could be associated with the lack of continuous, uniform data for statistical analysis. The increase in mercury could be attributed to the fact that mercury bioaccumulates/biomagnifies up the food chain more quickly than HCB and DDTR, and the rate of depuration of mercury is slow in fish after concentrations return to normal conditions. This effect is also magnified by the age structure of the upper trophic level fish such as largemouth bass, which are a long-lived species. The largemouth bass sampled in 2008 were estimated to be between 2 and 7 years old and would experience little depuration during this period. The middle (bluegill) and lower (silversides) trophic level fish are faster-growing and shorter-lived species. The sampled bluegill represented an age structure between 1 and 3 years, while the silversides typically only live 1 year and die after they spawn. The younger age structure in the middle and tropic level fish can yield a different data trend in fish tissue samples, as a result, than the older higher trophic level fish that have been exposed over a longer period.

Fish tissue concentrations were discussed in detail in the Updated RI Addendum (AMEC, 2011a).

**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 (WCC, 1993) and during the additional ecological studies (WCC, 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. Detailed discussion of the benthic macroinvertebrate sampling may be found in the Revised RI Addendum (AMEC, 2011).

### 1.3.7 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. NSR generally increased with increasing river flow rate, increasing frequency of berm overtopping events, and longer durations of inundation by river flow. 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. Detailed results of Anchor QEA, LLC's (Anchor QEA) NSR evaluation are provided in Appendix F of the November 14, 2011, Revised RI Addendum (AMEC, 2011a).

### 1.3.8 Debris Evaluation

Sidescan 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 environs 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 record.

## 1.4 CONTAMINANT FATE AND TRANSPORT

### 1.4.1 Updated Conceptual Site Model

This updated Conceptual Site Model (CSM) for OU-2 contaminant fate and transport was refined from the CSM developed during the 1991 RI and subsequent investigations, using additional information and data developed between 2006 and 2009. An explanation of Basin hydrology, COC deposition within the Basin, environmental effects on sediment resuspension, and sediment deposition within the Basin is provided below.

**Basin Hydrology**

The Tombigbee River is hydraulically controlled upstream of the Coffeeville Lock and Dam and is free-flowing downstream of the dam to the river's confluence with the Alabama River. The Lower Tombigbee River, which is next to OU-2, typically experiences a drier season in the summer and fall months and a wetter, flooding season in the winter and spring months. Tidal fluctuations are evident upstream of OU-2 to the USGS gauge at Leroy during summer low-flow conditions. Winter and spring storms typically cause flooding in the Lower Tombigbee River drainage. These floods often exceed the action stage (19 feet NAVD88) and flood stage (24 feet NAVD88) and can be several weeks in duration.

The Basin was connected to the river and subject to its water elevation changes until the construction of the berm and gate system in 2006 as part of the ESPP. The berm and gate system became operational in 2007. The berm was constructed on an area of existing higher ground in the floodplain (i.e., eastern shoreline of the river). This higher ground was present along the northern and eastern sides of the Basin and Round Pond. Minimum surface elevations in this area were approximately 6 to 7 feet NAVD88. An approximately 35-foot-high bluff (likely the former western shore of the river) bounds the floodplain and Basin on the western boundary. The southern portion of OU-2 was connected to the river by bottomland hardwood forest and a meandering natural channel. Basin hydraulics before berm construction were such that, when flooding occurred, floodwaters flowed into the Basin from the river through the natural channel and through the bottomland hardwood forest from south to north until floodwaters exceeded 6 to 7 feet NAVD88. At this elevation, flow was from north to south through OU-2. Once floodwaters receded below 6 to 7 feet NAVD88, the Basin drained to the south through the natural channel to the river.

The berm was completed to an elevation of 12 feet NAVD88, with the top of the gate and associated spillway at 11 feet NAVD88. The natural channel was straightened to allow more effective sediment transport into the Basin at water elevations less than 12 feet NAVD88. The gate system became operational in March 2007. The increased berm elevation allows flooding of the Basin to occur from south to north to an elevation of 12 feet NAVD88, when the flow direction switches from north to south. The operation of the gate maintains floodwaters at an elevation of 11 feet NAVD88 to allow incoming suspended sediment to settle. Sediments are allowed to settle for 48 hours before the controlled release of the floodwaters.

Basin water elevations were allowed to equilibrate with the river water elevations before January 2009. The effects of wind speed on sediment resuspension were evaluated in January 2009 as described in AMEC, 2011a. This study indicated that a minimum water elevation of 6 feet NAVD88 may protect sediments from wind-driven resuspension under most wind speed scenarios at OU-2. Floodwaters are currently retained for a 48-hour period and slowly decanted to a minimum elevation of 6 to 7 feet NAVD88, so that the Basin and the river do not equilibrate at elevations less than 6 to 7 feet NAVD88.

**COC Deposition**

The Olin McIntosh Plant discharged wastewater to the Basin from 1952 to 1974. BASF (formerly Ciba-Geigy, located north of OU-2) manufactured DDTR during this period and indirectly discharged DDTR to the Basin. The COCs that were transported with the wastewater deposited in the Basin and the deposition pattern of the COCs were influenced by several factors, including:

- Discharge location
- Basin bathymetry
- Elevation, duration, and inundation rates of floods
- Water levels, particularly pertaining to low water conditions in summer and droughts
- Wind effects
- Geochemical and physical parameters

Mercury concentrations greater than 0.2 mg/kg in sediment form a wedge that narrows as one travels north and east across the Basin, except for the deeper portion of the Basin, where focusing likely increases sediment deposition. Maximum depths with mercury concentrations greater than 0.2 mg/kg range from 5 to 6 feet, north to south, and from 4 to 9 feet, east to west.

HCB is more prevalent in the southern portion of the Basin (Figure 4-6). HCB is not as mobile as mercury because of its hydrophobic properties and likely settled first from the discharge wastewater in this area. Concentrations of HCB in 2009 sediment results were highest in the southern portion of the Basin near the inlet channel and the former wastewater ditch.

DDTR historically exhibited a different distribution pattern from mercury and HCB. In 1991, DDTR concentrations in surficial sediment decreased from north to south in the Basin. This pattern was reversed by 2008, when higher concentrations were detected in the south, and lower concentrations were observed in the north. Overall, concentrations decreased over time by an order of magnitude. The reduction in DDTR concentrations was likely the result of the implementation of natural degradation and two remedial efforts by BASF. DDTR concentrations detected in the southern portion of the Basin may reflect residuals from BASF's property, including their discharge ditch east of the Basin.

**Sediment Resuspension**

The mobility of mercury within the Basin may be related to resuspension of surficial sediment from stochastic wind events and, possibly, other factors. The effects of wind speed on sediment resuspension were evaluated in January 2009. Environmental factors that may drive sediment resuspension in the Basin include wind speed, depth of water, surface water velocity, and geochemical parameters in the water column. Alluvial sediments do not always deposit in uniform layers in floodplains and oxbows, and mixing and lateral displacement of sediment is possible (Longwell et al., 1969). High wind speeds and low water elevations may exacerbate this effect at OU-2. Shallower portions of the Basin may also be more susceptible to wind-driven resuspension and the effects of a drought.

Other factors such as surface water velocity, seasonal turnover, groundwater seepage velocity, and geochemistry may also contribute to resuspension effects. Surface water velocities, even during storm events, were very low (0.2 foot per second or less) and do not appear to control migration to a great extent. Large storms (e.g., hurricanes) may produce higher surface water velocities. Geochemistry in the water column, as it relates to sediment already resuspended, is further evaluated in Section 5.4. Resuspension due to seasonal turnover may occur for a portion of the year (spring and fall) and would be limited to the deeper portion of the Basin, which comprises approximately 20 percent of the Basin by area and does not include Round Pond. Groundwater seepage velocity may also affect resuspension if velocities are sufficient to move sediment.

**Sediment Deposition**

Some areas of the Basin, such as the deeper and southern portions of the Basin, experience more deposition than other areas. The deeper portion of the Basin contains higher concentrations of COCs at greater depths than other areas of the Basin because of sediment transport (also known as focusing) into this deeper area. More deposition is also evident in the southern portion of the Basin, based on sediment pin data. There is a statistically significant decrease in concentrations in surficial sediments in the southern portion of the Basin. The COC depths from the coring results indicate a pattern of greater sedimentation in the southern portion and the deeper portion of the Basin.

Sediments in the southern portion of the Basin contain more sand and lower TOC than other areas of the Basin, and may indicate deposition when river flows enter the Basin from the south during flooding. Samples from the southern portion of the Basin had the highest percentage composition of sand. Floodwaters traveling north through the inlet channel from the Tombigbee River during flood events are expected to provide larger grain-size particles. After the water reaches the Basin and velocities decrease, sand and larger silts would theoretically be the first particle sizes to fall from suspension and deposit in the southern portion of the Basin. The slower-moving water from the river and from overland flow from the north would be expected to hold the silt and clay particles in suspension longer and eventually deposit the smaller particles over time across the remainder of OU-2 (MACTEC, 2007). The sediment load entering the Basin during floods is less than that available in the river, as indicated by lower TSS entering the Basin than is contained in the river during flooding. Accumulation of incoming sediment is evident in the southern portion of the Basin where surficial sediment mercury concentrations have decreased, grain size and TOC data are consistent with incoming sediment, and a review of aerial photographs over time shows deposition (AMEC, 2011a).

The mercury concentrations in sediment form a wedge that narrows as one travels north and east across the Basin, except for the deeper portion, indicating the potential for less long-term sedimentation in the northern portion of the Basin in comparison with the southern portion. The northwest portion of the Basin received 5 to 6 inches of net accumulation in 2008, the highest accumulation during sediment pin monitoring. It is likely that the bathymetry of the northwest portion of the Basin lends itself to focusing. BASF placed a soil cap in Cypress Swamp as a remedy for DDTR contamination just before the August 2008 flood event. Approximately half of this sediment accumulation appeared suddenly after the BASF soil cap eroded during the August 2008 storm event. BASF modified the drainage path in this area and replaced their cap after this storm event. This accumulation appeared quickly, is tactilely firm, and has remained with little erosion over time. The cap material was native quarry material containing sands, silts, and clays. It is also possible that native soils from the BASF property eroded into the Basin with the cap material, contributing to the sediment pin accumulation in the northwest portion of the Basin.

The estimated annual average NSR in the Basin is 0.3 inch/year, with the 95 percent confidence interval ranging from 0.2 to 0.4 inch/year. NSR increases with increasing river flow rate, increasing frequency of berm overtopping, and longer duration of Basin inundation by river flow. Most of the current site data were collected during a low-flow period or drought. Annual NSR calculated for the 2005 through 2009 period was likely lower than the actual long-term average value.

Anchor QEA's estimation of NSR assumes an even distribution of sediment over the Basin (AMEC, 2011a). AMEC, 2011a indicates that deposition was concentrated in the southern portion of the Basin based on measured sediment accumulation. The volume of annual deposition in the Basin (excluding the northwest accumulation suspected from BASF) based on the sediment pin data was calculated to be 90,000 cubic feet per year. The volume of annual deposition was also calculated using Anchor QEA's estimated annual sedimentation rate over the Basin, which was 83,000 cubic feet per year. The two values are within 10 percent of each other and represent two lines of evidence (one estimated through modeling techniques and one based on physical measurements) indicating deposition in portions of the Basin.

### 1.4.2 Potential Routes of Migration

This section presents potential routes of COC migration, and discusses sediment interactions with surface water and groundwater.

**Sediment and Surface Water Relationship**

Unfiltered and filtered mercury in 2008 surface water samples averaged 0.246 and 0.0147 μg/L, respectively. Unfiltered and filtered mercury in 2009 surface water samples averaged 0.0473 and 0.00781 μg/L, respectively. Methylmercury in unfiltered and filtered samples also decreased an order of magnitude from 2008 to 2009. Most of the mercury and methylmercury in surface water is associated with suspended solids in the water column. Suspension of these solids is stochastic and is mainly influenced by wind effects. Average concentrations of mercury in overflow from the gate ranged from 0.0182 to 0.126 μg/L. Mercury was detected in an upstream river sample at 0.00564 μg/L. A mass balance between the flow rate and mercury concentrations in the overflow and river indicates that mercury in the overflow will not cause an exceedance of the mercury AWQC (0.012 μg/L) in the river, under the conditions sampled. Concentrations of filtered mercury and methylmercury in overflow from the gate were below the mercury AWQC.

**Sediment and Groundwater Relationship**

The overall goal of the OU-2 groundwater investigation was to determine whether the OU-2 sediments act as a continuing source of COCs to groundwater and the river. Filtered mercury was not detected above screening levels in micro-wells installed in OU-2. Cores generally showed that an unimpacted zone of clay remains between the Basin sediments and the alluvial aquifer. Based on the evaluation of the analytical data collected and the solute transport model results, a groundwater plume with COC concentrations above the AWQC was not present at the Basin. The AWQC for COCs in the Tombigbee River is not predicted to be exceeded as a result of contributions from groundwater. Groundwater beneath the Basin may contact and seep upward through the clayey sediments. Additional studies will be performed to estimate the groundwater seepage velocity as part of the remedial process.

### 1.4.3 Contaminant Persistence

This section presents COC persistence in the Basin, sediment resuspension, and the vertical and horizontal COC distribution with sediment depth.

Relatively lower mercury concentrations were often encountered near the sediment surface with relatively higher mercury concentrations at mid-depth in the total core interval for some cores. Other locations indicated relatively higher mercury concentrations nearer to the surface. The horizontal and vertical distribution of HCB and DDTR, where detected in sediment, was within the mercury footprint. A consistent correlation of mercury concentrations with depth throughout the Basin and Round Pond was not evident in the coarse cores.

Vertical migration of mercury within the sediment deposits was not evident in the data from the 2009 sediment fine and coarse cores. A review of these data indicated that the maximum mercury concentration was not consistently detected at any one depth throughout the fine cores (i.e., a "spike" was not apparent). Groundwater seepage velocity and erosion/relocation during storm events may also affect migration of mercury if the magnitude of the groundwater seepage velocity and storm event is sufficient.

Sediment depths with age were successfully correlated in core SDCR-8 (Appendix H, Table H-7 of the RI Addendum [AMEC, 2011a]). These data indicated that the highest mercury concentration of 440 mg/kg in SDCR-8 was detected at a depth of 6 feet; the mercury concentration in the top 1 foot was 23 mg/kg. The higher mercury concentrations in this core correlated with the years 1959 to 1968, when wastewater that contained mercury was discharged to OU-2.

Battelle performed sorption studies on the sediment from the Basin and potential cap materials (Battelle Laboratory, 2010). The study concluded that the sediment is extremely sorptive of mercury because of the small particle size, high sulfur content, and high organic content of the sediment. Both the Battelle study data and the pore water/sediment ratios obtained from the fine cores were used to provide a range of $K_d$ values in the FS. This range may be lower and higher than that provided by the Battelle study.

### 1.4.4 Contaminant Migration

Natural forces move mercury through the environment, while the chemical form of mercury determines how it moves through the environment (Congressional Research Service [CRS], 2006). Methylmercury is the biologically active form of mercury and bioaccumulates up the food chain (MACTEC, 2008). The significance of methylation is that methylmercury is more easily absorbed by living tissues in comparison to inorganic mercury (CRS, 2006). This section discusses the geophysical parameters and factors that may affect the distribution of mercury in OU-2, and Basin water quality contributions to the river.

**Geochemical Parameters**

Mercury in the environment undergoes a biogeochemical cycle, and its presence is the result of natural (e.g., geothermal activity) and anthropogenic activities (MACTEC, 2008). Geochemical and physical factors can affect the methylation of mercury, because mercury methylation in ecosystems depends on mercury loadings, nutrient content, pH, oxidation-reduction conditions, bacterial activity, and other variables (Eisler, 2006). Small changes in these parameters can increase or decrease methylation and demethylation rates in aquatic systems (Eisler, 2006).

This section summarizes the factors that affect methylation of mercury and how the conditions at OU-2 relate to these factors. While general trends may be observed as individual indicator parameters increase or decrease, the suite of parameters should be evaluated as a whole to indicate the potential for methylation of mercury.

Several geochemical factors that can affect the methylation of mercury in sediment include acid-volatile sulfide/simultaneously-extracted metals (AVS/SEM), TOC, metals, sulfates and sulfides, temperature, pH, and oxidation-reduction potential (ORP). Other factors, such as sediment grain size, are correlated with the occurrence and distribution of total mercury.

AVS/SEM ratios are greater than 1 throughout OU-2 (range = 9.93 to 156), and exceed 1 to the extent that temperature or seasonal variability would not likely decrease the ratio below 1. These ratios may be an indication that methylation of mercury may be limited because of excess sulfide ions present in the sediment that complex with mercury and methylmercury. Even the lowest AVS/SEM ratios in sediment samples have excess capacity to complex with complexing ions, and increasing the AVS/SEM ratio does not increase complexing with additional excess sulfide. A correlation between AVS/SEM is not expected because any additional AVS/SEM does not contribute additional complexing, leading to no increased complexing with additional AVS/SEM and no correlation between AVS/SEM and mercury.

The sulfide concentrations (<37J – 3,300 mg/kg in 2008) detected throughout OU-2 further support this conclusion. Excess sulfide may bind mercury and make it unavailable for methylation by bacteria by reacting with the mercury to form mercuric sulfide (cinnabar) and by inhibiting the dissolution of mercury. Sulfides in the sediment may also complex with methylmercury and reduce its bioavailability. Battelle's sediment sorption study also supported the high sulfur content of OU-2 sediments (Battelle, 2010). Sediments were analyzed for total sulfides, which includes sulfides other than hydrogen sulfide.

The binding of sulfide is a complex process. Depending on concentrations of dissolved organic carbon (DOC), sulfides, and sulfates, sulfide and DOC may bind preferentially to each other instead of the mercury. The levels of sulfide in the Basin may inhibit the formation of stable metacinnabar. The amount of sulfide that accumulates in response to sulfate reduction can shift the optimal range for methylmercury production and bioavailability.

Existing concentrations of iron (11,000–57,005 mg/kg) and manganese (135–1,165 mg/kg) in sediments may indicate the mineralization of mercury. Iron and manganese may affect methylation or demethylation, depending on the concentration and chemistry of the environment. Iron and manganese may also reduce dissolved mercury through complexation.

TOC may affect methylation or demethylation depending on the environment. TOC can enhance mercury methylation by acting as a food source, thereby increasing the metabolism of heterotrophic microorganisms. In contrast, mercury methylation may be inhibited through the formation of mercury complexes with organic ligands. Methylmercury comprises between 0.00736 and 0.136 percent of mercury in the Basin. TOC concentrations in 2009 ranged from 644 to 60,500 mg/kg.

Other factors that influence the methylation of mercury in sediment at OU-2, but likely do not play as important a role as the factors discussed above, are sulfate concentrations, ORP, oxidative dissolution of cinnabar, and pH.

Sediment and surface water sampling for methylmercury represents a snapshot of methylmercury production in the Basin at a given moment; the sampling period was selected to represent conditions favoring methylmercury production. Methylation potential may be slightly higher or slightly lower at other times of the year.

The concentration of sulfates in sediment at OU-2 are not limiting for sulfate-reducing bacteria (SRB), the major group of organisms responsible for methylation of mercury in sediments. Though sulfate reduction results in decreased methylmercury formation, when sulfate is present, a kinetic relationship relating sulfate reduction to mercury methylation has been documented (King et al., 1999). However, the percentage of total mercury that is methylmercury in sediment in the central portion of the Basin is 0.01 to 0.07 percent, indicating that methylation by SRB is limited. Areas near the shoreline exhibit a slightly higher methylmercury percentage, approximately 0.1 percent. Reducing conditions in OU-2 sediment indicated by the ORP values also favor the methylation of mercury, but other factors as described above may limit this process. The pH of sediments in OU-2 was acidic to neutral and is not expected to favor the methylation of mercury.

The occurrence and distribution of total mercury concentrations commonly are correlated with the occurrence and distribution of silt, clay, and TOC. An important factor in controlling sediment trace-metal concentrating capacity is grain size. As grain size decreases, metal concentrations increase. The affinity between trace-metal cations and silt- and clay-size particles is relatively strong because of the high positive charge of the trace-metal cations and the high density of negative charges of silt- and clay-size particles (USGS, 1998). A comparison of the grain size in the Basin (Figure 4-8 in the RI Addendum [AMEC, 2011a]) with the isoconcentrations of mercury (Figures 4-4a through d in the RI Addendum [AMEC, 2011a]) and methylmercury (Figures 4-5a through c in the RI Addendum [AMEC, 2011a]) does not indicate a clear relationship between grain size and concentration. Other geophysical parameters may contribute to the distribution of these constituents in the Basin.

Analysis of these geochemical factors using Spearman correlations reveals weak relationships when methylmercury and percent methylmercury are compared to these geochemical factors. The maximum coefficient of determination for the various correlations, including total mercury, yields a predictive variability of approximately 43 percent. Coefficients less than 50 percent are considered very weak or not meaningful. Though trends or relationships may be described based on the data and on predictive values of the geochemical correlations with methylmercury, use of the correlations to define interactions or significant relationships in OU-2 is not recommended. Relationships to geochemical parameters are presented in a qualitative manner as a result.

## 1.5 BASELINE RISK ASSESSMENT

### 1.5.1 Ecological Risk Assessment

An ERA was performed to evaluate the potential for adverse ecological 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 risk estimates. Remedial activities including removal and capping occurred upgradient (north) of OU-2 for DDTR, which will minimize migration of DDTR into OU-2. Concentrations of DDTR in OU-2 sediment decreased an order of magnitude since the 1990s, thus reducing exposure for this constituent of potential concern (COPC).

A qualitative analysis of risk was performed for the benthic macroinvertebrate, fish, and soil invertebrate communities by comparing site sediment, surface water, surface soil, and tissue concentrations to available literature-based toxicity reference values. Based on the qualitative assessment of benthic macroinvertebrates and fish, potential risk is posed to these communities in OU-2. Mercury, methylmercury, HCB, and DDTR in environmental media in OU-2 are anticipated to potentially cause adverse effects to the benthic macroinvertebrate community in OU-2. Exceedances of mercury effects levels indicate a potential for risk to the fish community from exposure to mercury in OU-2 sediments. Surface water methylmercury, HCB, and DDTR concentrations indicate a potential for risk to the fish community from exposure to OU-2 surface water. Fish tissue residue concentrations also exceed effects levels for mercury, HCB, and DDTR. DDTR in environmental media at OU-2, except for DDTR in surface water, is not anticipated to cause adverse effects to the fish community in OU-2. DDTR surface water data used in this qualitative assessment were collected in 1994, and concentrations are likely lower today based on two remedial efforts conducted by the adjacent landowner and reductions in DDTR sediment concentrations since the 1990s. Therefore, potential risk from exposure to DDTR in sediments and surface water is likely overestimated. Potential risk to the benthic macroinvertebrate and fish communities must be concluded, but is likely overestimated for exposure to DDTR. Based on the qualitative risk assessment for soil invertebrates, mercury, methylmercury, DDTR, and HCB do not pose a potential for risk to the soil invertebrate community in OU-2.

Quantitative analysis indicated that there are a few receptors whose no observed adverse effect level (NOAEL)-based hazard quotients (HQs) exceeded the threshold value of 1, but the lowest adverse effect level (LOAEL)-based HQs did not exceed the threshold value of 1. This indicates that these receptors' risk lies between the NOAEL and the LOAEL. These risks would not constitute a population-level effect, but a small percentage of individuals might have a potential for adverse effects due to exposure to the COPC. The receptors and the COPCs that have a borderline potential for adverse health effects are: the mink for methylmercury, the pied-billed grebe for methylmercury and DDTR, the little blue heron for methylmercury, the great blue heron for DDTR, and the Carolina wren for methylmercury and DDTR.

Quantitative analysis also indicated that there are a few receptors whose individual HQs for the COPCs were below the threshold value of 1, but the hazard indices (HIs; sums of the HQs) exceeded 1. These receptors are the little brown bat, the short-tailed shrew, and the wood duck. This assessment would indicate that there may be a potential for individual receptors to experience adverse effects, though population level effects are not expected.

The Carolina wren has NOAEL-based HIs that exceed the threshold value of 1. Individual HQs for mercury and HCB were below the threshold value of 1; however, the individual HQs for methylmercury and DDTR (2.4 and 1.8, respectively) were above the threshold value of 1. LOAEL-based HIs also exceeded the threshold value of 1, with risk being driven from methylmercury (HQ=2.4) and DDTR (HQ=1.4). This assessment indicates that the potential for adverse risk for this receptor is present for methylmercury and DDTR. The flying insects collected in 2010 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 are not expected to ingest significant amounts of flying insects. The inclusion of flying insects for the Carolina wren increased the exposure point concentrations for the site COPCs and may have overestimated risk for this receptor.

Previous studies of the effects of site COPCs on the prothonotary warblers, an insectivorous bird with a small home range similar to the Carolina wren, indicated no adverse risk to the reproduction or long-term survival of insectivorous birds (Institute of Environmental and Human Health [IEHH], 1999). This study indicates that the potential risk to the insectivorous terrestrial birds, such as the Carolina wren, may be overestimated (AMEC, 2011b).

The most significant potential exposure pathway was determined to be ingestion of fish by avian receptors. The DDTR dataset used to evaluate this pathway was from 2001, which is historical and adds a notable level of uncertainty or overestimation of risk. When risks were estimated using the lowest effect values reported, three avian receptors (belted kingfisher, little blue heron, and great blue heron) were calculated to have potential to reach exposures exceeding these values (i.e., these receptors had LOAEL-based HIs that exceeded 1).

USEPA will select final remediation goals as a risk management decision. The Remedial Goal Option (RGO) Report (AMEC, 2012) recommended a mercury preliminary remediation goal (PRG) using the biota-sediment accumulation factor (BSAF) approach. This PRG was 1.6 mg/kg dry weight (dw) in sediment based on risk to the little blue heron. The mercury PRG was calculated using the power regression equation and included data from forage fish species combined. The mercury PRG in sediment predicted by Spreadsheet-Based Ecological Risk Assessment for the Fate of Mercury (SERAFM) was 10.7 mg/kg dw. The PRG was deemed realistic as a cleanup goal because of the conservative nature of the underlying risk parameters (i.e., toxicity values, exposure frequency, etc.). The RGO report recommended a cleanup goal range of mercury of 1.6 to 10.7 mg/kg dw be applied to OU-2 sediment. The recommended sediment cleanup goal was 3 mg/kg for DDTR based on upgradient and off-site concentrations. The recommended cleanup goal for HCB was 7.6 mg/kg based on risk to the mink.

The RGO report recommended a cleanup goal for soils of 1.7 mg/kg dw based on risk to the Carolina wren. Three soil sampling locations exceed this PRG in the surficial layer (0–1 inch) and are discussed further in Section 2.3. These locations are adjacent to the Basin. The recommended soil cleanup goal for DDTR was 3 mg/kg based on upgradient, offsite concentrations that may serve as an ongoing source of DDTR in OU-2. DDTR surficial soil concentrations did not exceed 3 mg/kg at OU-2. HCB concentrations do not pose unacceptable risk within floodplain soils, and an HCB PRG was not calculated.

Three of the ten assessment endpoints that were quantitatively assessed had NOAEL-based HIs that are less than the threshold value of 1.

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

Seven of the ten assessment endpoints quantitatively assessed had NOAEL-based HIs that are equal to or greater than the threshold value of 1, and these endpoints are as follows:

- Assessment Endpoint 4: Insectivorous Aquatic Mammals - Receptor Species: Little Brown Bat
- 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 8: Omnivorous Aquatic Birds – Receptor Species: Wood Duck
- Assessment Endpoint 10: Insectivorous Terrestrial Mammals – Receptor Species: Short-tailed Shrew

- Assessment Endpoint 13: Insectivorous Terrestrial Birds – Receptor Species: Carolina Wren

Because either NOAEL-based or LOAEL-based HIs were equal to or exceeded the threshold value of 1, potential risk must be concluded for these seven assessment endpoints and nine receptors.

### 1.5.2 Human Health Risk Assessment

Exposure media evaluated in the updated HHRA included floodplain soil, surface water, and ingested fish filets. COPCs in floodplain soil included mercury and DDTR. COPCs in surface water included mercury and methylmercury, HCB, and DDTR. COPCs in fish tissue included mercury (assumed to be methylmercury), HCB, and DDTR. The HHRA was based on site-specific data collected from 1991 through 2010 and on recommendations from USEPA Region 4.

Exposure pathways considered in the HHRA 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 filets. OU-2 is wholly contained within Olin property and has limited access for on-site employees and off-site resident trespassers. Because site access is limited by local topography, construction and operation of the berm and gate system, and Olin security, the frequency of exposure for trespassers is expected to be low. Trespassing has historically been minimal; the area is currently posted with no trespassing signs and fenced to the north, west, and south.

Hazard estimates for current resident trespasser adults and adolescents exposed to floodplain soil, surface water, and through fish ingestion do not exceed an HI of 1. Hazard estimates for potential future resident trespasser adults and adolescents exposed to soil and surface water are less than 1.

USEPA required 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. HIs for potential future fish ingestion exceed the target HI of 1. This unrestricted potential future scenario has been incorporated into the HHRA; however, these potential future exposures are unlikely to occur because:

- Olin operates a multi-million dollar manufacturing facility on property next to OU-2. It is unlikely to relinquish control of the Basin and surrounding property.

- Olin will continue to operate the facility and maintain site security, which will limit access to the Basin and Round Pond; therefore, exposures to floodplain soil, surface water, and fish tissues will also remain of low frequency.

It is probable that future exposures will remain similar to those predicted in the current scenario. Therefore, risks and hazards are unlikely to exceed acceptable limits in the future.

Cancer risks associated with resident trespasser adults and adolescent exposure scenarios did not exceed the acceptable risk range for site COPCs. Most of the risk observed is associated with HCB and DDTR in largemouth bass filets. However, conservative exposure assumptions for the fish ingestion pathway were used, including the assumption that receptors would only ingest largemouth bass. In reality, fishermen would catch and ingest a variety of fish from multiple locations along the river. Therefore, the estimated risk associated with fish ingestion is potentially an overestimate. Risk resulting from DDTR is likely overestimated because the DDTR surface water and fish tissue data were collected before the implementation of two remedial efforts by the adjacent landowner to mitigate DDTR migration to OU-2. Concentrations detected in sediment for DDTR and HCB have decreased over time, indicating that fish tissue concentrations should also decrease.

Currently there is no unacceptable risk to human health. It is unlikely that current conditions restricting access would change in the future.

## 1.6 SUMMARY

- The amount of buried debris within the Basin was evaluated from sidescan data collected during the bathymetric survey. Debris covers approximately 30 to 50 percent of the shallow portions of the Basin and approximately 15 percent of the deeper portions. The percent of buried debris in the deeper portions of the Basin may be underestimated because of limitations of the scanning equipment in deeper, softer sediment environments.
- Overflow from the gate was collected from three gate-overtopping events and two events that did not overtop the berm. Unfiltered mercury concentrations in the gate overflow ranged from 0.0182 to 0.126 µg/L. Modeling using mass balance calculations and the unfiltered mercury concentrations provides mercury concentrations in the river of 0.0063 µg/L, which is below the AWQC of 0.012 µg/L. These concentrations would not cause an exceedance of the AWQC under the conditions sampled. Filtered mercury and methylmercury were below the mercury AWQC in the gate overflow samples.
- Average mercury concentrations in surficial sediment samples decreased from 41.4 to 32.8 mg/kg between 1991 and 2009. Average surficial mercury concentrations also decreased from 36.3 to 32.8 mg/kg between 2008 and 2009. These averages represent only 3 sampling events. The statistical significance is limited due to the limited number

of sampling events and variability in sampling. Decreased concentrations were most prevalent in the southern portion of the Basin north of the inlet channel, where sediment from incoming flood events deposit.

- Mercury concentrations in the surficial sediment (top 4 inches) are relatively higher in the central portion of the Basin in a west-east direction. An isolated area of higher mercury concentrations was observed in the northeast corner of the Basin. The distribution of mercury in the surficial sediment changed slightly over the years, potentially due to resuspension and deposition of incoming sediments.

- Average surficial methylmercury concentration per transect ranged from 0.00431 to 0.0115 mg/kg with the higher concentrations present along the northeast and eastern edges of the Basin. The percentage of methylmercury to mercury ranged between 0.00739 and 0.136 percent. The percentage of methylmercury was generally within the lower range for most of the Basin and Round Pond. The higher percentages were associated with the samples collected along the eastern edge of the Basin.

- Results from the coarse cores indicated that mercury was detected at higher concentrations at depth compared to surface concentrations at some locations in the Basin. Other cores indicated higher concentrations at the surface. Sample intervals with mercury concentrations greater than 0.2 mg/kg were collected from a wedge that narrows as one travels north and east throughout the Basin, except for the deeper portion of the Basin where focusing may increase deposition. HCB and DDTR were detected within the mercury depth footprint.

- Aging of the sediment core from the deeper portion of the Basin indicated that the upper 1 foot of sediment dated from 2001 to 2009, with a concentration of 23 mg/kg. The highest mercury concentration in the coarse cores was detected in the 5- to 6-foot interval of the deeper portion of the Basin core. This interval corresponded to a period from 1959 to 1968 when mercury was discharged to the Basin.

- Fine core samples were collected within the top 18 inches of sediment. Porewater samples associated with the fine cores were also collected. These data were used to support modeling of diffusion through cap materials in the FS and modeling of mercury uptake in a food chain model in the updated ERA (AMEC, 2011b).

- The annual rate of sediment deposition from incoming floodwaters over the Basin was estimated by Anchor QEA at 0.3 inch/year. Measurement of sediment accumulation in the southern portion of the Basin in 2009 was approximately 2.5 inches. Comparison of the volume of material deposited over the Basin based on Anchor QEA's overall deposition rate and the volume of material deposited annually in the southern portion of the Basin indicated a similar sediment deposition. The two volume estimates were within 10 percent of each other and represented two lines of evidence (one estimated through modeling and one based on physical measurements in the Basin).

- Mercury concentrations in the surficial sediment in the southern portion of the Basin decreased from 1991 to 2009. Grain size distributions and TOC analyses for the southern portion of the Basin indicated a higher sand percentage and lower TOC percentage, which may indicate incoming sediment, compared to northern and central portions of the Basin. This area was where heavier particles would settle when floodwaters entered the Basin from the inlet channel.

- The average concentration of mercury in surficial floodplain soils was 0.814 mg/kg. Mercury concentrations in subsurficial soils were generally less than 1 mg/kg with slight increases and decreases with depth. Mercury concentrations in surficial floodplain soils generally decreased with increasing distance from the water's edges of the Basin and Round Pond. These concentrations were less than those collected in the 1990s. HCB concentrations ranged from 0.0035 mg/kg to 0.275 J mg/kg and were less than historical soil samples. Average DDTR concentrations in surficial floodplain soils ranged from <0.002 UJ mg/kg in the southeastern portion of the floodplains to 2.23 mg/kg in the northwest portion of the floodplain. Concentrations decreased from north to south, with the highest concentrations 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.

- Mercury concentrations in micro-wells between the Basin and the river were less than the AWQC of 0.012 µg/L. Mercury in the OU-2 sediments did not act as a continuing source to groundwater or the Tombigbee River via the groundwater pathway because mercury above the screening level was not detected in groundwater associated with OU-2. Model results demonstrated that HCB concentrations at the isolated location where HCB was detected in groundwater would not result in an exceedance of the HCB AWQC in the Tombigbee River. DDTR was not detected above the reporting limit in the groundwater samples. DDTR in sediment was not a continuing source to groundwater or the Tombigbee River.

- Mercury was not detected in terrestrial vegetation. The average methylmercury concentration in terrestrial vegetation was 0.00314 mg/kg. HCB and DDTR were detected in one vegetation sample.

- Mercury, HCB, and DDTR concentrations in spiders were similar throughout the floodplain, likely due to their predatory nature. Flying insect COC concentrations varied throughout the floodplain and reflected the potential wide-ranging habits of these insects. Concentrations of COCs in crawling insects were the lowest of the three groups, likely reflective of their localized nature.

- Mercury concentrations in 2008 fish tissue in upper trophic level fish increased since 2007. Fish were not collected in 2009. Mercury concentrations in middle and lower trophic level fish decreased. The upper trophic level fish may decrease in mercury concentration as the upper trophic level fish continue to feed on the middle and lower trophic level fish.

- The ERA indicated that three assessment endpoints were below NOAEL-based HIs. Seven assessment endpoints were above either the NOAEL or LOAEL. The 10 representative receptor species for these seven assessment endpoints are the little brown bat, mink, pied-billed grebe, belted kingfisher, little blue heron, great blue heron, wood duck, short-tailed shrew, and Carolina wren. Potential risk is concluded for these endpoints/ representative receptors species.

- Hazard estimates for current resident trespasser adults and adolescents exposed to floodplain soils, surface water, and through fish ingestion do not exceed an HI of 1. Hazard estimates for potential future trespasser adults and adolescents exposed to surface water and floodplain soil are also less than 1. Only an unrestricted potential future scenario for fish ingestion exceeded 1. This potential future scenario of unrestricted use is unlikely to occur because 1) Olin is unlikely to relinquish control of the Basin and surrounding property, and 2) Olin will continue with operation of the facility and site security, which will reduce exposure to a low frequency.

# 2.0 REMEDIAL ACTION OBJECTIVES/GENERAL RESPONSE ACTIONS

## 2.1 COCS

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. USEPA has also requested the evaluation of other COCs, which include HCB and DDTR. The primary release mechanism for mercury and HCB to OU-2 was the discharge through the former wastewater ditch (Figure 1-1) from 1952 to 1974 (WCC, 1993). The presence of DDTR is a result of indirect discharges from the BASF (formerly Ciba-Geigy) Superfund site located immediately north of OU-2. Olin did not manufacture DDTR or intermediate daughter products associated with DDTR at its McIntosh plant.

PRGs were developed for mercury, HCB, and DDTR in the RGO report (Revision 0) and submitted to USEPA in August 2010 (MACTEC, 2010b). A revised RGO report (Revision 2) was submitted to USEPA on February 3, 2012, after incorporation of USEPA comments. Recommended PRGs are listed with the RAOs below.

## 2.2 REMEDIAL ACTION OBJECTIVES

RAOs are identified to address risk and comply with applicable or relevant and appropriate requirements (ARARs). The RAOs for OU-2 are designed to reduce mercury in sediment, surface water, and biota. RAOs are listed below:

- ***Reduce, or mitigate, risk to piscivorous birds from ingestion of fish exposed to mercury-contaminated sediments.*** The mercury PRG recommended for sediments ranged from 1.6 to 10.7 mg/kg in the February 2012 RGO Report (AMEC, 2012). The sediment PRG is the mercury concentration in sediment that will be protective of ecological receptors.
- ***Reduce, or mitigate, risk to piscivorous mammals from incidental ingestion of HCB-contaminated sediments.*** The HCB PRG for OU-2 sediments recommended in the February 2012 RGO Report was 7.6 mg/kg (AMEC, 2012).
- ***Reduce, or mitigate, risk to piscivorous birds from ingestion of fish exposed to DDTR-contaminated sediments*** – The recommended DDTR PRG for OU-2 sediments is 3 mg/kg (AMEC. 2012). A remedial goal of 3 mg/kg for DDTR represents the residual DDTR remaining at the upgradient, off-site BASF Superfund site (formerly Ciba-Geigy), which is immediately north of OU-2 and the indirect source of DDTR to OU-2.

- ***Reduce, or mitigate, future potential risk to humans from ingestion of fish*** – Human ingestion of fish does not result in unacceptable risk based on current land use and Olin security measures; this RAO is currently achieved. This RAO would remain achieved in the future by meeting the USEPA recommended fish tissue concentration consumption guideline of 0.3 mg/kg for mercury (USEPA, 2001) should Olin no longer continue facility operations and security at OU-2.
- ***Reduce, or mitigate, risk to ecological receptors exposed to COCs in contaminated floodplain soils*** – The soil goal of 1.7 mg/kg for mercury will be applied to the floodplain soils. A remediation goal of 3 mg/kg will be applied to DDTR in floodplain soils; this goal is consistent with the residual DDTR concentration for the BASF Superfund site immediately north of OU-2. HCB concentrations do not pose unacceptable risk within the floodplain soils.

Chemical-specific ARARs/TBCs include the recommended PRGs for OU-2. Surficial sediment concentrations in the Basin and Round Pond exceed these concentrations for mercury. DDTR and HCB concentrations above the sediment PRGs are within the area which will be remediated for mercury in sediment and will be encompassed within the remedial footprint for mercury in sediment.

Mercury in floodplain soil was detected above the PRG (1.7 mg/kg) in three floodplain soil samples in the surficial layer (0-1 inch). These locations are adjacent to the Basin. One sample (FPSS2-10) is located on the banks of the channel between the Basin and Round Pond (Figure 1-3) and will be encompassed within the remedial footprint for mercury in sediments. A statistical comparison of the floodplain and sediment results indicates that this sample is representative of sediment rather than floodplain soils. The average mercury concentration (0.814 mg/kg) in the floodplain soil was below the mercury PRG, excluding sample FPSS2-10. Two locations (FPSS15-10 and FPSB5-10) at the southern edge of the Basin slightly exceeded the mercury PRG at concentrations of 2.5 and 2.4 mg/kg. Additional sampling will be performed during the remedial design to confirm the mercury concentration in these areas, and appropriate adjustments to the remedial footprint will be made, if needed. Maximum adjustment is expected to be less than approximately 5% of total remedial area and would be limited to the southern edges of the Basin. Concentrations of DDTR and HCB in floodplain soils were not above the PRGs. Separate remediation technologies and alternatives were not developed or evaluated for floodplain soils, as a result.

## 2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO BE CONSIDERED CRITERIA

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. *See* also 40 C.F.R. § 300.430(f)(1)(ii)(B). ARARs include only federal and state environmental or facility siting laws/regulations. Therefore, the CERCLA requirement for compliance with or waiver 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, CERCLA actions must only comply with the "substantive requirements," not the administrative requirements of regulations. 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 the agencies for determining compliance with certain requirements, such as those typically identified as Location-Specific ARARs.

*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, state environmental, or state facility siting laws that specifically address a hazardous substance, pollutant, or contaminant, remedial action, location, or other circumstance at a CERCLA 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. *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, state environmental, or state 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 relevant and appropriate.

Per 40 C.F.R. § 300.400(g)(5), only those state standards which are promulgated, are identified in a timely manner, and are more stringent than federal requirements may be applicable or relevant and appropriate. For the purposes of identification and notification of promulgated state standards, the term "promulgated" means that the standards are of general applicability and are legally enforceable. State ARARs are considered more stringent where there is no corresponding federal ARAR, where the State ARAR provides a more stringent concentration of a contaminant, or the where a State ARAR is broader in scope than a federal requirement.

In addition to ARARs, the lead and support agencies may, as appropriate, identify other advisories, criteria, or guidance to be considered for a particular release. The "to-be-considered" (TBC) category consists of advisories, criteria, or guidance that were developed by EPA, other federal agencies, or states that may be useful in developing CERCLA remedies. *See* 40 C.F.R. § 300.400(g)(3). TBCs can be used in the absence of ARARs, when ARARs are insufficient to develop cleanup goals, or when multiple contaminants may be posing a cumulative risk. *See* EPA, OSWER Directive No. 9234.0-05, *Interim Guidance on Compliance with Applicable or Relevant and Appropriate Requirements* (July 9, 1987).

In accordance with 40 C.F.R. § 300.400(g), EPA has identified the potential ARARs and TBCs for the evaluated alternatives. Tables 2-1, 2-2, and 2-3 list respectively the Chemical-, Action-, and Location-Specific ARARs/TBCs for remedial actions in the evaluated alternatives.

### 2.3.1 ARAR Categories

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), Olin and the lead and support agencies shall identify the 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 the 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).

#### 2.3.1.1 Chemical-Specific ARARs/TBC Guidance

Chemical-specific ARARs are usually health- or risk-based numerical values limiting the amount or concentration of a chemical that may be found in, or discharged to, the environment. The state or federal ambient water quality criteria established under Section 303 or 304 of the Clean Water Act are examples of Chemical-specific ARARs that are used to establish remediation levels for restoration of surface water. *See* 40 C.F.R. §§ 300.430(e)(2)(i)(B), (C), & (E).

Table 2-1 lists Chemical-specific ARARs/TBCs for OU-2, which includes water quality criteria for protection of fish and wildlife use of the Lower Tombigbee River; risk-based fish tissue criterion for mercury; and water quality criteria for toxic pollutants.

2.3.1.2 Action-Specific ARARs/TBC Guidance

Action-specific ARARs are usually technology-based or activity-based requirements or limitations that control actions taken at hazardous waste sites. Action-specific requirements often include performance, design and controls, or restrictions on particular kinds of activities related to management of hazardous substances. Action-specific ARARs are triggered by the types of remedial activities and types of wastes that are generated, stored, treated, disposed, emitted, discharged, or otherwise managed. Potential action-specific ARARs include: development of technology-based and water-quality-based effluent limitations and standards for discharge of pollutants to surface waters (all alternatives except "No Action" alternative); standards for development of a solid waste, industrial landfill unit (Alternative 3); and TBC guidance on in-situ capping of contaminated sediments (Alternatives 2A and 2B). For purposes of developing and evaluating alternatives, it was assumed that dredged sediment would not fail TCLP and, therefore, not be subject to RCRA Subtitle C disposal requirements. This assumption is supported by historical data. Six composite bulk sediment samples were extracted by TCLP and the extract was analyzed for mercury and HCB in 1995. The results show that the sediment would not hazardous by TCLP (WCC, 1996). Action-specific ARARs relating to the characterization, segregation, storage, and off-site disposal of RCRA Subtitle C hazardous wastes were retained in the event that dredged waste was found to be hazardous and required off-site disposal.

Table 2-2 lists potential action-specific ARARs/TBC guidance for OU-2 remedial action alternatives.

2.3.1.3 Location-Specific ARARs/TBC Guidance

Location-specific requirements establish restrictions on permissible concentrations of hazardous substances, establish requirements for how activities will be conducted because they are in special locations (*e.g.*, wetlands, floodplains, critical habitats, coastal areas), or establish siting parameters for facilities based on their proximity to special locations.

OU-2 is located between a bluff to the west and the Tombigbee River to the east. A solid waste, industrial landfill unit is identified on top of the bluff, which is approximately 20 to 30 feet higher in elevation than the floodplain in Alternative 3. The exact location of a potential solid waste, industrial landfill unit in Alternative 3 may change. Additionally, portions of OU-2 are located in a coastal area, as defined by ADEM Admin. Code r. 335-8-1-.02(k).

The evaluated alternatives may also impact federally- or state-designated endangered or threatened species or their critical habitat. At minimum, "substantive compliance with the [Endangered Species Act] means that the lead agency must identify whether a threatened or endangered species, or its critical habitat, will be affected by a proposed response action." EPA, OSWER Directive No. 9234.1-02, "CERCLA Compliance with Other Laws Manual: Part II, Clean Air Act and Other Environmental Statutes and State Requirements," at 4-11 (Aug. 1989). ESA Section 7 consultation with the U.S. Department of the Interior for endangered or threatened species or critical habitat impacts is not required for cleanup actions conducted entirely on-site. Such consultation is strongly recommended by USEPA.

Consultation with the U.S. Fish and Wildlife Service is not required under the Fish and Wildlife Coordination Act, 16 U.S.C. § 661 *et seq.*, for on-site actions that result in the control or structural modification of a natural stream or body of water (as in Alternative 2C – dry capping). Such consultation is likewise strongly recommended by USEPA. *See id.* at 4-22.

Table 2-3 lists potential location-specific ARARs/TBC guidance for OU-2 remedial action alternatives.

### 2.3.2 ARARs Applicable to Off-Site Activities

Remediation wastes that are generated and subsequently transferred off-site or transported in commerce along public right-of-ways must meet any applicable requirements such as those for packaging, labeling, marking, manifesting, and placarding requirements for hazardous materials. In addition, CERCLA Section 121(d)(3) provides that the off-site transfer of any hazardous substance, pollutant, or contaminant generated during CERCLA response actions be sent to a treatment, storage, or disposal facility that is in compliance with applicable federal and state laws and has been approved by EPA for acceptance of CERCLA waste. *See* also 40 C.F.R. § 300.440 (so called "Off-Site Rule").

### 2.3.3 Evaluation and Waiver of ARARs

The remedial alternatives are evaluated in this FS to determine whether they comply with identified chemical-, action-, and location-specific ARARs. As stated above, compliance with ARARs is a threshold requirement of CERCLA that every remedy must meet, unless an ARAR waiver can be used. *See* 40 C.F.R. § 300.430(f)(1)(A). Under CERCLA Section 121(d)(4), a remedial action that does not attain an ARAR may be selected if EPA finds that one of the six waivers is justified. It is not anticipated that the evaluated alternatives would require an ARAR waiver.

Location-specific and action-specific ARARs are listed in Tables 2-2 and 2-3, respectively.

### 2.3.4 Principal Threat Waste Determination

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" (USEPA, 1991). Source material is defined by USEPA 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." USEPA 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 National Oil and Hazardous Substance Pollution Contingency Plan (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. (USEPA, 1991)

The inherent toxicity, the physical state, the potential mobility, and the degradation products of the material are all taken into account. If the toxicity and mobility of the source material combine to pose a potential risk of $10^{-3}$ or greater, EPA 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 require treatment.

EPA provided further guidance on principal threat waste in a 1997 "rule of thumb" document. In addition to the concepts above, this 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 following section addresses the species of mercury as it relates to toxicity, lack of mobility of the OU-2 sediment, the fact that the OU-2 sediment can be reliably contained, does not present a significant risk to human health or the environment, and is not a source material.

**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 is approximately 0.00736 to 0.136 percent of the total mercury species, based on data collected in 2009. Summary tables of analytical data for surficial sediment, surface water, sediment cores, gate overflow, floodplain soils, vegetation, and insects are provided in Appendix A. Mercury, 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 Human Health Risk Assessment Report (Rev. Nov. 22, 2010) determined that the quantitative risk is orders of magnitude below the $10^{-3}$ limit discussed in the 1991 EPA Guidance.

| Receptor Population | Carcinogenic Risk (Total Risk Across All Media) |
|---|---|
| Resident Trespasser, Adult (Current) | $6x10^{-6}$ |
| Resident Trespasser, Adult (Future) | $3x10^{-5}$ |
| Resident Trespasser, Pre-Adolescent/Adolescent (Current) | $2x10^{-6}$ |
| Resident Trespasser, Pre-Adolescent/Adolescent (Future) | $7x10^{-6}$ |

**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. More detailed or specific guidance as to what would make source material "mobile" is not provided by EPA or other agencies. A review of previous EPA site-specific determinations was conducted to better understand how EPA has applied these principles at other sites.

Prior EPA Determinations

The following EPA determinations were obtained by reviewing the Records of Decision or "RODs" for sites that were available online:

Mercury at the LCP Bridge Street Facility was described as highly mobile or toxic in six areas and "will be a continuing source of groundwater contamination because some of the contamination is located below the water table." It was therefore determined to be principal threat waste due to the continuing release (i.e. mobility) to groundwater.

At the Alcoa (Point Comfort)/Lavaca Bay Site, elemental mercury identified onsite was not found to be highly mobile and was of limited areal extent, and all evidence indicated that the mercury DNAPL was contained. The mercury-containing materials were therefore not principal threat waste because the mercury was not mobile beyond the limited area of the source material.

Polychlorinated Biphenyls ("PCBs") in site sediment at the Eustis Lake site were not considered to be principal threat waste because they were "non-mobile (limited to sediment within Eustis Lake with no impacts to surface water, air, or groundwater) contaminated source material of low to moderate toxicity (average concentrations less than the risk-based remediation goal of 1 mg/kg in the lake). All available data suggest that mobility and migration of contaminated sediments were limited to the confines of the Eustis Lake.

Olin McIntosh OU-2

Mercury within the Basin and Round Pond is not a source that would cause an exceedance of ambient water quality criteria (AWQC) in the Tombigbee River. 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. The mobility or transport of mercury outside of the Basin and Round Pond is limited by construction of a berm and gate system and by the clay formation under the Basin/Round Pond.

The berm and gate system surrounding OU-2 was constructed in 2006 to manage water levels and isolate the Basin/Round Pond to enhance quiescent conditions and restrict surface overflows. Water overflowing the gate structure 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 AWQC of 0.12 µg/L. A mass balance indicated that the mercury concentration in the Tombigbee River at the confluence with the Basin would not exceed the AWQC (AMEC, 2011). HCB and DDTR have very limited solubility and would not be very mobile within OU-2, based on literature values for solubility.

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 confirm that mercury does not fully penetrate the sediment deposits. A pathway between the sediment and the underlying aquifer is not complete and is expected to remain incomplete.

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.

Data conclude that the sediments do not migrate beyond the confines of the Basin/Round Pond and that the clay barrier serves to maintain the sediment as immobile. A mass balance between flow from the Basin and the Tombigbee River indicated that the mercury concentration in the Tombigbee River at the confluence with the Basin would not exceed the AWQC, under the conditions sampled. The core results collected in 2010 confirm that mercury does not fully penetrate the sediment deposits, and a pathway between the sediment and the underlying aquifer is not complete.

This is analogous to the Alcoa (Point Comfort)/Lavaca Bay and Eustis Lake sites because the mercury-contaminated material would not be likely to migrate beyond the Basin and, hence, would not impact the surface water outside of OU-2, groundwater, or air.

**Containment**

Sediment caps have been approved by USEPA 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 (Section 4.2.2.3). 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.

**Significant Risk to Human Health and the Environment**

A human health risk assessment (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. The Human Health Risk Assessment Report (Rev. Nov. 22, 2010) determined that none of the risk figures exceed the $10^{-3}$ limit discussed in the 1991 EPA Guidance. Current risk to human health is within the USEPA acceptable range and below $10^{-3}$ for carcinogenic risk for future risk scenarios, even where access is unrestricted by Olin. Olin plans to maintain access restrictions into the future. Future non-carcinogenic risk is below an HI of 5. This level of risk is not considered acute. Using conservative methods of calculating risk, ecological risk associated with OU-2 is also low and results in a HI less than 10.

**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. This situation does not exist at OU-2. 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. Additionally, they also do not act to cause an exceedance of the AWQC outside of OU-2 at the confluence of the Basin outflow and the Tombigbee River.

Results of the human health risk assessment did not find unacceptable risk to humans due to direct contact with surface water or sediment. There is no direct contact pathway between submerged sediments and human receptors. Mercury concentrations in floodplain soils, which humans may contact, are below the USEPA Region 4 human health screening criteria.

Results of the ERA indicate that risk to ecological receptors are associated with ingestion of insects and fish and not direct exposure to sediment and surface, with the exception of the mink exposed to HCB in sediment. The risk-based PRG was exceeded for the mink at one sample location in an isolated area. This isolated detection of 8.9 mg/kg is relatively near the risk-based PRG.

The sediments at OU-2 do not act as a reservoir for migration of contamination or provide a source for direct exposure. Sediment at OU-2 does not meet the definition of a source material.

**Summary**

The COCs in sediments at OU-2 are not highly mobile outside of OU-2, can be reliably contained, do not pose a significant risk to human health or the environment, and do not meet the definition of a source material. Nor do the sediments contain elemental mercury. Therefore, the principal threat waste characterization does not apply to OU-2 sediment.

## 2.4 GENERAL RESPONSE ACTIONS

General Response Actions (GRAs) represent the types of remedial responses available for impacted media to meet RAOs. The GRAs for OU-2 sediments include:

- **No Action**, as mandated by CERCLA, includes no new remedial measures. According to the NCP, 40 CFR 300.68, No Action is retained for detailed analysis and used as a baseline in comparing alternatives.
- **Institutional Controls (ICs)** are intended to restrict exposure to impacted media. ICs can include extended sediment monitoring and restrictions on fish consumption. ICs do not reduce constituent concentrations or protect ecological receptors. ICs, as a stand-alone remedial action, are appropriate where there is significant natural recovery, where constituents are immobile, where the risk assessment does not identify constituents as potential future hazards, where the costs to implement remedial measures outweigh the benefits, or where the short-term risk to implement a technology outweighs the benefit. ICs will be considered for OU-2 in combination with other remedial technologies.

- **Containment** includes preventing direct exposure to the impacted media and limiting constituent mobility. Containment technologies do not reduce toxicity or volume. Long-term, in-place management would be required along with a long-term monitoring program. Examples of sediment containment are in situ capping and natural or enhanced sedimentation.

- **Removal** involves dredging of impacted sediment followed by either on-site or off-site treatment and/or disposal to reduce risk. Removal does not provide treatment or reduce toxicity; therefore, it must be combined with treatment and/or disposal. Dredging of wet sediment may result in incomplete sediment removal due to sediment resuspension during dredging and remaining residuals. Experience at similar sites indicates that complete removal is very difficult and often not achieved. While the mass of impacted sediment may be reduced, risk may or may not be reduced to acceptable levels. Short-term effects such as an increase in sediment suspension and re-mobilization of mercury, followed by an increase in mercury concentrations in fish, have occurred at other sites and must be considered.

- **Disposal** of dredged sediments can be accomplished by removal to an off-site facility or disposal on-site. Off-site disposal would involve transporting non-hazardous sediment to an approved, permitted landfill.

# 3.0 TECHNOLOGY IDENTIFICATION / SCREENING AND ALTERNATIVE DEVELOPMENT

## 3.1 IDENTIFICATION OF REMEDIAL TECHNOLOGY TYPES AND PROCESS OPTIONS

Remedial technologies and corresponding process options are presented in Table 3-1. The following sections describe the technologies and identify those retained for further evaluation and combination into remedial alternatives.

## 3.2 EVALUATION AND SCREENING OF TECHNOLOGIES

Treatment effectiveness, implementability, and cost were considered in evaluating potentially applicable technologies:

> ***Implementability*** considers both the technical and institutional feasibility of implementing each alternative. Technical feasibility includes the ability to construct, operate, and maintain the alternative. Examples of institutional implementability include the ability to obtain approvals from other agencies, the availability of treatment and disposal services, the availability of equipment and technical expertise, and community acceptance.
>
> ***Effectiveness*** considers short-term effectiveness during remedial action and long-term effectiveness after the remedial action is completed. Remedial alternatives that do not meet RAOs will not be considered for detailed analysis.
>
> ***Cost*** considers the order of magnitude of capital and operations and maintenance expenditures. Cost estimates are relative and not absolute. The procedure used is based on engineering judgment, site-specific information, and dredging and capping unit costs provided by sediment remediation contractors. Costs are provided on a low, medium, and high basis.

Screening of the remedial technologies is summarized below. Technologies retained for further evaluation are combined into remedial action alternatives in Section 3.3.

> ***No Action*** is retained and provides the baseline for comparing alternatives.
>
> ***Institutional Controls (ICs)*** are retained for combination with other remedial technologies. The existing ICs, including fences, warning signs, operation of the berm and gate system, and fishing limitations and site security imposed by Olin, are already effective at limiting exposure below unacceptable limits.
>
> ***Containment*** is retained for combination into alternatives. Containment includes the technologies for capping.

> ***Removal*** is retained for combination into alternatives. Removal includes the process options of mechanical dredging, hydraulic dredging, and isolation excavation. Hydraulic dredging with mechanical removal of buried debris is considered the most viable of the three and is retained for combination into alternatives.
>
> ***Disposal*** is retained for combination into alternatives. Disposal includes the process options on-site and off-site landfill. These technologies are retained for combination into alternatives.
>
> ***Treatment*** is retained for combination into alternatives. Treatment includes process options for dewatering and subsequent treatment of dewatering fluids.

Remedial alternatives are often developed from the applicable remedial technologies and then screened again before detailed evaluation of the remedial alternatives. A remedial alternative screening will not be performed in this FS because the number of applicable remedial technologies is limited for sediment remediation at OU-2. Remedial alternatives for detailed evaluation and comparison are developed below.

## 3.3 ALTERNATIVE DEVELOPMENT

Alternatives are developed to assemble a range of distinct remedial options with the potential to achieve the RAOs. Remedial alternatives are developed by assembling combinations of the remedial technologies screened in Section 3.2. The remedial alternatives for OU-2 are listed below.

- 1 No Action
- 2A In situ capping and ICs
- 2B In situ capping, dry capping and ICs
- 2C Dry capping and ICs
- 3 Debris removal, hydraulic dredging, dewatering, onsite or offsite disposal, and ICs

A conceptual drawing of Remedial Alternative 2A is provided in Figure 3-1.

## 3.4 ALTERNATIVE DESCRIPTIONS

The alternatives listed in Section 3.3 are described below. The six alternatives assembled for further evaluation will not be screened prior to the detailed analysis in Section 4.0 as discussed in Section 3.2.

### 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 USEPA 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.

**Alternative 2A: In Situ Capping and ICs**

Alternative 2A combines in situ capping with ICs. In this alternative, a cap would be applied over the areas of sediment exceeding the remediation goal. This cap would serve as a barrier between the environment and mercury in the sediment, thus reducing risks to acceptable levels. A cap typically consists of 3 layers: 1) a mixing zone, 2) cap material layer, and 3) habitat layer. The mixing or transition zone 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 is placed above the mixing zone. The effectiveness of cap material consisting of native borrow soil with and without amendments, such as bentonite pellets and activated carbon, is evaluated in Section 4.2. A thin layer (3 to 6 inches) of reactive cap material such as, but not limited to, pelletized activated carbon, apatite, or biopolymers, may also be applied as a polishing layer within the cap material. The uppermost layer is the habitat layer, consisting of native soils with armor (stone placement to prevent erosion). 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 flooding. ICs would be employed to limit risks to human receptors.

**Alternative 2B: In situ Capping, Dry Capping and ICs**

Alternative 2B combines in situ capping, dry capping, and ICs. A cap would be applied over the areas of sediment exceeding the remediation goal consistent with Alternative 2A. The portion of the Basin that is at elevation -5 feet NAVD88 or lower would be capped in situ, as in Alternative 2A. The portions of the Basin that are shallower than -5 feet NAVD88 and Round Pond would be capped in the dry. Capping in the dry is defined as dewatering the area and using earth-moving equipment to place cap material over the sediment. The areas would be incrementally segregated with portadams into 300- by 400-foot sections and dewatered. The water would be pumped to Modutanks® (or equivalent) located on the bluff. Solids would settle inside the Modutank®, 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. This cap would provide a barrier between the environment and the mercury 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 portadams 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 and to maintain consistent water levels for equipment. ICs would be employed to limit risks to human receptors.

**Alternative 2C: Dry Capping and ICs**

Alternative 2C combines dry capping with ICs. In this alternative, areas of Basin and Round Pond that exceed the remediation goal would be capped in the dry as described in Alternative 2B. ICs would be employed to limit risks to human receptors.

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

Alternative 3 combines debris removal with mechanical equipment, hydraulic dredging, dewatering, onsite or offsite disposal, and ICs. In this alternative, risks are reduced to acceptable levels by removing sediments exceeding the remediation goal through hydraulic methods. The dredged sediments would be dewatered prior to disposal in an onsite or offsite landfill. It is assumed that the dredged sediments would be considered non-hazardous. This assumption would be verified with TCLP analysis prior to sediment removal. The residual water from dewatering would be either discharged to the river under a permit or returned to the Basin. 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 flooding. ICs would be employed to limit risks to human receptors.

These five remedial alternatives will be evaluated and compared in accordance with the evaluation criteria under CERCLA (USEPA, 1988) and the 11 risk management principles for contaminated sediment (USEPA 2002, 2005).

# 4.0 DETAILED ANALYSIS OF ALTERNATIVES

Performing a detailed, comparative analysis of the retained remedial alternatives is the last step of the FS process. The remedial alternatives are evaluated with respect to nine CERCLA evaluation criteria. The nine criteria include:

- Overall protection of human health and the environment
- Compliance with ARARs
- Short-term effectiveness
- Long-term effectiveness
- Reduction of toxicity, mobility, and volume (TMV) through treatment
- Implementability
- Cost
- State acceptance
- Community acceptance

The remedial alternatives were evaluated for the first seven criteria and then compared with one another to identify their respective strengths and weaknesses. Two criteria, State and community acceptance, were not evaluated because they will be based on comments received and addressed in the Record of Decision following the review period.

## 4.1 ALTERNATIVE 1 – NO ACTION

### 4.1.1 Description

The No Action alternative provides a baseline for comparison with the range of other developed alternatives. Its inclusion among the alternatives is mandated by USEPA guidance. Natural sedimentation has likely already reduced mercury concentrations in sediment at or below the sediment PRG in some portions of the Basin (area north of the inlet channel) and will continue. The timeframe to achieve the sediment PRG in other portions of the Basin and Round Pond would be very lengthy and beyond the timeframe evaluated in this FS. 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.

#### 4.1.2 Alternative Evaluation

##### 4.1.2.1 Overall Protection of Human Health and the Environment

Under the No Action Alternative, ICs such as security monitoring and berm/gate maintenance would be discontinued so that risk to human receptors would increase above acceptable levels. Risk to ecological receptors through bioaccumulation would not be mitigated. The No Action alternative is not considered protective of human health or the environment.

##### 4.1.2.2 Compliance with ARARs

The No Action alternative does not comply with ARARs because PRGs for sediment are not met for mercury, DDTR, and HCB.

##### 4.1.2.3 Long-Term Effectiveness

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

##### 4.1.2.4 Short-Term Effectiveness

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

##### 4.1.2.5 Reduction of TMV through Treatment

This alternative does not include any measures to reduce TMV.

##### 4.1.2.6 Implementability

No measures are implemented under this alternative.

##### 4.1.2.7 Cost

The No Action Alternative has no capital or maintenance cost.

## 4.2 ALTERNATIVE 2A – IN SITU CAPPING AND ICS

### 4.2.1 Description

In Alternative 2A, a cap would be applied in situ over the areas of sediment exceeding the remediation goal. Figure 4-1a shows the area where mercury concentrations are above and below a PRG of 1.6 to 10.7 mg/kg for surficial sediment and includes the channel connecting the Basin and Round Pond. The mercury isoconcentration contours on Figure 4-1a are based on surficial sediment data collected in 2009. 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 4-1b and 4-1c 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.

A cap typically consists of three layers: 1) a mixing zone, 2) a cap material layer, and 3) a habitat layer. The purpose of the mixing zone is to provide a buffer at the cap/sediment interface that prevents sediment mixing into the cap material layer during placement. The cap material layer is placed above the mixing zone, and a habitat layer is at the surface of the cap. A model for the migration of mercury through cap material was performed, and the results indicate that a cap of native soil without amendments would be effective in meeting PRGs. Model results indicate that capping with amendments would also be effective. Native soils would be excavated from the borrow area along the bluff. The mercury migration model is discussed in more detail in Section 4.2.2.3.

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. Figures 1-12a and 1-13a show that the side slopes are not extreme over the area of the Basin. Special requirements (such as terracing or side-slope stabilization) are not necessary to apply a cap to the deeper portion of the Basin. 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 would be employed to limit risks to human receptors. ICs would consist of warning signs, 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.

### 4.2.2 Alternative Evaluation

#### 4.2.2.1 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 USEPA-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 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.

#### 4.2.2.2 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 PRGs for mercury, DDTR, and HCB in sediment. Workers would wear appropriate personal protective equipment (PPE) for the protection of worker safety. OSHA construction standards and recordkeeping/reporting requirements would be met during the remedial action. 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.

#### 4.2.2.3 Long-Term Effectiveness

An in situ cap would be effective in the long term at achieving RAOs. Sediment caps have been approved by USEPA for remediation at many sites. There are no treatment residuals in capping alternatives. 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 PRGs are exceeded so that the exposure pathway is eliminated.

A conceptual cap design includes three layers to effectively create the exposure barrier: 1) the mixing zone, 2) the cap material layer, and 3) the habitat layer. The mixing zone, the layer applied directly above the sediment, allows for mixing between the sediment and cap material that may occur during placement. 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 cap material layer would consist of native soils excavated from the borrow area along the bluff, located immediately west of the Basin/Round Pond. The native borrow soil consists of mostly clay and silt particles with some sand. This material was used to construct the berm in 2006. Amendments and polishing agents such as pelletized activated carbon, apatite, hematite, organo clay, pelletized bentonite, activated aluminum, and biopolymers may be added to the cap material. Selection of potential amendments or a polishing layer will be evaluated during the remedial design. The habitat layer provides a depth of material that allows burrowing organisms to recolonize the habitat without breaching the cap material layer. This helps preserve the integrity of the cap in the long term. The habitat layer would include stone armoring to prevent erosion and resuspension of cap material. The stone armoring also prevents animals that may burrow or excavate nests from disturbing the cap material. 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), referred to as the Reible model, was selected to predict the performance of the cap to contain mercury based on prior agreement with USEPA. The Excel® version of the Reible model is used in this FS to evaluate whether a cap, with or without amendments, is effective as an isolation barrier at OU-2. This model divides the modeled system into five parts: the underlying sediment with COCs greater than PRGs, the chemical isolation layer (cap material layer), the biologically active (bioturbation) layer or habitat layer, the sediment-water interface, and the overlying surface water (Lampert and Reible, 2009). These system components are depicted in Figure 4-2. The Reible model also accounts for sediment deposition. The Reible model was originally developed for organic contaminants and was modified to evaluate mercury at OU-2 by setting the organic fraction percentage to 100. Inputs to the Reible model, values for each input, and source of input values for contaminant properties, sediment properties, and cap properties are listed in Table 4-1.

Three cap types were selected for modeling. The selections represent both passive and reactive capping agents and are adequate to demonstrate whether or not capping is a feasible alternative. Treatability tests would be performed during the design phase of a capping alternative to confirm sorption capacity and to select the most appropriate materials, thicknesses, and other design parameters.

The passive capping agents selected, native borrow soil and bentonite pellets, are consistent with the materials selected for the Battelle sorption capacity study (Battelle, 2010) sponsored by USEPA ORD using native soil collected from OU-2. Activated carbon was included to represent a reactive capping amendment that could also be used as a polishing agent. The use of activated carbon in capping has become more prevalent in literature since the completion of the Battelle study.

The three cap types modeled are listed below:

1. Native borrow soil as cap material and native borrow soil with armor stone as a habitat layer
2. Native borrow soil with activated carbon as cap material and native borrow soil with armor stone as a habitat layer
3. Bentonite pellets as cap material and native borrow soil with armor stone as a habitat layer

The two amendments modeled, activated carbon and bentonite pellets, are considered representative of amendments that either increase cap sorption of COCs or reduce hydraulic conductivity. (Bentonite pellets are sometimes referred to as "Aquablok®" in the appendices; a reference to Aquablok® is not an endorsement of this supplier's name.) A more thorough analysis of cap amendments would be performed during remedial design of this alternative.

Midlevel, less, and more conservative scenarios were modeled for each of the three cap materials.

A midlevel conservative scenario is represented by the following model inputs:

- Cap material $K_d$ associated with the average pore water mercury concentration in sediment, as developed from the raw data generated during the USEPA ORD study conducted by Battelle (Battelle, 2010) (Appendix C)

- Average pore water concentration from 2009 fine core results for the top 1 foot of sediment (Appendix A) from the south-central portion of the Basin, where mercury concentrations are relatively higher
- Darcy velocity (groundwater upwelling) calculated using the mid-range of hydraulic conductivity for sediment beneath the Basin/Round Pond (Appendix D)
- Overall average depositional velocity for the Basin estimated as 0.3 inch/year (AMEC, 2011a)

A less conservative scenario is represented by the following model inputs:

- Cap material $K_d$ associated with the lower range of mercury concentrations in pore water, as developed from the raw data generated during the USEPA ORD study (Battelle, 2010) (Appendix C)
- Average range of pore water mercury concentrations from the 2009 fine core results for the top 1 foot of sediment (Appendix A)
- Darcy velocity calculated using the lower range of hydraulic conductivity for sediment beneath the Basin/Round Pond (Appendix D)
- Depositional velocity experienced in the southern portion of the Basin measured as 2 inches/year (AMEC, 2011a)

A more conservative scenario is represented by the following inputs:

- Cap material $K_d$ associated with the higher range of mercury concentrations in pore water, developed from the raw data generated during the USEPA ORD study (Battelle, 2010) (Appendix C)
- Maximum pore water mercury concentration averaged over the length of a core (Appendix A)
- Darcy velocity calculated using the higher range of hydraulic conductivity for sediment beneath the Basin/Round Pond (Appendix D)
- Depositional velocity of 0 inch/year

The method and calculations for estimating the $K_d$ of the cap material are provided in Appendix C. The $K_d$ values for the cap material are based on a linear fit applied to the raw data provided by Battelle (Battelle, 2010) from a study sponsored by USEPA ORD using native soil collected from OU-2. The Battelle study raw data was used to create a linear relationship because the Reible model requires $K_d$ inputs with a linear relationship; the Battelle study applied a non-linear fit. Actual $K_d$ values of cap materials would be calculated from site-specific treatability studies completed during the design phase.

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 to calculate a Darcy velocity or groundwater upwelling were made 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 was used as a very conservative value. The actual gradient within the cap layer is expected to be much less. The hydraulic gradient was calculated 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. Calculation of the Darcy velocity is provided in Appendix D. 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 model runs are included in Appendix E. Model inputs are listed in Table 4-1. The output for each cap material and modeling scenario are discussed below and summarized in Table 4-2.

**Native Borrow Soil Material**

The native borrow soil material was modeled for various cap thicknesses using the mid-level, less, and more conservative scenarios (Table 4-1). The modeled cap thicknesses were 8 inches, 12 inches, and 16 inches. The cap thickness included a 4-inch bioturbation or habitat layer. A minimum thickness of 8 inches was used because this is the minimum thickness typically placed. A mixing zone was not included in the model and would need to be added to obtain a total cap thickness including a habitat layer, cap material layer, and mixing zone.

Breakthrough time for the cap is defined as the number of years for the concentration of mercury at the interface of the habitat layer and chemical isolation layers of the cap (cap material layer) to reach the sediment PRG of 3 to 6 mg/kg. Each modeled thickness (8, 12, and 16 inches) demonstrated that breakthrough was never reached for the native borrow soil material under a mid-level conservative scenario. An 8-inch placement thickness for native borrow soil was selected for subsequent modeling. This thickness was selected for modeling purposes; the actual thickness and composition of a cap would be developed during remedial design.

The less and more conservative scenarios using native borrow soil material were modeled using an 8-inch cap placement thickness using the inputs indicated above for these scenarios. The modeled condition demonstrated that breakthrough was never reached for the native borrow material under the less and more conservative scenarios.

**Native Borrow Soil Material Amended with Activated-Carbon**

A native borrow material amended with activated carbon (50/50 ratio) was modeled using an 8-inch placement thickness and the representative case conditions (Table 4-1). The ratio of 50/50 was assumed based on reliability of placement. Bench scale studies would be required in remedial design to estimate the mass of activated carbon needed for both mercury sorption and sorption of naturally occurring constituents (TOC) that would also sorb to activated carbon. The log $K_d$ was developed by averaging the log $K_d$ of the native borrow soil material and activated carbon (USEPA, 1997; Rao et al., 2009). The modeled condition demonstrated that breakthrough was never reached for the activated-carbon native borrow material under a mid-level conservative scenario.

The less and more conservative scenarios using native borrow soil material with activated carbon were modeled using an 8-inch cap placement thickness using the inputs indicated above for these scenarios. The modeled condition demonstrated that breakthrough was never reached for the native borrow material with activated carbon under the less and more conservative scenarios.

**Bentonite Pellets**

A bentonite pellet cap was modeled using an 8-inch placement thickness (4 inches of bentonite pellets and 4 inches of native borrow material with armor for the habitat layer) and the representative case conditions. The default porosity was used in the model because the porosity of 0.001, which is representative of bentonite pellets, results in numerical problems with the model. The modeled condition demonstrated that breakthrough was never reached for bentonite pellets under the mid-level conservative scenario.

The less and more conservative scenarios using bentonite pellets were modeled using an 8-inch cap placement thickness using the inputs indicated above for these scenarios. The modeled condition demonstrated that breakthrough was never reached for bentonite pellets under the less and more conservative scenarios.

**Sensitivity Analysis**

A sensitivity analysis was performed on the Reible model for the inputs that appeared sensitive. This analysis was performed by varying one input, while holding the remaining inputs constant. Inputs were varied within the ranges of site-specific data, where available. Potential sensitive inputs were $K_d$, porewater concentration, Darcy velocity, depositional velocity, cap material (changes the diffusion equations used in the model), cap consolidation depth, sediment consolidation due to cap placement, and porosity. The most sensitive inputs determined in the sensitivity analysis were the depositional velocity, cap consolidation depth, and porosity. The modeled inputs are acceptable based on the sensitivity analysis because with the range of sensitivities used indicate that the concentrations of mercury at the cap material/habitat layer interface will not reach the 3-6 mg/kg PRG for mercury. The sensitivity analysis is included in Appendix E.

The results of the model for migration of mercury through cap materials indicated that a cap without amendments would 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.

#### 4.2.2.4 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, unlike dredging, which is associated with substantially increased risks, as discussed in Section 4.4.

#### 4.2.2.5 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.

Mercury in sediment in OU-2 is not a principal threat waste, as discussed in Section 2.3, because it does not act as a reservoir for migration of mercury to groundwater, surface water, or air, nor does it act as a source where risk is high due to direct contact. Capping would not destroy or treat the COCs in sediment.

Capping does not involve 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.

#### 4.2.2.6 Implementability

ICs 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 (AMEC, 2011a) 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.

Future remedial actions are not anticipated once the cap is placed. Compliance with conditions of the permits identified in Table 2-1 would be required. Monitoring would consist of sampling to monitor COC concentrations in sediment and fish tissue with time.

#### 4.2.2.7 Cost

The cost for Alternative 2A is presented in Tables 4-3a through 4-3d. The actual composition and thickness of the cap would be specified during the remedial design.

Capital cost estimates were provided by Sevenson Environmental Services, an experienced sediment remediation contractor. The capital estimates and detailed assumptions used to develop the costs are included in Appendix F.

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 cap were costed, representing the range of potential costs
    - Table 4-3a gives the costs for a native soil cap equal to 10 inches: cap design consists of a 2-inch native soil mixing zone, 4 inches of native soil cap material layer, and a 4-inch habitat layer consisting of native soil with armor. An additional 3 inches of native soil as cap material and an additional 2 inches of habitat material would be placed to ensure that a 10-inch minimum thickness would be achieved throughout the Basin and Round Pond. Gas venting mechanisms would be included in cap placement.
    - Table 4-3b gives the costs for a native soil cap with bentonite pellets as an amendment: cap design consists of a 2-inch mixing zone, 4 inches of bentonite pellets, and a 4-inch habitat layer. Additional material would be placed in each layer, based on the remedial contractor's experience, to achieve an acceptable thickness. Gas venting mechanisms would be included in cap placement.
    - Table 4-3c gives the costs for a native soil cap a polishing layer over 15 acres where mercury concentrations are greater than 50 mg/kg, as shown in Figure 4-1d: cap design consists of a 2-inch mixing zone, 4 inches of native soil, a 4-inch polishing layer of a reactive amendment and a 4-inch habitat layer. A polishing layer unit cost of $600/ton was applied to represent a variety of potential polishing materials. Cap material selection and final costing will be dependent upon bench-scale studies performed during remedial design. A mercury isoconcentration contour of 50 mg/kg represents the highest concentrations of mercury detected both in surficial sediment and pore water. Additional material would be placed in each layer, based on the remedial contractor's experience, to achieve an acceptable thickness. Gas venting mechanisms would be included in cap placement.
    - Table 4-3d gives the costs for a native soil cap with bentonite pellets and a polishing layer over 15 acres where mercury concentrations are greater than 50 mg/kg, as shown in Figure 4-1d: cap design consists of a 2-inch mixing zone, 4 inches of bentonite pellets, a 4-inch polishing layer of a reactive amendment and a 4-inch habitat layer. Additional material would be placed in each layer, based on the remedial contractor's experience, to achieve an acceptable thickness. Gas venting mechanisms would be included in cap placement.

- 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:
    - Annual berm inspections and maintenance
    - 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

The projected costs are tabulated below.

| Alternative 2A | Total Cost | Total Present Worth |
|---|---|---|
| Native Soil Cap | $13,400,000 | $12,900,000 |
| Bentonite Pellet Cap | $16,900,000 | $16,400,000 |
| Native Soil Cap/Polishing 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 30 years, based on the life cycle of the higher trophic fish species (approximately 10 years). An annual discount rate of 7 percent was applied to calculate present worth.

## 4.3 ALTERNATIVE 2B – IN SITU CAPPING, DRY CAPPING AND ICS

### 4.3.1 Description

Alternative 2B combines in situ capping, dry capping, and ICs. 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 portadams into 300- by 400-foot sections and dewatered. The water would be pumped to Modutanks® or equivalent, located on the bluff. Solids would settle inside the Modutank®, and the water would be returned to the Basin. A geotextile would be placed in the dewatered parcel, and then a native soil cap would be applied by earth moving equipment. This native soil cap would provide a barrier between the environment and the mercury in the sediment, thus reducing risks to acceptable levels. The native soil 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 portadams 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 be employed to limit risks to human receptors. Implementation would take approximately 7 months.

### 4.3.2 Alternative Evaluation

#### 4.3.2.1 Overall Protection of Human Health and the Environment

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

### 4.3.2.2 Compliance with ARARs

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

### 4.3.2.3 Long-Term Effectiveness

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

### 4.3.2.4 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.

### 4.3.2.5 Reduction of TMV Through Treatment

Reduction of TMV through treatment for Alternative 2B is consistent with 2A. Mercury in sediment in OU-2 is not a principal threat waste, as discussed in Section 2.3, because it does not act as a reservoir for migration of mercury to groundwater, surface water, or air, nor does it act as a source where risk is high due to direct contact. Capping would not destroy or treat the contaminated sediment.

Capping would not involve treatment; treatment residuals are not a concern for this alternative. Capping is considered permanent with appropriate armor for protection against erosion and proper maintenance.

#### 4.3.2.6 Implementability

ICs 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.

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. The conditions of the permits identified in Table 2-1 would be complied with. Monitoring would consist of sediment sampling to monitor COC concentrations in sediment and fish tissue over time.

#### 4.3.2.7 Cost

The cost for Alternative 2B is presented in Table 4-4. Capital cost estimates were provided by Sevenson, an experienced sediment remediation contractor. The capital estimates and detailed assumptions used to develop the costs are included in Appendix F.

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):
    - 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):
    - 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 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 regarding the borrow area after excavation
- Long-term operations, maintenance, monitoring, and reporting, including:
    - Berm and cap maintenance
    - 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 2B was used for costing to provide a basis of comparison to the site 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 | $14,300,000 |
| Total Present Worth | $13,800,000 |

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). An annual discount rate of 7 percent was applied to calculate present worth.

## 4.4 ALTERNATIVE 2C – DRY CAPPING, AND ICS

### 4.4.1 Description

Alternative 2C combines dry capping and ICs. In this alternative, 300- by 400-foot sections of the Basin and Round Pond would be isolated with portadams and dewatered. The water would be pumped to Modutanks® or equivalent, located on the bluff. Solids would settle inside the Modutanks®, and the water would be returned to the Basin. A geotextile would be placed in the dewatered parcel, and then a native soil cap would be applied. Borrow area or nearby native soils would be used to place a native soil cap over the areas of the sediment exceeding the remediation goal, as shown in Figure 4-1. This native soil cap would provide a barrier between the environment and the mercury in the sediment, thus reducing risks to acceptable levels. The native soil 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 as described in Alternative 2A would limit risks to human receptors.

### 4.4.2 Alternative Evaluation

#### 4.4.2.1 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.

#### 4.4.2.2 Compliance with ARARs

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

#### 4.4.2.3 Long-Term Effectiveness

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

#### 4.4.2.4 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.

#### 4.4.2.5 Reduction of TMV Through Treatment

Reduction of TMV through treatment for Alternative 2C is consistent with Alternatives 2A and 2B. Mercury in sediment in OU-2 is not a principal threat waste, as discussed in Section 2.3, because it does not act as a reservoir for migration of mercury to groundwater, surface water, or air, nor does it act as a source where risk is high due to direct contact. Capping would not destroy or treat the contaminated sediment.

Capping would not involve treatment; treatment residuals are not a concern for this alternative. Capping is considered permanent with appropriate armor for protection against erosion and proper maintenance.

#### 4.4.2.6 Implementability

ICs 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. The conditions of the permits identified in Table 2-1 would be complied with. Monitoring would consist of sediment sampling to monitor COC concentrations in sediment and fish tissue over time.

#### 4.4.2.7 Cost

The cost for Alternative 2C is presented in Table 4-5. Capital cost estimates were provided by Sevenson, an experienced sediment remediation contractor. The capital estimates and detailed assumptions used to develop the costs are included in Appendix F.

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
- 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:
    - Berm and cap maintenance
    - 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 | $16,400,000 |
| Total Present Worth | $15,900,000 |

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). An annual discount rate of 7 percent was applied to calculate present worth.

## 4.5 ALTERNATIVE 3 – DEBRIS REMOVAL, HYDRAULIC DREDGING, DEWATERING, ONSITE OR OFFSITE DISPOSAL, AND ICS

### 4.5.1 Description

Alternative 3 combines mechanical debris removal, hydraulic dredging, dewatering, onsite or offsite disposal, and ICs. The extensive buried debris identified in the debris survey (AMEC, 2011a) 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 4-4, 4-5, 4-6 and 4-7, and are based on a PRG of 1.6 to 10.7 mg/kg mercury in sediment. The isoconcentration contours drawn on Figure 4-4 are based on the 2009 surficial sediment results, including both fine core and grab sample results. Figures 4-5 through 4-7 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 4-4. Mercury concentrations in sediment greater than 4 feet in depth are listed on Figures 4-4 through 4-7. 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 4-4 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 would be dredged 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.

### 4.5.2 Alternative Evaluation

#### 4.5.2.1 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 (U.S. Army Corps of Engineers [USACE], 2008). Resuspension and residuals remaining in the sediment would likely approach 10 percent, 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 USEPA-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 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.

#### 4.5.2.2 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. Workers performing the remedial action would wear appropriate PPE to protect their safety. OSHA construction standards and recordkeeping/reporting requirements would be met during the remedial action. 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.

#### 4.5.2.3 Long-Term Effectiveness

Evidence that dredging projects led to the achievement of long-term remedial action objectives is generally lacking (National Research Council [NRC], 2007). 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. The *Technical Guidelines for Environmental Dredging of Contaminated Sediments* (Palermo et al., 2008) states that "all dredging operations resuspend sediment, release contaminants, and generate residuals."

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, and resuspension may be up to 10 percent of the total mass of sediment dredged, even when proper precautions and equipment are used to reduce resuspension (NRC, 2007). Low sediment bulk density and the presence of debris tend to increase resuspension and residuals (NRC, 2007). 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 operating the berm and gate system to enhance sedimentation.

#### 4.5.2.4 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.

#### 4.5.2.5 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.

Mercury in sediment in OU-2 is not a principal threat waste, as discussed in Section 2.3, because it does not act as a reservoir for migration of mercury to groundwater, surface water, or air. Nor does it act as a source where risk is high due to direct contact.

#### 4.5.2.6 Implementability

ICs 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 (AMEC, 2011a) 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 USEPA-approved and permitted facility. Sufficient land for onsite disposal is available along the bluff, as depicted in Figure 4-8.

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 would be maintained in the long term. Compliance with the substantial requirements of the permits identified in Table 2-1 would be required. Monitoring would consist of sampling to evaluate COC concentrations in sediment and fish tissue with time.

#### 4.5.2.7 Cost

The costs for Alternative 3 with onsite and offsite disposal of the dredged sediments are presented in Tables 4-6a and 4-6b, respectively. Either all of the dewatered sediment would be disposed of on-site or off-site. A combination of on-site and off-site disposal is not anticipated.

Capital cost estimates were provided by Sevenson, an experienced sediment remediation contractor. The capital estimates and detailed assumptions used to develop the costs are included in Appendix F.

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:
  - Construction of a disposal cell in the borrow area to be lined with an HDPE liner and 2-feet of clay.
  - Transportation of dredged material to the onsite disposal cell
  - 2-foot clay cover over the dredged material
  - Re-grading and seeding the landfill area
- For offsite disposal:
  - Transportation and disposal of dredged material in an offsite non-hazardous landfill
- Demobilization
- Long-term operations, maintenance, monitoring, and reporting including:
  - Berm and landfill cell maintenance
  - Confirmation sampling performed upon completion of dredging and 1 year later
  - 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
  - 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 | $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). An annual discount rate of 7 percent was applied to calculate present worth.

## 4.6 COMPARATIVE ANALYSIS OF ALTERNATIVES

Table 4-7 summarizes the evaluation criteria for the alternatives, which are discussed below. Table 4-8 presents the application of the 11 risk management principles for contaminated sediment (USEPA 2002, 2005). The remedial alternatives are also scored and ranked in Table 4-7.

### 4.6.1 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. No Action would not reduce COC concentrations in sediment to

PRGs. 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 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 will be protective of human health and the environment compared to dredging.

### 4.6.2 Compliance with ARARs

Alternative 1, No Action, does not comply with ARARs because the PRGs for sediment would not be met. 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 more certainty that capping with or without amendments will comply with ARARs compared to dredging.

### 4.6.3 Long-Term Effectiveness

Alternative 1, No Action, is not considered effective in the long term. Risk to ecological receptors would not be mitigated, and the ICs currently implemented are expected to deteriorate over time. 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. USEPA has approved caps for remediation at many sites.

### 4.6.4 Short-Term Effectiveness

Alternatives 1 and 3 are not considered effective in the short term. Alternative 1 (No Action) does not meet the sediment PRGs. 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.

### 4.6.5 Reduction of TMV through Treatment

Alternative 1, No Action, does not reduce TMV. Capping Alternatives 2A, 2B, and 2C would reduce mobility by isolating 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.

### 4.6.6 Implementability

ICs are already implemented at OU-2. Alternative 1, No Action, requires no implementation. 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.

### 4.6.7 Cost

Total and present worth costs are presented in Tables 4-3a through 4-6b and total costs are summarized in Table 4-7.

### 4.6.8 Recommended Remedial Alternative

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 severe, 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. Modeling based on current information and assumptions discussed in this FS has predicted that capping without amendments or a polishing layer 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 recommended remedial alternative for OU-2 is Alternative 2A, capping, based on these considerations. Alternative 2A also produces the highest score in Table 4-7. The specific cap composition and thickness will also be developed as part of the remedial design. The conclusion of the model that a native cap will be effective will be verified by treatability studies during the design phase.

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# TABLES

**FIGURES**

**TABLE 2-1**

**POTENTIAL CHEMICAL-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action/Medium | 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 | The quality of any waters receiving sewage, industrial wastes or other wastes, regardless of their use, shall be such as will not cause the best usage of any other waters to be adversely affected by such sewage, industrial wastes or other wastes. | Discharges to waters of the State of Alabama, as defined by ADEM Admin. Code r. 335-6-10-.02(10) **– relevant and appropriate** | ADEM Admin. Code r. 335-6-10-.05(1) |
| | 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. | Discharges to waters of the State of Alabama classified for fish and wildlife use, as defined by ADEM Admin. Code r. 335-6-11-.02 – **relevant and appropriate** | ADEM Admin. Code r. 335-6-10-.09(5)(e)(5) |
| | 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 use, as defined by ADEM Admin. Code r. 335-6-11-.02 – **relevant and appropriate** | ADEM Admin. Code r. 335-6-10-.09(5)(e)(9) |

**TABLE 2-1**

**POTENTIAL CHEMICAL-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action/Medium | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | Concentrations of toxic pollutants in State waters shall not exceed the criteria indicated to the extent commensurate with the designated usage of such waters:<br>• 4,4'-DDD: As calculated by Eq. 19[1]<br>• 4,4'-DDE: As calculated by Eq. 19<br>• 4,4'-DDT: 0.001 µg/L<br>• Hexachlorobenzene: As calculated by Eq. 19<br>• Mercury: 0.012 µg/L | Discharges of toxic pollutants to waters of the State – **relevant and appropriate** | ADEM Admin. Code r. 335-6-10-.07(1), Tbl. 1 |

[1] Refer to ADEM Admin. Code r. 335-6-10-.07(1)(d)(2)(ii) for Equation 19, relating to calculation of toxic pollutant criteria for consumption of fish only for those pollutants classified as carcinogens, applicable to all waters of the State of Alabama. *See* ADEM Admin. Code r. 335-6-10-.07(1)(e).

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| 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).<br><br>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. | 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).<br><br>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 events expected/predicted during construction disturbance based on historic precipitation information, and during extended periods of adverse weather and seasonal conditions. | | ADEM Admin. Code r. 335-6-12-.21(4) |
| 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 | Fugitive emissions from construction operations, grading, or the clearing of land – **TBC** | ADEM Admin. Code r. 335-3-4-.02(1) & (2)[2] |

[2] 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 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | becoming airborne.<br><br>Shall not cause or permit the discharge of visible fugitive dust emissions beyond the lot line of the property on which the emissions originate. | | |
| ***Waste Characterization and Storage—Primary Wastes (e.g., excavated sediments and soils) and Secondary Wastes (e.g., de-wateringresidues )*** | | | |
| Characterization of solid waste (all primary and secondary wastes) | 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.<br><br>Must determine whether the waste is (characteristic waste) identified in subpart C of 40 CFR part 261by either:<br><br>(1) Testing the waste according to the methods set forth in subpart C of 40 CFR part 261, or according to an equivalent method approved by the Administrator under 40 CFR 260.21; or<br><br>(2) Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used. | Generation of solid waste as defined in 40 C.F.R. § 261.2 — **applicable** | 40 C.F.R. § 262.11<br><br>ADEM Admin. Code r. 335-14-3-.01(2) |
| | 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) |
| Characterization of hazardous waste (all primary and secondary wastes) | 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)<br><br>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.*<br><br>*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) |
| | Must determine the underlying hazardous constituents [as defined in 40 C.F.R. | Generation of RCRA characteristic hazardous waste (and is not D001 | 40 C.F.R. § 268.9(a) |

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | § 268.2(i)] in the waste. | non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal – **applicable** | |
| | 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.<br>*Note:* This determination can be made concurrently with the hazardous waste determination required in 40 CFR 262.11. | | 40 C.F.R. § 268.7(a) |
| Temporary on-site storage of hazardous waste in containers (*e.g.*, excavated sediments and soils) | A generator may accumulate hazardous waste at the facility provided that:<br>• Waste is placed in containers that comply with 40 C.F.R. §§ 265.171-173; and<br>• The date upon which accumulation begins is clearly marked and visible for inspection on each container; and<br>• Container is marked with the words "hazardous waste"; or | Accumulation of RCRA hazardous waste on site as defined in 40 C.F.R. § 260.10 – **applicable** | 40 C.F.R. § 262.34(a)(1)(i);<br>ADEM Admin. Code r. 335-14-3-.03(5)(a)1(i)<br>40 C.F.R. § 262.34(a)(2) &(3);<br>ADEM Admin. Code r. 335-14-3-.03(5)(a)(2)&(3) |
| | • Container may be marked with other words that identify the contents. | Accumulation of 55 gal. or less of RCRA hazardous waste <u>or</u> one quart of acutely hazardous waste listed in 261.33(e) at or near any point of generation **– applicable** | 40 CFR 262.34(c)(1) |
| 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<br>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<br>ADEM Admin. Code r. 335-14-5-.09(3) |

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | Keep containers closed during storage, except to add/remove waste. Open, handle and store containers in a manner that will not cause containers to rupture or leak. | | 40 C.F.R. § 265.173<br><br>ADEM Admin. Code r. 335-14-5-.09(4)(a)&(b) |
| Use and management of hazardous waste in containers | Containers having capacity greater than 30 gallons must not be stacked over two containers high | Storage of RCRA hazardous waste in containers — **applicable** | 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 C.F.R. § 264.175(b). | Storage of RCRA hazardous waste in containers *with free liquids* – **applicable** | 40 C.F.R. § 264.175(a)<br><br>ADEM Admin. Code r. 335-14-5-.09(6)(a) |
| | Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or<br><br>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)<br><br>ADEM Admin. Code r. 335-14-5-.09(6)(c)( |
| Closure of RCRA container storage unit | 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.<br><br>[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<br><br>ADEM Admin. Code r. 335-14-5-.09(9)(a) |
| Temporary on-site storage of remediation waste in staging piles (*e.g.*, excavated sediments and soils) | Must be located within the contiguous property under the control of the owner/operator where the wastes are to be managed in the staging pile originated.<br><br>For purposes of this section, storage includes mixing, sizing, blending or other similar physical operations so long as intended to prepare the wastes for | Accumulation of non-flowing hazardous remediation waste (or remediation waste otherwise subject to land disposal restrictions) as defined in 40 C.F.R. § 260.10 –**applicable** | 40 C.F.R. § 264.554(a)(1)<br><br>ADEM Admin. Code r. 335-14-5-.19(5)(a) |

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | subsequent management or treatment. | | |
| Performance criteria for staging pile | Staging pile must:<br>• Facilitate a reliable, effective and protective remedy;<br>• Must be designed to prevent or minimize releases of hazardous wastes and constituents into the environment, and minimize or adequately control cross–media transfer as necessary to protect human health and the environment (e.g. use of liners, covers, run–off/run–on controls). | Storage of remediation waste in a staging pile **–applicable** | 40 C.F.R. § 264.554(d)(1)(i) and (ii)<br>ADEM Admin. Code r. 335-14-5-.19(5)(d)1.(i) and (ii) |
| Operation of a staging pile | Must not operate for more than 2 years, except when an operating term extension under 40 CFR 264.554(i) is granted. *Note:* Must measure the 2-year limit (or other operating term specified) from first time remediation waste placed in staging pile.<br>Must not use staging pile longer than the length of time designated by EPA in appropriate decision document | Storage of remediation waste in a staging pile **– applicable** | 40 C.F.R. § 264.554(d)(1)(iii)<br>ADEM Admin. Code r. 335-14-5-.19(5)(d)1.(iii)<br>40 C.F.R. § 264.554(h)<br>ADEM 335-14-5-.19(5)(h) |
| Design criteria for a staging pile | In setting standards and design criteria, must consider the following factors:<br>• Length of time pile will be in operation;<br>• Volumes of waste you intend to store in the pile;<br>• Physical and chemical characteristics of the wastes to be stored in the unit;<br>• Potential for releases from the unit;<br>• Hydrogeological and other relevant environmental conditions at the facility that may influence the migration of any potential releases; and<br>• Potential for human and environmental exposure to potential releases from the unit. | Storage of remediation waste in a staging pile **– applicable** | 40 C.F.R. § 264.554(d)(2)(i) –(vi)<br>ADEM Admin. Code r. 335-14-5-.19(5)(d)2(i) through (vi) |
| Closure of staging pile of | Must be closed within 180 days after the operating term by removing or decontaminating all remediation waste, contaminated containment system | Storage of remediation waste in staging pile in ***previously*** | 40 C.F.R. § 264.554(j)(1) |

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| remediation waste | components, and structures and equipment contaminated with waste and leachate.<br><br>Must decontaminate contaminated sub –soils in a manner that EPA determines will protect human and the environment. | ***contaminated area*** – **applicable** | and (2)<br><br>ADEM Admin. Code r. 335-14-5-.19(5)(k) |
| | ***Discharge of Wastewater*** | | |
| Discharge of residual water from dewatering activities to surface water | Comply with any applicable substantive water quality requirements under the Alabama Water Pollution Control Act (AWPCA) or the Clean Water Act (CWA) including application of technology- or ambient water quality- based effluent limitations to ensure discharge does not cause or contribute to violation of water quality standards. | Discharge of pollutants into surface waters – **applicable** | ADEM Admin. Code r. 335-6-6-.04(f), (h), (i), and (j) |
| | Conditions for the discharge shall meet the requirements, as appropriate, provided in ADEM Admin. Code r. 335-6-6-.14 such as the following:<br>• Technology based effluent limitations and standards based on effluent limitations and standards promulgated under Sections 301 of the [CWA], or case-by-case effluent limitations determined under Section 402(a)(1) of the [CWA] when technology based standards or new source performance standards have not been promulgated, or on a combination of the two.<br>• Other applicable effluent limitations and standards under Sections 301, 302, 303, 304, 307, 318, and 405 of the [CWA] and applicable effluent guidelines and standards under 40 C.F.R. Subchapter N.; and<br>• Other requirements in addition to or more stringent than promulgated effluent limitations, guidelines, or standards under Sections 301, 306, 307, 318, and 405 of the Clean Water Act where necessary to achieve water quality standards established under Section 303 of the Clean Water Act and AWPCA §2-22-9(g) | | 40 C.F.R. § 122.44(a), (b), (d)<br><br>ADEM Admin. Code r. 335-6-6-.14 (3)(a), (b), (e) |
| | Limitations must be applied to control all pollutants or pollutant parameters that are or may be discharged at a level which cause, have reasonable potential to cause or contribute to an exceedance of a narrative or numerical water quality standard. | | ADEM Admin. Code r. 335-6-6-.14(e)(1)(i) |
| | Take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of effluent standards which has the reasonable likelihood of adversely affecting human health and the environment. | | 40 C.F.R. § 122.41(d)<br><br>ADEM Admin. Code r. 335-6-6-.12(d) |

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | Properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used to achieve compliance with effluent standards. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. | | 40 C.F.R. § 122.41(e)<br>ADEM Admin. Code r. 335-6-6-.12(e) |
| Flow to the Tombigbee River | (10) Mixing Zones. Limits calculated to comply with water quality standards may allow an opportunity for mixing with the receiving waters in accordance with rule 355-6-10-.05. Determination of mixing zones shall be in accordance with the following requirements.<br>(a) Whole effluent acute toxicity limitations shall be applied at the perimeter of the zone of initial dilution (ZID), when the discharge is mixed with the receiving stream by a high rate diffuser, in the absence of a high rate diffuser, acute limitations shall be applied based on best professional judgment and may be applied at the end of the pipe.<br>(b) Whole effluent chronic toxicity limitations shall be applied at the perimeter of a mixing zone developed using best professional judgment and, in instances where the discharge is to a lake or other water body having zero or near zero flow, limitations developed to meet chronic toxicity water quality standards and human health criteria for substances classified as non-carcinogens shall be applied at the perimeter of a mixing zone developed using best professional judgment. A mixing zone may be developed using isopleth studies, diffuser models, or other methods that are appropriate to the particular situation being evaluated. For discharges to waters of the coastal area, the mixing zone for whole effluent toxicity limitations and for limitations developed to meet chronic toxicity water quality standards and human health criteria for substances classified as non-carcinogens shall be the discharge information zone as defined by rule 335-8- 2-.12(1)(a).<br>(c) When developing permit limits for discharge to flowing streams to comply with human health water quality criteria for pollutants classified as carcinogens the wastewater discharge shall be assumed to be completely mixed in the receiving water at the moment of discharge. When the discharge is to an impoundment or estuary, the allowable mixing zone shall be based on best professional judgment.<br>(d) Mixing zone prohibitions.<br>1. Mixing zones in streams shall not preclude passage of aquatic life up or down stream, shall not exceed a width of 50 percent of the stream width, shall not exceed a length of five times the width of the mixing zone, and shall not exceed an area of 25 percent of the stream cross-sectional area, and a mixing | Discharge of pollutants into surface waters – **applicable** | 40CFR§125.86(b)(4)(ii)<br>ADEM Admin. Code r. 335-6-6-.02(eee), 335-6-6-.15(10) |

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | zone shall not encompass drinking water intakes.<br>2. The total area of all mixing zones in a lake shall not encompass more than ten percent of the surface area of the lake, the radius of any one zone shall not be greater than 750 feet, and a mixing zone shall not encompass water intakes. | | |
| Technology-based treatment requirements for wastewater discharge | To the extent that EPA promulgated effluent limitations are inapplicable, shall develop on a case-by-case Best Professional Judgment (BPJ) basis under § 402(a)(1)(B) of the CWA, technology-based effluent limitations by applying the factors listed in 40 C.F.R. § 125.3(d) and shall consider:<br>• The appropriate technology for this category or class of point sources, based upon all available information; and<br>• Any unique factors relating to the discharge. | | 40 C.F.R. § 125.3(c)(2) |
| Water-quality-based effluent limits for wastewater discharge | Must develop water-quality-based effluent limits that ensure:<br>• The level of water quality to be achieved by limits on point sources established under this paragraph is derived from, and complies with all applicable water quality standards; and<br>• Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with the assumptions and requirements of any available wasteload allocation for the discharge prepared by the State and approved by EPA pursuant to 40 C.F.R. § 130.7. | Discharge of pollutants to surface waters that causes, or has reasonable potential to cause, or contributes to an instream excursion above a narrative or numeric criteria within a State water quality standard established under § 303 of the CWA - **applicable** | 40 C.F.R. § 122.44(d)(1)(vii) |
| | Must attain or maintain a specified water quality through water-quality-related effluent limits established under § 302 of the CWA. | | 40 C.F.R. § 122.44(d)(2)<br>ADEM Admin. Code r. 335-6-6-.14(e)(2) |
| | ***On-Site Landfill Construction, Closure and Post-Closure*** | | |
| Buffer zones for industrial landfill unit | Buffer zones around the perimeter of the landfill unit shall be a minimum of 100 feet in width measured in a horizontal plane. No disposal or storage practices for waste shall take place in the buffer zone. Roads, access control measures, earth storage, and buildings may be placed in the buffer zone. | Construction of an industrial landfill unit, as defined by ADEM Admin. Code r. 335-13-1-.03(69) – **relevant and appropriate** | ADEM Admin. Code r. 335-13-4-.12(2)(f) |
| Run–on/run–off control systems for landfill cover | The facility must have a run-on control system to prevent flow onto the active and/or closed portions of the landfill during the peak discharge from a 25-year storm; a run-off control system from the active and/or closed portions of the landfill to collect and control at least the water volume resulting from a 24- | Construction of an industrial landfill unit, as defined by ADEM Admin. Code r. 335-13-1-.03(69) – **relevant and appropriate** | ADEM Admin. Code r. 335-4-.17 |

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | hour, 25-year storm; and on-site drainage structures to carry incident precipitation from the disposal site so as to minimize the generation of leachate, erosion and sedimentation. Run-off from the active and/or closed portions of the landfill unit must be handled in accordance with ADEM Admin. Code r. 335-13-4-.01(2)(a) and (b) and shall be routed to a settling basin or other sedimentation control structure to remove sediment prior to release onto adjacent properties or waters. | | |
| Landfill cover and design | A final cover system must be installed which is designed to minimize infiltration and erosion. The final cover system must be comprised of an erosion layer underlain by an infiltration layer(s) as follows:<br>• The infiltration layer for an industrial landfill unit must be comprised of a minimum of 18 inches of earthen material and/or a synthetic layer that has a permeability less than or equal to the permeability of any bottom liner system, or natural subsoils present, or a permeability no greater than 1 x $10^{-5}$ cm/sec, whichever is less.<br>• The erosion layer must consist of a minimum of 6 inches of earthen material that is capable of sustaining native plant growth. | Construction of an industrial landfill unit, as defined by ADEM Admin. Code r. 335-13-1-.03(69) – **relevant and appropriate** | ADEM Admin. Code r. 335-13-4-.20(2)(b)(1)-(2) |
| Leachate collection | A leachate collection system shall be required that is designed and constructed to maintain less than 30 cm depth of leachate over the liner. | Construction of an industrial landfill unit, as defined by ADEM Admin. Code r. 335-13-1-.03(69) – **relevant and appropriate** | ADEM Admin. Code r. 335-13-4-.18(2) |
| Landfill soil cover design | The final soil cover shall be graded so that:<br>• Surface water does not pond over the landfill unit;<br>• The maximum final grade of the final cover system shall not exceed 25 percent or as specified by the Department to minimize erosion;<br>• Slopes longer than 25 feet shall require horizontal terraces, of sufficient width for equipment operation, for every 20 feet rise in elevation or utilize other erosion control measures approved by the Department;<br>• The minimum final grade of the final cover system shall not be less than 5 percent or as specified by the Department to minimize ponding;<br>• Final grading of the infiltration layer shall be completed within 90 days after the unit has received the last known receipt of waste. | Construction of an industrial landfill unit, as defined by ADEM Admin. Code r. 335-13-1-.03(69) – **relevant and appropriate** | ADEM Admin. Code r. 335-13-4-.20(2)(c)(1)-(5) |
| | A vegetative or some other appropriate cover must be established to minimize erosion and, when applicable, maximize evapotranspiration. Within 90 days | Construction of an industrial landfill unit, as defined by ADEM | ADEM Admin. Code r. |

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
**Olin McIntosh OU-2**

| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | after completion of final grading requirements, the owner shall prepare the final cover for the establishment of a vegetative cover or alternative cover. Deep rooted vegetation (roots that my grown below the 6-inch erosion layer) shall be prohibited as vegetative cover. | Admin. Code r. 335-13-1-.03(69) – **relevant and appropriate** | 335-13-4-.20(2)(d) |
| Protection of closed industrial landfill | Post-closure use of the property used for the disposal operation must never be allowed to disturb the integrity of the final cover, liner(s), or any other component of the containment system, or the function of the monitoring systems necessary to comply with the requirements of these Rules. | Construction of an industrial landfill unit, as defined by ADEM Admin. Code r. 335-13-1-.03(69) – **relevant and appropriate** | ADEM Admin. Code r. 335-13-4-.20(3)(d) |
| Post–closure care for closed industrial landfill | Following closure of each industrial landfill unit, the owner or operator must conduct post-closure care. Post-closure care must be conducted for a minimum of 30 years, or the effective date of § 258.1 of 40 C.F.R. Part 258, Solid Waste Disposal Criteria, whichever is later; except as provided under 335-13-4-.20(3)(b), and consist of at least the following:<br>• Eroded areas shall be filled with suitable soil cover, compacted, graded and appropriate cover established as described in 335-13-4-.20(2)(d).<br>• Areas which provide for ponding of surface water shall be filled, graded and an appropriate cover established as described in 335-13-4-.20(2)(d).<br>• Landfilled areas with extensive surface cracks in soil cover shall be corrected as necessary to prevent infiltration of surface water.<br>• An appropriate cover shall be maintained on the facility at all times as described in 335-13-4-.20(2)(d).<br>• Access control structures shall be maintained or erected and signs shall be posted stating that the facility is closed and giving the location of the nearest permitted landfill unit.<br>• Any waste dumped at the landfill unit following closure shall be removed to an approved landfill unit by the owner.<br>• Monitoring devices and pollution control equipment such as groundwater monitoring wells, explosive gas monitoring systems, erosion, and surface water control structures, and leachate facilities shall be maintained. Monitoring requirements shall continue in effect throughout the active life and post-closure care period unless all solid waste is removed and no unpermitted discharge to waters has occurred.<br>• Other deficiencies such as vector control shall be corrected. | Construction of an industrial landfill unit, as defined by ADEM Admin. Code r. 335-13-1-.03(69) – **relevant and appropriate** | ADEM Admin. Code r. 335-13-4-.20(3)(a) |

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
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| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| Post–closure notices for closed landfill | Within 90 days after final closure requirements in 335-13-4-.20 are achieved, the permittee or owner of a facility shall record a notation onto the land deed containing the property utilized for disposal, and/or some other legal instrument that is normally examined during a title search, that will in perpetuity, notify any potential purchaser of the property that:<br>• The land has been used as a solid waste disposal facility landfill unit;<br>• Its use is restricted by the items contained in 335-13-4-.20(3)(c) and 335-13-4-.20(3)(d);<br>• The locations and dimensions of the landfill unit with respect to permanently surveyed benchmarks and section corners shall be on a plat prepared and sealed by a land surveyor;<br>• Contain a note, prominently displayed, which states the name of the operating agency, the type of landfill unit and the beginning and closure dates of the disposal activity.<br>• Certification by an Engineer or Land Surveyor that all closure requirements have been completed as determined necessary by the Department. | Construction of an industrial landfill unit, as defined by ADEM Admin. Code r. 335-13-1-.03(69) **– relevant and appropriate** | ADEM Admin. Code r. 335-13-4-.20(2)(i) |
| ***Waste Disposal — Excavated Sediments and Soils and Secondary Wastes*** | | | |
| 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 CFR 268.40 before land disposal. | Land disposal, as defined in 40 CFR 268.2, of restricted RCRA waste – **applicable** | 40 C.F.R. § 268.40(a)<br>ADEM Admin. Code r. 33-14-9-.04 |
| | All underlying hazardous constituents [as defined in 40 CFR 268.2(i)] must meet the Universal Treatment Standards, found in 40 CFR 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)<br>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 CFR 268.49(c) <u>or</u> according to the UTSs specified in 40 CFR 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal. | Land disposal, as defined in 40 CFR 268.2, of restricted hazardous soils – **applicable** | 40 C.F.R. § 268.49(b)<br>ADEM Admin. Code r. 33-14-9-.04(9) |

**TABLE 2-2**

**POTENTIAL ACTION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE (TBC)**
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| Action | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | ***Transportation of Wastes*** | | |
| 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);<br><br>ADEM Admin. Code r. 335-14-3-.03(1) – (4) |
| Transportation of samples (*i.e.* contaminated soils and wastewaters) | Except as provided in 40 C.F.R. § 261.4(d)(2), a sample of waste is not subject to any requirements of 40 C.F.R. Parts 261 through 268 or 270 provided the requirements specified in subparagraphs d)(1) (i) through (iii) are complied with.<br><br>Exemption does not apply if laboratory determines waste is hazardous but it no longer meeting conditions in paragraph (d)(1). | 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) |
| | ***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 Eng'rs, Tech. Report DOER-1, *Guidance for Subaqueous Dredged Material Capping* (1998). |

**TABLE 2-3**
**POTENTIAL LOCATION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE CONSIDERED GUIDANCE (TBC)**

**Olin McIntosh OU-22**

| Location | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | ***Floodplains*** | | |
| Presence of 100-year floodplain or floodplain as defined by ADEM Admin. Code r. 335-13-1-.03(54) | Land-based disposal unit shall not restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human health and the environment. | Construction of industrial landfill as defined by ADEM Admin. Code r. 335-13-1-.03(54) – **applicable** | ADEM Admin. Code r. 335-13-4-.01(1)(a) |
| 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*<br><br>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<br><br>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.<br><br>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) |
| | Structures and facilities must be constructed in accordance with existing criteria and standards set forth under the National Flood Insurance Program (NFIP) and must include mitigation of adverse impacts wherever feasible.<br><br>If newly constructed structures or facilities are to be located in a floodplain, accepted floodproofing and other flood protection measures shall be undertaken. To achieve flood protection, EPA shall, wherever practicable, elevate structures above the base flood level rather than filling land. | Construction of structures and facilities within floodplains – **relevant and appropriate** | 40 C.F.R. Part 6, App. A, § 6(c)(1) & (2) |

**TABLE 2-3**
**POTENTIAL LOCATION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE CONSIDERED GUIDANCE (TBC)**

**Olin McIntosh OU-22**

| Location | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | ***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)<br>ADEM Admin. Code r. 335-13-4-.01(1)(b) |
| | 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 **– applicable** | 16 U.S.C. § 703(a) |
| | ***Archaeologically or Historically Sensitive Areas*** | | |
| Presence of an archaeologically or historically sensitive area, as determined by the Alabama Historical Commission | Landfill units shall not be located on a site that is archaeologically or historically sensitive as determined by the Alabama Historical Commission. | Locating industrial landfill – **applicable** | ADEM Admin. Code r. 335-13-4-.01(1)(e) |

**TABLE 2-3**
**POTENTIAL LOCATION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE CONSIDERED GUIDANCE (TBC)**

**Olin McIntosh OU-22**

| Location | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | ***Wetlands*** | | |
| Presence of wetlands, as defined by U.S. Army Corps of Engineers regulations at 33 C.F.R. § 328.3(b) | A facility shall be located so as to not adversely impact water quality by complying with the following:<br>• A facility shall not cause a discharge of pollutants into waters of the State, including wetlands, that is in violation of the requirements of the NPDES, Alabama Water Pollution Control Act and/or section 404 of the Clean Water Act, as amended.<br>• A facility shall not cause non-point source pollution of waters of the State, including wetlands, that violates any requirements of an area wide and State-wide water quality management plan that has been approved under the Alabama Water Pollution Control Act.<br>• Landfill units including buffer zones shall not be permissible in wetlands, beaches, or dunes.<br>• Landfill units shall not be permissible in any location where the disposal of solid waste would significantly degrade wetlands, beaches or dunes. | Locating industrial landfills – **relevant and appropriate** | ADEM Admin. Code r. 335-13-4-.01(2)(a)-(d) |
| 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) |
| 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*<br><br>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,<br>Section 2.(a) *Protection of Wetlands* |

**TABLE 2-3**
**POTENTIAL LOCATION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE CONSIDERED GUIDANCE (TBC)**

**Olin McIntosh OU-22**

| Location | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | ***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) |
| Location encompassing coastal area, as defined by ADEM Admin. Code r. 335-8-1-.02(k) | A facility shall be located so as to not adversely impact water quality by complying with the following:<br>• Landfill units shall be located outside the boundaries of the coastal area, unless no other reasonable alternative is available. | Locating industrial landfill in a coastal area – **relevant and appropriate** | ADEM Admin. Code r. 335-13-4-.01(2)(e) |
| | ***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) |

**TABLE 2-3**
**POTENTIAL LOCATION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE CONSIDERED GUIDANCE (TBC)**

**Olin McIntosh OU-22**

| Location | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | No discharge of dredged or fill material shall be permitted if it:<br>• Causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard;<br>• Violates any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act;<br>• 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;<br>• 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. | | 40 C.F.R. § 230.10(b) |
| | 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) |
| | 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) |

**TABLE 2-3**
**POTENTIAL LOCATION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE CONSIDERED GUIDANCE (TBC)**

**Olin McIntosh OU-22**

| 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:<br>• There will be no dredging or filling in close proximity to existing submersed grassbeds;<br>• 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) |
| | 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) |
| 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:<br>• 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<br>• 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) |

**TABLE 2-3**
**POTENTIAL LOCATION-SPECIFIC APPLICABLE AND RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE CONSIDERED GUIDANCE (TBC)**

**Olin McIntosh OU-22**

| Location | Requirements | Prerequisite | Citation |
|---|---|---|---|
| | ***Drainage of Waterbodies*** | | |
| Presence of any stream or other body of water proposed to be impounded, diverted, controlled, or modified for drainage | Whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States, or by any public or private agency under Federal permit or license, such department or agency 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 – **relevant and appropriate** | 16 U.S.C. § 662(a) |

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

**TABLE 3-1**

**REMEDIAL TECHNOLOGY SCREENING SUMMARY**
**Olin McIntosh OU-2**

| General Response Actions | Technology Type | Process Options | Description | Cost | Implementability | Short-Term Effectiveness | Long-Term Effectiveness | Retain |
|---|---|---|---|---|---|---|---|---|
| **No Action** | **Natural Recovery** | **Natural Recovery** | Berm and gate operation would cease. Existing measures to be neglected and site left "as-is" (inclusion of this remedial action mandated by USEPA). | **Low** | **Straightforward** | **Not Effective** | **Not Effective** | **Yes** |
| **Institutional Controls** | **Physical Mechanisms** | **Fences** | Restrict access to limit exposure above permissible limits. OU-2 currently is fenced to limit access from the north, west, and south. | **Low** | **Straightforward** | **Effective** Human exposure is low and is limited to employees maintaining and sampling OU-2 under controlled conditions. | **Effective** Human exposure is low and is limited to employees maintaining and sampling OU-2 under controlled conditions. Long term maintenance is required. | **Yes** |
| | | **Warning Signs** | Provide advisory to limit exposure above permissible limits. | **Low** | **Straightforward** Olin McIntosh is private property and warning sings are already in-place. | **Moderately Effective** Human exposure is low and is limited to employees maintaining and sampling OU-2 under controlled conditions. | **Moderately Effective** Human exposure is low and is limited to employees maintaining and sampling OU-2 under controlled conditions. | **Yes** |
| | **Legal and Administrative Mechanisms** | **Fishing Advisory** | Restrict use to limit exposure above permissible limits. | **Low** | **Straightforward** Olin McIntosh is private property with on site security that restricts use to employees only. Fishing is prohibited for all personnel. | **Moderately Effective** Human exposure is low and is limited to employees maintaining and sampling OU-2 under controlled conditions. | **Moderately Effective** Human exposure is low and is limited to employees maintaining and sampling OU-2 under controlled conditions. | **Yes** |
| **Containment** | **Enhanced Sedimentation/Water Level Management (ES/WLM)** | **Berm/Gate System** | Engineering controls that regulate flooding and enhance deposition of sediment. ES/WLM is a long-term remedial strategy that limits resuspension of sediment while building a layer of cleaner sediments. The berm also serves as a barrier to trespassers by restricting boat and foot traffic from the river to the Basin. | **Moderate** | **Straightforward** ES/WLM is already implemented at OU-2 and will provide for quiescent conditions and minimum water levels suitable for implementing capping or dredging. | **Effective in Conjunction with Other Technologies** ES/WLM will provide quiescent conditions/minimum water level during capping or dredging, reduce resuspension, and promote sedimentation over cap or dredged area. | **Effective in Conjunction with Other Technologies** ES/WLM will provide quiescent conditions/minimum water level during capping or dredging, reduce resuspension, and promote sedimentation over cap or dredged area. | **Yes** (In combination with other technologies) |
| | **Capping** | **In situ Capping** | Containment is accomplished by placing cap material over areas of sediment exceeding the remediation goal. A bioactive zone or habitat (consisting of native soils with armoring) will be place over the cap materials. | **Moderate** | **Moderately Difficult** Implementable for the Basin and Round Pond, but requires significant effort. | **Effective** Is a technology proven to provide immediate risk reduction. Benthic organisms and habitat temporarily will be affected by burial. Capping will include placement of a habitat layer so that effect is temporary. | **Effective** Is a technology proven to provide long-term risk reduction. ES/WLM with capping will enhance the deposition of incoming clean sediments on cap and reduce resuspension | **Yes** |
| | | **Dry Capping** | Containment is accomplished by dewatering the Basin and Round Pond, moving soil from the bluff area or other nearby source to create a cap over areas of sediment exceeding the remediation goal. A bioactive zone or habitat (consisting of native soils with armoring) will be place over the cap materials. | **Moderate** | **Moderately Difficult** Implementable for the Basin and Round Pond, but requires significant effort. Dewatering of OU-2 may be difficult, especially if flooding occurs. | **Effective** Is a proven technology to provide immediate risk reduction. Aquatic habitat will be destroyed. Capping will include placement of a habitat layer so that effect is temporary. Semi-aquatic species will relocate temporarily. | **Effective** Is a technology proven to provide long-term risk reduction. ES/WLM with capping will enhance the deposition of incoming clean sediments on cap and reduce resuspension | **Yes** |

**TABLE 3-1**

**REMEDIAL TECHNOLOGY SCREENING SUMMARY**
**Olin McIntosh OU-2**

| General Response Actions | Technology Type | Process Options | Description | Cost | Implementability | Short-Term Effectiveness | Long-Term Effectiveness | Retain |
|---|---|---|---|---|---|---|---|---|
| **Removal** | **Dredging** | **Debris Removal, Mechanical Dredging** | Underwater debris/sediment removal using mechanical methods, such as buckets or clam-shells, would be combined with dewatering and disposal of dredged materials. | **High** | **Extremely Difficult** Controlling sediment resuspension is very difficult. Heavy debris such as trees buried throughout the Basin and Round Pond would make dredging problematic. | **Not Effective** High potential for resuspension, especially with mechanical dredging. Resuspension and dredge residuals may prevent achievement of remedial action goals. Dredging will destroy the unique aquatic habitat. Resuspension of mercury into the water column would likely cause a short-term increase of mercury in biota for the lifespan of ecological receptors. | **Moderately Effective** Dredging in the long term may be considered effective in removing mass, but effectiveness in meeting risk based clean up goals has not always been demonstrated. Evidence that dredging projects led to the achievement of long-term remedial action objectives is generally lacking (National Research Council, 2007). | **No** |
| | | **Debris Removal, Hydraulic Dredging** | Debris removal through mechanical means followed by underwater sediment removal using hydraulic methods, typically vacuum extraction, would be combined with dewatering and disposal of dredged materials. | **High** | **Extremely Difficult** Controlling sediment resuspension is very difficult. Heavy debris such as trees buried throughout the Basin and Round Pond would make dredging problematic and increase resuspension similar to levels associated with mechanical dredging. The percent water typically resulting from hydraulic dredging (90%) would consume more water than is held in the Basin at a 6 foot elevation. Large volume of sediment would require dewatering and disposal. | **Not Effective** Resuspension and residuals remaining have been reported up to 10%, even with hydraulic dredging when proper precautions and equipment to reduce resuspension were used. Resuspension and dredge residuals may prevent achievement of remedial action goals. Dredging will destroy the unique aquatic habitat. Resuspension of mercury into the water column would likely cause a short-term increase of mercury in biota for the lifespan of ecological receptors. | **Moderately Effective** Dredging in the long term may be considered effective in removing mass, but effectiveness in meeting risk based clean up goals has not always been demonstrated. Evidence that dredging projects led to the achievement of long-term remedial action objectives is generally lacking (National Research Council, 2007). | **Yes** |
| | **Excavation** | **Isolation** | Isolation and dewatering through the use of coffer dams or sheet pile barriers to excavate "in the dry," would be combined with disposal of excavated material. | **High** | **Not Implementable** Dewatering and excavating OU-2 is not practical. It will be difficult, if not impossible, to dewater the Basin to the extent that the sediments are dry enough to consolidate and provide substantial structural strength without adding significant cover material. Consequently, it would be unsafe for equipment and personnel to operate on the surface of dewatered sediments. Constructing platforms from which to work over the large area of the Basin would be time consuming and difficult. Timeframe to complete dry excavation will be much longer than hydraulic dredging and may not be feasible during a the construction season, when flooding is minimal. | **Not Applicable** Excavation could be effective if implementable. Excavation will destroy the unique aquatic habitat. | **Not Applicable** Excavation could be effective if implementable. | **No** |
| **Disposal** | **Landfill** | **Onsite Landfill** | Construct an approved landfill cell(s) on site. Dredge and deposit sediments and/or bulk waste (debris). It is anticipated that the dredged sediments will be non-hazardous | **High** | **Moderately Difficult** Handling is extensive and will require large areas of land. Suitable land availability in OU-2 is limited. | **Effective** Landfill cells are a proven technology to reduce mobility and contain waste. | **Effective** Landfill cells are a technology proven to reduce mobility and contain waste. | **Yes** |
| | | **Offsite Landfill** | Offsite disposal at an existing non-hazardous landfill. | **High** | **Moderately Difficult** Handling is extensive. | **Effective** A permitted landfill is a technology proven to reduce mobility and contain waste. | **Effective** A permitted landfill is a technology proven to reduce mobility and contain waste. | **Yes** |
| **Treatment** | **Treatment of Dredged Sediments** | **Dewatering** | Dredged sediments would be dewatered either mechanically or in Geotubes® to prepare for onsite or offsite landfill disposal. | **Medium** | **Moderately Difficult** There is limited space near OU-2 to accommodate staging and treatment activities. | **Effective** Dewatering would be accomplished through proven technologies. | **Effective** Once dewatered, the sediments would be disposed of in an onsite or offsite landfill or NCDU. | **Yes** |

MNR = monitored natural recovery
ES = Enhanced Sedimentation
WLM = Water Level Management
NCDU - Nearshore Confined Disposal Unit

PREPARED/DATE: KPW 4/20/11
CHECKED/DATE: CED 5/16/11

**TABLE 4-1**

**STEADY-STATE CAP DESIGN MODEL INPUTS**
**Olin McIntosh OU-2**

| Model Item Number | Model Properties | Scenario Input Values, Native Borrow Material: Midlevel Conservative Scenario | Less Conservative Scenario | More Conservative Scenario | Units | Comments |
|---|---|---|---|---|---|---|
| | **Contaminant Properties:** | | | | | |
| | Contaminant | Mercury | Mercury | Mercury | | |
| 1 | Partition Coefficient, log $K_d$ (a) | 3.06 | 3.10 | 2.80 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | 0.00 | 0.00 | log L/kg | Included in Log $K_{oc}$ |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | 1.88E-05 | 1.88E-05 | $cm^2/s$ | Based on Kuss, Holzmann, and Ludwig 2009, see note (b) |
| 4 | Cap Decay Rate, $\lambda_1$ | 0.00E+00 | 0.00E+00 | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $\lambda_2$ | 0.00E+00 | 0.00E+00 | 0.00E+00 | $yr^{-1}$ | No decay |
| | **Sediment Properties:** | | | | | |
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.75 | 0.64 | 2.2 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | 1 | 1 | fraction | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $\rho_{DOC}$ | 0 | 0 | 0 | mg/L | Included in $K_d$ |
| 9 | Darcy Velocity, $V$ (d) | 4.73E-02 | 4.73E-06 | 4.73E+00 | cm/yr | See note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0.762 | 5.08 | 0 | cm/yr | 0.3 inch *2.54 cm/inch overall Basin average (MACTEC, 2011a) - 0 (no deposition) and 2 inch/year as measured in southern portion of the Basin |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | 10 | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | 100 | 100 | $cm^2/yr$ | Model default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | 1 | 1 | $cm^2/yr$ | Model default |
| | **Cap Properties:** | | | | | |
| 14 | Depth of Interest (Habitat Layer/Cap Material Interface), $z$ | 10 | 10 | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | 1 | 1 | fraction | $K_{oc}$ versus $K_d$ adjustment |
| 16 | Conventional Cap placed depth | 20.32 | 20.32 | 20.32 | cm | 8 inch cap * 2.54cm/inch = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials: Granular (G) or Consolidated Silty/Clay (C) | C | C | C | | AquaBlok® = C, Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | 3.048 | 3.048 | cm | Based on correspondence with Dr. S. Chattopadhyay (10 percent) |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | 10.16 | 10.16 | cm | Based on correspondence with Dr. S. Chattopadhyay (25 percent) |
| 20 | Porosity, ε | 0.3 | 0.3 | 0.3 | fraction | Model default |
| 21 | Particle Density, $\rho_P$ | 2.6 | 2.6 | 2.6 | $g/cm^3$ | Model default |
| 22 | fraction organic carbon, $(f_{oc})_{eff}$ | 1 | 1 | 1 | fraction | $K_{oc}$ adjustment for $K_d$ |

Notes:
(a) Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).
(b) Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.
(c) Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin (0-12 inches) where sediment concentrations are higher = 0.75 ug/L, and maximum porewater mercury concentrations = 2.2 ug/L (average 0-12 inches)

(d) See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.
(e) The porosity of 0.001 (0.1%) for an AquaBlok® cap would not run in the model due to numerical problems; in its place the model default of 0.3 (30%) was utilized.

**TABLE 4-1**

**STEADY-STATE CAP DESIGN MODEL INPUTS**
**Olin McIntosh OU-2**

| Model Item Number | Model Properties | Scenario Input Values – Native Borrow Material and Activated Carbon (50/50 Mix): Midlevel Conservative Scenario | Less Conservative Scenario | More Conservative Scenario | Units | Comments |
|---|---|---|---|---|---|---|
| | **Contaminant Properties:** | | | | | |
| | Contaminant | Mercury | Mercury | Mercury | | |
| 1 | Partition Coefficient, log $K_d$ (a) | 3.15 | 3.20 | 2.85 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | 0.00 | 0.00 | log L/kg | Included in Log $K_{oc}$ |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | 1.88E-05 | 1.88E-05 | $cm^2/s$ | Based on Kuss, Holzmann, and Ludwig 2009, see note (b) |
| 4 | Cap Decay Rate, $\lambda_1$ | 0.00E+00 | 0.00E+00 | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $\lambda_2$ | 0.00E+00 | 0.00E+00 | 0.00E+00 | $yr^{-1}$ | No decay |
| | **Sediment Properties:** | | | | | |
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.75 | 0.64 | 2.2 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | 1 | 1 | fraction | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $\rho_{DOC}$ | 0 | 0 | 0 | mg/L | Included in $K_d$ |
| 9 | Darcy Velocity, $V$ (d) | 4.73E-02 | 4.73E-06 | 4.73E+00 | cm/yr | See note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0.762 | 5.08 | 0 | cm/yr | 0.3 inch *2.54 cm/inch overall Basin average (MACTEC, 2011a) - 0 (no deposition) and 2 inch/year as measured in southern portion of the Basin |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | 10 | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | 100 | 100 | $cm^2/yr$ | Model default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | 1 | 1 | $cm^2/yr$ | Model default |
| | **Cap Properties:** | | | | | |
| 14 | Depth of Interest (Habitat Layer/Cap Material Interface), $z$ | 10 | 10 | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | 1 | 1 | fraction | $K_{oc}$ versus $K_d$ adjustment |
| 16 | Conventional Cap placed depth | 20.32 | 20.32 | 20.32 | cm | 8 inch cap * 2.54cm/inch = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials: Granular (G) or Consolidated Silty/Clay (C) | C | C | C | | AquaBlok® = C, Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | 3.048 | 3.048 | cm | Based on correspondence with Dr. S. Chattopadhyay (10 percent) |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | 10.16 | 10.16 | cm | Based on correspondence with Dr. S. Chattopadhyay (25 percent) |
| 20 | Porosity, ε | 0.3 | 0.3 | 0.3 | fraction | Model default |
| 21 | Particle Density, $\rho_P$ | 2.6 | 2.6 | 2.6 | $g/cm^3$ | Model default |
| 22 | fraction organic carbon, $(f_{oc})_{eff}$ | 1 | 1 | 1 | fraction | $K_{oc}$ adjustment for $K_d$ |

Notes:
(a) Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).
(b) Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.
(c) Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin (0-12 inches) where sediment concentrations are higher = 0.75 ug/L, and maximum porewater mercury concentrations = 2.2 ug/L (average 0-12 inches)

(d) See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.
(e) The porosity of 0.001 (0.1%) for an AquaBlok® cap would not run in the model due to numerical problems; in its place the model default of 0.3 (30%) was utilized.

**TABLE 4-1**

**STEADY-STATE CAP DESIGN MODEL INPUTS**
**Olin McIntosh OU-2**

| Model Item Number | Model Properties | Scenario Input Values Bentonite Pellets: Midlevel Conservative Scenario | Less Conservative Scenario | More Conservative Scenario | Units | Comments |
|---|---|---|---|---|---|---|
| | **Contaminant Properties:** | | | | | |
| | Contaminant | Mercury | Mercury | Mercury | | |
| 1 | Partition Coefficient, log $K_d$ (a) | 3.13 | 3.15 | 2.98 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | 0.00 | 0.00 | log L/kg | Included in Log $K_{oc}$ |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | 1.88E-05 | 1.88E-05 | $cm^2/s$ | Based on Kuss, Holzmann, and Ludwig 2009, see note (b) |
| 4 | Cap Decay Rate, $\lambda_1$ | 0.00E+00 | 0.00E+00 | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $\lambda_2$ | 0.00E+00 | 0.00E+00 | 0.00E+00 | $yr^{-1}$ | No decay |
| | **Sediment Properties:** | | | | | |
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.75 | 0.64 | 2.2 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | 1 | 1 | fraction | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $\rho_{DOC}$ | 0 | 0 | 0 | mg/L | Included in $K_d$ |
| 9 | Darcy Velocity, $V$ (d) | 4.73E-06 | 4.73E-06 | 4.73E-06 | cm/yr | See note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0.762 | 5.08 | 0 | cm/yr | 0.3 inch *2.54 cm/inch overall Basin average (MACTEC, 2011a) - 0 (no deposition) and 2 inch/year as measured in southern portion of the Basin |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | 10 | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{Pw}$ | 100 | 100 | 100 | $cm^2/yr$ | Model default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{P}$ | 1 | 1 | 1 | $cm^2/yr$ | Model default |
| | **Cap Properties:** | | | | | |
| 14 | Depth of Interest (Habitat Layer/Cap Material Interface), $z$ | 10 | 10 | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | 1 | 1 | fraction | $K_{oc}$ versus $K_d$ adjustment |
| 16 | Conventional Cap placed depth | 20.32 | 20.32 | 20.32 | cm | 8 inch cap * 2.54cm/inch = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials: Granular (G) or Consolidated Silty/Clay (C) | C | C | C | | AquaBlok® = C, Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | 3.048 | 3.048 | cm | Based on correspondence with Dr. S. Chattopadhyay (10 percent) |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | 10.16 | 10.16 | cm | Based on correspondence with Dr. S. Chattopadhyay (25 percent) |
| 20 | Porosity, ε | 0.3 (e) | 0.3 (e) | 0.3 (e) | fraction | Model default |
| 21 | Particle Density, $\rho_P$ | 2.6 | 2.6 | 2.6 | $g/cm^3$ | Model default |
| 22 | fraction organic carbon, $(f_{oc})_{eff}$ | 1 | 1 | 1 | fraction | $K_{oc}$ adjustment for $K_d$ |

Notes:
(a) Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).
(b) Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.
(c) Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin (0-12 inches) where sediment concentrations are higher = 0.75 ug/L, and maximum porewater mercury concentrations = 2.2 ug/L (average 0-12 inches)

(d) See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.
(e) The porosity of 0.001 (0.1%) for an AquaBlok® cap would not run in the model due to numerical problems; in its place the model default of 0.3 (30%) was utilized.

Prepared By: KPH 04/26/2011
Checked By: HEF 04/26/2011

**TABLE 4-2**
**BREAKTHROUGH TIMES AND POREWATER/SEDIMENT CONCENTRATIONS FOR MODELED CAP MATERIALS**

**Olin McIntosh OU-2**

| Model Scenario | Placement Cap Thickness[a] (inches) | Effective Cap Thickness H-eff[b] (cm) | Effective Cap Thickness H-eff[b] (inches) | Habitat Layer/Cap Material Interface Concentration at Steady State (mg/kg) | Time to Breakthrough (years) |
|---|---|---|---|---|---|
| **Native Borrow Material:** | | | | | |
| Midlevel Conservative[c] | 8 | 7.3 | 2.9 | 7.04E-98 | Never |
| Midlevel Conservative[c] | 12 | 15.9 | 6.3 | 3.31E-213 | Never |
| Midlevel Conservative[c] | 16 | 24.5 | 9.7 | <1.00E-311 | Never |
| Less Conservative[d] | 8 | 7.3 | 2.9 | -- | Never |
| More Conservative | 8 | 7.3 | 2.9 | 0.10169 | Never |
| **Activated Carbon and Native Borrow Material (50/50 Mix):** | | | | | |
| Midlevel Conservative[c] | 8 | 7.3 | 2.9 | 3.02E-120 | Never |
| Less Conservative[d] | 8 | 7.3 | 2.9 | -- | Never |
| More Conservative | 8 | 7.3 | 2.9 | 0.103 | Never |
| **Bentonite Pellets[e]:** | | | | | |
| Midlevel Conservative[c] | 8 | 7.3 | 2.9 | 7.30E-114 | Never |
| Less Conservative[d] | 8 | 7.3 | 2.9 | -- | Never |
| More Conservative | 8 | 7.3 | 2.9 | 0.079 | Never |

Prepared By/Date: KPH 04/27/2011
Checked By/Date: HEF 04/27/2011

Notes:

[a]Thickness includes 4 inch bioturbation or habitat zone above cap material but does not include the mixing zone below cap or cap compaction.

[b]Adjusted for biozone and compaction.

[c]Varying cap thicknesses were run under the representative conditions to select cap thickness.

[d]Numerical problems with the model, as sedimentation overcomes advection and dispersion, burial is faster than mercury movement

[e]The porosity of 0.001 (0.1%) for bentonite pellet cap would not run in the model due to numerical problems; in its place the model default of 0.3 (30%) was utilized.

Selected Cap Thickness for modeling the less and more conservative native borrow soil and all scenarios for activated carbon/native borrow soil mix and bentonite pellets

-- - not applicable due to numerical problems addressed in footnote d
cm - centimeter
ug/kg - microgram per kilogram
ug/L - microgram per liter

**Alternative 2A**
**IN SITU CAPPING - NATIVE SOIL**

# COST ESTIMATE SUMMARY

**Site:** Olin McIntosh Operable Unit 2
**Location:** McIntosh, Alabama
**Phase:** Feasibility Study
**Base Year:** 2012
**Date:** April 9, 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 consisting of a native soil mixing layer, native soil cap layer, and native soil and stone habitat layer.

**CAPITAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Implementation of ICs | 1 | LS | $1,600 | $1,600 | See Cost Worksheets for details |
| SUBTOTAL | | | | $1,600 | |
| Capping Remedy | | | | | |
| Design and Treatability Study | 1 | LS | $60,000 | $60,000 | See Cost Worksheets for details |
| Cap Placement | 1 | LS | $11,987,511 | $11,987,511 | See Cost Worksheets for details |
| SUBTOTAL | | | | $12,049,111 | |
| Post Construction Confirmation Sampling | | | | | |
| Cap Sediment Sampling | 1 | LS | $20,214 | $20,214 | See Cost Worksheets for details |
| Surface Water Sampling | 1 | LS | $10,359 | $10,359 | See Cost Worksheets for details |
| SUBTOTAL | | | | $12,079,683 | |
| Contingency | 1 | per cent | $12,049,111 | $120,491 | 1% of Scope |
| SUBTOTAL | | | | $12,200,174 | |
| 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 | |
| **TOTAL CAPITAL COSTS** | | | | **$12,400,000** | |

**ANNUAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Inspection and Maintenance | 1 | LS | $3,500 | $3,500 | See Cost Worksheets for details |
| 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:**

| DESCRIPTION | YEAR | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | Surface water sampling to be performed quarterly, see Cost Worksheets for details |
| Spiders/Flying 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/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | |

| Alternative 2A<br>IN SITU CAPPING - NATIVE SOIL | | | | | | COST ESTIMATE SUMMARY |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | See Cost Worksheets for details |
| Spiders/Flying 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 | See Cost Worksheets for details |
| Spiders/Flying 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 | |
| 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 | See Cost Worksheets for details |
| 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 | |

| Alternative 2A<br>IN SITU CAPPING - NATIVE SOIL | | | | | | COST ESTIMATE SUMMARY |
|---|---|---|---|---|---|---|
| **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 | See Cost Worksheets for details |
| Spiders/Flying 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 | |
| **5-Year Review Report & Annual Surface Water Monitoring** | | | | | | |
| 5-Year Review Report | | 1 | LS | $5,000 | $5,000 | See Cost Worksheets for details |
| 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 | |

| Alternative 2A<br>IN SITU CAPPING - NATIVE SOIL | | | | COST ESTIMATE SUMMARY | | |
|---|---|---|---|---|---|---|
| **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 | |
| **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 | |

**Alternative 2A**
**IN SITU CAPPING - NATIVE SOIL**

# COST ESTIMATE SUMMARY

**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 | NA | 1.000 | $12,400,000 |
| 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 | | | $12,857,000 |

| | |
|---|---|
| **TOTAL COST** | $13,400,000 |
| **TOTAL PRESENT VALUE OF ALTERNATIVE** | $12,900,000 |

Note: Totals rounded to the nearest $100,000.

Prepared By: KPW 3/30/2012
Checked By: JAN 4/2/2012

**Alternative 2A - Bentonite Pellets**
**IN SITU CAPPING**

# COST ESTIMATE SUMMARY

**Site:** Olin McIntosh Operable Unit 2
**Location:** McIntosh, Alabama
**Phase:** Feasibility Study
**Base Year:** 2012
**Date:** April 9, 2012

Alternative 2A consists of capping of sediment with native soils 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 consisting of a native soil mixing layer, bentonite pellet cap layer, and native soil and stone habitat layer.

**CAPITAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Implementation of ICs | 1 | LS | $1,600 | $1,600 | See Cost Worksheets for details |
| SUBTOTAL | | | | $1,600 | |
| Capping Remedy | | | | | |
| Design and Treatability Study | 1 | LS | $60,000 | $60,000 | See Cost Worksheet for details |
| Cap Placement | 1 | LS | $15,405,992 | $15,405,992 | See Cost Worksheets for details |
| SUBTOTAL | | | | $15,467,592 | |
| Post Construction Confirmation Sampling | | | | | |
| Cap Sediment Sampling | 1 | LS | $20,214 | $20,214 | See Cost Worksheets for details |
| Surface Water Sampling | 1 | LS | $10,359 | $10,359 | See Cost Worksheets for details |
| SUBTOTAL | | | | $15,498,164 | |
| Contingency | 1 | per cent | $15,467,592 | $154,676 | 1% of Scope |
| SUBTOTAL | | | | $15,652,840 | |
| Management | | | | | |
| Project Management | 1 | per cent | $15,467,592 | $154,676 | 1% of Scope |
| Construction Management | 1 | per cent | $15,467,592 | $154,676 | 1% of Scope |
| SUBTOTAL | | | | $15,962,192 | |
| **TOTAL CAPITAL COSTS** | | | | **$15,900,000** | |

**ANNUAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Inspection and Maintenance | 1 | LS | $3,500 | $3,500 | See Cost Worksheets for details |
| 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:**

| DESCRIPTION | YEAR | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | Surface water sampling to be performed quarterly, see Cost Worksheets for details |
| Spiders/Flying 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 | See Cost Worksheets for details |
| Spiders/Flying 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 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying 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 | |

**Alternative 2A - Bentonite Pellets**
**IN SITU CAPPING**

# COST ESTIMATE SUMMARY

| | Year | Qty | Unit | Unit Cost | Cost | Notes |
|---|---|---|---|---|---|---|
| **Pre-5-Year Review Report Monitoring** | | | | | | |
| Topographic Survey | | 1 | LS | $8,270 | $8,270 | |
| Sediment Core Sampling | | 1 | LS | $20,214 | $20,214 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | | $59,399 | |
| Contingency | | 10 | per cent | $59,399 | $5,940 | 10% of Scope |
| SUBTOTAL | | | | | $65,339 | |
| Management | | | | | | |
| Project Management | | 5 | per cent | $59,399 | $2,970 | 5% of Scope |
| SUBTOTAL | 4 | | | | $68,309 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying 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 | |
| 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 | See Cost Worksheets for details |
| 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 | $8,270 | $8,270 | |
| Sediment Core Sampling | | 1 | LS | $20,214 | $20,214 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | | $59,399 | |
| Contingency | | 10 | per cent | $59,399 | $5,940 | 10% of Scope |
| SUBTOTAL | | | | | $65,339 | |
| Management | | | | | | |
| Project Management | | 5 | per cent | $59,399 | $2,970 | 5% of Scope |
| SUBTOTAL | 9 | | | | $68,309 | |
| **5-Year Review Report & Annual Surface Water Monitoring** | | | | | | |
| 5-Year Review Report | | 1 | LS | $5,000 | $5,000 | See Cost Worksheets for details |
| 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 | |

| Alternative 2A - Bentonite Pellets<br>IN SITU CAPPING | | | | | | COST ESTIMATE SUMMARY |
|---|---|---|---|---|---|---|
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 14 | | | | $68,309 | |
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 19 | | | | $68,309 | |
| **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 | |
| **Pre-5-Year Review Report Monitoring** | | 1 | LS | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 24 | | | | $68,309 | |
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 29 | | | | $68,309 | |
| **5-Year Review Report & Annual SW Monitoring** | | 1 | LS | $17,663 | $17,663 | Same as Year 10 |
| SUBTOTAL | 30 | | | | $17,663 | |

**Alternative 2A - Bentonite Pellets**
**IN SITU CAPPING**

# COST ESTIMATE SUMMARY

**PRESENT VALUE ANALYSIS AT DISCOUNT RATE OF: 7%**

| COST TYPE | YEAR | TOTAL COST | TOTAL COST PER YEAR | DISCOUNT FACTOR | PRESENT VALUE |
|---|---|---|---|---|---|
| Capital Costs | 0 | $15,900,000 | NA | 1.000 | $15,900,000 |
| 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 | $68,309 | $68,309 | 0.763 | $52,112 |
| 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 | $68,309 | $68,309 | 0.544 | $37,155 |
| 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 | $68,309 | $68,309 | 0.388 | $26,491 |
| 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 | $68,309 | $68,309 | 0.277 | $18,888 |
| 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 | $68,309 | $68,309 | 0.197 | $13,467 |
| 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 | $68,309 | $68,309 | 0.141 | $9,602 |
| Periodic Cost | 30 | $17,663 | $17,663 | 0.131 | $2,320 |
| | | $16,881,000 | | | $16,352,000 |
| | | **TOTAL COST** | | | $16,900,000 |
| **TOTAL PRESENT VALUE OF ALTERNATIVE** | | | | | **$16,400,000** |

Note: Totals rounded to nearest $100,000.

Prepared By: KPW 3/30/2012
Checked By: JAN 4/2/2012

**Alternative 2A - Native Soil with Polishing Layer**
**IN SITU CAPPING**

# COST ESTIMATE SUMMARY

**Site:** Olin McIntosh Operable Unit 2
**Location:** McIntosh, Alabama
**Phase:** Feasibility Study
**Base Year:** 2012
**Date:** April 9, 2012

Alternative 2A consists of capping of sediment with 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 consisting of a native soil mixing layer, native soil cap layer, polishing layer over a 15-acre footprint, and native soil and stone habitat layer. 15 acre footprint represents area with mercury concentration greater than 50 ppm.

**CAPITAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Implementation of ICs | 1 | LS | $1,600 | $1,600 | |
| SUBTOTAL | | | | $1,600 | |
| Capping Remedy | | | | | |
| Design and Treatability Study | 1 | LS | $60,000 | $60,000 | See Cost Worksheets for details |
| Cap Placement | 1 | LS | $17,298,962 | $17,298,962 | See Cost Worksheets for details |
| SUBTOTAL | | | | $17,360,562 | |
| Post Construction Confirmation Sampling | | | | | |
| Cap Sediment Sampling | 1 | LS | $20,214 | $20,214 | See Cost Worksheets for details |
| Surface Water Sampling | 1 | LS | $10,359 | $10,359 | See Cost Worksheets for details |
| SUBTOTAL | | | | $17,391,135 | |
| Contingency | 1 | per cent | $17,360,562 | $173,606 | 1% of Scope |
| SUBTOTAL | | | | $17,564,740 | |
| Management | | | | | |
| Project Management | 1 | per cent | $17,360,562 | $173,606 | 1% of Scope |
| Construction Management | 1 | per cent | $17,360,562 | $173,606 | 1% of Scope |
| SUBTOTAL | | | | $17,911,952 | |
| **TOTAL CAPITAL COSTS** | | | | **$17,900,000** | |

**ANNUAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Inspection and Maintenance | 1 | LS | $3,500 | $3,500 | See Cost Worksheets for details |
| 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:**

| DESCRIPTION | YEAR | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | Surface water sampling to be performed quarterly, see Cost Worksheets for details |
| Spiders/Flying 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/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | |

| Alternative 2A - Native Soil with Polishing Layer IN SITU CAPPING | | | | | | COST ESTIMATE SUMMARY |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | $8,270 | $8,270 | |
| Sediment Core Sampling | | 1 | LS | $20,214 | $20,214 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | | $59,399 | |
| Contingency | | 10 | per cent | $59,399 | $5,940 | 10% of Scope |
| SUBTOTAL | | | | | $65,339 | |
| Management | | | | | | |
| Project Management | | 5 | per cent | $59,399 | $2,970 | 5% of Scope |
| SUBTOTAL | 4 | | | | $68,309 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying 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 | |
| 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 | See Cost Worksheets for details |
| 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 | |

| Alternative 2A - Native Soil with Polishing Layer IN SITU CAPPING | | | | | | COST ESTIMATE SUMMARY |
|---|---|---|---|---|---|---|
| **Pre-5-Year Review Report Monitoring** | | | | | | |
| Topographic Survey | | 1 | LS | $8,270 | $8,270 | |
| Sediment Core Sampling | | 1 | LS | $20,214 | $20,214 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | | $59,399 | |
| Contingency | | 10 | per cent | $59,399 | $5,940 | 10% of Scope |
| SUBTOTAL | | | | | $65,339 | |
| Management | | | | | | |
| Project Management | | 5 | per cent | $59,399 | $2,970 | 5% of Scope |
| SUBTOTAL | 9 | | | | $68,309 | |
| **5-Year Review Report & Annual Surface Water Monitoring** | | | | | | |
| 5-Year Review Report | | 1 | LS | $5,000 | $5,000 | See Cost Worksheets for details |
| 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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 14 | | | | $68,309 | |
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 19 | | | | $68,309 | |
| **5-Year Review Report & Annual SW Monitoring** | | 1 | LS | $17,663 | $17,663 | Same as Year 10 |
| SUBTOTAL | 20 | | | | $17,663 | |

| **Alternative 2A - Native Soil with Polishing Layer**<br>**IN SITU CAPPING** | | | | COST ESTIMATE SUMMARY | | |
|---|---|---|---|---|---|---|
| **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 | |
| **Pre-5-Year Review Report Monitoring** | | 1 | LS | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 24 | | | | $68,309 | |
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 29 | | | | $68,309 | |
| **5-Year Review Report & Annual SW Monitoring** | | 1 | LS | $17,663 | $17,663 | Same as Year 10 |
| SUBTOTAL | 30 | | | | $17,663 | |

**Alternative 2A - Native Soil with Polishing Layer**
**IN SITU CAPPING**

# COST ESTIMATE SUMMARY

**PRESENT VALUE ANALYSIS AT DISCOUNT RATE OF: 7%**

| COST TYPE | YEAR | TOTAL COST | TOTAL COST PER YEAR | DISCOUNT FACTOR | PRESENT VALUE |
|---|---|---|---|---|---|
| Capital Costs | 0 | $17,900,000 | NA | 1.000 | $17,900,000 |
| Annual O&M | 1 - 30 | $120,000.00 | $4,000 | 12.409 | $49,636 |
| Periodic Cost | 1 | $71,291.26 | $71,291 | 0.935 | $66,627 |
| Periodic Cost | 2 | $35,552.71 | $35,553 | 0.873 | $31,053 |
| Periodic Cost | 3 | $35,552.71 | $35,553 | 0.816 | $29,022 |
| Periodic Cost | 4 | $68,308.85 | $68,309 | 0.763 | $52,112 |
| Periodic Cost | 5 | $41,302.71 | $41,303 | 0.713 | $29,448 |
| Periodic Cost | 6 | $11,912.85 | $11,913 | 0.666 | $7,938 |
| Periodic Cost | 7 | $11,912.85 | $11,913 | 0.623 | $7,419 |
| Periodic Cost | 8 | $11,912.85 | $11,913 | 0.582 | $6,933 |
| Periodic Cost | 9 | $68,308.85 | $68,309 | 0.544 | $37,155 |
| Periodic Cost | 10 | $17,662.85 | $17,663 | 0.508 | $8,979 |
| Periodic Cost | 11 | $11,912.85 | $11,913 | 0.475 | $5,660 |
| Periodic Cost | 12 | $11,912.85 | $11,913 | 0.444 | $5,289 |
| Periodic Cost | 13 | $11,912.85 | $11,913 | 0.415 | $4,943 |
| Periodic Cost | 14 | $68,308.85 | $68,309 | 0.388 | $26,491 |
| Periodic Cost | 15 | $17,662.85 | $17,663 | 0.362 | $6,402 |
| Periodic Cost | 16 | $11,912.85 | $11,913 | 0.339 | $4,035 |
| Periodic Cost | 17 | $11,912.85 | $11,913 | 0.317 | $3,771 |
| Periodic Cost | 18 | $11,912.85 | $11,913 | 0.296 | $3,525 |
| Periodic Cost | 19 | $68,308.85 | $68,309 | 0.277 | $18,888 |
| Periodic Cost | 20 | $17,662.85 | $17,663 | 0.258 | $4,564 |
| Periodic Cost | 21 | $11,912.85 | $11,913 | 0.242 | $2,877 |
| Periodic Cost | 22 | $11,912.85 | $11,913 | 0.226 | $2,689 |
| Periodic Cost | 23 | $11,912.85 | $11,913 | 0.211 | $2,513 |
| Periodic Cost | 24 | $68,308.85 | $68,309 | 0.197 | $13,467 |
| Periodic Cost | 25 | $17,662.85 | $17,663 | 0.184 | $3,254 |
| Periodic Cost | 26 | $11,912.85 | $11,913 | 0.172 | $2,051 |
| Periodic Cost | 27 | $11,912.85 | $11,913 | 0.161 | $1,917 |
| Periodic Cost | 28 | $11,912.85 | $11,913 | 0.150 | $1,792 |
| Periodic Cost | 29 | $68,308.85 | $68,309 | 0.141 | $9,602 |
| Periodic Cost | 30 | $17,662.85 | $17,663 | 0.131 | $2,320 |
| | | $18,881,000 | | | $18,352,000 |

| | |
|---|---|
| **TOTAL COST** | $18,900,000 |
| **TOTAL PRESENT VALUE OF ALTERNATIVE** | $18,400,000 |

Note: Totals rounded to nearest $100,000.

Prepared By: KPW 3/30/2012
Checked By: JAN 4/2/2012

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**IN SITU CAPPING**

# DRAFT COST ESTIMATE SUMMARY

**Site:** Olin McIntosh Operable Unit 2
**Location:** McIntosh, Alabama
**Phase:** Feasibility Study
**Base Year:** 2012
**Date:** April 9, 2012

Alternative 2A consists of capping of sediment with 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 consisting of a native soil mixing layer, bentonite pellet cap layer, polishing layer over a 15-acre footprint, and native soil and stone habitat layer. 15 acre footprint represents mercury concetration greater than 50 ppm.

**CAPITAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Implementation of ICs | 1 | LS | $1,600 | $1,600 | See Cost Worksheets for details |
| SUBTOTAL | | | | $1,600 | |
| | | | | | |
| Capping Remedy | | | | | |
| Design and Treatability Study | 1 | LS | $60,000 | $60,000 | See Cost Worksheets for details |
| Cap Placement | 1 | LS | $20,783,368 | $20,783,368 | |
| SUBTOTAL | | | | $20,844,968 | |
| | | | | | |
| Post Construction Confirmation Sampling | | | | | |
| Cap Sediment Sampling | 1 | LS | $20,214 | $20,214 | See Cost Worksheets for details |
| Surface Water Sampling | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | $20,875,541 | |
| | | | | | |
| Contingency | 1 | per cent | $20,844,968 | $208,450 | 1% of Scope |
| SUBTOTAL | | | | $21,083,991 | |
| | | | | | |
| Management | | | | | |
| Project Management | 1 | per cent | $20,844,968 | $208,450 | 1% of Scope |
| Construction Management | 1 | per cent | $20,844,968 | $208,450 | 1% of Scope |
| SUBTOTAL | | | | $21,500,890 | |
| | | | | | |
| **TOTAL CAPITAL COSTS** | | | | **$21,500,000** | |

**ANNUAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Inspection and Maintenance | 1 | LS | $3,500 | $3,500 | See Cost Worksheets for details |
| 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 | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | Surface water sampling to be performed quarterly, see Cost Worksheets for details |
| Spiders/Flying 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 | |

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**IN SITU CAPPING**

DRAFT COST ESTIMATE SUMMARY

| | | | | | | |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | $8,270 | $8,270 | |
| Sediment Core Sampling | | 1 | LS | $20,214 | $20,214 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | | $59,399 | |
| Contingency | | 10 | per cent | $59,399 | $5,940 | 10% of Scope |
| SUBTOTAL | | | | | $65,339 | |
| Management | | | | | | |
| Project Management | | 5 | per cent | $59,399 | $2,970 | 5% of Scope |
| SUBTOTAL | 4 | | | | $68,309 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying 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 | |
| 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 | See Cost Worksheets for details |
| 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 | |

| Alternative 2A - Bentonite Pellets with Polishing Layer IN SITU CAPPING | | | | DRAFT COST ESTIMATE SUMMARY | | |
|---|---|---|---|---|---|---|
| **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 | $8,270 | $8,270 | |
| Sediment Core Sampling | | 1 | LS | $20,214 | $20,214 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | | $59,399 | |
| Contingency | | 10 | per cent | $59,399 | $5,940 | 10% of Scope |
| SUBTOTAL | | | | | $65,339 | |
| Management | | | | | | |
| Project Management | | 5 | per cent | $59,399 | $2,970 | 5% of Scope |
| SUBTOTAL | 9 | | | | $68,309 | |
| **5-Year Review Report & Annual Surface Water Monitoring** | | | | | | |
| 5-Year Review Report | | 1 | LS | $5,000 | $5,000 | See Cost Worksheets for details |
| 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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 14 | | | | $68,309 | |
| **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 | |

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**IN SITU CAPPING**

DRAFT COST ESTIMATE SUMMARY

| | | | | | | |
|---|---|---|---|---|---|---|
| **Pre-5-Year Review Report Monitoring** | | 1 | LS | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 19 | | | | $68,309 | |
| **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 | |
| **Pre-5-Year Review Report Monitoring** | | 1 | LS | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 24 | | | | $68,309 | |
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 29 | | | | $68,309 | |
| **5-Year Review Report & Annual SW Monitoring** | | 1 | LS | $17,663 | $17,663 | Same as Year 10 |
| SUBTOTAL | 30 | | | | $17,663 | |

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**IN SITU CAPPING**

## DRAFT COST ESTIMATE SUMMARY

**PRESENT VALUE ANALYSIS AT DISCOUNT RATE OF: 7%**

| COST TYPE | YEAR | TOTAL COST | TOTAL COST PER YEAR | DISCOUNT FACTOR | PRESENT VALUE |
|---|---|---|---|---|---|
| Capital Costs | 0 | $21,500,000 | NA | 1.000 | $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 | $68,309 | $68,309 | 0.763 | $52,112 |
| 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 | $68,309 | $68,309 | 0.544 | $37,155 |
| 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 | $68,309 | $68,309 | 0.388 | $26,491 |
| 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 | $68,309 | $68,309 | 0.277 | $18,888 |
| 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 | $68,309 | $68,309 | 0.197 | $13,467 |
| 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 | $68,309 | $68,309 | 0.141 | $9,602 |
| Periodic Cost | 30 | $17,663 | $17,663 | 0.131 | $2,320 |
| | | $22,481,000 | | | $21,952,000 |
| **TOTAL COST** | | | | | $22,500,000 |
| **TOTAL PRESENT VALUE OF ALTERNATIVE** | | | | | **$22,000,000** |

Note: Totals rounded to nearest $100,000.

Prepared By: KPW 3/30/2012
Checked By: JAN 4/2/2012

**TABLE 4-4 ESTIMATED COST FOR ALTERNATIVE 2B**
**IN SITU DRY CAP HYBRID**
**Olin McIntosh OU-2**

**Alternative 2B**
**HYBRID CAPPING**

# COST ESTIMATE SUMMARY

**Site:** Olin McIntosh Operable Unit 2
**Location:** McIntosh, Alabama
**Phase:** Feasibility Study
**Base Year:** 2012
**Date:** April 9, 2012

Alternative 2B consists of applying a native soil cap (shallow areas capped in the dry and deeper areas capped in situ), 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.

**CAPITAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Implementation of ICs | 1 | LS | $1,600 | $1,600 | See Cost Worksheet for details |
| SUBTOTAL | | | | $1,600 | |
| Hybrid Capping | | | | | |
| Design and Treatability Study | 1 | LS | $60,000 | $60,000 | See Cost Worksheet for details |
| Cap Placement | 1 | LS | $12,867,899 | $12,867,899 | See Cost Worksheet for details |
| SUBTOTAL | | | | $12,929,499 | |
| Post Construction Confirmation Sampling | | | | | |
| Cap Sediment Sampling | 1 | LS | $20,214 | $20,214 | See Cost Worksheets for details |
| Surface Water Sampling | 1 | LS | $10,359 | $10,359 | See Cost Worksheets for details |
| SUBTOTAL | | | | $12,960,071 | |
| Contingency | 1 | per cent | $12,929,499 | $129,295 | 1% of Scope |
| SUBTOTAL | | | | $13,089,366 | |
| Management | | | | | |
| Project Management | 1 | per cent | $12,929,499 | $129,295 | 1% of Scope |
| Construction Management | 1 | per cent | $12,929,499 | $129,295 | 1% of Scope |
| SUBTOTAL | | | | $13,347,956 | |
| **TOTAL CAPITAL COSTS** | | | | **$13,300,000** | |

**ANNUAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Inspection and Maintenance | 1 | LS | $3,500 | $3,500 | See Cost Worksheets for details |
| 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** | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | Surface water sampling to be performed quarterly, see Cost Worksheets for details |
| Spiders/Flying 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/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 4-4 ESTIMATED COST FOR ALTERNATIVE 2B**
**IN SITU DRY CAP HYBRID**
**Olin McIntosh OU-2**

| Alternative 2B<br>HYBRID CAPPING | | | | | | COST ESTIMATE SUMMARY |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | $8,270 | $8,270 | |
| Sediment Core Sampling | | 1 | LS | $20,214 | $20,214 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | | $59,399 | |
| Contingency | | 10 | per cent | $59,399 | $5,940 | 10% of Scope |
| SUBTOTAL | | | | | $65,339 | |
| Management | | | | | | |
| Project Management | | 5 | per cent | $59,399 | $2,970 | 5% of Scope |
| SUBTOTAL | 4 | | | | $68,309 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying 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 | |
| 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 | See Cost Worksheets for details |
| 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 | $8,270 | $8,270 | |
| Sediment Core Sampling | | 1 | LS | $20,214 | $20,214 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | | $59,399 | |
| Contingency | | 10 | per cent | $59,399 | $5,940 | 10% of Scope |
| SUBTOTAL | | | | | $65,339 | |
| Management | | | | | | |
| Project Management | | 5 | per cent | $59,399 | $2,970 | 5% of Scope |
| SUBTOTAL | 9 | | | | $68,309 | |
| **5-Year Review Report & Annual Surface Water Monitoring** | | | | | | |
| 5-Year Review Report | | 1 | LS | $5,000 | $5,000 | See Cost Worksheets for details |
| 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 | |

**TABLE 4-4 ESTIMATED COST FOR ALTERNATIVE 2B**
**IN SITU DRY CAP HYBRID**
**Olin McIntosh OU-2**

| Alternative 2B HYBRID CAPPING | | | | | COST ESTIMATE SUMMARY | |
|---|---|---|---|---|---|---|
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 14 | | | | $68,309 | |
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 19 | | | | $68,309 | |
| **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 | |
| **Pre-5-Year Review Report Monitoring** | | 1 | LS | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 24 | | | | $68,309 | |
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 29 | | | | $68,309 | |
| **5-Year Review Report & Annual SW Monitoring** | | 1 | LS | $17,663 | $17,663 | Same as Year 10 |
| SUBTOTAL | 30 | | | | $17,663 | |

**TABLE 4-4 ESTIMATED COST FOR ALTERNATIVE 2B**
**IN SITU DRY CAP HYBRID**
**Olin McIntosh OU-2**

**Alternative 2B**
**HYBRID CAPPING**

# COST ESTIMATE SUMMARY

**PRESENT VALUE ANALYSIS AT DISCOUNT RATE OF: 7%**

| COST TYPE | YEAR | TOTAL COST | TOTAL COST PER YEAR | DISCOUNT FACTOR | PRESENT VALUE |
|---|---|---|---|---|---|
| Capital Costs | 0 | $13,300,000 | NA | 1.000 | $13,300,000 |
| 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 | $68,309 | $68,309 | 0.763 | $52,112 |
| 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 | $68,309 | $68,309 | 0.544 | $37,155 |
| 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 | $68,309 | $68,309 | 0.388 | $26,491 |
| 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 | $68,309 | $68,309 | 0.277 | $18,888 |
| 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 | $68,309 | $68,309 | 0.197 | $13,467 |
| 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 | $68,309 | $68,309 | 0.141 | $9,602 |
| Periodic Cost | 30 | $17,663 | $17,663 | 0.131 | $2,320 |
| | | $14,281,000 | | | $13,752,000 |

| | |
|---|---|
| **TOTAL COST** | $14,300,000 |
| **TOTAL PRESENT VALUE OF ALTERNATIVE** | $13,800,000 |

Note: Values rounded to nearest $100,000.

Prepared By: KPW 3/30/2012
Checked By: JAN 4/2/2012

**Alternative 2C**
**DRY CAPPING**

# COST ESTIMATE SUMMARY

**Site:** Olin McIntosh Operable Unit 2
**Location:** McIntosh, Alabama
**Phase:** Feasibility Study
**Base Year:** 2012
**Date:** April 9, 2012

Alternative 2C consists of applying a native soil cap in the dry 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.

**CAPITAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Implementation of ICs | 1 | LS | $1,600 | $1,600 | |
| SUBTOTAL | | | | $1,600 | |
| Hybrid Capping | | | | | |
| Design and Treatability Study | 1 | LS | $60,000 | $60,000 | See Cost Worksheet for details |
| Cap Placement | 1 | LS | $13,630,551 | $13,630,551 | See Cost Worksheet for details |
| SUBTOTAL | | | | $13,692,151 | |
| Post Construction Confirmation Sampling | | | | | |
| Cap Sediment Sampling | 1 | LS | $20,214 | $20,214 | See Cost Worksheets for details |
| Surface Water Sampling | 1 | LS | $10,359 | $10,359 | See Cost Worksheets for details |
| SUBTOTAL | | | | $13,722,723 | |
| Contingency | 10 | per cent | $13,692,151 | $1,369,215 | 10% of Scope |
| SUBTOTAL | | | | $15,091,939 | |
| Management | | | | | |
| Project Management | 1 | per cent | $13,692,151 | $136,922 | 1% of Scope |
| Construction Management | 1 | per cent | $13,692,151 | $136,922 | 1% of Scope |
| SUBTOTAL | | | | $15,365,782 | |
| **TOTAL CAPITAL COSTS** | | | | **$15,400,000** | |

**ANNUAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Inspection and Maintenance | 1 | LS | $3,500 | $3,500 | See Cost Worksheets for details |
| 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:**

| DESCRIPTION | YEAR | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | Surface water sampling to be performed quarterly, see Cost Worksheets for details |
| Spiders/Flying 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 | |

**Alternative 2C**
**DRY CAPPING**

## COST ESTIMATE SUMMARY

| | | | | | | |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | $8,270 | $8,270 | |
| Sediment Core Sampling | | 1 | LS | $20,214 | $20,214 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | | $59,399 | |
| Contingency | | 10 | per cent | $59,399 | $5,940 | 10% of Scope |
| SUBTOTAL | | | | | $65,339 | |
| Management | | | | | | |
| Project Management | | 5 | per cent | $59,399 | $2,970 | 5% of Scope |
| SUBTOTAL | 4 | | | | $68,309 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying 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 | |
| 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 | See Cost Worksheets for details |
| 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 | |

| Alternative 2C DRY CAPPING | | | | COST ESTIMATE SUMMARY | | |
|---|---|---|---|---|---|---|
| **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 | $8,270 | $8,270 | |
| Sediment Core Sampling | | 1 | LS | $20,214 | $20,214 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| SUBTOTAL | | | | | $59,399 | |
| Contingency | | 10 | per cent | $59,399 | $5,940 | 10% of Scope |
| SUBTOTAL | | | | | $65,339 | |
| Management | | | | | | |
| Project Management | | 5 | per cent | $59,399 | $2,970 | 5% of Scope |
| SUBTOTAL | 9 | | | | $68,309 | |
| **5-Year Review Report & Annual Surface Water Monitoring** | | | | | | |
| 5-Year Review Report | | 1 | LS | $5,000 | $5,000 | See Cost Worksheets for details |
| 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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 14 | | | | $68,309 | |
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 19 | | | | $68,309 | |
| **5-Year Review Report & Annual SW Monitoring** | | 1 | LS | $17,663 | $17,663 | Same as Year 10 |
| SUBTOTAL | 20 | | | | $17,663 | |

| Alternative 2C DRY CAPPING | | | | COST ESTIMATE SUMMARY | | |
|---|---|---|---|---|---|---|
| **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 | |
| **Pre-5-Year Review Report Monitoring** | | 1 | LS | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 24 | | | | $68,309 | |
| **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 | $68,309 | $68,309 | Same as Year 9 |
| SUBTOTAL | 29 | | | | $68,309 | |
| **5-Year Review Report & Annual SW Monitoring** | | 1 | LS | $17,663 | $17,663 | Same as Year 10 |
| SUBTOTAL | 30 | | | | $17,663 | |

**TABLE 4-5 ESTIMATED COST FOR ALTERNATIVE 2C**
**CAPPING IN THE DRY**



**Alternative 2C**
**DRY CAPPING**

## COST ESTIMATE SUMMARY

**PRESENT VALUE ANALYSIS AT DISCOUNT RATE OF: 7%**

| COST TYPE | YEAR | TOTAL COST | TOTAL COST PER YEAR | DISCOUNT FACTOR | PRESENT VALUE |
|---|---|---|---|---|---|
| Capital Costs | 0 | $15,400,000 | NA | 1.000 | $15,400,000 |
| 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 | $68,309 | $68,309 | 0.763 | $52,112 |
| 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 | $68,309 | $68,309 | 0.544 | $37,155 |
| 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 | $68,309 | $68,309 | 0.388 | $26,491 |
| 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 | $68,309 | $68,309 | 0.277 | $18,888 |
| 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 | $68,309 | $68,309 | 0.197 | $13,467 |
| 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 | $68,309 | $68,309 | 0.141 | $9,602 |
| Periodic Cost | 30 | $17,663 | $17,663 | 0.131 | $2,320 |
| | | $16,381,000 | | | $15,852,000 |

| | |
|---|---|
| **TOTAL COST** | $16,400,000 |
| **TOTAL PRESENT VALUE OF ALTERNATIVE** | $15,900,000 |

Note: Totals rounded to nearest $100,000.

Prepared By: KPW 3/30/2012
Checked By: JAN 4/2/2012

**TABLE 4-6A ESTIMATED COST FOR ALTERNATIVE 3 WITH ONSITE DISPOSAL DREDGING**



**Alternative 3 - With Onsite Disposal**
**DREDGING**

# DRAFT COST ESTIMATE SUMMARY

**Site:** Olin McIntosh Operable Unit 2
**Location:** McIntosh, Alabama
**Phase:** Feasibility Study
**Base Year:** 2012
**Date:** April 9, 2012

Alternative 3 consists of debris removal, hydraulic dredging, dewatering, onsite or offsite disposal, 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.

**CAPITAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Implementation of ICs | 1 | LS | $1,600 | $1,600 | See Cost Worksheets for details |
| SUBTOTAL | | | | $1,600 | |
| Dredging | | | | | |
| Design and Treatability Study | 1 | LS | $60,000 | $60,000 | See Cost Worksheet for details |
| Dredging Operations | 1 | LS | $48,495,746 | $48,495,746 | See Cost Worksheet for details |
| SUBTOTAL | | | | $48,557,346 | |
| Post Construction Confirmation Sampling | | | | | |
| Cap Sediment Sampling | 1 | LS | $20,214 | $20,214 | See Cost Worksheets for details |
| Surface Water Sampling | 1 | LS | $10,359 | $10,359 | See Cost Worksheets for details |
| SUBTOTAL | | | | $48,587,918 | |
| Contingency | 10 | per cent | $48,557,346 | $4,855,735 | 10% of Scope |
| SUBTOTAL | | | | $53,443,653 | |
| Management | | | | | |
| Project Management | 1 | per cent | $48,557,346 | $485,573 | 1% of Scope |
| Construction Management | 1 | per cent | $48,557,346 | $485,573 | 1% of Scope |
| SUBTOTAL | | | | $54,414,800 | |
| **TOTAL CAPITAL COSTS** | | | | **$54,400,000** | |

**ANNUAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Berm Inspection and Maintenance | 1 | LS | $3,500 | $3,500 | See Cost Worksheets for details |
| 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:**

| DESCRIPTION | YEAR | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | Surface water sampling to be performed quarterly in Year 1, see Cost Worksheets for details |
| Spiders/Flying 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 | |

| Alternative 3 - With Onsite Disposal DREDGING | | | | | | DRAFT COST ESTIMATE SUMMARY |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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** | | | | | | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | 4 | | | | $35,553 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying 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 | |
| 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 | See Cost Worksheets for details |
| 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 | |

| **Alternative 3 - With Onsite Disposal DREDGING** | | | | | | DRAFT COST ESTIMATE SUMMARY |
|---|---|---|---|---|---|---|
| **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** | | | | | | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | 9 | | | | $35,553 | |
| **5-Year Review Report & Annual Surface Water Monitoring** | | | | | | |
| 5-Year Review Report | | 1 | LS | $5,000 | $5,000 | See Cost Worksheets for details |
| 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 | $35,553 | $35,553 | Same as Year 9 |
| SUBTOTAL | 14 | | | | $35,553 | |
| **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 | |

| Alternative 3 - With Onsite Disposal<br>DREDGING | | | | DRAFT COST ESTIMATE SUMMARY | | |
|---|---|---|---|---|---|---|
| **Pre-5-Year Review Report Monitoring** | | 1 | LS | $35,553 | $35,553 | Same as Year 9 |
| SUBTOTAL | 19 | | | | $35,553 | |
| **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 | |
| **Pre-5-Year Review Report Monitoring** | | 1 | LS | $35,553 | $35,553 | Same as Year 9 |
| SUBTOTAL | 24 | | | | $35,553 | |
| **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 | $35,553 | $35,553 | Same as Year 9 |
| SUBTOTAL | 29 | | | | $35,553 | |
| **5-Year Review Report & Annual SW Monitoring** | | 1 | LS | $17,663 | $17,663 | Same as Year 10 |
| SUBTOTAL | 30 | | | | $17,663 | |

**Alternative 3 - With Onsite Disposal**
**DREDGING**

# DRAFT COST ESTIMATE SUMMARY

**PRESENT VALUE ANALYSIS AT DISCOUNT RATE OF: 7%**

| COST TYPE | YEAR | TOTAL COST | TOTAL COST PER YEAR | DISCOUNT FACTOR | PRESENT VALUE |
|---|---|---|---|---|---|
| Capital Costs | 0 | $54,400,000 | NA | 1.000 | $54,400,000 |
| 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 | $35,553 | $35,553 | 0.763 | $27,123 |
| 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 | $35,553 | $35,553 | 0.544 | $19,338 |
| 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 | $35,553 | $35,553 | 0.388 | $13,788 |
| 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 | $35,553 | $35,553 | 0.277 | $9,831 |
| 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 | $35,553 | $35,553 | 0.197 | $7,009 |
| 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 | $35,553 | $35,553 | 0.141 | $4,997 |
| Periodic Cost | 30 | $17,663 | $17,663 | 0.131 | $2,320 |
| | | $55,184,000 | | | $54,777,000 |

| | |
|---|---|
| **TOTAL COST** | $55,200,000 |
| **TOTAL PRESENT VALUE OF ALTERNATIVE** | **$54,800,000** |

Note: Total values rounded to nearest $100,000.

Prepared By: KPW 3/30/2012
Checked By: JAN 4/2/2012

**TABLE 4-6B ESTIMATED COST FOR ATLERNATIVE 3 WITH OFFSITE DISPOSAL DREDGING**



**Alternative 3 - With Offsite Disposal**
**DREDGING**

# DRAFT COST ESTIMATE SUMMARY

**Site:** Olin McIntosh Operable Unit 2
**Location:** McIntosh, Alabama
**Phase:** Feasibility Study
**Base Year:** 2012
**Date:** April 9, 2012

Alternative 3 consists of debris removal, hydraulic dredging, dewatering, onsite or offsite disposal, 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.

**CAPITAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Implementation of ICs | 1 | LS | $1,600 | $1,600 | See Cost Worksheets for details |
| SUBTOTAL | | | | $1,600 | |
| Dredging | | | | | |
| Design and Treatability Study | 1 | LS | $60,000 | $60,000 | See Cost Worksheet for details |
| Dredging Operations | 1 | LS | $61,537,895 | $61,537,895 | See Cost Worksheet for details |
| SUBTOTAL | | | | $61,599,495 | |
| Post Construction Confirmation Sampling | | | | | |
| Cap Sediment Sampling | 1 | LS | $20,214 | $20,214 | See Cost Worksheets for details |
| Surface Water Sampling | 1 | LS | $10,359 | $10,359 | See Cost Worksheets for details |
| SUBTOTAL | | | | $61,630,068 | |
| Contingency | 10 | per cent | $61,599,495 | $6,159,950 | 10% of Scope |
| SUBTOTAL | | | | $67,790,017 | |
| Management | | | | | |
| Project Management | 1 | per cent | $61,599,495 | $615,995 | 1% of Scope |
| Construction Management | 1 | per cent | $61,599,495 | $615,995 | 1% of Scope |
| SUBTOTAL | | | | $69,022,000 | |
| **TOTAL CAPITAL COSTS** | | | | **$69,000,000** | |

**ANNUAL COSTS:**

| DESCRIPTION | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Inspection and Maintenance | 1 | LS | $3,500 | $3,500 | See Cost Worksheets for details |
| 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 | QTY | UNITS | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | Surface water sampling to be performed quarterly in Year 1, see Cost Worksheets for details |
| Spiders/Flying 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 | |

| **Alternative 3 - With Offsite Disposal DREDGING** | | | | | DRAFT COST ESTIMATE SUMMARY | |
|---|---|---|---|---|---|---|
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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** | | | | | | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | 4 | | | | $35,553 | |
| Surface Water Sampling and Analysis | | 1 | LS | $10,359 | $10,359 | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | See Cost Worksheets for details |
| Spiders/Flying 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 | |
| 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 | See Cost Worksheets for details |
| 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 | |

| Alternative 3 - With Offsite Disposal DREDGING | | | | DRAFT COST ESTIMATE SUMMARY | | |
|---|---|---|---|---|---|---|
| **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** | | | | | | |
| Fish Sampling and Analysis | | 1 | LS | $9,236 | $9,236 | |
| Spiders/Flying Insects Sampling & Analysis | | 1 | LS | $11,320 | $11,320 | See Cost Worksheets for details |
| 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 | 9 | | | | $35,553 | |
| **5-Year Review Report & Annual Surface Water Monitoring** | | | | | | |
| 5-Year Review Report | | 1 | LS | $5,000 | $5,000 | See Cost Worksheets for details |
| 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 | $35,553 | $35,553 | Same as Year 9 |
| SUBTOTAL | 14 | | | | $35,553 | |
| **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 | |

| Alternative 3 - With Offsite Disposal DREDGING | | | | | DRAFT COST ESTIMATE SUMMARY | |
|---|---|---|---|---|---|---|
| **Pre-5-Year Review Report Monitoring** | | 1 | LS | $35,553 | $35,553 | Same as Year 9 |
| SUBTOTAL | 19 | | | | $35,553 | |
| **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 | |
| **Pre-5-Year Review Report Monitoring** | | 1 | LS | $35,553 | $35,553 | Same as Year 9 |
| SUBTOTAL | 24 | | | | $35,553 | |
| **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 | $35,553 | $35,553 | Same as Year 9 |
| SUBTOTAL | 29 | | | | $35,553 | |
| **5-Year Review Report & Annual SW Monitoring** | | 1 | LS | $17,663 | $17,663 | Same as Year 10 |
| SUBTOTAL | 30 | | | | $17,663 | |

**Alternative 3 - With Offsite Disposal**
**DREDGING**

# DRAFT COST ESTIMATE SUMMARY

**PRESENT VALUE ANALYSIS AT DISCOUNT RATE OF: 7%**

| COST TYPE | YEAR | TOTAL COST | TOTAL COST PER YEAR | DISCOUNT FACTOR | PRESENT VALUE |
|---|---|---|---|---|---|
| Capital Costs | 0 | $69,000,000 | NA | 1.000 | $69,000,000 |
| 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 | $35,553 | $35,553 | 0.763 | $27,123 |
| 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 | $35,553 | $35,553 | 0.544 | $19,338 |
| 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 | $35,553 | $35,553 | 0.388 | $13,788 |
| 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 | $35,553 | $35,553 | 0.277 | $9,831 |
| 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 | $35,553 | $35,553 | 0.197 | $7,009 |
| 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 | $35,553 | $35,553 | 0.141 | $4,997 |
| Periodic Cost | 30 | $17,663 | $17,663 | 0.131 | $2,320 |
| | | $69,784,000 | | | $69,377,000 |

| | |
|---|---|
| **TOTAL COST** | $69,800,000 |
| **TOTAL PRESENT VALUE OF ALTERNATIVE** | **$69,400,000** |

Note: Totals rounded to nearest $100,000.

Prepared By: KPW 3/30/2012
Checked By: JAN 4/2/2012

**TABLE 4-7**

**COMPARATIVE ANALYSIS, SCORING, AND RANKING OF REMEDIAL ALTERNATIVES**
**Olin McIntosh OU-2**

| Alternative | Description | Overall Protection of Human Health and the Environment | Criteria Score[1] | Compliance with ARARs | Criteria Score[1] | Short-term Effectiveness | Criteria Score[1] | Long-term Effectiveness | Criteria Score[1] | Reduction of TMV Through Treatment | Criteria Score[1] | Implementability | Criteria Score[1] | Cost | Criteria Score[1] | Total Score | RANK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No Action | Unacceptable risk to human health would result from lack of IC maintenance. Risk to ecological receptors would not be mitigated. | N.A. | Does not comply with ARARs. | N.A. | No immediate short-term impact. | N.A. | Natural sedimentation has likely already reduced mercury concentrations in sediment at or below the sediment PRG in some portions of the Basin (area north of the inlet channel) and will continue. The timeframe to achieve the sediment PRG in other portions of the Basin and Round Pond would be very lengthy and beyond the tiemframe evaluated in this FS. | N.A. | Does not reduce TMV. | N.A. | No active implementation required. | N.A. | Total Cost = $0 | N.A. | N.A. | **5** |
| 2A | In situ Capping and ICs | Isolates and prevents exposure of contaminated sediment to ecological receptors. ICs limit exposure to human receptors. | 5 | Complies with ARARs | 5 | Minimal risks to workers during construction activities. Temporary, reversible, impact to habitat. | 4 | Modeling using site specific data has predicted capping without or with an amendment or polishing layer to be an effective long-term solution at OU-2. Capping has been approved by EPA and demonstrated as effective at other Superfund sites with mercury containing sediment. | 4 | Capping would reduce the mobility of COCs in sediment by creating a barrier and preventing contact with surface water and receptors. Capping does not treat or reduce COCs in sediment. | 4 | Implementation is a well-proven, conventional technology. Capping has been approved by EPA and implemented at other Superfund sites with mercury containing sediment. Caps require long-term maintenance. Addition of cap amendments and/or polishing layers will increase complexity and durantion. | 4 | Total Cost :<br>Native Soil Cap - $13,400,000,<br>Bentonite Pellet Cap - $16,900,000<br>Native Soil w Polishing Layer - $18,900,000<br>Bentonite Pellet Cap w Polishing Layer - $22,500,000 | 5 | **31** | **1** |
| 2B | Dry capping, In situ Capping, and ICs | Isolates and prevents exposure of contaminated sediment to ecological receptors. ICs limit exposure to human receptors. | 5 | Complies with ARARs | 5 | Minimal risks to workers during construction activities. Temporary, reversible, impact to habitat. | 4 | Modeling using site specific data has predicted capping to be an effective long-term solution at OU-2. Capping has been approved by EPA and demonstrated as effective at other Superfund sites with mercury containing sediment. | 4 | Capping would reduce the mobility of COCs in sediment by creating a barrier and preventing contact with surface water and receptors. Capping does not treat or reduce COCs in sediment. | 4 | Uncertainties regarding construction of roads/pathways and segregating barriers for dewatering. Additional equipment, materials, and labor required compared to in situ capping. | 3 | Total Cost (Native Soil Cap) = $14,300,000 | 4 | **29** | **2** |
| 2C | Dry capping and ICs | Isolates and prevents exposure of contaminated sediment to ecological receptors. ICs limit exposure to human receptors. | 5 | Complies with ARARs | 5 | Minimal risks to workers during construction activities. Temporary, reversible, impact to habitat. More invasive than 2B. | 3 | Modeling using site specific data has predicted capping to be an effective long-term solution at OU-2. Capping has been approved by EPA and demonstrated as effective at other Superfund sites with mercury containing sediment. | 4 | Capping would reduce the mobility of COCs in sediment by creating a barrier and preventing contact with surface water and receptors. Capping does not treat or reduce COCs in sediment. | 4 | Uncertainties regarding construction of roads/pathways and segregating barriers for dewatering. Additional equipment, materials, and labor required compared to in situ capping. | 3 | Total Cost (Native Soil Cap) = $16,400,000 | 4 | **28** | **3** |
| 3 | Debris removal, hydraulic dredging, dewatering onsite or offsite disposal, and ICs | Resuspension and residuals may prevent achievement of RAOs. | 3 | Resuspension and residuals may prevent compliance with ARARs | 3 | Adverse short-term impacts are expected: destruction of habitat, increased COC concentrations in SW, increased bioaccumulation in ecological receptors. | 2 | Evidence that dredging leads to the achievement of long-term RAOs is generally lacking (National Research Council, 2007). Dredging would be effective at mass removal, but is often unsuccessful at reducing risk to acceptable levels. | 3 | Dredging reduces volume, but will temporarily increase the mobility of the COCs. | 3 | Implementation is a well-proven, conventional technology. Extensive buried debris and potential for resuspension will incrase complexity and duration. | 2 | Total Cost = $55,200,000 (on-site disposal) to $69,800,000 (off-site disposal) | 2 | **18** | **4** |

Notes:
N.A. - The no-action alternative was not scored because it did not meet the threshold critea of 1) Protection of Human Health and the Environment, or 2) Compliance With ARARs.
1. Criteria are scored from 1 to 5, with 5 being the highest score.
2. Ranked from 1 to 5, with 1 being the preferred alternative.

Prepared/Date: KPW 04/09/2012
Checked/Date: CED 04/09/2012

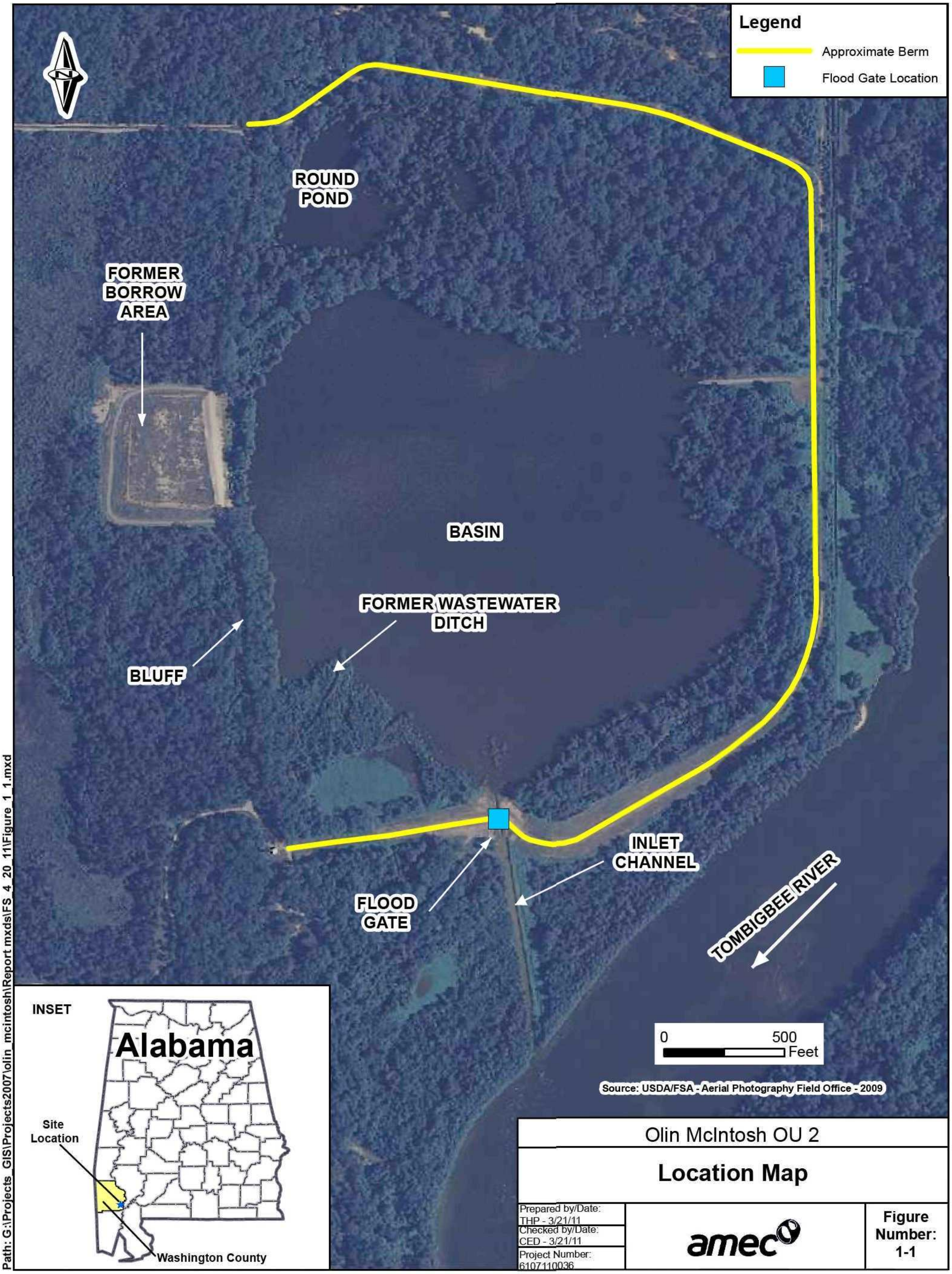
**TABLE 4-8**

**APPLICATION OF THE 11 RISK MANAGEMENT PRINCIPLES FOR CONTAMINATED SEDIMENT**
**Olin McIntosh OU-2**

| Risk Management Principles | How the Principle Has Been Applied |
|---|---|
| 1. Control Sources Early | The berm and gate system were constructed in 2006 and operational in 2007. WLM has reduced resuspension of contaminated sediment and isolated Basin waters and receptor species from the Tombigbee River. |
| 2. Involve the Community Early and Often | ADEM, NOAA, and ADCNR participate as a part of USEPA's team and provides report review. |
| 3. Coordinate with States, Local Governments, Tribes, and Natural Resource Trustees | |
| 4. Develop and Refine a Conceptual Site Model that Considers Sediment Stability | A site conceptual model was developed during the Remedial Investigation phase. The updated site conceptual model was presented in Section 5.1 of the Updated Remedial Investigation Addendum (MACTEC, 2011). |
| 5. Use an Iterative Approach in a Risk Based Framework | An iterative approach has been used to evaluate risks and obtain additional data where data gaps were identified. Risk-based methods were used in calculating PRGs (BSAF method) and developing the RAOs. |
| 6. Carefully Evaluate the Assumptions and Uncertainties Associated with Site Characterization Data and Site Models | Site specific data has been collected to evaluate the nature and extent of sediment contamination over several years. Additional samples were collected to address data gaps. Uncertainties associated with site characterization have been reduced to the extent practicable. |
| 7. Select Site-specific, Project-specific, and Sediment-specific Risk Management Approaches that will Achieve Risk-based Goals | Site specific PRGs for sediments have been calculated. This FS evaluates approaches that could achieve the PRGs and the risk-based fish tissue residue criterion for mercury with a recommendation made as to the remedial action most likely to achieve the risk-based RAOs. |
| 8. Ensure that Sediment Cleanup Levels are Clearly Tied to Risk Management Goals | The PRGs are based upon mercury, HCB, and DDTR concentrations in sediment and the Federal fish tissue advisory level. Remedial Action Objectives were developed to address the risks identified in the HHRA and ERA |
| 9. Maximize the Effectiveness of Institutional Controls and Recognize their Limitations | Fencing, signs, and fishing advisories have been implemented at OU-2. The McIntosh plant has security that monitors OU-2 to prevent trespassing and prohibits fishing in OU-2. The Enhanced Sedimentation Pilot Project was run for 2 years to monitor the effectiveness of ES/WLM. ES/WLM did not prove effective for all areas of the Basin and Round Pond as a stand-alone remedy, but is being considered in conjunction with other remedial technologies. |
| 10 Design Remedies to Minimize Short-term Risks while Achieving Long-term Protection | The FS evaluates the alternatives with respect to short- and long-term risks and effectiveness and makes a recommendation as to the most appropriate remedial action that will be effective in achieving the RAOs in both the short and long term. |
| 11. Monitor During and After Sediment Remediation to Assess and Document Remedy Effectiveness | Monitoring is built-in to the cost estimates for each alternative in the FS. Monitoring should consist of periodic confirmation that concentrations of mercury in fish are declining and that the PRGs are achieved in sediment. |

ADCNR = Alabama Department of Conservation and Natural Resources.
NOAA = National Oceanic and Atmospheric Administration.

Prepared by/Date: KPW 5/10/11
Checked by/Date: CED 5/16/11

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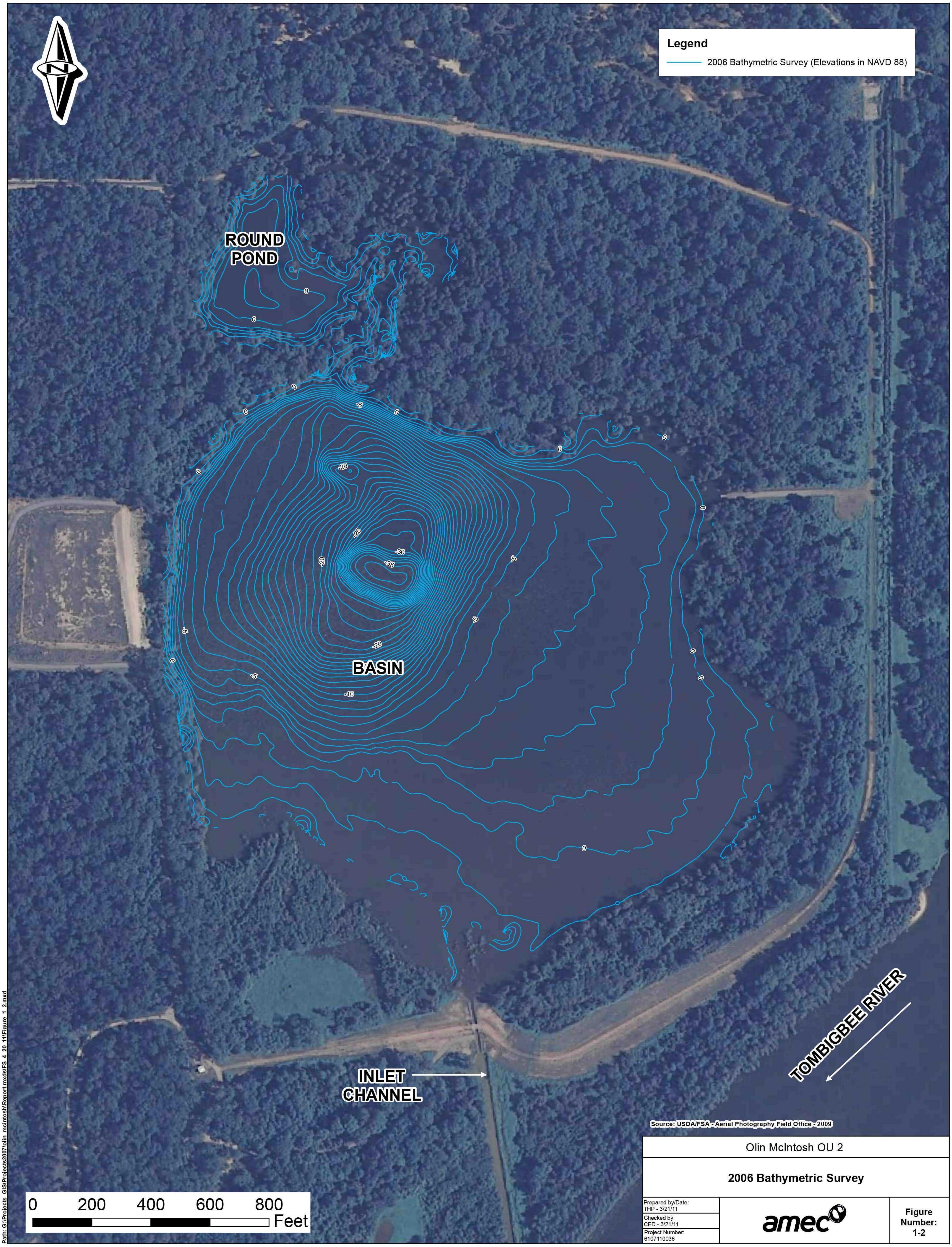


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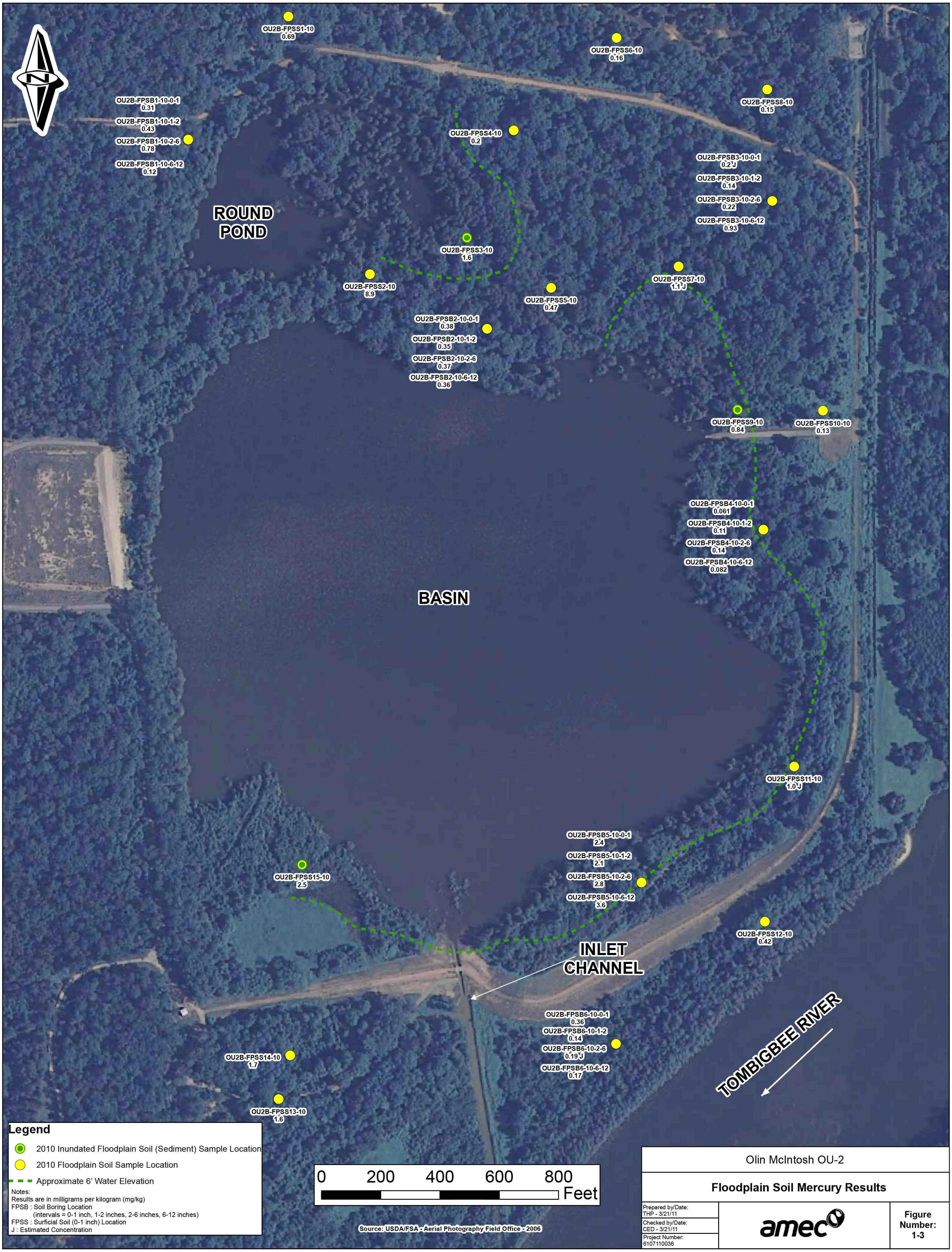

OU2B-FPSS1-10
0.69
OU2B-FPSS6-10
0.16
OU2B-FPSS8-10
0.15
OU2B-FPSB1-10-0-1
0.31
OU2B-FPSB1-10-1-2
0.43
OU2B-FPSB1-10-2-6
0.78
OU2B-FPSB1-10-6-12
0.12
OU2B-FPSS4-10
0.2
OU2B-FPSB3-10-0-1
0.2 J
OU2B-FPSB3-10-1-2
0.14
OU2B-FPSB3-10-2-6
0.22
OU2B-FPSB3-10-6-12
0.93
ROUND
POND
OU2B-FPSS3-10
1.6
OU2B-FPSS7-10
1.1 J
OU2B-FPSS2-10
8.9
OU2B-FPSS5-10
0.47
OU2B-FPSB2-10-0-1
0.38
OU2B-FPSB2-10-1-2
0.35
OU2B-FPSB2-10-2-6
0.37
OU2B-FPSB2-10-6-12
0.36
OU2B-FPSS9-10
0.84
OU2B-FPSS10-10
0.13
OU2B-FPSB4-10-0-1
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OU2B-FPSB4-10-1-2
0.11
OU2B-FPSB4-10-2-6
0.14
OU2B-FPSB4-10-6-12
0.082
BASIN
OU2B-FPSS11-10
1.0 J
OU2B-FPSB5-10-0-1
2.4
OU2B-FPSB5-10-1-2
2.1
OU2B-FPSB5-10-2-6
2.8
OU2B-FPSB5-10-6-12
3.6
OU2B-FPSS15-10
2.5
OU2B-FPSS12-10
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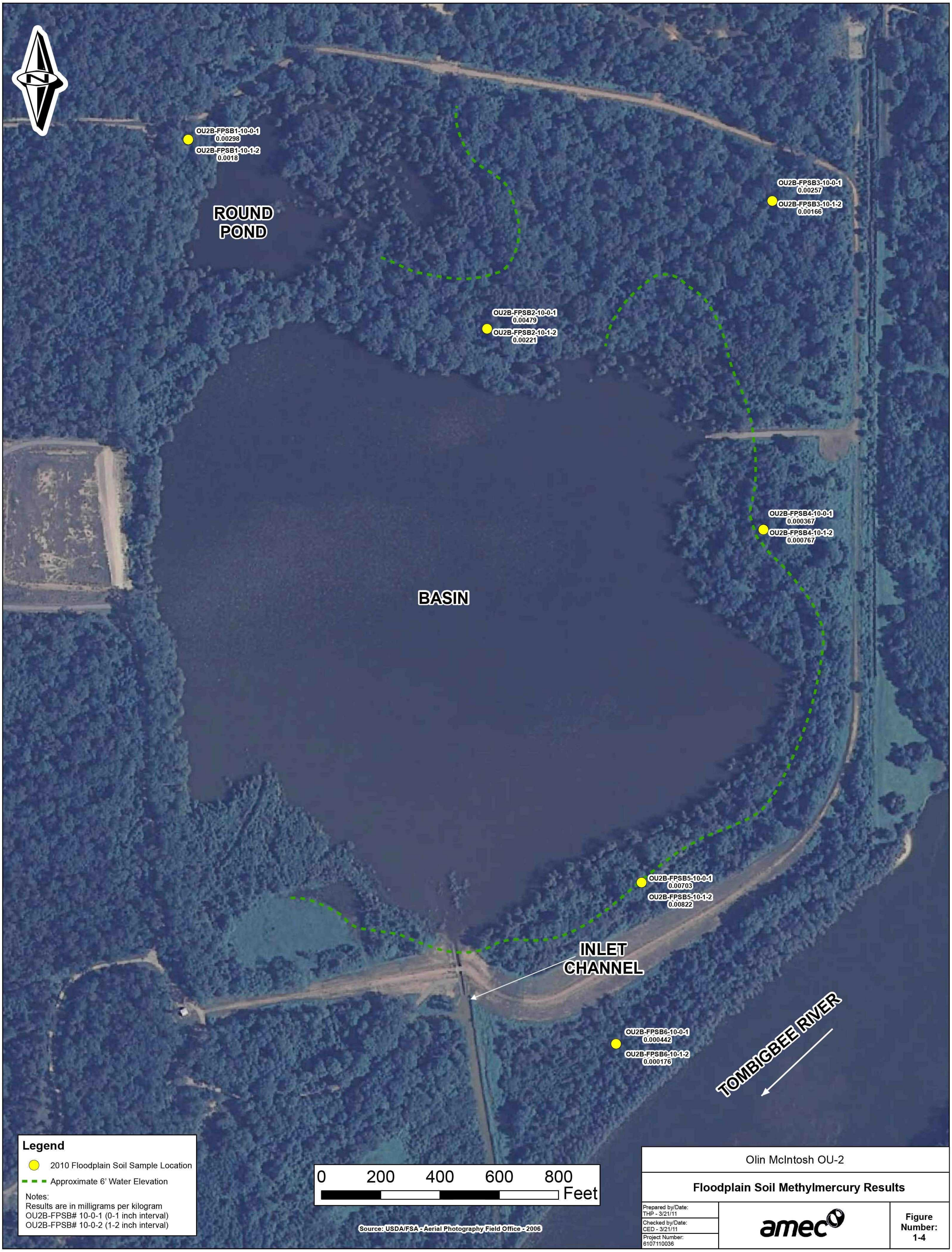
INLET
CHANNEL
OU2B-FPSB6-10-0-1
0.36
OU2B-FPSB6-10-1-2
0.14
OU2B-FPSB6-10-2-6
0.19 J
OU2B-FPSB6-10-6-12
0.17
OU2B-FPSS14-10
1.7
OU2B-FPSS13-10
1.6
TOMBIGBEE RIVER
Legend
2010 Inundated Floodplain Soil (Sediment) Sample Location
2010 Floodplain Soil Sample Location
Approximate 6' Water Elevation
Notes:
Results are in milligrams per kilogram (mg/kg)
FPSB : Soil Boring Location
(intervals = 0-1 inch, 1-2 inches, 2-6 inches, 6-12 inches)
FPSS : Surficial Soil (0-1 inch) Location
J : Estimated Concentration
0 200 400 600 800
Feet
Source: USDA/FSA - Aerial Photography Field Office - 2006
Olin McIntosh OU-2
Floodplain Soil Mercury Results
Prepared by/Date:
THP - 3/21/11
Checked by/Date:
CED - 3/21/11
Project Number:
6107110036
amec
Figure
Number:
1-3

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Olin McIntosh OU-2

**Floodplain Soil Hexachlorobenzene Results**

| | | |
|---|---|---|
| Prepared by/Date: THP - 3/21/11<br>Checked by/Date: CED - 3/21/11<br>Project Number: 6107110036 | amec | **Figure Number: 1-5** |

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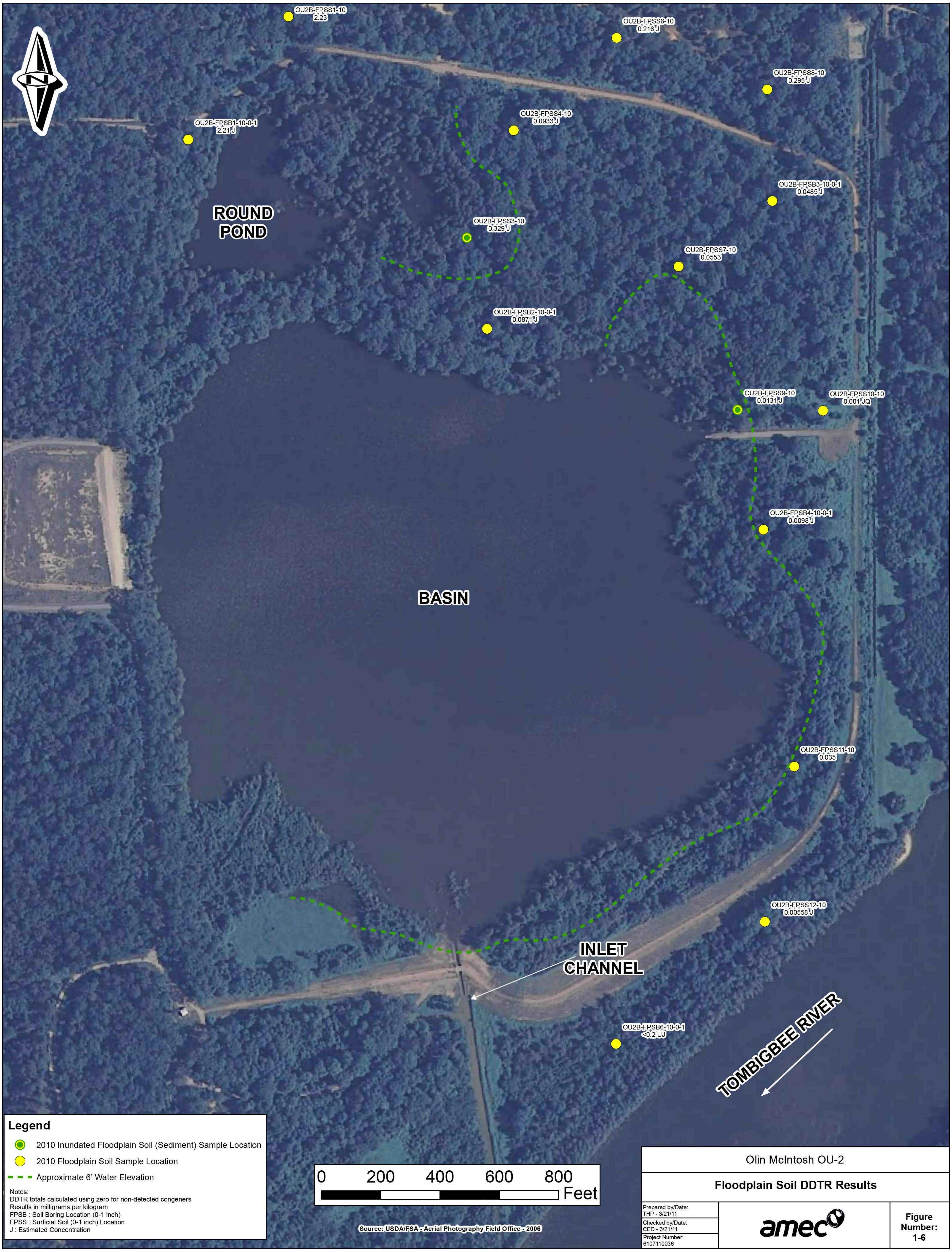


**Legend**

- 2010 Inundated Floodplain Soil (Sediment) Sample Location
- 2010 Floodplain Soil Sample Location
- Approximate 6' Water Elevation

Notes:
DDTR totals calculated using zero for non-detected congeners
Results in milligrams per kilogram
FPSB : Soil Boring Location (0-1 inch)
FPSS : Surficial Soil (0-1 inch) Location
J : Estimated Concentration

Olin McIntosh OU-2

**Floodplain Soil DDTR Results**

| | | |
|---|---|---|
| Prepared by/Date: THP - 3/21/11 | amec | Figure Number: 1-6 |
| Checked by/Date: CED - 3/21/11 | | |
| Project Number: 6107110036 | | |

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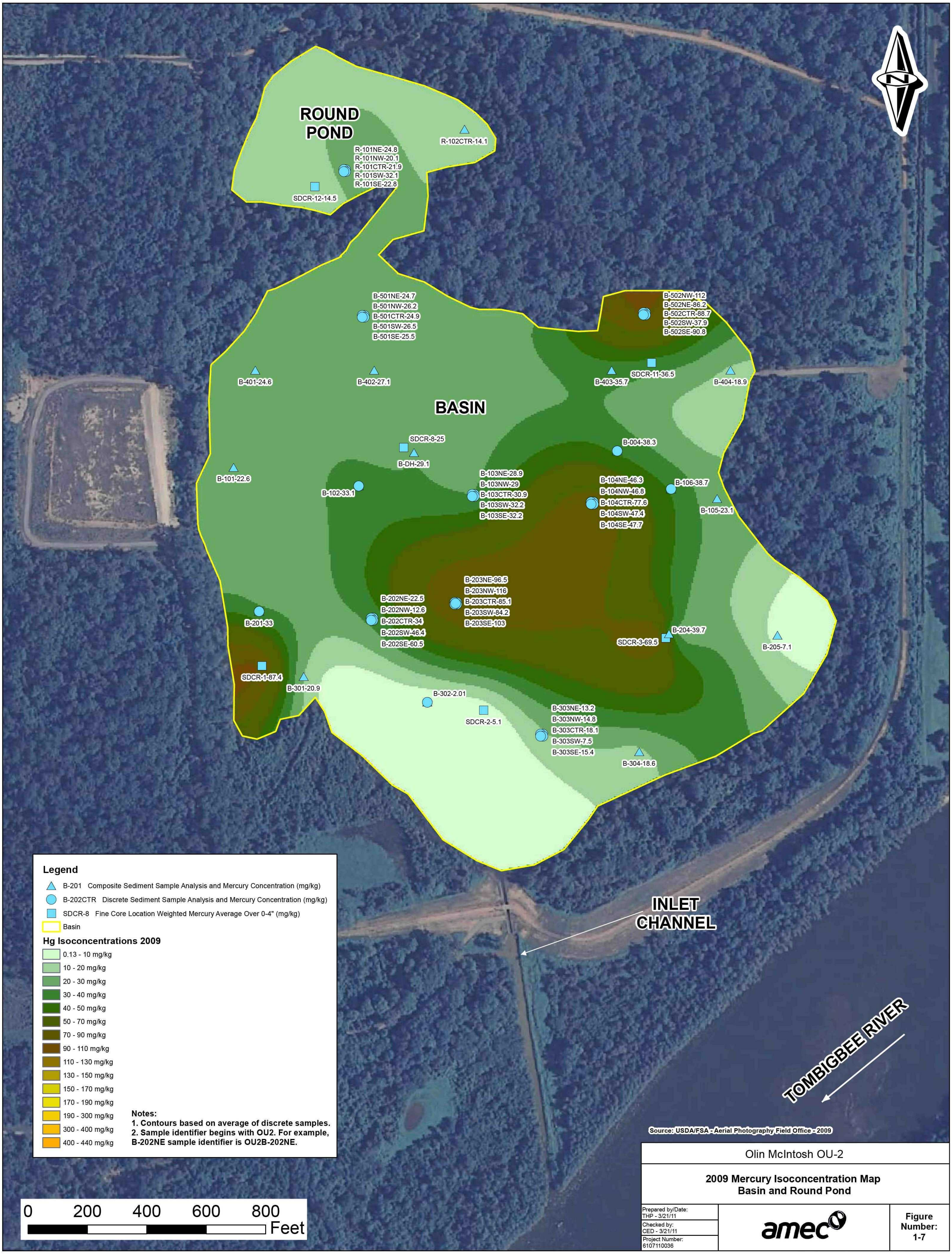


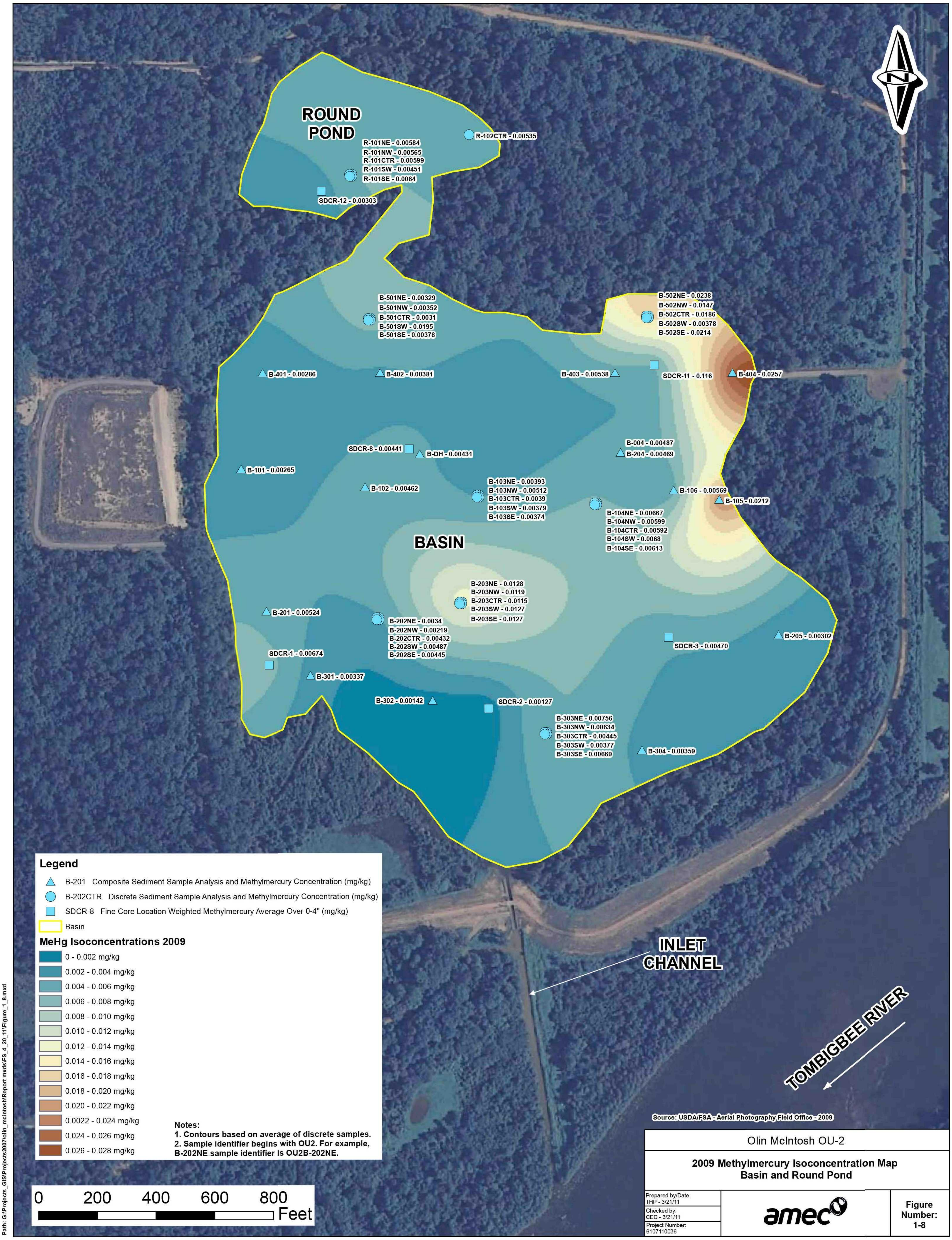

Olin McIntosh OU-2

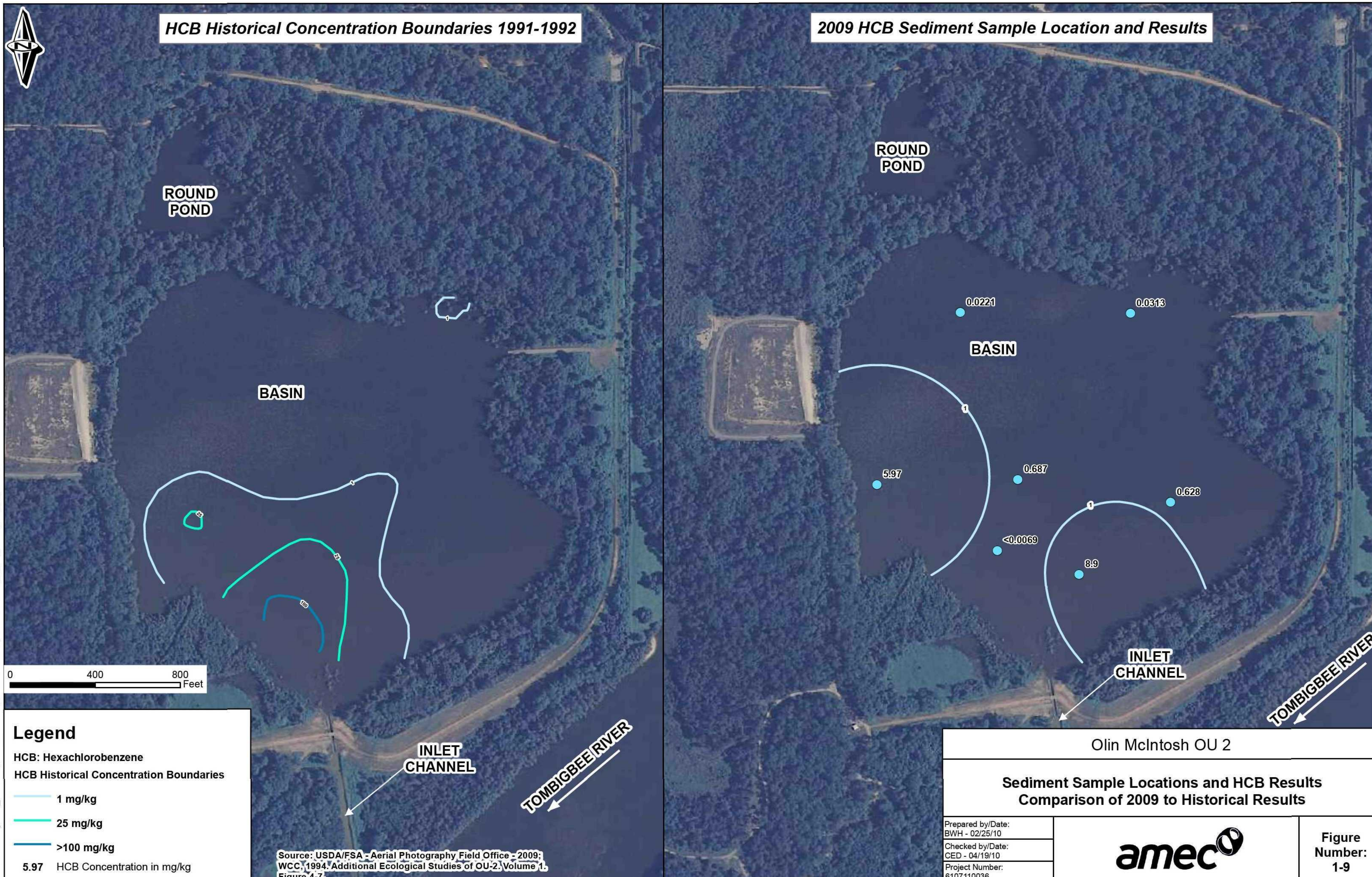
**2009 Mercury Isoconcentration Map**
**Basin and Round Pond**

Prepared by/Date: THP - 3/21/11
Checked by: CED - 3/21/11
Project Number: 6107110036

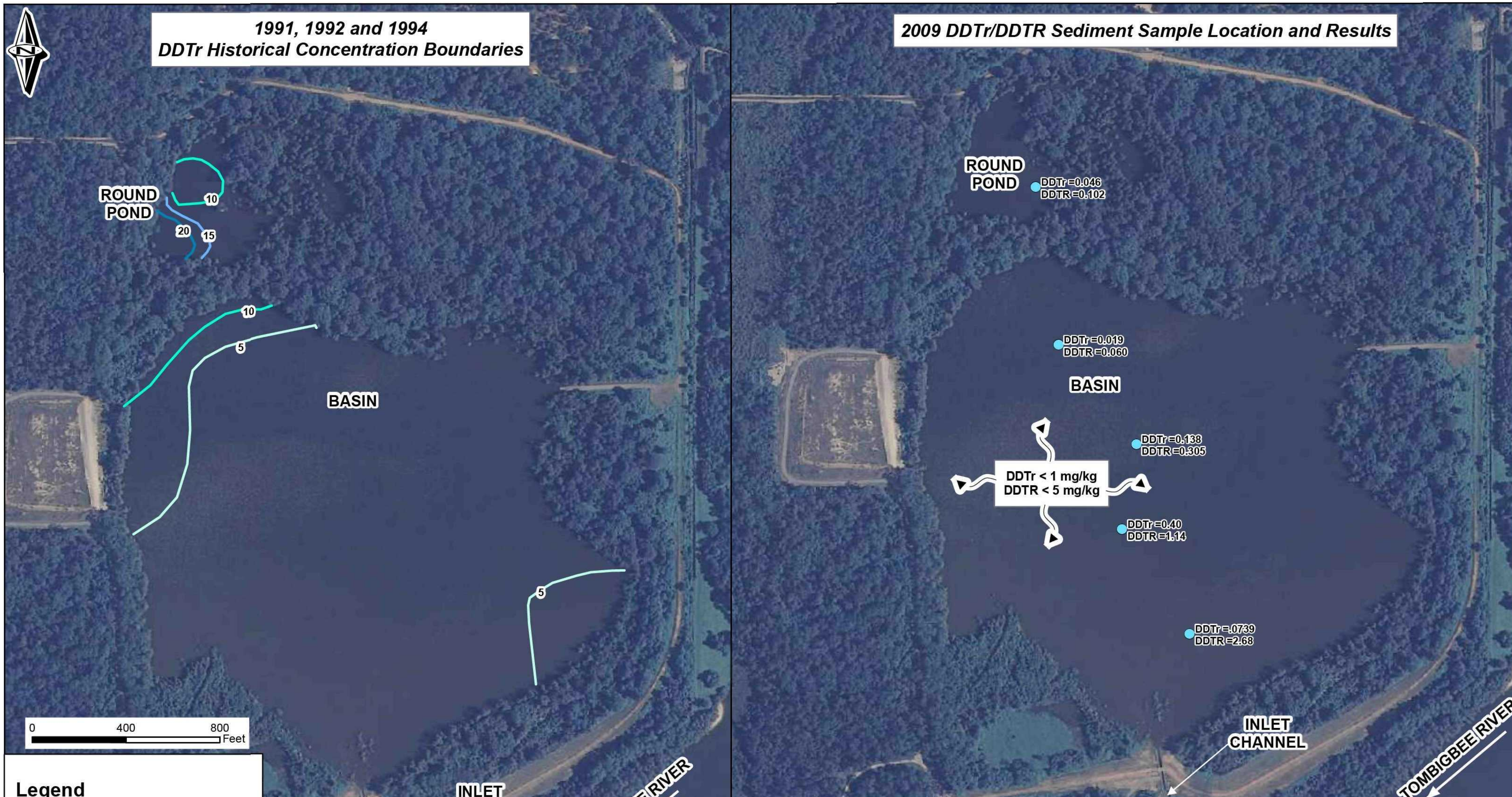
amec

Figure Number: 1-7


ROUND POND
R-102CTR - 0.00535
R-101NE - 0.00584
R-101NW - 0.00565
R-101CTR - 0.00599
R-101SW - 0.00451
R-101SE - 0.0064
SDCR-12 - 0.00303
B-501NE - 0.00329
B-501NW - 0.00352
B-501CTR - 0.0031
B-501SW - 0.0195
B-501SE - 0.00378
B-502NE - 0.0238
B-502NW - 0.0147
B-502CTR - 0.0186
B-502SW - 0.00378
B-502SE - 0.0214
B-401 - 0.00286
B-402 - 0.00381
B-403 - 0.00538
SDCR-11 - 0.116
B-404 - 0.0257
B-004 - 0.00487
B-204 - 0.00469
SDCR-8 - 0.00441
B-DH - 0.00431
B-101 - 0.00265
B-102 - 0.00462
B-103NE - 0.00393
B-103NW - 0.00512
B-103CTR - 0.0039
B-103SW - 0.00379
B-103SE - 0.00374
B-106 - 0.00569
B-105 - 0.0212
B-104NE - 0.00667
B-104NW - 0.00599
B-104CTR - 0.00592
B-104SW - 0.0068
B-104SE - 0.00613
BASIN
B-203NE - 0.0128
B-203NW - 0.0119
B-203CTR - 0.0115
B-203SW - 0.0127
B-203SE - 0.0127
B-201 - 0.00524
B-202NE - 0.0034
B-202NW - 0.00219
B-202CTR - 0.00432
B-202SW - 0.00487
B-202SE - 0.00445
SDCR-3 - 0.00470
B-205 - 0.00302
SDCR-1 - 0.00674
B-301 - 0.00337
B-302 - 0.00142
SDCR-2 - 0.00127
B-303NE - 0.00756
B-303NW - 0.00634
B-303CTR - 0.00445
B-303SW - 0.00377
B-303SE - 0.00669
B-304 - 0.00359
INLET CHANNEL
TOMBIGBEE RIVER
N
Legend
B-201 Composite Sediment Sample Analysis and Methylmercury Concentration (mg/kg)
B-202CTR Discrete Sediment Sample Analysis and Methylmercury Concentration (mg/kg)
SDCR-8 Fine Core Location Weighted Methylmercury Average Over 0-4" (mg/kg)
Basin
MeHg Isoconcentrations 2009
0 - 0.002 mg/kg
0.002 - 0.004 mg/kg
0.004 - 0.006 mg/kg
0.006 - 0.008 mg/kg
0.008 - 0.010 mg/kg
0.010 - 0.012 mg/kg
0.012 - 0.014 mg/kg
0.014 - 0.016 mg/kg
0.016 - 0.018 mg/kg
0.018 - 0.020 mg/kg
0.020 - 0.022 mg/kg
0.0022 - 0.024 mg/kg
0.024 - 0.026 mg/kg
0.026 - 0.028 mg/kg
Notes:
1. Contours based on average of discrete samples.
2. Sample identifier begins with OU2. For example, B-202NE sample identifier is OU2B-202NE.
0 200 400 600 800
Feet
Source: USDA/FSA - Aerial Photography Field Office - 2009
Olin McIntosh OU-2
2009 Methylmercury Isoconcentration Map
Basin and Round Pond
Prepared by/Date: THP - 3/21/11
Checked by: CED - 3/21/11
Project Number: 6107110036
amec
Figure Number: 1-8
Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\Figure_1_8.mxd



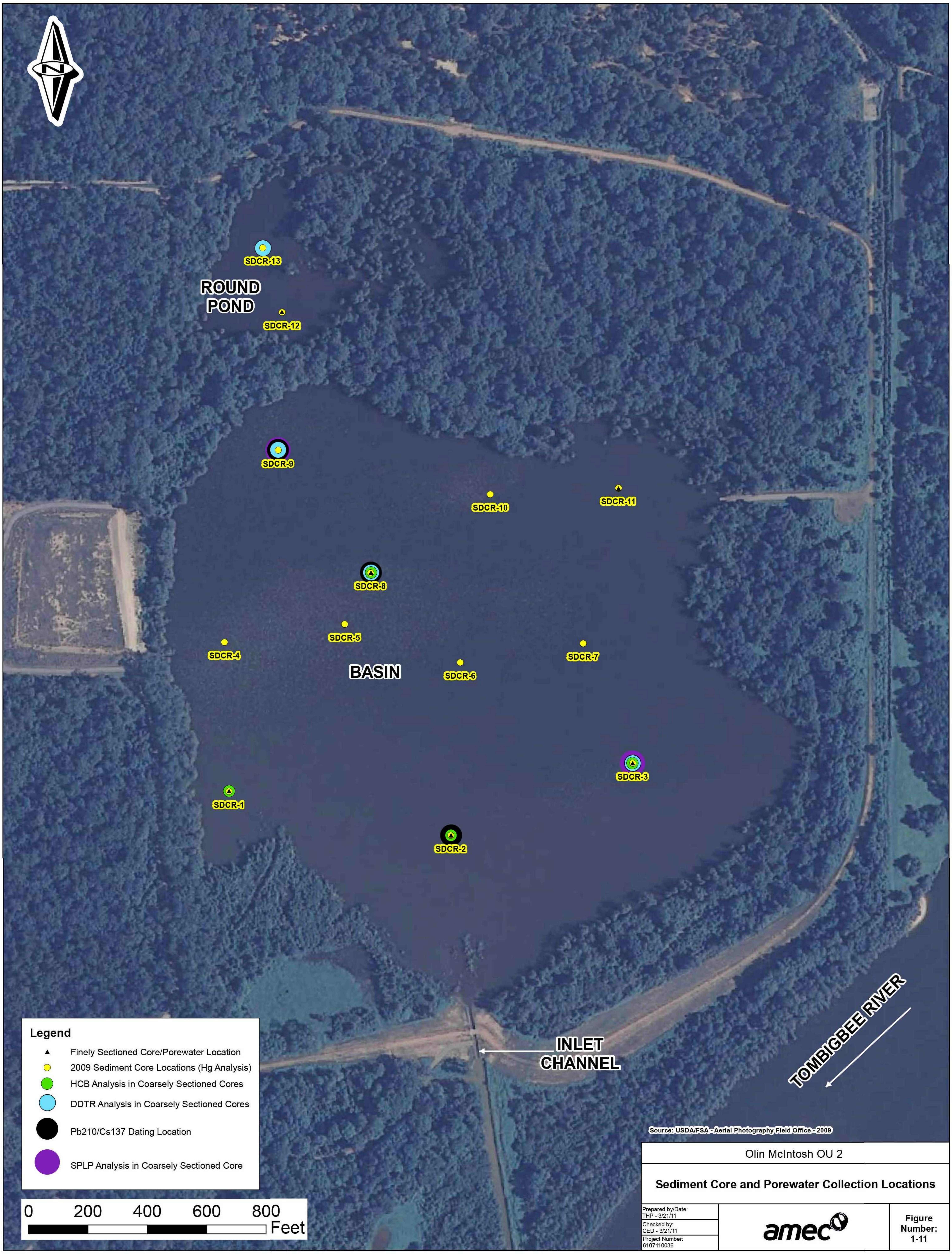

Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\Figure_1_9.mxd

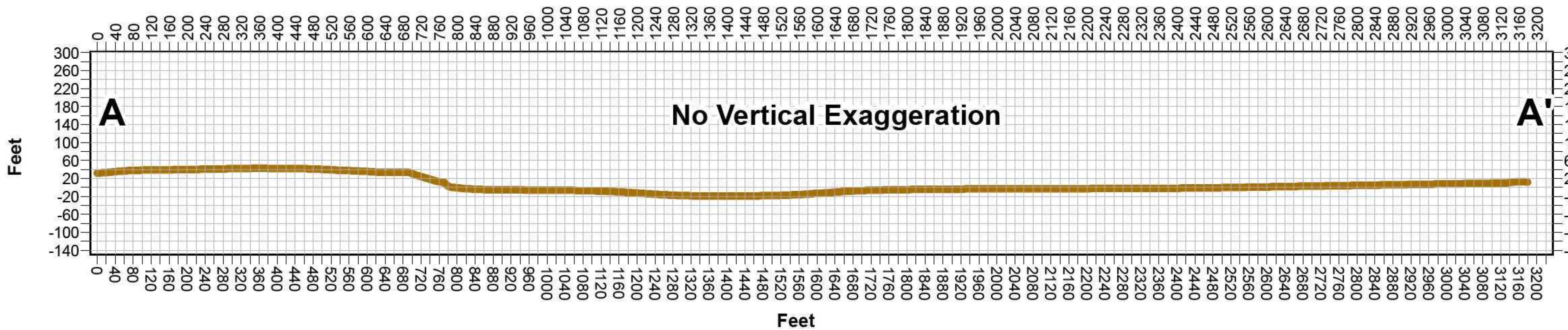


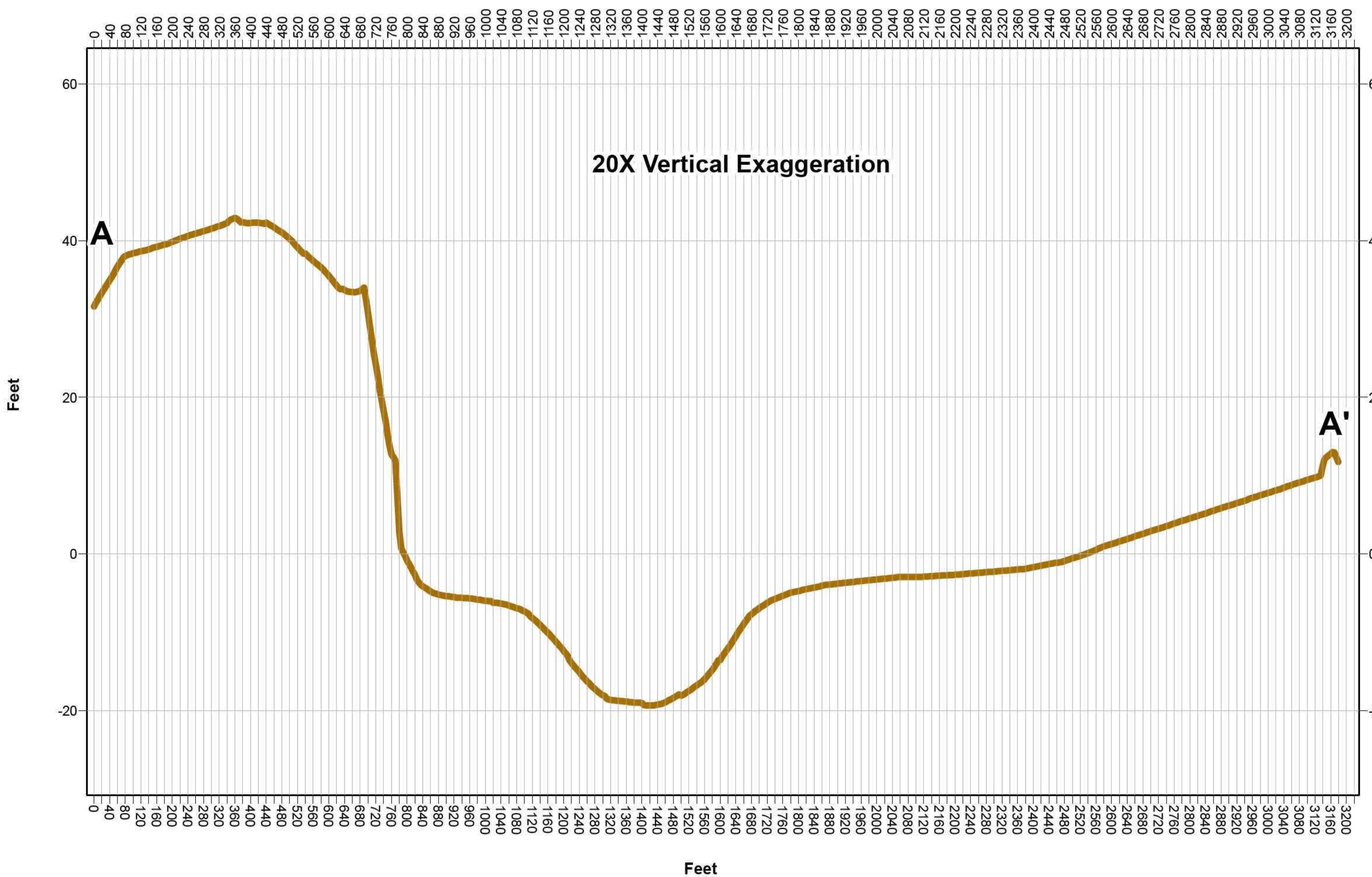

Olin McIntosh OU 2

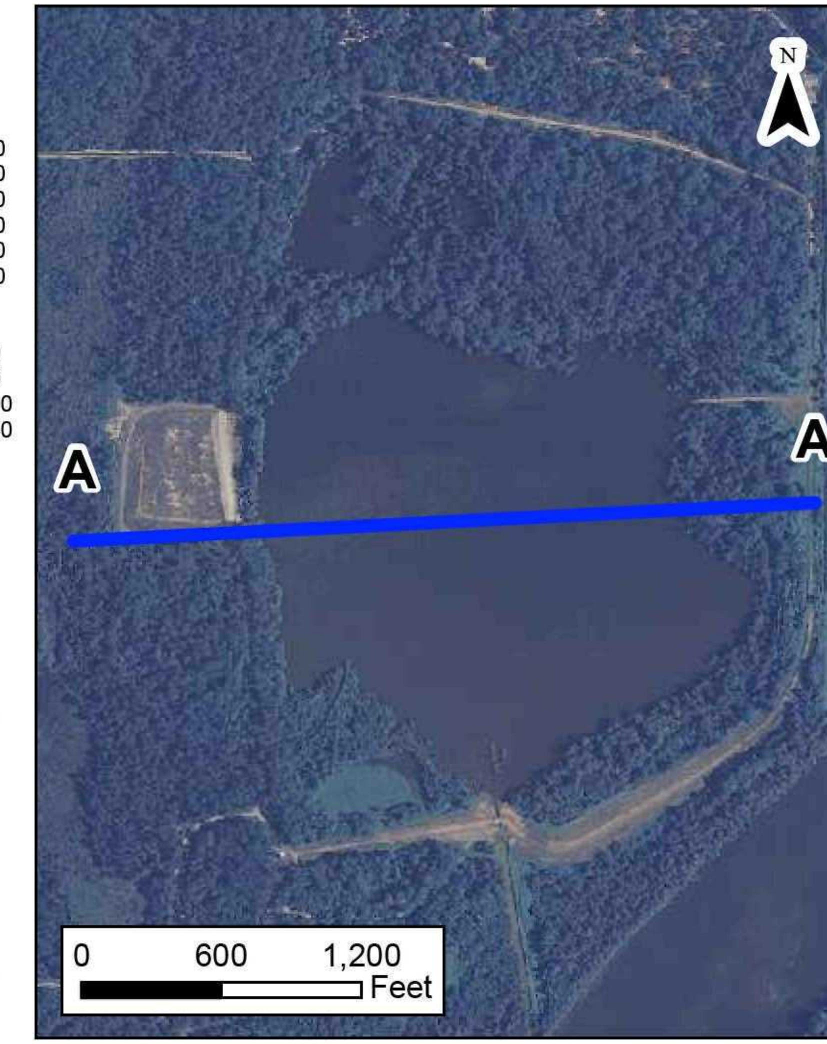
**Sediment Sample Locations and DDTr/DDTR Results**
**Comparison of 2009 to Historical Results**

| | | |
|---|---|---|
| Prepared by/Date: BWH - 4/19/10<br>Checked by/Date: CED - 10/29/10<br>Project Number: 6107110036 | amec | **Figure Number: 1-10** |


N
ROUND POND
SDCR-13
SDCR-12
SDCR-9
SDCR-10
SDCR-11
SDCR-8
SDCR-5
SDCR-4
BASIN
SDCR-6
SDCR-7
SDCR-3
SDCR-1
SDCR-2
INLET CHANNEL
TOMBIGBEE RIVER
Legend
Finely Sectioned Core/Porewater Location
2009 Sediment Core Locations (Hg Analysis)
HCB Analysis in Coarsely Sectioned Cores
DDTR Analysis in Coarsely Sectioned Cores
Pb210/Cs137 Dating Location
SPLP Analysis in Coarsely Sectioned Core
0 200 400 600 800
Feet
Source: USDA/FSA - Aerial Photography Field Office - 2009
Olin McIntosh OU 2
Sediment Core and Porewater Collection Locations
Prepared by/Date: THP - 3/21/11
Checked by: CED - 3/21/11
Project Number: 6107110036
amec
Figure Number: 1-11
Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\Figure_1_11.mxd



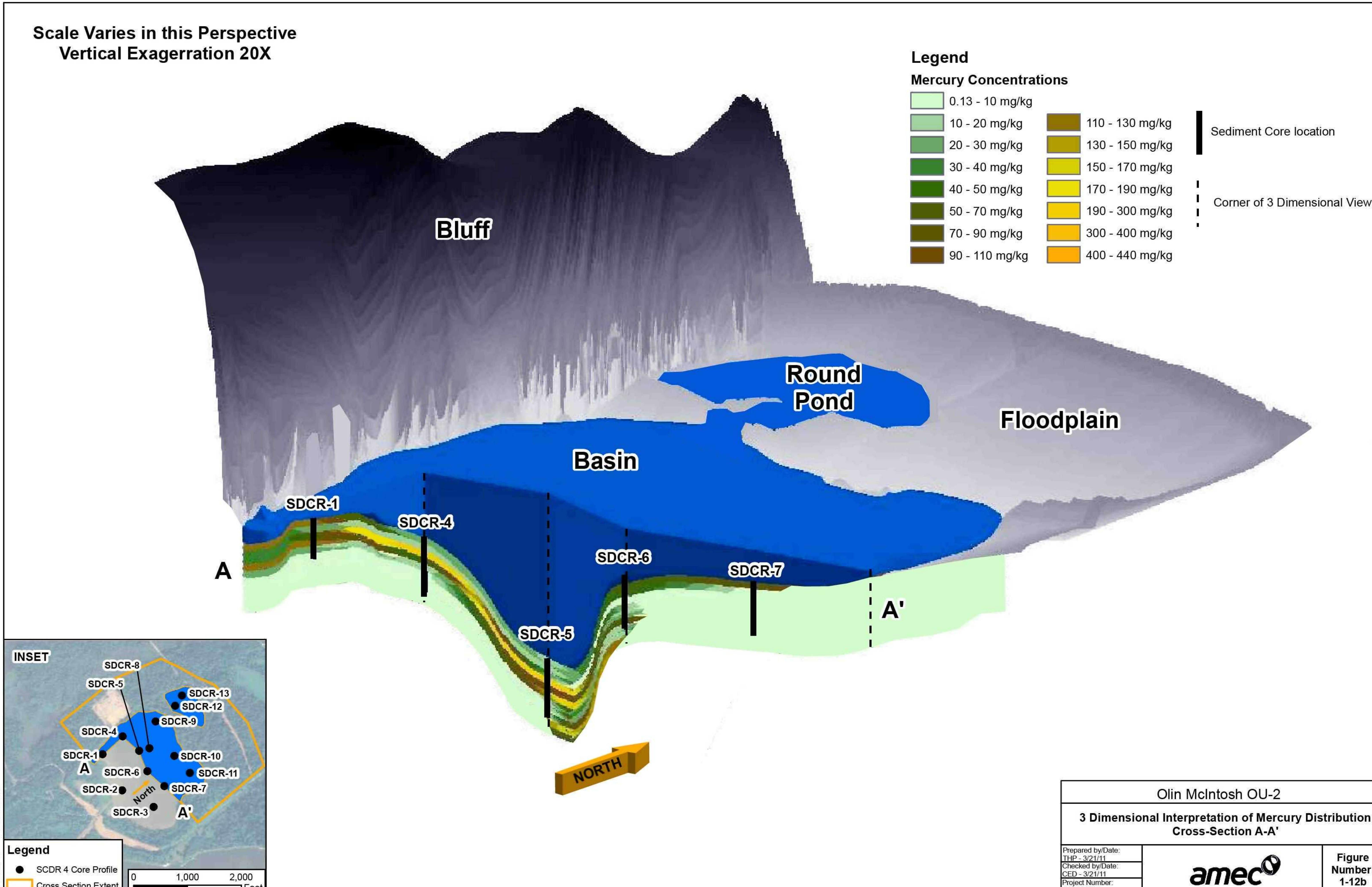




Olin McIntosh OU-2

**Cross Section A - A'**
**Zero Vertical Exaggeration VS.**
**20X Vertical Exaggeration**

| | | |
|---|---|---|
| Prepared by/Date: THP - 4/7/11<br>Checked by/Date: HEF - 4/7/11<br>Project Number: 6107110036 | amec | **Figure Number: 1-12a** |




Map Document: (G:\Projects_GIS\Projects2007\olin_mcintosh\sed_core_results\X_sect\mxds\fig_4_14a.mxd)
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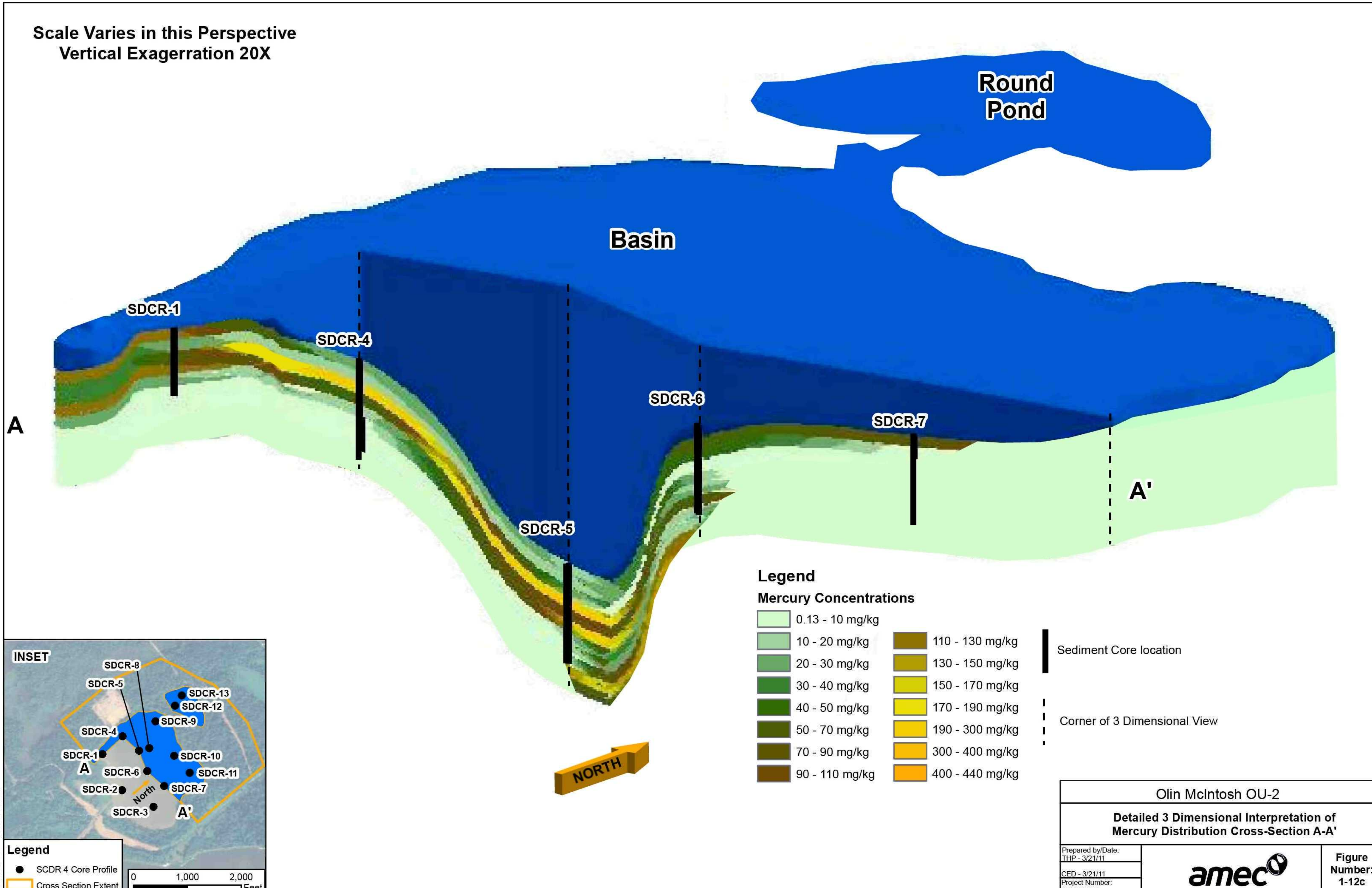
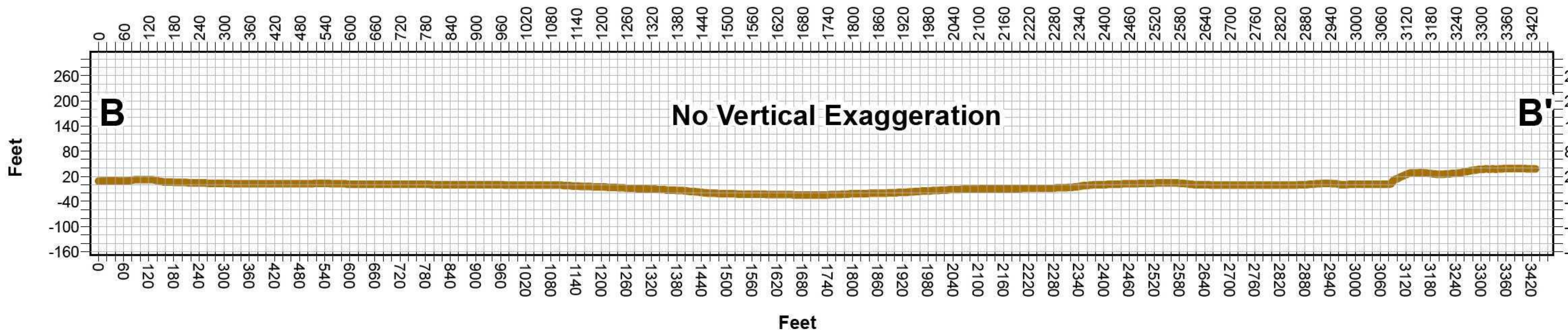
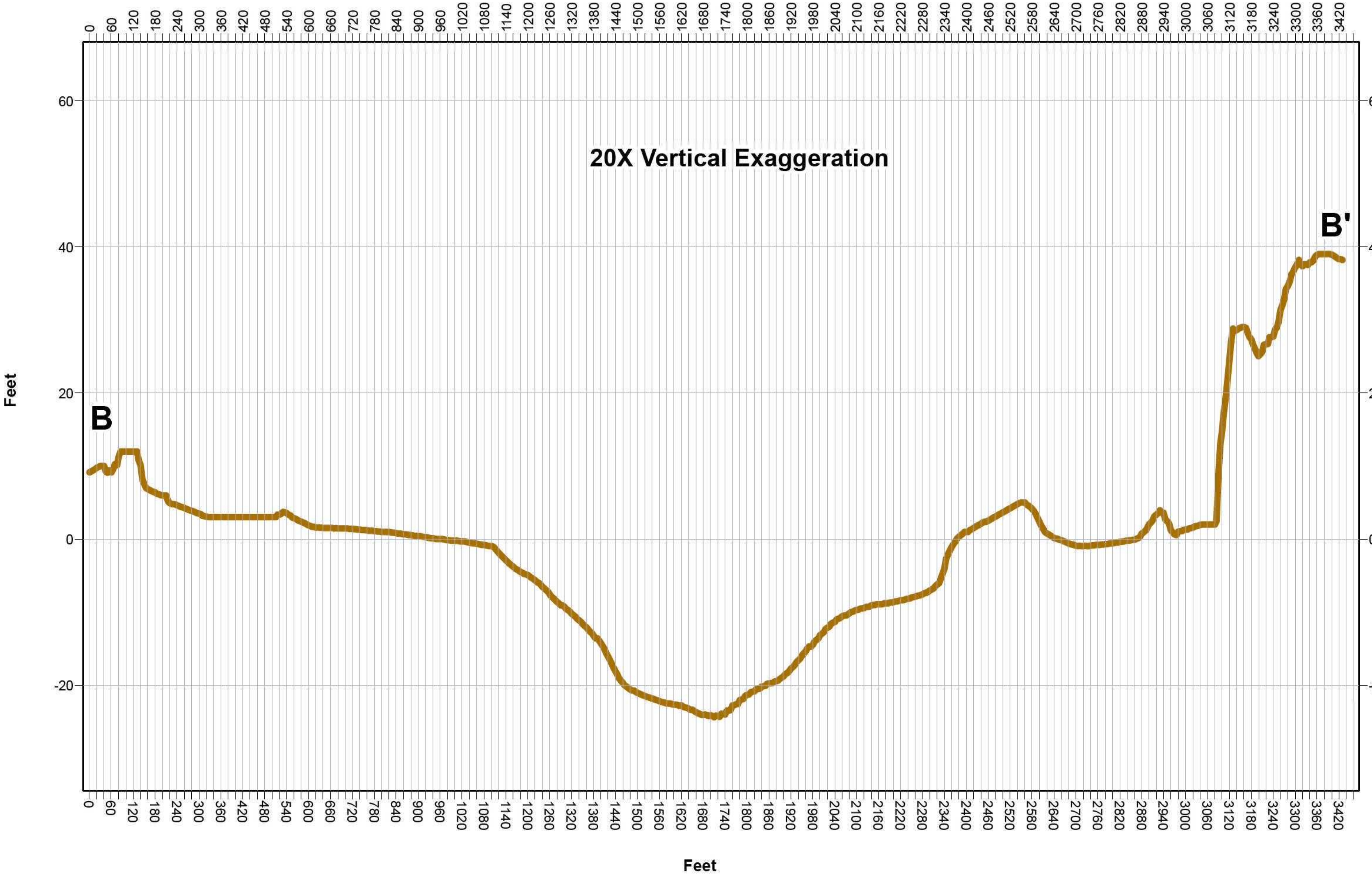



Map Document: (G:\Projects_GIS\Projects2007\olin_mcintosh\sed_core_results\X_sect\mxds\fig_4_14b.mxd)
5/20/2010 -- 11:14:16 AM





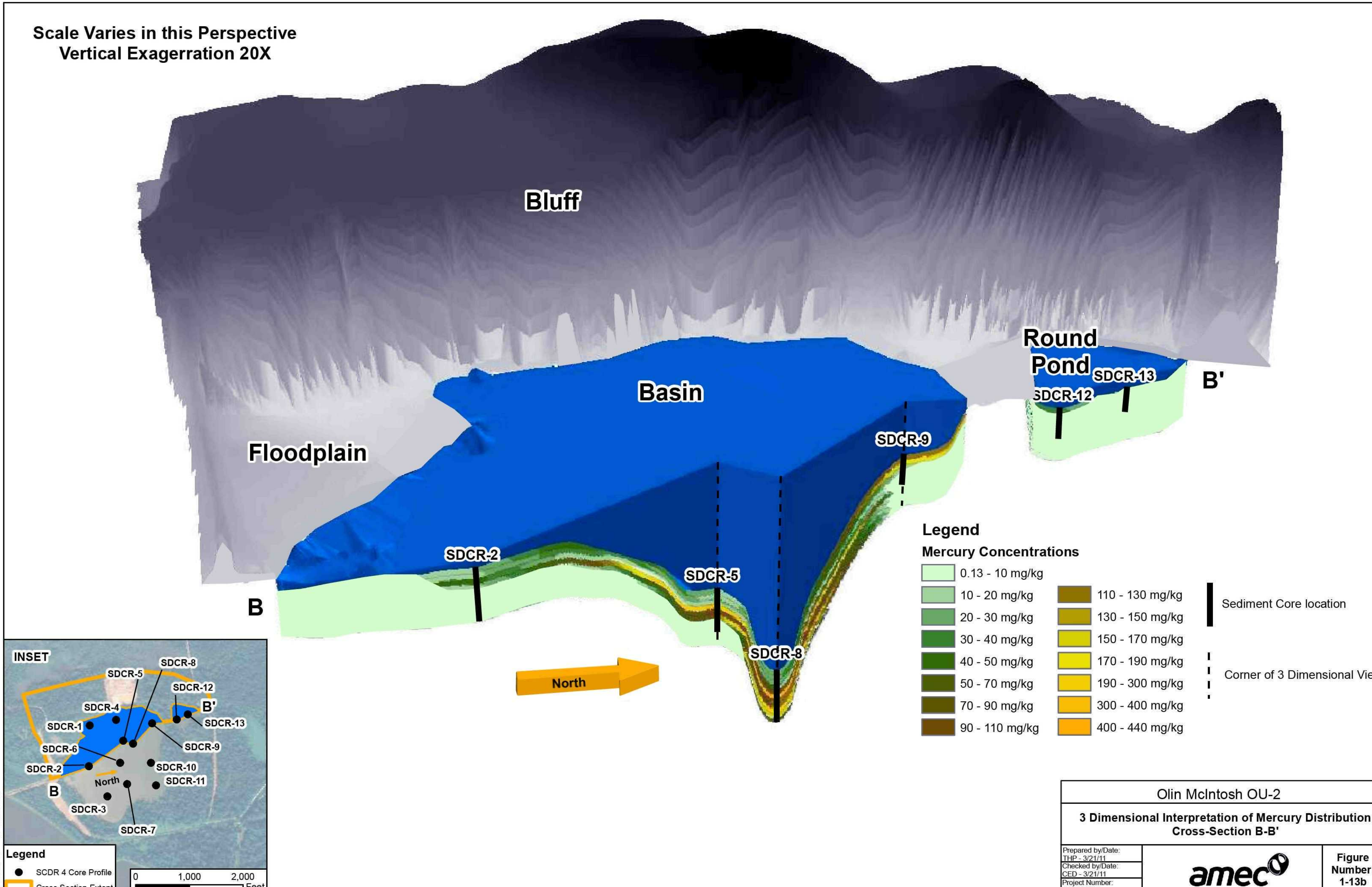
Olin McIntosh OU-2

**Cross Section B - B'**
**Zero Vertical Exaggeration VS.**
**20X Vertical Exaggeration**

Prepared by/Date: THP - 4/7/11
Checked by/Date: HEF - 4/7/11
Project Number: 6107110036

amec

**Figure Number: 1-13a**




Olin McIntosh OU-2

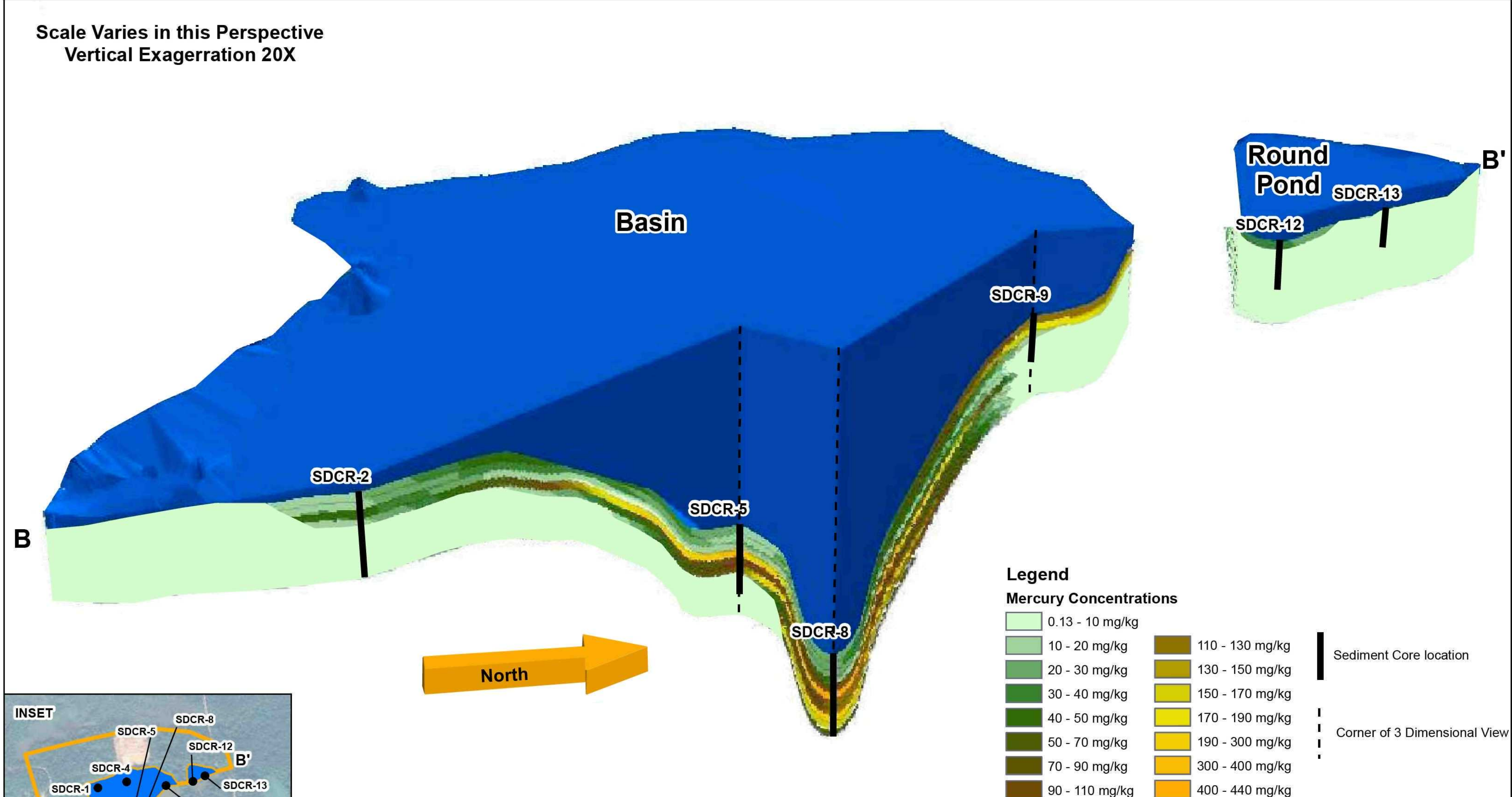
**3 Dimensional Interpretation of Mercury Distribution Cross-Section B-B'**

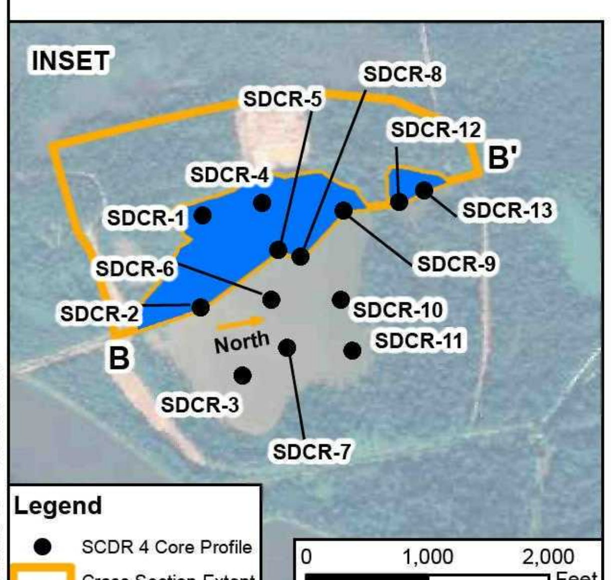
Prepared by/Date: THP - 3/21/11
Checked by/Date: CED - 3/21/11
Project Number: 6107110036

amec

Figure Number: 1-13b

Map Document: (G:\Projects_GIS\Projects2007\olin_mcintosh\sed_core_results\X_sect\mxds\fig_4_15a.mxd)
5/20/2010 -- 1:49:36 PM




Map Document: (G:\Projects_GIS\Projects2007\olin_mcintosh\sed_core_results\X_sect\mxds\fig_4_14b.mxd)
5/20/2010 -- 4:56:02 PM

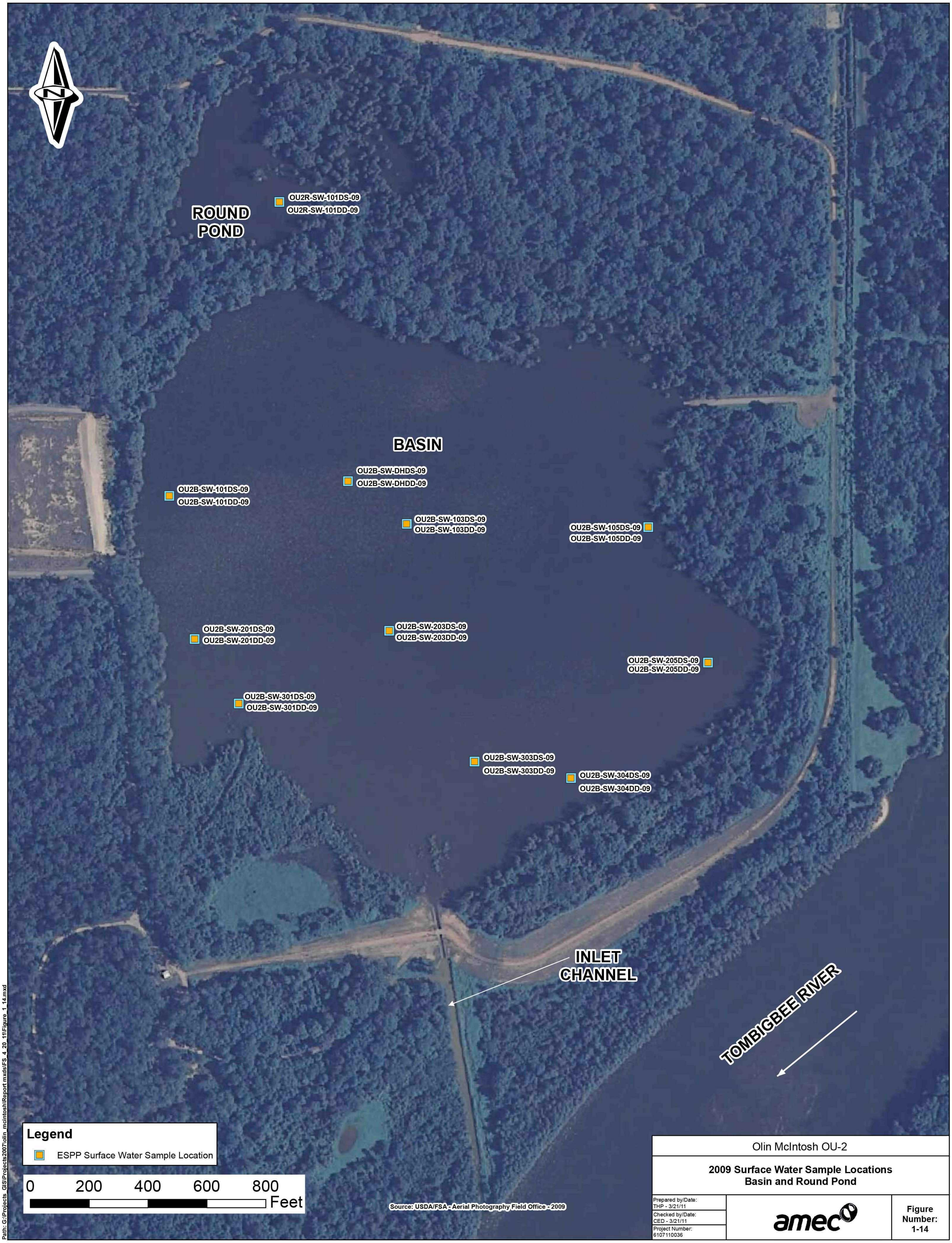
Olin McIntosh OU-2

**Detailed 3 Dimensional Interpretation of Mercury Distribution Cross-Section B-B'**

Prepared by/Date: THP - 3/21/11
Checked by/Date: CED - 3/21/11
Project Number: 6107110036

amec

Figure Number: 1-13c




Olin McIntosh OU-2

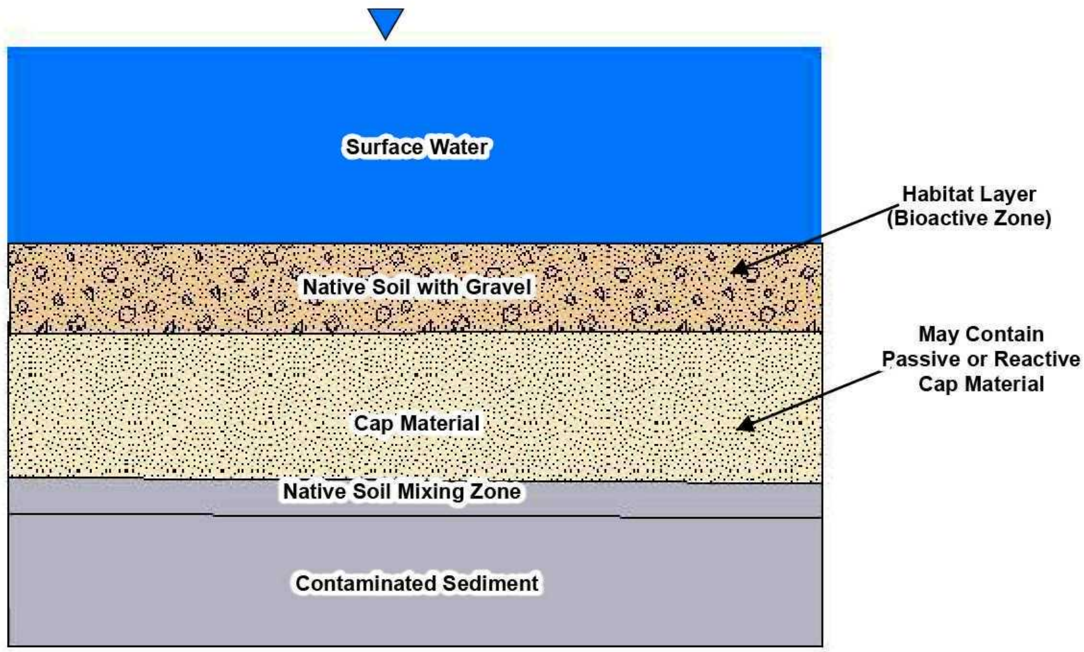
**2009 Surface Water Sample Locations**
**Basin and Round Pond**

Prepared by/Date: THP - 3/21/11
Checked by/Date: CED - 3/21/11
Project Number: 6107110036

amec

**Figure Number: 1-14**

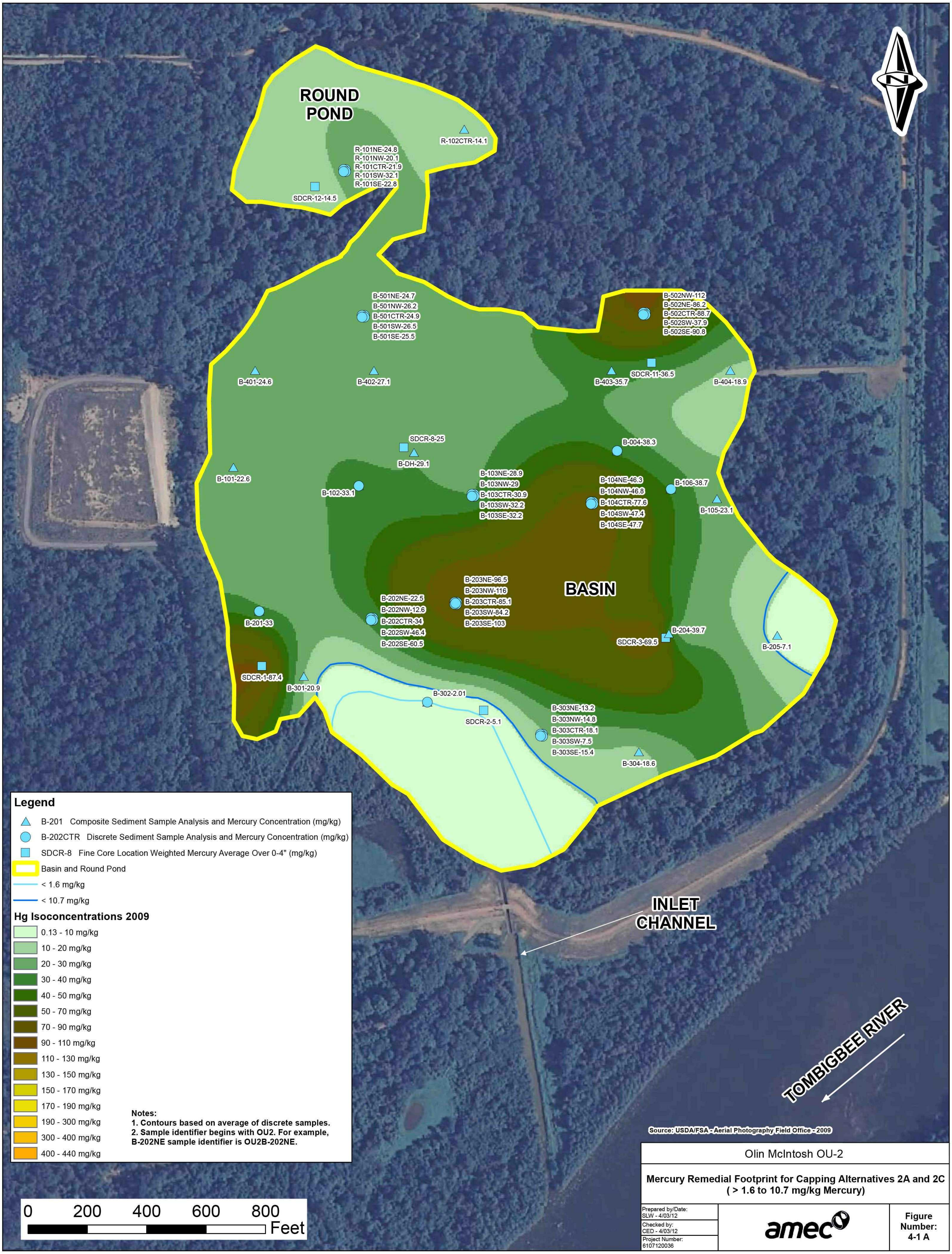
Path: G:\Projects_GIS\Projects2007\olin mcintosh\Report mxds\FS_4_20_11\Figure_1_14.mxd




A. Native Soil Cap
Remedial Alternative 2A

| Olin McIntosh OU-2 | | |
|---|---|---|
| **Remedial Alternative Concept** | | |
| Prepared by/Date: THP - 3/26/12<br>Checked by/Date: FKM - 3/27/12<br>Project Number: 6107110036 | amec | **Figure Number: 3-1** |

Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\add 4_28_11\figure_3_1.mxd

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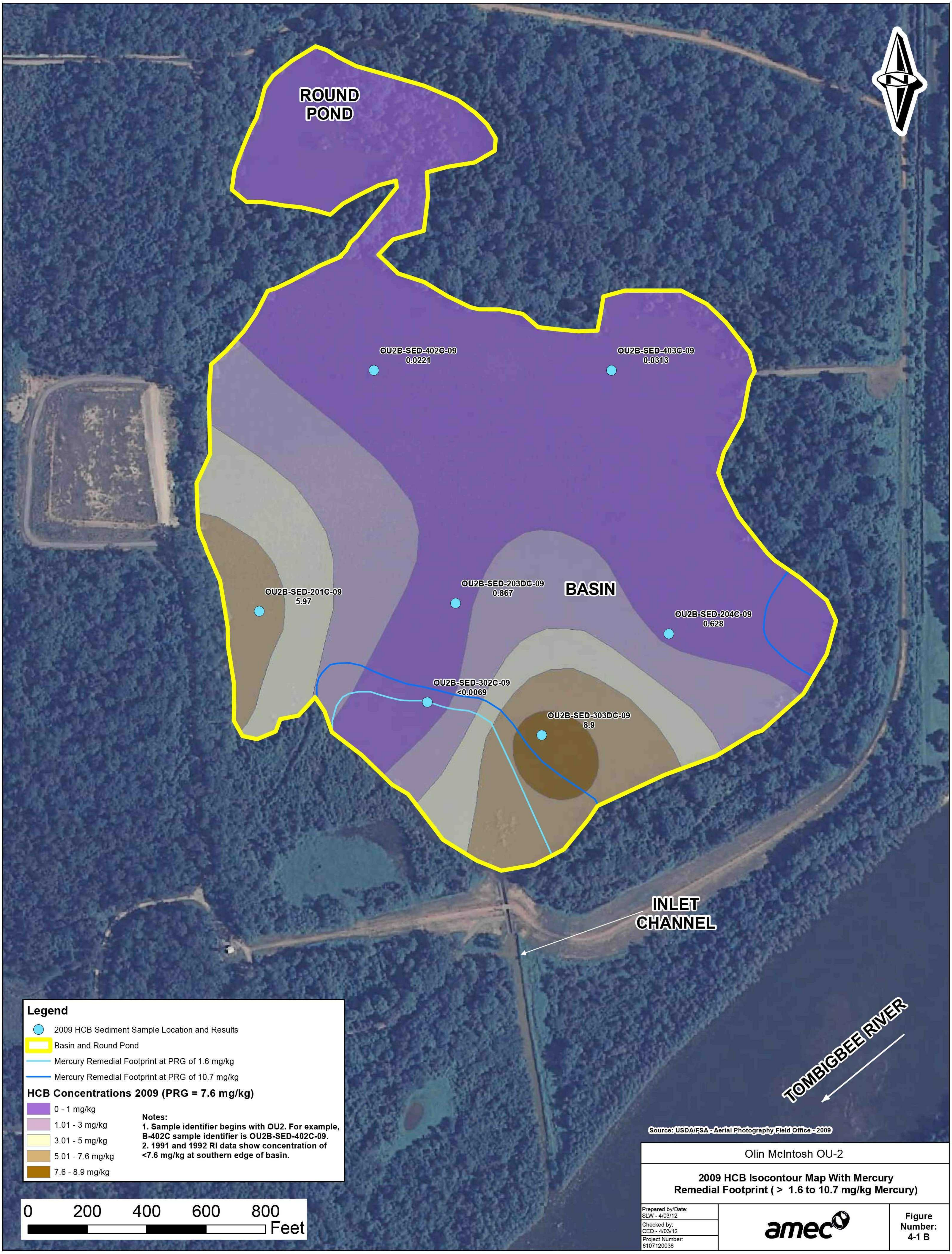
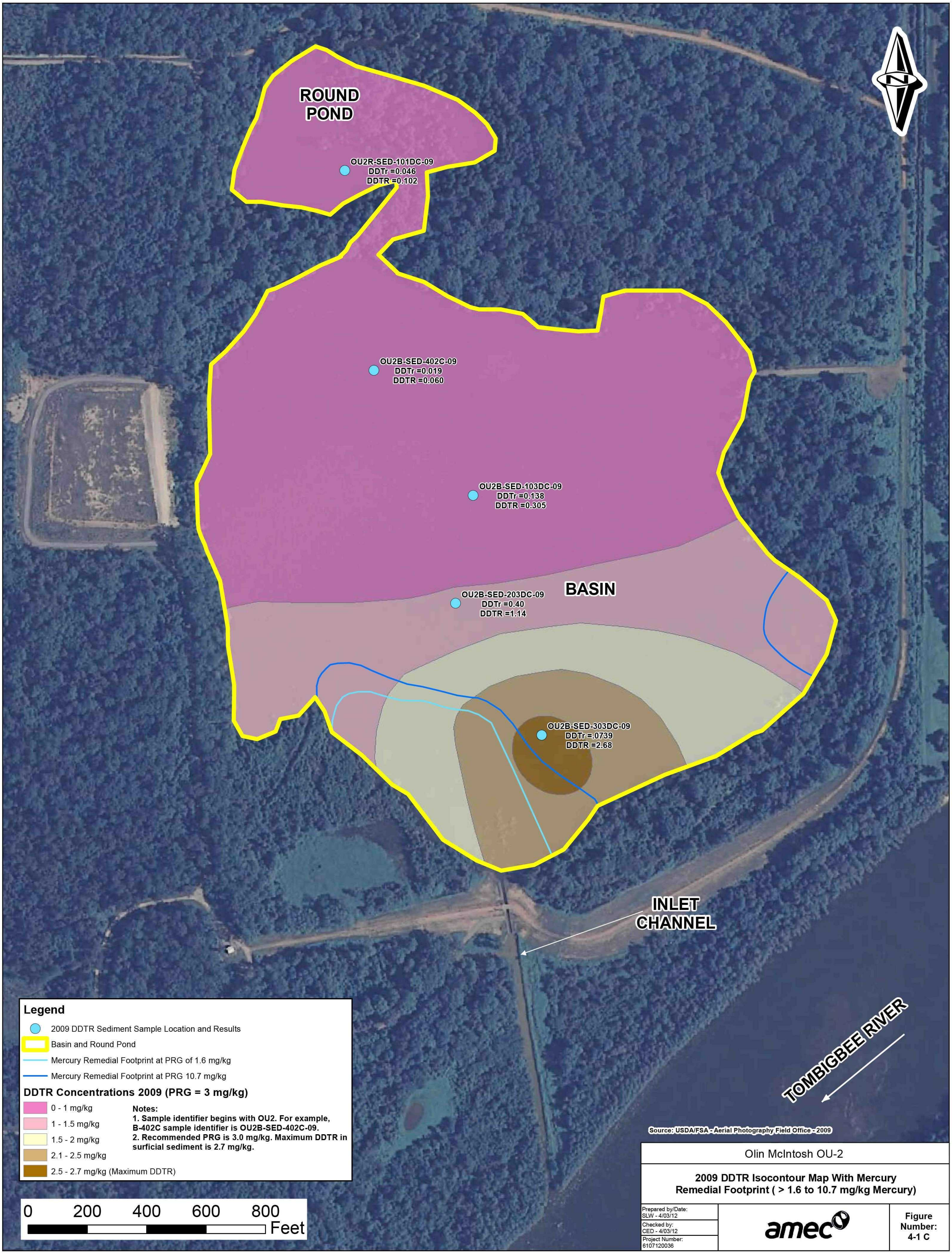



Olin McIntosh OU-2

**2009 HCB Isocontour Map With Mercury Remedial Footprint ( > 1.6 to 10.7 mg/kg Mercury)**

| | | |
|---|---|---|
| Prepared by/Date: SLW - 4/03/12<br>Checked by: CED - 4/03/12<br>Project Number: 6107120036 | amec | Figure Number: 4-1 B |

Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\add 4_28_11\figure_4_1_B.mxd

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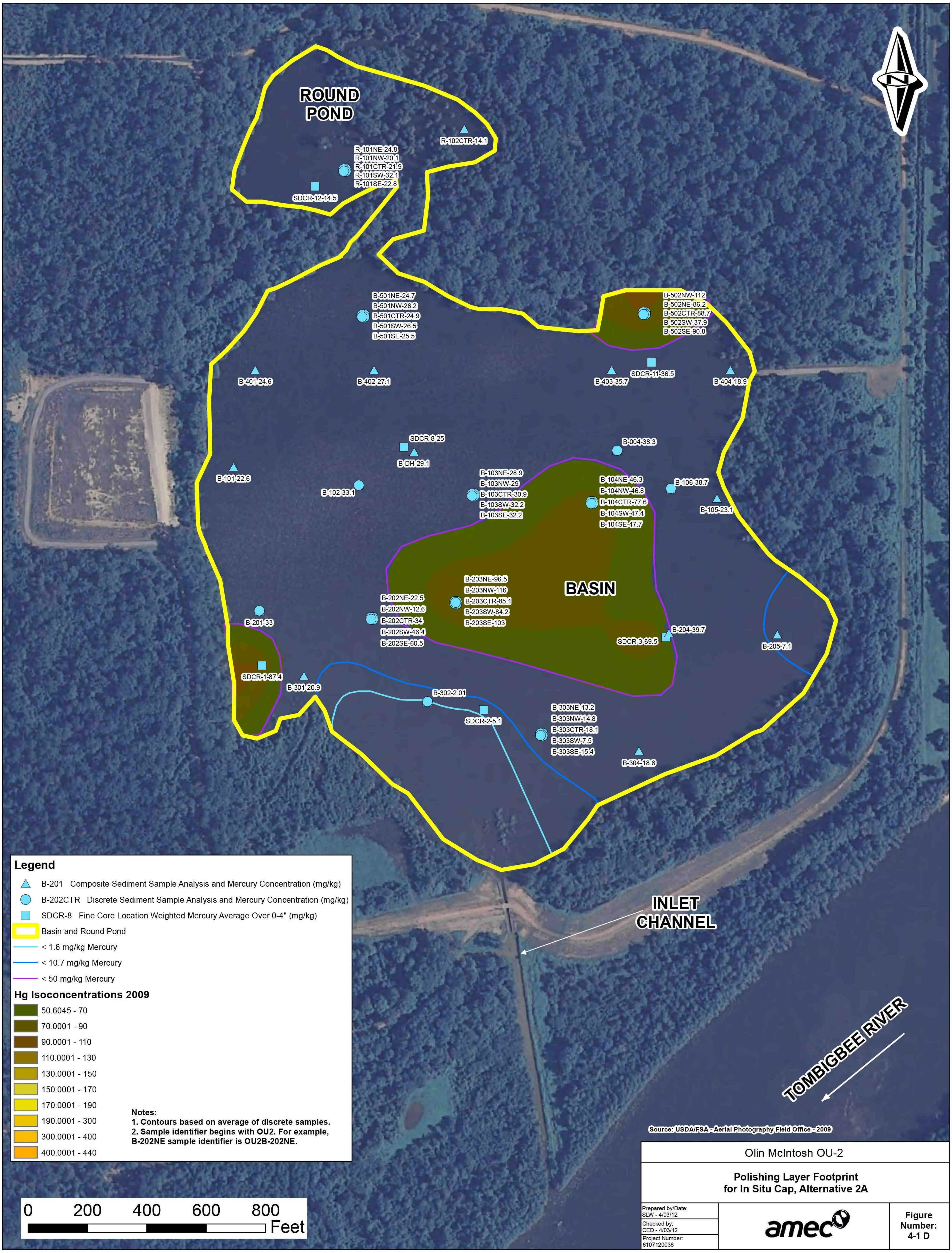


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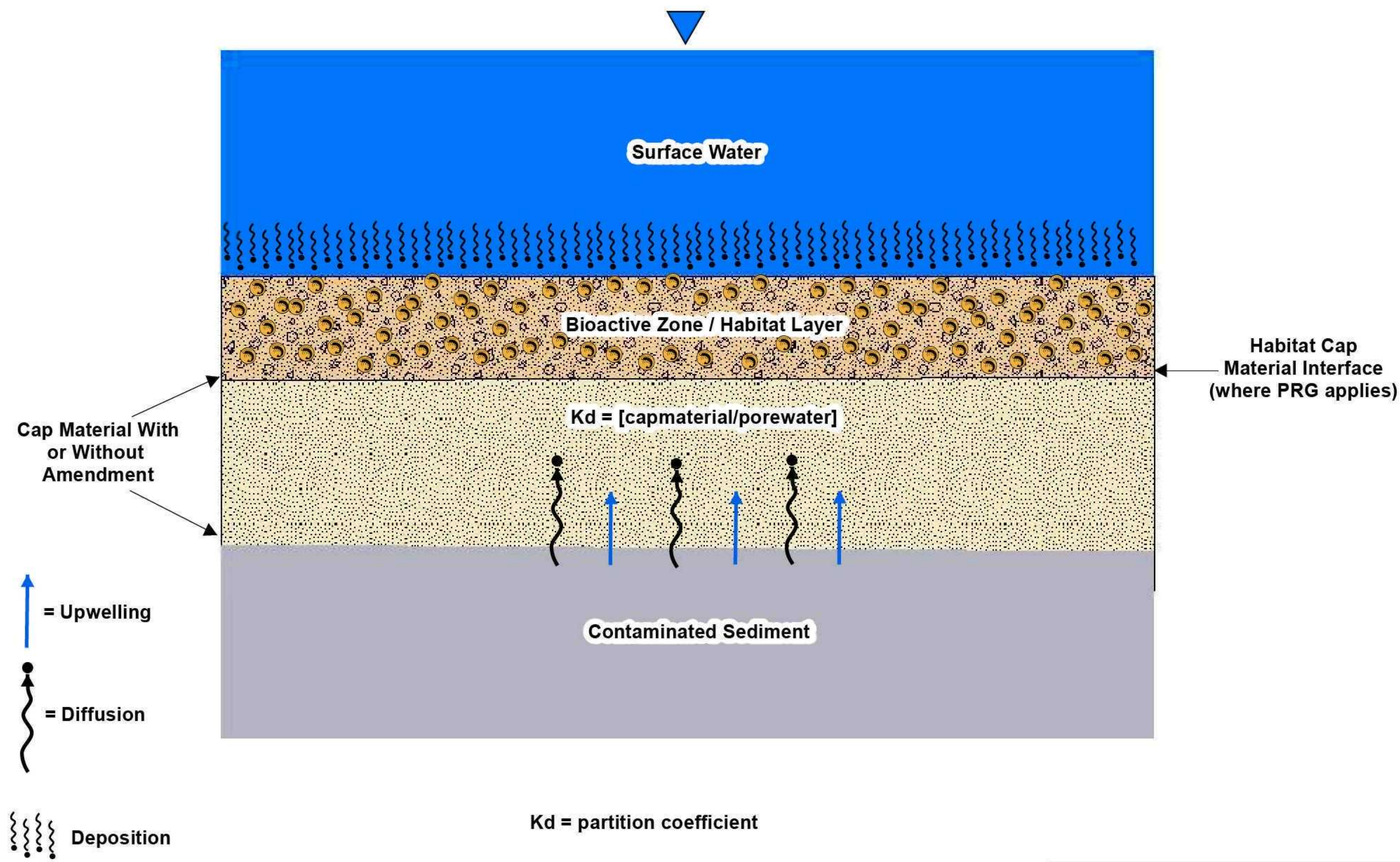



Olin McIntosh OU-2

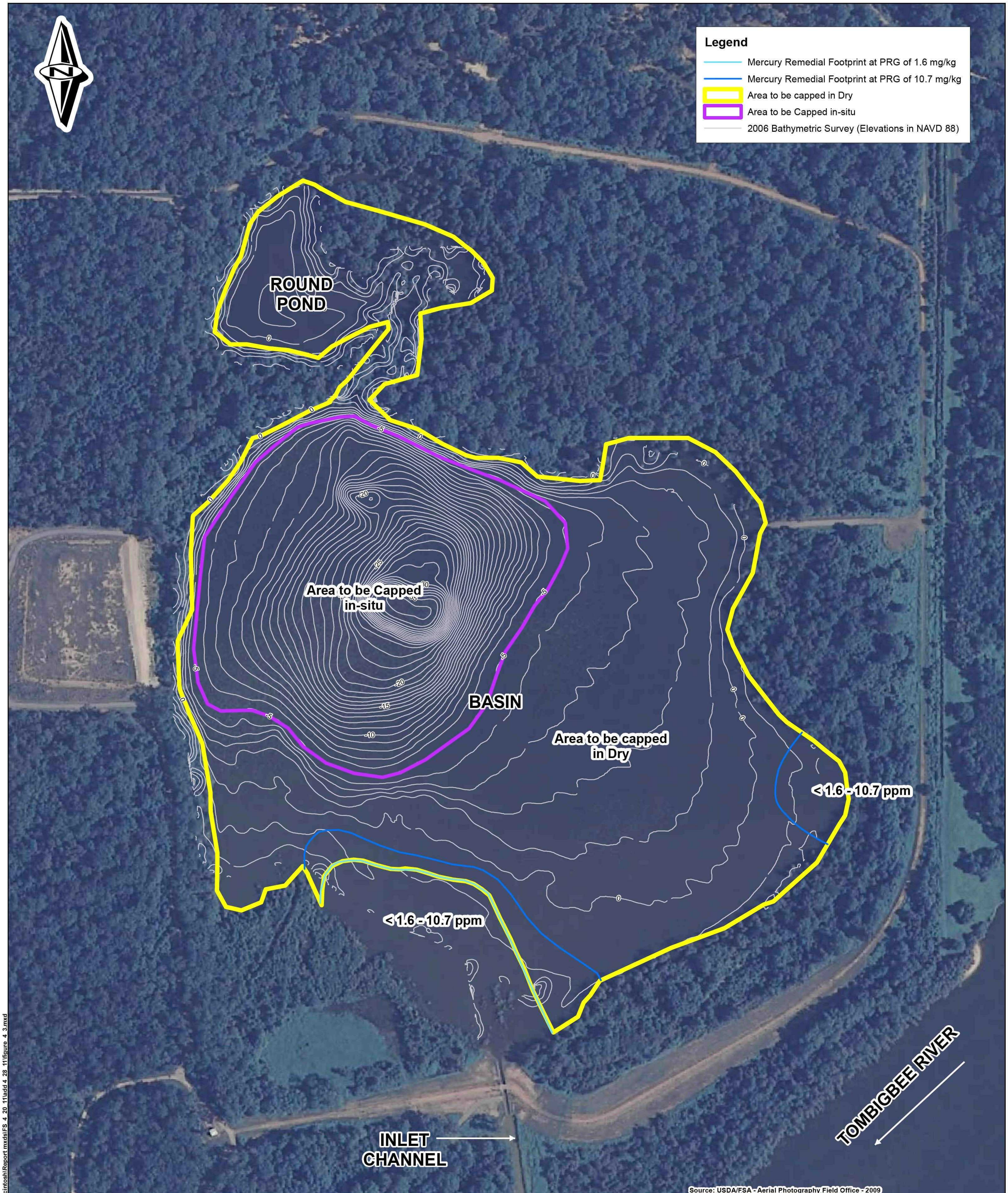
**Steady-State Cap Design Model Schematic**

Prepared by/Date: SLW - 4/03/12
Checked by/Date: HEF - 4/03/12
Project Number: 6107120036

amec

Figure Number: 4-2

Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\add 4_28_11\figure_4_2.mxd




Olin McIntosh OU 2

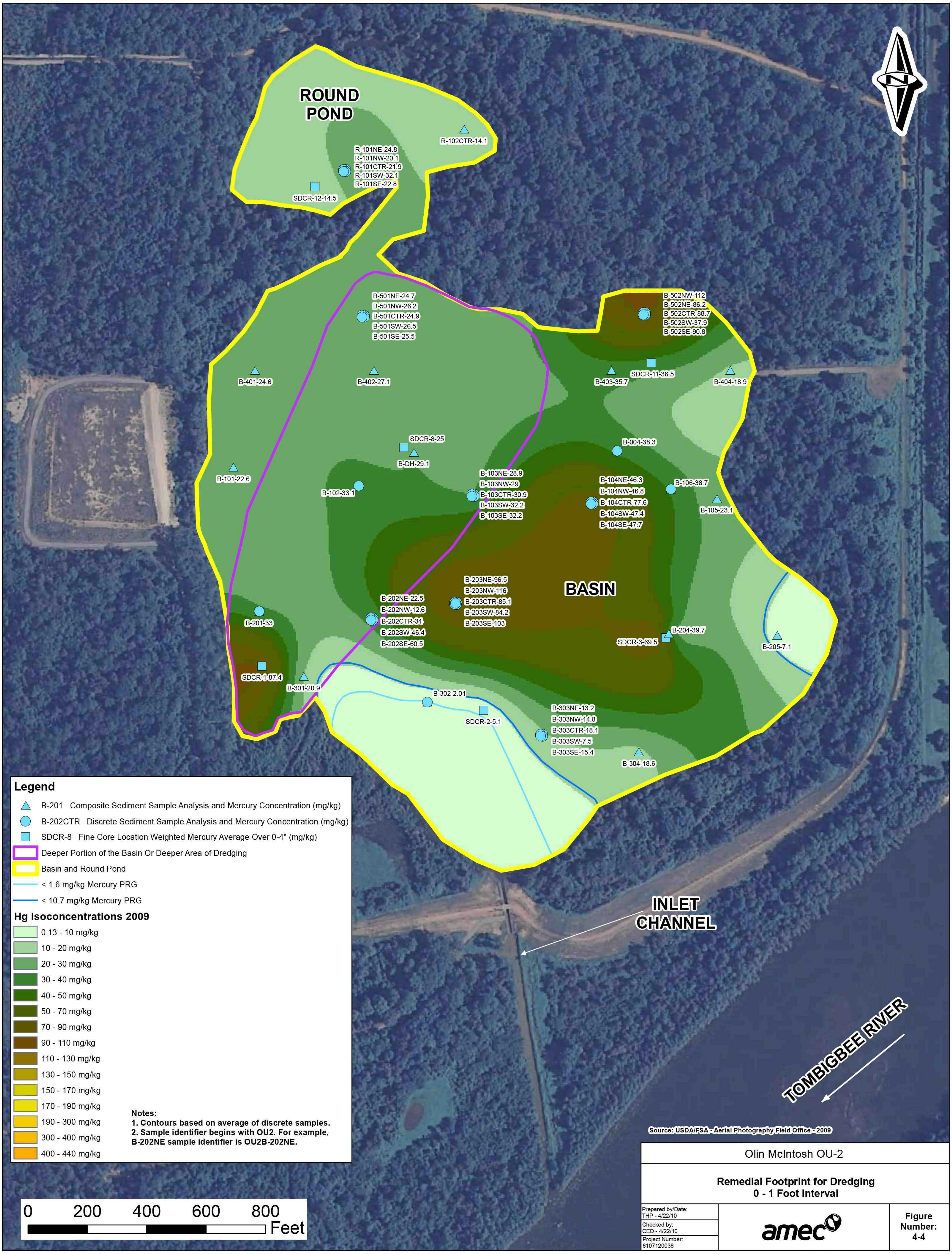
**Remedial Footprint for Capping Alternative 2B (In-Situ / Dry Capping Hybrid)**

Prepared by/Date: SLW - 4/03/12
Checked by: CED - 4/03/12
Project Number: 6107120036

amec

Figure Number: 4-3

Path: G:\Projects GIS\Projects2007\olin mcintosh\Report mxds\FS 4 20 11\add 4 28 11\figure 4 3.mxd

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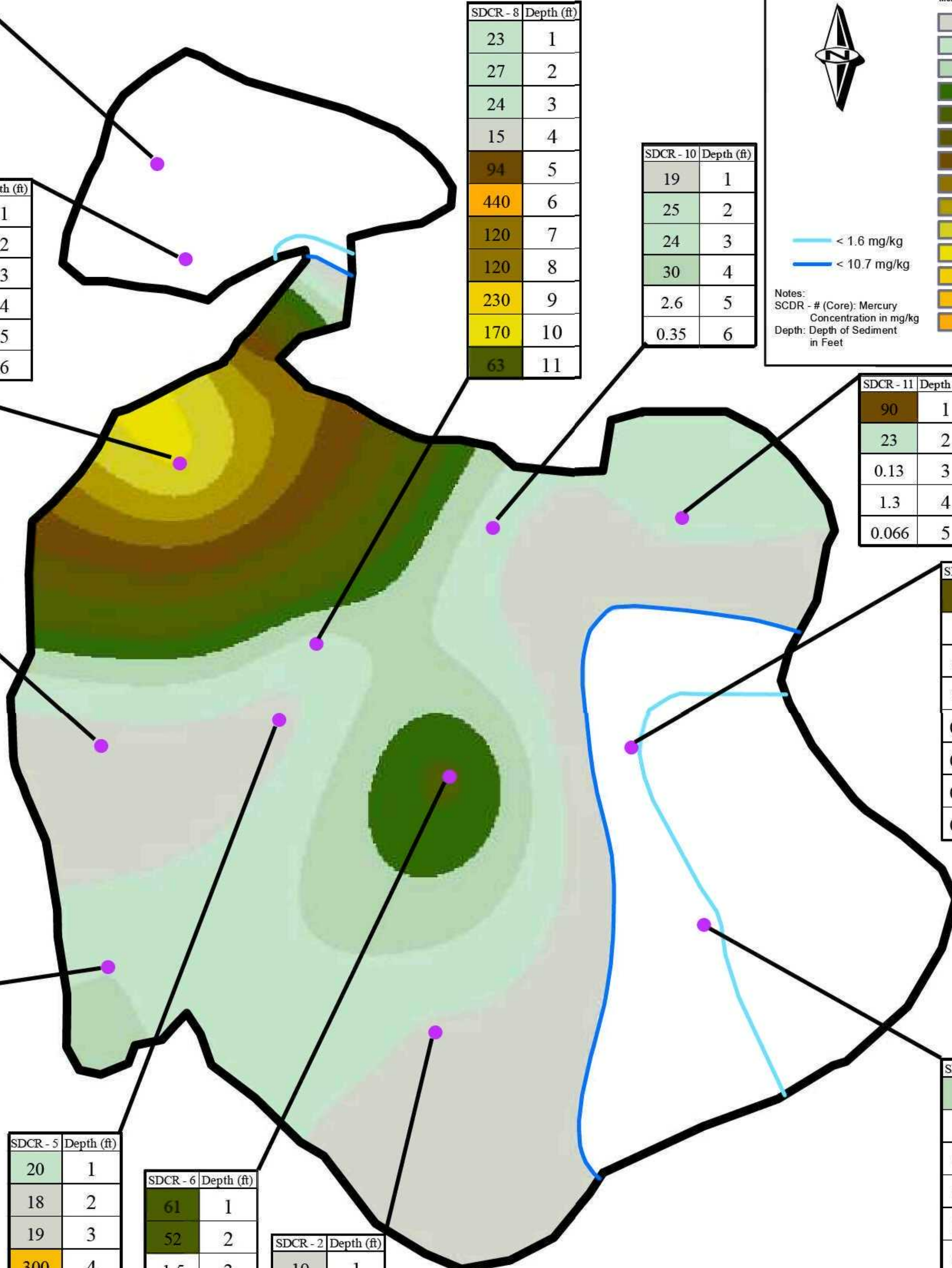


| SDCR - 13 | Depth (ft) |
|---|---|
| 18 | 1 |
| 0.30 | 2 |
| 0.27 | 3 |
| 0.17 | 4 |
| 0.092 | 5 |

| SDCR - 12 | Depth (ft) |
|---|---|
| 33 | 1 |
| 0.38 | 2 |
| 0.68 | 3 |
| 0.17 | 4 |
| 0.094 | 5 |
| 0.088 | 6 |

| SDCR - 9 | Depth (ft) |
|---|---|
| 120 | 1 |
| 170 | 2 |
| 15 | 3 |
| 3.1 | 4 |
| 0.25 | 5 |
| 0.14 | 6 |

| SDCR - 4 | Depth (ft) |
|---|---|
| 23 | 1 |
| 16 | 2 |
| 230 | 3 |
| 64 | 4 |
| 17 | 5 |
| 1.7 | 6 |
| 0.69 | 7 |
| 0.43 | 8 |
| 0.11 | 9 |

| SDCR - 1 | Depth (ft) |
|---|---|
| 121 | 1 |
| 30 | 2 |
| 52 | 3 |
| 115 | 4 |
| 22 | 5 |
| 0.17 | 6 |

| SDCR - 5 | Depth (ft) |
|---|---|
| 20 | 1 |
| 18 | 2 |
| 19 | 3 |
| 300 | 4 |
| 96 | 5 |
| 120 | 6 |
| 9 | 7 |
| 1 | 8 |
| 0.55 | 9 |

| SDCR - 6 | Depth (ft) |
|---|---|
| 61 | 1 |
| 52 | 2 |
| 1.5 | 3 |
| 1.7 | 4 |
| 0.64 | 5 |
| 0.49 | 6 |
| 0.060 | 7 |
| 0.073 | 8 |

| SDCR - 2 | Depth (ft) |
|---|---|
| 19 | 1 |
| 19 | 2 |
| 42 | 3 |
| 18 | 4 |
| 0.17 | 5 |
| 0.38 | 6 |
| 0.070 | 7 |
| 0.060 | 8 |
| 0.057 | 9 |
| 0.055 | 10 |

| SDCR - 8 | Depth (ft) |
|---|---|
| 23 | 1 |
| 27 | 2 |
| 24 | 3 |
| 15 | 4 |
| 94 | 5 |
| 440 | 6 |
| 120 | 7 |
| 120 | 8 |
| 230 | 9 |
| 170 | 10 |
| 63 | 11 |

| SDCR - 10 | Depth (ft) |
|---|---|
| 19 | 1 |
| 25 | 2 |
| 24 | 3 |
| 30 | 4 |
| 2.6 | 5 |
| 0.35 | 6 |

| SDCR - 11 | Depth (ft) |
|---|---|
| 90 | 1 |
| 23 | 2 |
| 0.13 | 3 |
| 1.3 | 4 |
| 0.066 | 5 |

| SDCR - 7 | Depth (ft) |
|---|---|
| 88 | 1 |
| 2.6 | 2 |
| 0.55 | 3 |
| 0.16 | 4 |
| 0.076 | 5 |
| 0.018 | 6 |
| 0.063 | 7 |
| 0.059 | 8 |

| SDCR - 3 | Depth (ft) |
|---|---|
| 34 | 1 |
| 2.8 | 2 |
| 0.53 | 3 |
| 0.50 | 4 |
| 0.13 | 5 |
| 0.19 | 6 |
| 0.13 | 7 |
| 0.07 | 8 |
| 0.074 | 9 |
| 0.14 | 10 |

**Mercury Concentrations**

- 6 - 20 mg/kg
- 20 - 30 mg/kg
- 30 - 40 mg/kg
- 40 - 50 mg/kg
- 50 - 70 mg/kg
- 70 - 90 mg/kg
- 90 - 110 mg/kg
- 110 - 130 mg/kg
- 130 - 150 mg/kg
- 150 - 170 mg/kg
- 170 - 190 mg/kg
- 190 - 300 mg/kg
- 300 - 400 mg/kg
- 400 - 440 mg/kg

< 1.6 mg/kg

< 10.7 mg/kg

Notes:
SCDR - # (Core): Mercury Concentration in mg/kg
Depth: Depth of Sediment in Feet

0 300 600 Feet

Olin McIntosh OU 2

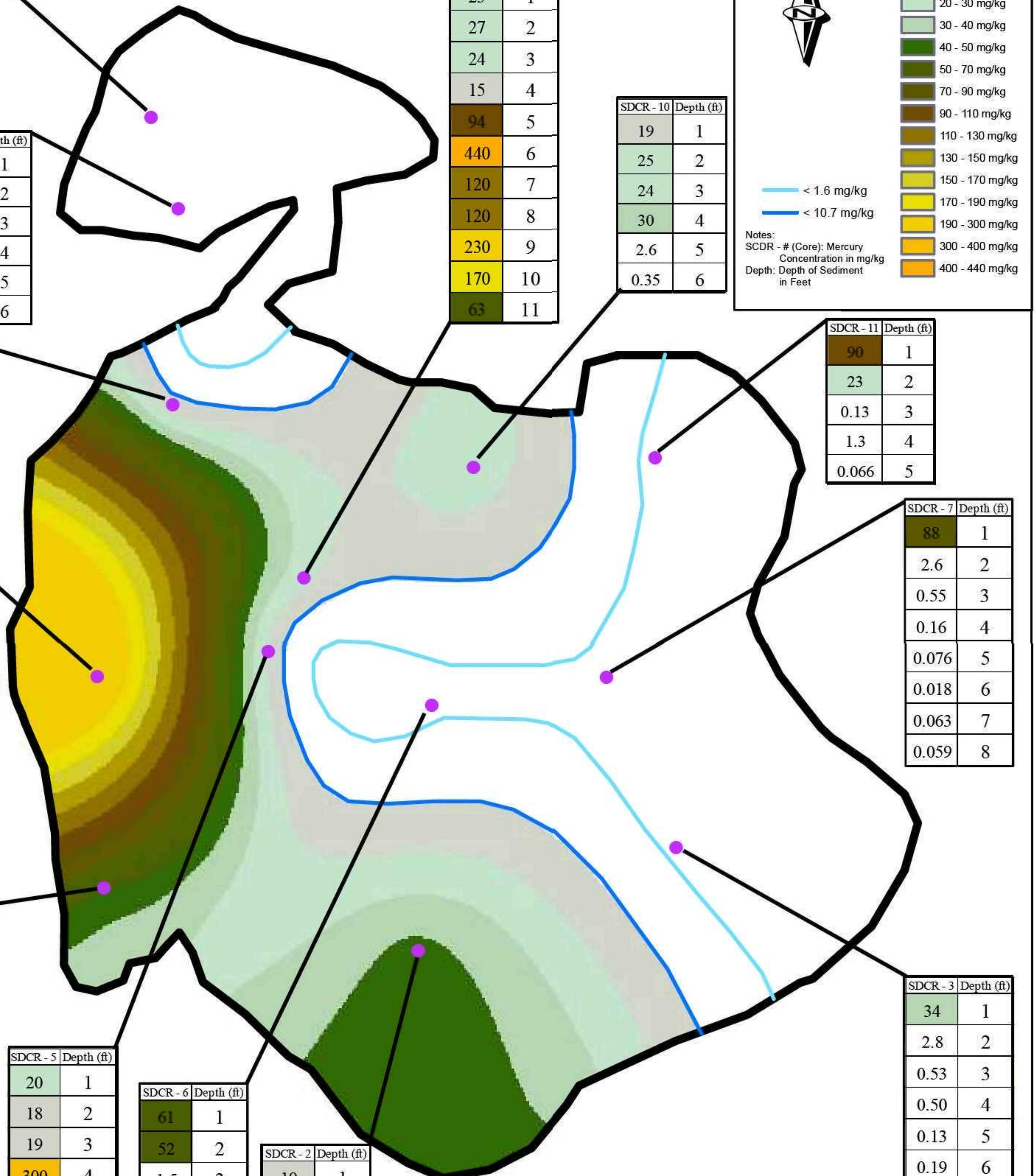
**Remedial Footprint for Dredging (Alternative 3)**
**1 - 2 Foot Interval**

Prepared by/Date: SLW - 4/03/12
Checked by: CED - 4/03/12
Project Number: 6107120036

amec

**Figure Number: 4-5**

Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\add 4_28_11\figure_4_5.mxd




| SDCR - 13 | Depth (ft) |
|---|---|
| 18 | 1 |
| 0.30 | 2 |
| 0.27 | 3 |
| 0.17 | 4 |
| 0.092 | 5 |

| SDCR - 12 | Depth (ft) |
|---|---|
| 33 | 1 |
| 0.38 | 2 |
| 0.68 | 3 |
| 0.17 | 4 |
| 0.094 | 5 |
| 0.088 | 6 |

| SDCR - 8 | Depth (ft) |
|---|---|
| 23 | 1 |
| 27 | 2 |
| 24 | 3 |
| 15 | 4 |
| 94 | 5 |
| 440 | 6 |
| 120 | 7 |
| 120 | 8 |
| 230 | 9 |
| 170 | 10 |
| 63 | 11 |

| SDCR - 10 | Depth (ft) |
|---|---|
| 19 | 1 |
| 25 | 2 |
| 24 | 3 |
| 30 | 4 |
| 2.6 | 5 |
| 0.35 | 6 |

| SDCR - 9 | Depth (ft) |
|---|---|
| 120 | 1 |
| 170 | 2 |
| 15 | 3 |
| 3.1 | 4 |
| 0.25 | 5 |
| 0.14 | 6 |

| SDCR - 11 | Depth (ft) |
|---|---|
| 90 | 1 |
| 23 | 2 |
| 0.13 | 3 |
| 1.3 | 4 |
| 0.066 | 5 |

| SDCR - 7 | Depth (ft) |
|---|---|
| 88 | 1 |
| 2.6 | 2 |
| 0.55 | 3 |
| 0.16 | 4 |
| 0.076 | 5 |
| 0.018 | 6 |
| 0.063 | 7 |
| 0.059 | 8 |

| SDCR - 4 | Depth (ft) |
|---|---|
| 23 | 1 |
| 16 | 2 |
| 230 | 3 |
| 64 | 4 |
| 17 | 5 |
| 1.7 | 6 |
| 0.69 | 7 |
| 0.43 | 8 |
| 0.11 | 9 |

| SDCR - 1 | Depth (ft) |
|---|---|
| 121 | 1 |
| 30 | 2 |
| 52 | 3 |
| 115 | 4 |
| 22 | 5 |
| 0.17 | 6 |

| SDCR - 3 | Depth (ft) |
|---|---|
| 34 | 1 |
| 2.8 | 2 |
| 0.53 | 3 |
| 0.50 | 4 |
| 0.13 | 5 |
| 0.19 | 6 |
| 0.13 | 7 |
| 0.07 | 8 |
| 0.074 | 9 |
| 0.14 | 10 |

| SDCR - 5 | Depth (ft) |
|---|---|
| 20 | 1 |
| 18 | 2 |
| 19 | 3 |
| 300 | 4 |
| 96 | 5 |
| 120 | 6 |
| 9 | 7 |
| 1 | 8 |
| 0.55 | 9 |

| SDCR - 6 | Depth (ft) |
|---|---|
| 61 | 1 |
| 52 | 2 |
| 1.5 | 3 |
| 1.7 | 4 |
| 0.64 | 5 |
| 0.49 | 6 |
| 0.060 | 7 |
| 0.073 | 8 |

| SDCR - 2 | Depth (ft) |
|---|---|
| 19 | 1 |
| 19 | 2 |
| 42 | 3 |
| 18 | 4 |
| 0.17 | 5 |
| 0.38 | 6 |
| 0.070 | 7 |
| 0.060 | 8 |
| 0.057 | 9 |
| 0.055 | 10 |

Olin McIntosh OU 2

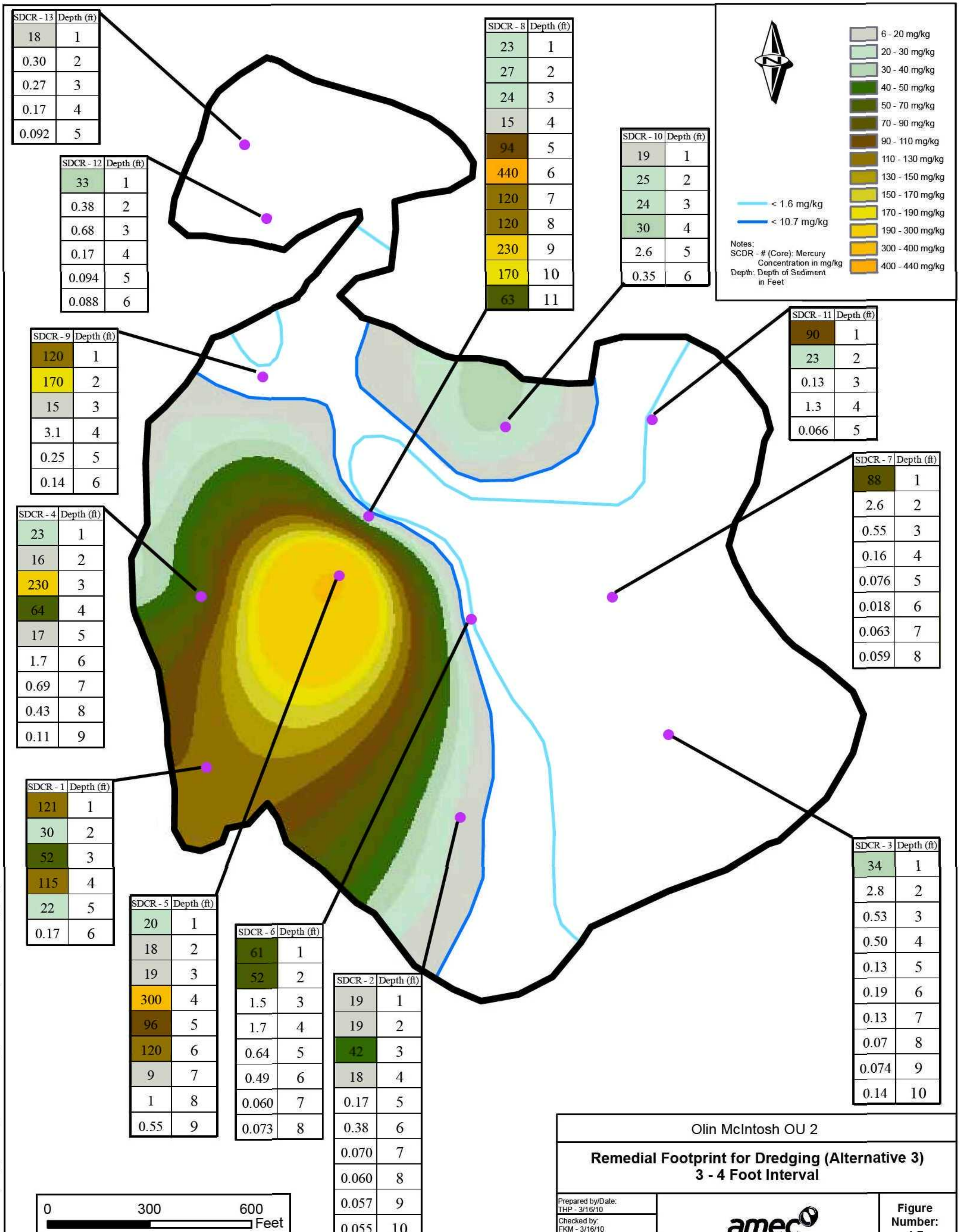
**Remedial Footprint for Dredging (Alternative 3)**
**2 - 3 Foot Interval**

Prepared by/Date: THP - 3/16/10
Checked by: FKM - 3/16/10
Project Number: 6107090035

amec

**Figure Number: 4-6**

Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\add 4_28_11\figure_4_6.mxd




| SDCR - 13 | Depth (ft) |
|---|---|
| 18 | 1 |
| 0.30 | 2 |
| 0.27 | 3 |
| 0.17 | 4 |
| 0.092 | 5 |

| SDCR - 12 | Depth (ft) |
|---|---|
| 33 | 1 |
| 0.38 | 2 |
| 0.68 | 3 |
| 0.17 | 4 |
| 0.094 | 5 |
| 0.088 | 6 |

| SDCR - 8 | Depth (ft) |
|---|---|
| 23 | 1 |
| 27 | 2 |
| 24 | 3 |
| 15 | 4 |
| 94 | 5 |
| 440 | 6 |
| 120 | 7 |
| 120 | 8 |
| 230 | 9 |
| 170 | 10 |
| 63 | 11 |

| SDCR - 10 | Depth (ft) |
|---|---|
| 19 | 1 |
| 25 | 2 |
| 24 | 3 |
| 30 | 4 |
| 2.6 | 5 |
| 0.35 | 6 |

| SDCR - 9 | Depth (ft) |
|---|---|
| 120 | 1 |
| 170 | 2 |
| 15 | 3 |
| 3.1 | 4 |
| 0.25 | 5 |
| 0.14 | 6 |

| SDCR - 11 | Depth (ft) |
|---|---|
| 90 | 1 |
| 23 | 2 |
| 0.13 | 3 |
| 1.3 | 4 |
| 0.066 | 5 |

| SDCR - 7 | Depth (ft) |
|---|---|
| 88 | 1 |
| 2.6 | 2 |
| 0.55 | 3 |
| 0.16 | 4 |
| 0.076 | 5 |
| 0.018 | 6 |
| 0.063 | 7 |
| 0.059 | 8 |

| SDCR - 4 | Depth (ft) |
|---|---|
| 23 | 1 |
| 16 | 2 |
| 230 | 3 |
| 64 | 4 |
| 17 | 5 |
| 1.7 | 6 |
| 0.69 | 7 |
| 0.43 | 8 |
| 0.11 | 9 |

| SDCR - 1 | Depth (ft) |
|---|---|
| 121 | 1 |
| 30 | 2 |
| 52 | 3 |
| 115 | 4 |
| 22 | 5 |
| 0.17 | 6 |

| SDCR - 5 | Depth (ft) |
|---|---|
| 20 | 1 |
| 18 | 2 |
| 19 | 3 |
| 300 | 4 |
| 96 | 5 |
| 120 | 6 |
| 9 | 7 |
| 1 | 8 |
| 0.55 | 9 |

| SDCR - 6 | Depth (ft) |
|---|---|
| 61 | 1 |
| 52 | 2 |
| 1.5 | 3 |
| 1.7 | 4 |
| 0.64 | 5 |
| 0.49 | 6 |
| 0.060 | 7 |
| 0.073 | 8 |

| SDCR - 2 | Depth (ft) |
|---|---|
| 19 | 1 |
| 19 | 2 |
| 42 | 3 |
| 18 | 4 |
| 0.17 | 5 |
| 0.38 | 6 |
| 0.070 | 7 |
| 0.060 | 8 |
| 0.057 | 9 |
| 0.055 | 10 |

| SDCR - 3 | Depth (ft) |
|---|---|
| 34 | 1 |
| 2.8 | 2 |
| 0.53 | 3 |
| 0.50 | 4 |
| 0.13 | 5 |
| 0.19 | 6 |
| 0.13 | 7 |
| 0.07 | 8 |
| 0.074 | 9 |
| 0.14 | 10 |

Olin McIntosh OU 2

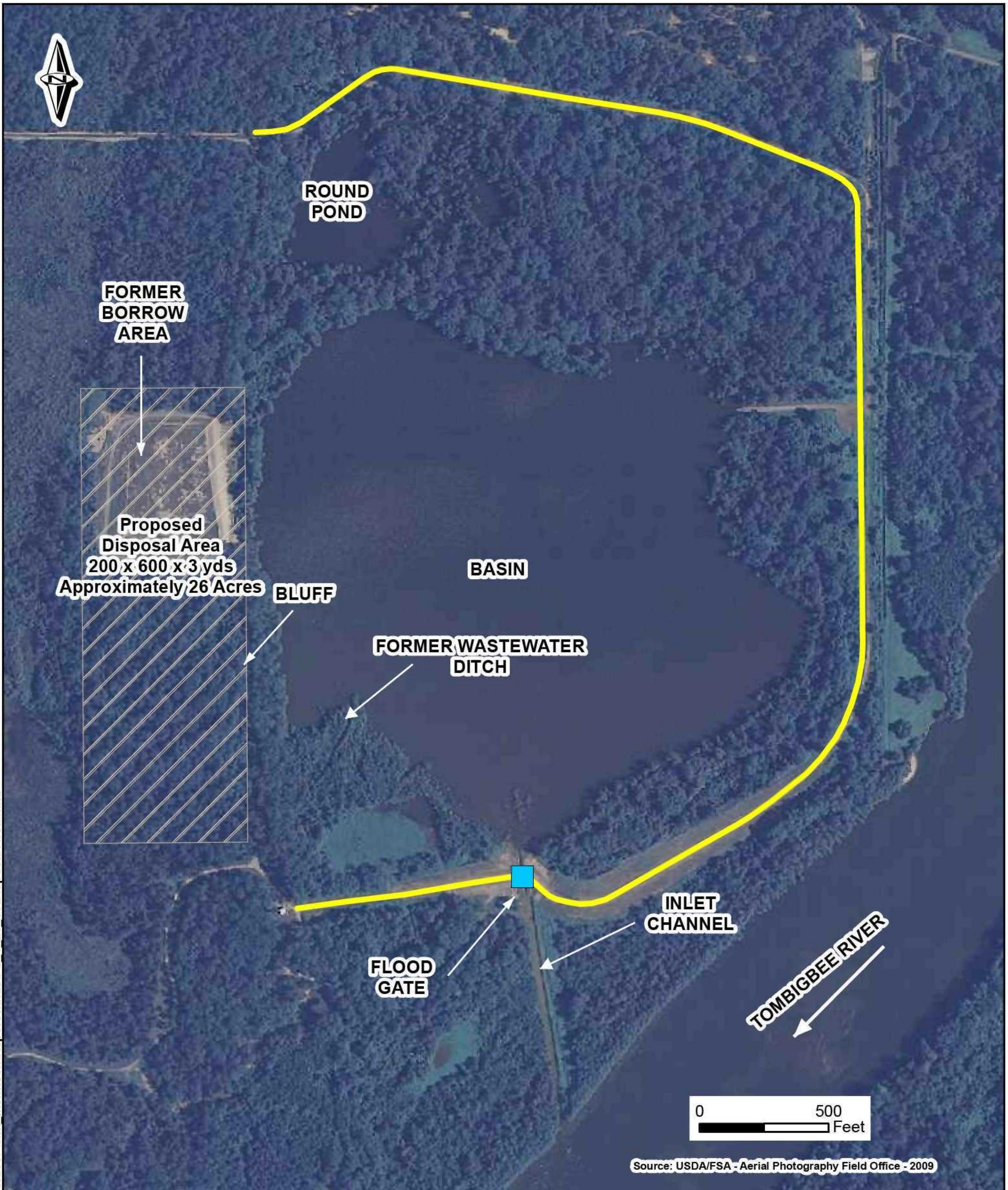
**Remedial Footprint for Dredging (Alternative 3)**
**3 - 4 Foot Interval**

Prepared by/Date: THP - 3/16/10
Checked by: FKM - 3/16/10
Project Number: 6107090035

amec

**Figure Number: 4-7**

Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\add 4_28_11\figure_4_7.mxd




Olin McIntosh OU 2

## Proposed On-Site Disposal Area For Alternative 3 (Dredging)

Prepared by/Date: SLW - 3/29/11
Checked by/Date: CED - 3/30/12
Project Number: 6107110036

amec

Figure Number: 4-8

**Legend**

- Flood Gate Location
- Approximate Berm
- Proposed On-Site Disposal Area

Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\Disposal Area.mxd

# APPENDIX A

# REMEDIAL INVESTIGATION TABLES

## APPENDIX A – LIST OF TABLES

**Table**

**TABLE A-1**

**ANALYTICAL RESULTS SUMMARY FOR HISTORICAL SURFACE WATER, SEDIMENT, AND SOIL SAMPLES**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Range of Concentrations - 1991 | | Range of Concentrations - | Range of Concentrations - | Range of Concentrations - 1995 | | Range of Concentrations - |
|---|---|---|---|---|---|---|---|
| **Surface Water** | **shallow samples** | **deep samples** | **1992** | **1994** | **surface samples** | **bottom samples** | **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 |
| Pesticides 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 |
| Pesticides 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[2] | 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 |
| Pesticides DDTr | 0.272 - 6.9 mg/kg dw | na | 0.67 - 4.01 mg/kg dw | na | 0.082 - 25.9 mg/kg dw |
| Pesticides 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 |
| Pesticides 4,4'-DDE | 0.1 - 1.4 mg/kg dw | na | na | na | na |
| Pesticides 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 |
| Pesticides 2,4'-DDD | na | na | 0.0327 D - 28 mg/kg dw | na | 0.2 - 1.7 mg/kg dw |
| Pesticides 2,4'-DDE | na | na | 0.163 D - 43 mg/kg dw | na | 1.5 - 5.7 mg/kg dw |
| Pesticides 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 |
| Pesticides 4,4'-DDE | na | na | 0.413 D - 41 mg/kg dw | na | 1.2 - 4.9 mg/kg dw |
| Pesticides 4,4'-DDT | na | na | 0.0199 D - 31 mg/kg dw | na | 0.12 - 0.36 mg/kg dw |
| Pesticides DDTr | na | na | 0.52 - 83 mg/kg dw | na | 1.66 - 7.66 mg/kg dw |
| Pesticides 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).
[2]- The maximum concentration of mercury detected (780 mg/kg, dw) was detected in a core sample at a depth of approximatedly 12 cm. Samples collected from this same core (station T09) at 2 and 4 cm were 67.3 and 49.4 mg/kg, dw, respectively (WCC, 1996).

PREPARED BY/DATE: KPH 4/13/10
CHECKED BY/DATE: RMR 4/19/10

**TABLE A-2**
**ANALYTICAL RESULTS SUMMARY FOR THE 2006 BASELINE ESPP SAMPLES**
**Updated RI Addendum**
**Olin McIntosh OU-2**

| | Range of Concentrations | |
|---|---|---|
| **Surface Water** | **Shallow Samples** | **Deep Samples** |
| Mercury (Unfiltered) | <0.2 - 0.329 µg/L | <0.2 µg/L |
| Mercury (Filtered) | <0.2 µg/L | <0.2 µg/L |
| Methylmercury (Unfiltered) | 0.000239 - 0.00097 µg/L | 0.000416 - 0.000514 µg/L |
| Methylmercury (Filtered) | 0.000108 - 0.000295 µg/L | 0.000234 - 0.000396 µg/L |
| Total Sulfate | 28.9 - 33.2 mg/L | 31.1 - 35.1 mg/L |
| Total Sulfide | <1 - 4.4 mg/L | < 1 mg/L |
| Total Hardness | 56 - 61 mg/L | 58 - 64 mg/L |
| Total Alkalinity | 37.4 - 42.1 mg/L | 35.9 - 39 mg/L |
| DOC | < 2 - 10 mg/L | 3.3 - 13 mg/L |
| TDS | 120 - 164 mg/L | 136 - 160 mg/L |
| TSS | 6 - 48 mg/L | 7 - 34 mg/L |
| Temperature | 24.6 - 29.6˚C | 21.8 - 23.2˚C |
| Specific Conductance | 2.40 - 3.71 mS/cm | 2.67 - 3.77 mS/cm |
| DO | 5.1 - 10.6 mg/L | 4.25 - 4.8 mg/L |
| pH | 6.96 - 8.73 | 6.78 - 7.13 |
| ORP | 140 - 205 mV | 192 - 215 mV |
| Turbidity | 11.2 - 74.1 NTU | 17.8 - 20.1 NTU |

| **Sediment** | **Range of Concentrations** |
|---|---|
| Mercury | 6.45 - 95.3 mg/kg dw |
| Methylmercury | 0.0026 - 0.011 mg/kg dw |
| HCB | NA |
| DDTr | NA |
| DDTR (estimated) | NA |
| Total Sulfate | <861 J - 10,900 mg/kg dw |
| Total Sulfide | <47 J - 8,100 J mg/kg dw |
| Selenium | NA |
| Molybdenum | NA |
| AVS/SEM | 9.09 - 99.0 |
| TOC | 6,100 - 41,000 mg/kg dw |
| Grain Size: Clay | 12.4 - 67.9 % |
| Grain Size: Silt | 18.3 - 70.3 % |
| Grain Size: Sand | 0.9 - 67.4 % |
| Percent Moisture | 27 - 80.4 % |
| Bulk Density | 0.945 - 1.82 $g/cm^3$ dw |
| pH | 6.29 - 7.15 |
| ORP | -525 - -117 mV |
| Temperature | 18.9 - 31˚C |

**Notes:**

AVS/SEM - ratio of acid-volatile sulfide to simultaneously extracted metals
˚C - degrees Celsius
DO - dissolved oxygen
DOC - dissolved organic carbon
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethylene
DDT - dichlorodiphenyltrichloroethane
DDTr - sum of 4,4' - isomers of DDD, DDE, and DDT
DDTR - sum of 2,4' - and 4,4' - isomers of DDD, DDE, and DDT
DDTR (estimated) - 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
dw - dry weight
$g/cm^3$ - gram per cubic centimeter
HCB - hexachlorobenzene
J - estimated
mg/kg - milligram per kilogram
mg/L - milligram per liter
mS/cm - milliSiemens per centimeter
mV - millivolt
NA - not analyzed
NTU - nephelometric turbidity unit
ORP - oxidation-reduction potential
TDS - total dissolved solids
TOC - total organic carbon
TSS - total suspended solids
µg/L - microgram per liter
% - percent
< - less than the reporting limit

PREPARED/DATE: KPH 4/13/10
CHECKED/DATE: RMR 4/14/10

**TABLE A-3**
**ANALYTICAL RESULTS SUMMARY FOR THE 2008 ESPP YEAR 1 SAMPLES**
**Updated RI Addendum**
**Olin McIntosh OU-2**

| | Range of Concentrations | |
|---|---|---|
| **Surface Water** | **Shallow Samples** | **Deep Samples** |
| Mercury (Unfiltered) | 0.0443 - 0.36 μg/L | 0.0834 - 0.909 μg/L |
| Mercury (Filtered) | 0.00858 - 0.0227 μg/L | 0.0109 - 0.0249 μg/L |
| Methylmercury (Unfiltered) | 0.00191 - 0.00484 μg/L | 0.00238 - 0.00553 μg/L |
| Methylmercury (Filtered) | 0.000606 - 0.00225 μg/L | 0.000586 - 0.00342 μg/L |
| Total Sulfate | NA | NA |
| Total Sulfide | NA | NA |
| Total Hardness | 66 - 80 mg/L | 68 - 80 mg/L |
| Total Alkalinity | 53.5 - 58.0 mg/L | 53.5 - 55.8 mg/L |
| DOC | 4.3 - 18.0 mg/L | 7.6 - 18 mg/L |
| TDS | 328 - 415 mg/L | 280 - 445 mg/L |
| TSS | 7.0 - 18 mg/L | 7 - 23 mg/L |
| Temperature | 28.2 - 31.9˚C | 26.6 - 28.7˚C |
| Specific Conductance | 0.493 - 0.763 mS/cm | 0.453 - 0.760 mS/cm |
| DO | 6.62 - 12.9 mg/L | 0.68 - 9.71 mg/L |
| pH | 6.78 - 8.81 | 6.69 - 8.58 |
| ORP | -52.1 - 401 mV | -17.1 - 427 mV |
| Turbidity | < 0.1 - 11.7 NTU | < 0.1 - 23.8 NTU |

| **Sediment** | **Range of Concentrations** |
|---|---|
| Mercury | 0.965 - 213 mg/kg dw |
| Methylmercury | 0.00206 J - 0.0234 mg/kg dw |
| HCB | <0.979 - 34.1 mg/kg dw |
| DDTr | <0.0144 - 0.324 mg/kg dw |
| DDTR (estimated) | <0.0144 - 0.638 mg/kg dw |
| Total Sulfate | <677 - 9,250 mg/kg dw |
| Total Sulfide | <38 J - 3,200 mg/kg dw |
| Selenium | <56 mg/kg dw |
| Molybdenum | <80 mg/kg dw |
| AVS/SEM | 14.2 - 78.2 |
| TOC | 2,220 J - 59,900 mg/kg dw |
| Grain Size: Clay | 5.3 - 79.5 % |
| Grain Size: Silt | 11.1 - 59.5 % |
| Grain Size: Sand | 0.7 - 81.2 % |
| Percent Moisture | 23.6 - 80.7 % |
| Bulk Density | 0.839 - 1.58 $g/cm^3$ dw |
| pH | 6.22 - 7.41 |
| ORP | -459 - -253 mV |
| Temperature | 23.4 - 35.0˚C |

**Notes:**

AVS/SEM - ratio of acid-volatile sulfide to simultaneously extracted metals
˚C - degrees Celsius
DO - dissolved oxygen
DOC - dissolved organic carbon
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethylene
DDT - dichlorodiphenyltrichloroethane
DDTr - sum of 4,4' - isomers of DDD, DDE, and DDT
DDTR - sum of 2,4' - and 4,4' - isomers of DDD, DDE, and DDT
DDTR (estimated) - 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
dw - dry weight
$g/cm^3$ - gram per cubic centimeter
HCB - hexachlorobenzene
J - estimated
mg/kg - milligram kilogram
mg/L - milligram per liter
mS/cm - milliSiemens per centimeter
mV - millivolt
NA - not analyzed
NTU - nephelometric turbidity unit
ORP - oxidation-reduction potential
TDS - total dissolved solids
TOC - total organic carbon
TSS - total suspended solids
μg/L - microgram per liter
% - percent
< - less than the reporting limit.

PREPARED/DATE: KPH 4/13/10
CHECKED/DATE: RMR 4/14/10

**TABLE A-4**
**ANALYTICAL RESULTS SUMMARY FOR THE 2009 SURFACE WATER AND SEDIMENT SAMPLES**
**Olin McIntosh OU-2**

| | **Range of Concentrations** | |
|---|---|---|
| **Surface Water** | **Shallow Samples** | **Deep Samples** |
| Mercury (Unfiltered) | 0.00731 - 0.0879 µg/L | 0.0139 - 0.155 µg/L |
| Mercury (Filtered) | 0.00357 - 0.0116 µg/L | 0.00444 - 0.0147 µg/L |
| Methylmercury (Unfiltered) | 0.000734 - 0.00119 µg/L | 0.000613 - 0.00171 µg/L |
| Methylmercury (Filtered) | 0.000413 - 0.000532 µg/L | 0.000413 - 0.000649 µg/L |
| Total Sulfate | NA | NA |
| Total Sulfide | NA | NA |
| Total Hardness | 34 - 46 mg/L | 34 - 52 mg/L |
| Total Alkalinity | 31.8 - 33.9 mg/L | 31.8 - 33.9 mg/L |
| DOC | 15 - 17 mg/L | 16 - 18 mg/L |
| TDS | 45 - 112 mg/L | 55 - 125 mg/L |
| TSS | < 4 - 16 mg/L | < 4 - 22 mg/L |
| Temperature | 23.2 - 27.1˚C | 20.9 - 25.2˚C |
| Specific Conductance | 0.120 - 0.145 mS/cm | 0.116 - 0.188 mS/cm |
| DO | 2.45 - 10.44 mg/L | 0.16 - 9.16 mg/L |
| pH | 6.41 - 7.24 | 6.30 - 7.04 |
| ORP | 197 - 292 mV | 72.8 - 304 mV |
| Turbidity | 5.4 - 9.8 NTU | 10.5 - 26.8 NTU |

| **Sediment** | **Range of Concentrations** |
|---|---|
| Mercury | 2.01 - 116 mg/kg dw |
| Methylmercury | 0.00142 - 0.0257 mg/kg dw |
| HCB | NA |
| DDTr* | 0.0337 – 0.768 mg/kg dw |
| DDTR* | 0.0784 – 2.718 mg/kg dw |
| Total Sulfate | < 1,240 - < 2,440 mg/kg dw |
| Total Sulfide | 800 - 3,300 mg/kg dw |
| Selenium | NA |
| Molybdenum | NA |
| AVS/SEM | 1.13 - 144 |
| TOC | 644 - 60,500 mg/kg dw |
| Grain Size: Clay | < 0.01 - 66 % |
| Grain Size: Silt | 13.2 - 70.8 % |
| Grain Size: Sand | < 0.01 - 84.1 % |
| Percent Moisture | < 0.1 - 81.4 % |
| Bulk Density | 0.921 - 2 g/cm$^3$ dw |
| pH | 6.29 - 8.81 |
| ORP | -440 - -165 mV |
| Temperature | 22.4 - 28.3˚C |

**Notes:**

AVS/SEM - ratio of acid-volatile sulfide to simultaneously extracted metals
˚C - degrees Celsius
DO - dissolved oxygen
DOC - dissolved organic carbon
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethylene
DDT - dichlorodiphenyltrichloroethane
DDTr - sum of 4,4' - isomers of DDD, DDE, and DDT
DDTR - sum of 2,4' - and 4,4' - isomers of DDD, DDE, and DDT
*DDTr and DDTR are provided based on the assumption of one half the reporting limit where sample concentrations were below detection
dw - dry weight
g/cm$^3$ - gram per cubic centimeter
HCB - hexachlorobenzene

J - estimated
mg/kg - milligram per kilogram
mg/L - milligram per liter
mS/cm - milliSiemens per centimeter
mV - millivolt
NA - not analyzed
NTU - nephelometric turbidity unit
ORP - oxidation-reduction potential
TDS - total dissolved solids
TOC - total organic carbon
TSS - total suspended solids
µg/L - microgram per liter
% - percent
< - less than the reporting limit

PREPARED/DATE: JAN 3/18/2012
CHECKED/DATE: ELF 3/20/12

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 0 | | | Transect 1 | | | Transect 1 | | | Transect 1 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-004C-06 | OU2B-SED-004C-08 | OU2-SED 004C-09 | OU2B-SED-101C-06 | OU2B-SED-101C-08 | OU2B-SED-101C-09 | OU2B-SED-102C-06 | OU2B-SED-102C-08 | OU2B-SED-102C-09 | OU2B-SED-103DC-06 | OU2B-SED-103DC-08 | OU2B-SED-103DC-09 |
| Sample Date: | 05/20/2006 | 06/07/2008 | 06/05/2009 | 05/21/2006 | 06/07/2008 | 06/05/2009 | 05/20/2006 | 06/07/2008 | 06/05/2009 | 05/23/2006 | 06/07/2008 | 06/06/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | 54.1 | 78.6 | 43.7 | 108 | 89.2 | 83.2 | 156 | 85.4 J | 90.9 | 77.2 | 84 | 144 |
| Grain Size - ASTMD422, % | | | | | | | | | | | | |
| Grain Size - Clay | 63.9 | 62.8 | 36 | 63.3 | 62.5 | 35.8 | 62.7 | 73.6 | 54.9 | 58.8 | 59.6 | 35.5 |
| Grain Size - Gravel | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 |
| Grain Size - Sand | 1.7 | 1.6 | 3.1 | 2.4 | 1.5 | 2.1 | 1.7 | 0.7 | 0.2 | 2.3 | 1.5 | 4.7 |
| Grain Size - Silt | 34.4 | 35.5 | 60.9 | 34.3 | 36 | 62 | 35.6 | 25.7 | 44.9 | 38.9 | 38.9 | 59.7 |
| Bulk Density - SM 2710FM, g/cm$^3$ | 1.34 | 0.951 | 1.21 | 1.3 | 1.06 | 1.23 | 1.1 | 1.01 | 0.921 | 1.22 | 1.2 | 1.3 |
| Mercury, Total - SW846 7471, mg/kg | 25.8 | 37.8 | 38.3 | 17.3 | 21.8 | 22.6 | 10 | 26.5 | 33.1 | 16.2 | 25.9 | 30.9 |
| Methylmercury - E1630, mg/kg | 0.00623 | 0.00517 | 0.00487 | 0.00316 | 0.00308 | 0.00265 | 0.00419 | 0.00488 | 0.00462 | 0.00681 | 0.00523 | 0.0039 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | | | |
| Iron | 40,967 | NA | N/A | 47,195 | NA | NA | 48,593 | NA | NA | 41,425 | NA | NA |
| Manganese | 634 | NA | N/A | 690 | NA | NA | 1165 | NA | NA | 679 | NA | NA |
| Molybdenum | NA | < 17.9 | N/A | NA | < 18.8 | NA | NA | < 21.1 | NA | NA | < 20.4 | NA |
| Selenium | NA | < 12.5 | N/A | NA | < 13.1 | NA | NA | < 14.8 | NA | NA | < 14.3 | NA |
| Percent Moisture - D2216, % | 71.3 | 54.62 | 70 | 77.6 | 55.5 | 73.2 | 79.3 | 59.11 | 78.3 | 77.9 | 58.35 | 69.8 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | < 0.0144 | 0.0541 |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | < 0.0144 | 0.0839 |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | < 0.0144 | <0.025 |
| 2,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.0394 |
| 2,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.128 |
| 2,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | <0.0126 |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | | | |
| Cadmium | 0.0029 | 0.000809 | 0.00257 | 0.00293 | 0.00126 | 0.00222 | 0.0041 | < 0.000198 | 0.00141 | 0.00306 | 0.000832 | 0.00351 |
| Copper | < 0.00178 | < 0.00772 | 0.0325 | < 0.00178 | < 0.00772 | 0.0223 | 0.0301 | 0.0529 J | 0.0605 J | 0.0399 | 0.0127 | 0.0218 |
| Lead | 0.0653 | 0.0718 | 0.0576 | 0.0614 | 0.0619 | 0.0483 | 0.0663 | 0.0716 | 0.0542 | 0.0649 | 0.0723 | 0.0698 |
| Nickel | 0.11 | 0.255 | 0.121 | 0.157 | 0.132 | 0.103 | 0.195 | 0.145 | 0.0988 | 0.196 | 0.159 | 0.187 |
| Zinc | 1.52 | 1.77 | 1.15 | 1.44 | 1.21 | 0.815 | 1.28 | 1.25 | 0.703 | 1.69 | 1.46 | 1.33 |
| Sulfate, Total - SW846 9038, mg/kg | 5,380 J | 6,150 | < 1660 | 6,850 J | 6,800 | < 1850 | 10,200 J | 9,250 | NA | 8,200 | 4,540 | NA |
| Sulfide, Total - SW846 9030A, mg/kg | 1,400 J | 1,700 | 1,600 | 1,500 J | 1,800 | 2,500 J | 8,100 J | 2,600 | NA | 1,600 J | 2,000 | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 14,000 | 16,100 | 16,300 | 20,000 | 16,100 | 12,900 | 34,000 | 21,200 | 16,200 | 21,000 | 16,900 | 10,900 |
| **FIELD PARAMETER:** | | | | | | | | | | | | |
| Oxidation-Reduction Potential - A2580A, mV | -355 | -297 | -393 | -504 | -384 | -384 | -411 | -280 | -403 | -385 | -339 | -393 |
| pH - EPA 150.1, pH Units | 6.98 | 7.15 | 7.2 | 6.94 | 6.76 | 6.75 | 6.67 | 6.82 | 6.59 | 6.97 | 6.97 | 6.78 |
| Temperature - EPA 170.1, °C | 22.7 | 29.1 | 22.9 | 24.1 | 28.9 | 24 | 18.9 | 23.4 | 22.4 | 23.3 | 26.1 | 25.1 |

**Notes:**
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
g/cm$^3$ - grams per cubic centimeter
in - inch
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
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 1 | | | Transect 1 | | | Transect 1 | | | Transect 1 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-103DNE-06 | OU2B-SED-103DNE-08 | OU2B-SED-103DNE-09 | OU2B-SED-103DNW-06 | OU2B-SED-103DNW-08 | OU2B-SED-103DNW-09 | OU2B-SED-103DSE-06 | OU2B-SED-103DSE-08 | OU2B-SED-103DSE-09 | OU2B-SED-103DSW-06 | OU2B-SED-103DSW-08 | OU2B-SED-103DSW-09 |
| Sample Date: | 05/23/2006 | 06/07/2008 | 06/0/2009 | 05/23/2006 | 06/07/2008 | 06/06/2009 | 05/23/2006 | 06/07/2008 | 06/06/2009 | 05/23/2006 | 06/07/2008 | 06/06/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | 81.7 | 57.4 | 89.9 | 85.7 | 95.5 | 91.9 | 95 | 39.5 | 48.8 | 60.6 | 71.4 | 90.8 |
| Grain Size - ASTMD422, % | | | | | | | | | | | | |
| Grain Size - Clay | 63.3 | 62.8 | 46.3 | 67.9 | 64.1 | 46 | 59.2 | 62 | 36.3 | 63.3 | 58.6 | 35.8 |
| Grain Size - Gravel | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 |
| Grain Size - Sand | 1.9 | 1.3 | 1.4 | 0.9 | 1.2 | 1.1 | 2.7 | 1.5 | 3.8 | 2 | 1.2 | 3.4 |
| Grain Size - Silt | 34.8 | 35.9 | 52.3 | 31.2 | 34.6 | 52.9 | 38.1 | 36.6 | 59.9 | 34.7 | 40.2 | 60.8 |
| Bulk Density - SM 2710FM, $g/cm^3$ | 0.982 | 0.993 | 1.27 | 1.01 | 1.03 | 1.23 | 0.985 | 1.01 | 1.23 | 1.03 | 1.03 | 1.03 |
| Mercury, Total - SW846 7471, mg/kg | 13.9 | 24.6 | 28.9 | 13.4 | 25.3 | 29 | 19.6 | 26.3 | 32.2 | 17.7 | 26.5 | 32.2 |
| Methylmercury - E1630, mg/kg | 0.00685 | 0.00319 | 0.00393 | 0.00737 | 0.00294 | 0.00512 | 0.00772 | 0.00367 | 0.00374 | 0.0074 | 0.00435 | 0.00379 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | | | |
| Iron | 40,390 | NA | NA | 42,515 | NA | NA | 38,669 | NA | NA | 40,465 | NA | NA |
| Manganese | 669 | NA | NA | 721 | NA | NA | 634 | NA | NA | 703 | NA | NA |
| Molybdenum | NA | < 18 | NA | NA | < 18.5 | NA | NA | < 16.8 | NA | NA | < 19.6 | NA |
| Selenium | NA | < 12.6 | NA | NA | < 13 | NA | NA | < 11.7 | NA | NA | < 13.8 | NA |
| Percent Moisture - D2216, % | 78.3 | 56.83 | 70.4 | 76.6 | 58.94 | 71.1 | 80.0 | 55.62 | 72.5 | 77.7 | 57.48 | 73.1 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | | | |
| Cadmium | 0.00227 | 0.000723 | 0.00226 | 0.00283 | 0.000345 | 0.00253 | 0.00338 | 0.000786 | 0.00243 | 0.0032 | 0.00313 | <0.0000770 |
| Copper | 0.0455 | 0.0387 | 0.0121 | 0.0251 | 0.161 | 0.0456 | 0.0417 | 0.233 | 0.00598 | 0.0781 | 0.116 | 0.0209 |
| Lead | 0.0693 | 0.074 | 0.0506 | 0.0652 | 0.0704 | 0.0556 | 0.07 | 0.0733 | 0.0561 | 0.0698 | 0.0714 | 0.0544 |
| Nickel | 0.162 | 0.159 | 0.124 | 0.195 | 0.188 | 0.146 | 0.204 | 0.181 | 0.29 | 0.198 | 0.138 | 0.174 |
| Zinc | 1.52 | 1.46 | 0.983 | 1.57 | 1.62 | 1.04 | 1.73 | 1.46 | 1.05 | 1.58 | 1.55 | 1.05 |
| Sulfate, Total - SW846 9038, mg/kg | 10,500 | 5,770 | NA | 8,510 | 5,810 | NA | 10,900 | 5,630 | NA | 8,690 | 5,360 | NA |
| Sulfide, Total - SW846 9030A, mg/kg | 1,400 J | 2,000 | NA | 1,000 J | 2,000 | NA | 1,500 J | 2,400 | NA | 1,600 J | 2,800 | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 22,000 | 14,800 | 13,300 | 24,000 | 15,700 | 16,000 | 24,000 | 14,300 | 15,400 | 22,000 | 18,600 | 13,500 |
| **FIELD PARAMETER:** | | | | | | | | | | | | |
| Oxidation-Reduction Potential - A2580A, mV | -371 | -355 | -388 | -309 | -350 | -380 | -361 | -335 | -382 | -349 | -378 | -394 |
| pH - EPA 150.1, pH Units | 6.97 | 6.95 | 6.89 | 6.84 | 6.95 | 6.79 | 6.84 | 6.99 | 6.78 | 6.87 | 7.05 | 6.8 |
| Temperature - EPA 170.1, °C | 22.9 | 27.1 | 24.3 | 22.5 | 27.4 | 24.9 | 22.5 | 23.5 | 25.6 | 22.7 | 24.1 | 24.9 |

**Notes:**
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
$g/cm^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between metho
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 1 | | | Transect 1 | | | Transect 1 | | | Transect 1 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-104DC-06 | OU2B-SED-104DC-08 | OU2B-SED-104DC-09 | OU2B-SED-104DNE-06 | OU2B-SED-104DNE-08 | OU2B-SED-104DNE-09 | OU2B-SED-104DNW-06 | OU2B-SED-104DNW-08 | OU2B-SED-104DNW-09 | OU2B-SED-104DSE-06 | OU2B-SED-104DSE-08 | OU2B-SED-104DSE-09 |
| Sample Date: | 05/24/2006 | 06/08/2008 | 06/06/2009 | 05/24/2006 | 06/08/2008 | 06/06/2009 | 05/24/2006 | 06/08/2008 | 06/06/2009 | 05/24/2006 | 06/08/2008 | 06/06/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | 39.9 | 78.2 | 88.6 | 54.4 | 76.5 | 82.3 | 37.7 | 52.3 | 74.6 | 24.8 | 99.3 | 33.8 |
| Grain Size - ASTMD422, % | | | | | | | | | | | | |
| Grain Size - Clay | 63.3 | 55.9 | 32.9 | 63.3 | 53.2 | 32.9 | 59.9 | 55.1 | 43.7 | 63.9 | 56.2 | 41.3 |
| Grain Size - Gravel | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 |
| Grain Size - Sand | 2.2 | 2.4 | 3.8 | 1.5 | 2.5 | 3.9 | 2 | 2.3 | 4.3 | 1.5 | 2.1 | 2.5 |
| Grain Size - Silt | 34.5 | 41.7 | 63.3 | 35.2 | 44.3 | 63.2 | 38.1 | 42.6 | 52.1 | 34.6 | 41.7 | 56.2 |
| Bulk Density - SM 2710FM, g/cm$^3$ | 0.945 | 0.987 | 1.16 | 1.14 | 1.08 | 0.996 | 1.18 | 1.16 | 1.12 | 1.18 | 1.17 | 1.23 |
| Mercury, Total - SW846 7471, mg/kg | 21.7 | 33.5 | 77.6 | 17.5 | 35.9 | 46.3 | 18.5 | 38.4 | 46.8 | 21.1 | 47 | 47.7 |
| Methylmercury - E1630, mg/kg | 0.00921 | 0.00873 | 0.00592 | 0.00969 | 0.00771 | 0.00667 | 0.00789 | 0.00654 | 0.00599 | 0.00892 | 0.00696 | 0.00613 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | | | |
| Iron | 42,189 | NA | NA | 40,521 | NA | NA | 39,964 | NA | NA | 37,732 | NA | NA |
| Manganese | 790 | NA | NA | 669 | NA | NA | 706 | NA | NA | 710 | NA | NA |
| Molybdenum | NA | < 15.1 | NA | NA | < 15.9 | NA | NA | < 18 | NA | NA | < 17.3 | NA |
| Selenium | NA | < 10.6 | NA | NA | < 11.2 | NA | NA | < 12.6 | NA | NA | < 12.1 | NA |
| Percent Moisture - D2216, % | 76.3 | 50.7 | 71 | 77.7 | 53.92 | 70.7 | 76.4 | 54.11 | 70.4 | 77.8 | 53.41 | 71.5 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | | | |
| Cadmium | 0.00328 | 0.00101 | 0.00307 | 0.00287 | 0.00112 | 0.00257 | 0.00314 | 0.00215 | 0.00325 | 0.00323 | 0.00284 | 0.00348 |
| Copper | 0.138 | 0.0102 | 0.0144 | 0.0501 | < 0.00772 | 0.0347 | 0.0633 | 0.0574 | 0.0513 | 0.112 | 0.0531 | 0.0488 |
| Lead | 0.0677 | 0.0629 | 0.0513 | 0.0768 | 0.0711 | 0.0541 | 0.0611 | 0.0687 | 0.0637 | 0.0578 | 0.0743 | 0.0606 |
| Nickel | 0.172 | 0.146 | 0.162 | 0.25 | 0.199 | 0.21 | 0.193 | 0.165 | 0.165 | 0.161 | 0.287 | 0.156 |
| Zinc | 1.54 | 1.36 | 1.42 | 1.58 | 1.57 | 1.43 | 1.53 | 1.54 | 1.57 | 2.26 | 1.95 | 1.3 |
| Sulfate, Total - SW846 9038, mg/kg | 3,510 | 7,290 | NA | 8,070 | 4,240 | NA | 8,030 | 7,100 | NA | 7,840 | 8,930 | NA |
| Sulfide, Total - SW846 9030A, mg/kg | 1,000 J | 1,700 | NA | 1,200 J | 2,300 | NA | 1,000 J | 2,100 | NA | 1,100 J | 2,800 | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 18,000 | 16,700 | 14,700 | 17,000 | 14,000 | 14,200 | 22,000 | 16,500 | 14,100 | 18,000 | 13,800 | 14,800 |
| **FIELD PARAMETER:** | | | | | | | | | | | | |
| Oxidation-Reduction Potential - A2580A, mV | -117 | -457 | -370 | -299 | -455 | -375 | -383 | -459 | -382 | -383 | -457 | -417 |
| pH - EPA 150.1, pH Units | 6.81 | 6.59 | 6.91 | 6.88 | 6.6 | 6.94 | 6.93 | 6.68 | 7.01 | 6.79 | 6.22 | 6.96 |
| Temperature - EPA 170.1, °C | 22.5 | 30.6 | 26.1 | 22.8 | 29.3 | 24.6 | 23 | 29.4 | 25.7 | 23.3 | 29.3 | 25.1 |

**Notes:**
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
g/cm$^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between meth
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 1 | | | Transect 1 | | | Transect 1 | | Transect 2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-104DSW-06 | OU2B-SED-104DSW-08 | OU2B-SED-104DSW-09 | OU2B-SED-105C-06 | OU2B-SED-105C-08 | OU2B-SED-105C-09 | OU2B-SED-106C-08 | OU2B-SED-106C-09 | OU2B-SED-201C-06 | OU2B-SED-201C-08 | OU2B-SED-201C-09 |
| Sample Date: | 05/24/2006 | 06/08/2008 | 06/06/2009 | 05/23/2006 | 06/08/2008 | 06/08/2009 | 06/08/2008 | 06/08/2009 | 05/21/2006 | 06/08/2008 | 06/08/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | 42.2 | 98.2 | 57.7 | 22.7 | 73.3 | 21 | NA | NA | 12.6 | 6.77 | 4.21 |
| Grain Size - ASTMD422, % | | | | | | | | | | | |
| Grain Size - Clay | 67.9 | 53.2 | 42.2 | 48.1 | 46.8 | 35.9 | NA | 34.3 | 33.7 | 32.2 | 18.1 |
| Grain Size - Gravel | NA | < 0.010 | < 0.01 | NA | < 0.010 | 2.7 | NA | < 0.01 | NA | < 0.010 | < 0.01 |
| Grain Size - Sand | 1.8 | 2.3 | 2.8 | 3.6 | 7.3 | 14.5 | NA | 1.2 | 22.8 | 38.7 | 21.5 |
| Grain Size - Silt | 30.3 | 44.5 | 55 | 48.3 | 45.9 | 46.9 | NA | 64.4 | 43.5 | 29.1 | 60.4 |
| Bulk Density - SM 2710FM, $g/cm^3$ | 1.17 | 1.1 | 1.12 | 1.16 | 1.0 | 1.32 | NA | NA | 1.62 | 1.38 | 1.42 |
| Mercury, Total - SW846 7471, mg/kg | 20.3 | 99.4 | 47.4 | 32.9 | 35.6 | 23.1 | 37.3 | 38.7 | 51.8 | 63.9 J | 33 |
| Methylmercury - E1630, mg/kg | 0.00942 | 0.00879 | 0.0068 | 0.00958 | 0.0134 | 0.0212 | 0.00435 J | 0.00569 | 0.00804 | 0.00983 | 0.00524 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | | |
| Iron | 39,372 | NA | NA | 34,210 | NA | NA | NA | NA | 19,596 | NA | NA |
| Manganese | 692 | NA | NA | 582 | NA | NA | NA | NA | 222 | NA | NA |
| Molybdenum | NA | < 15.7 | NA | NA | < 17 | NA | NA | NA | NA | < 80 | NA |
| Selenium | NA | < 11 | NA | NA | < 11.9 | NA | NA | NA | NA | < 56 | NA |
| Percent Moisture - D2216, % | 77.2 | 54.69 | 68.8 | 65.8 | 60.92 | 72.3 | 55.41 | 70.2 | 44.9 | 32.27 | 39.7 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.00729 | 5.97 |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | | |
| Cadmium | 0.00291 | < 0.000198 | 0.0025 J | 0.0015 | 0.00105 | 0.00255 | NA | NA | < 0.000541 | < 0.000198 J | 0.000954 |
| Copper | 0.0732 | 0.0794 | 0.0332 J | 0.0435 | 0.157 | 0.1146 | NA | NA | 0.0155 | 0.0167 J | 0.055 J |
| Lead | 0.0623 | 0.0728 | 0.0603 | 0.0585 | 0.0934 | 0.0622 | NA | NA | 0.0381 | 0.0442 | 0.0287 |
| Nickel | 0.163 | 0.38 | 0.132 | 0.0919 | 0.168 | 0.0942 | NA | NA | 0.0384 | 0.0414 J | 0.0308 |
| Zinc | 1.69 | 1.85 | 1.43 | 1.33 | 1.56 | 0.851 | NA | NA | 0.16 | 0.133 J | 0.226 |
| Sulfate, Total - SW846 9038, mg/kg | 7,240 | 3,210 | NA | 4,760 | 2,350 | NA | NA | NA | 2,160 J | 2,490 | NA |
| Sulfide, Total - SW846 9030A, mg/kg | 1,100 J | 1,700 | NA | < 72 J | 1,000 | NA | NA | NA | 160 J | 210 J | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 20,000 | 14,400 | 12,000 | 20,000 | 31,200 | 57,700 | 16,900 | 10,700 | 7,200 | 14,400 J | 5,700 |
| **FIELD PARAMETER:** | | | | | | | | | | | |
| Oxidation-Reduction Potential - A2580A, mV | -381 | -457 | -366 | -154 | -418 | -386 | -391 | -314 | -223 | -349 | -397 |
| pH - EPA 150.1, pH Units | 6.82 | 6.63 | 6.82 | 6.9 | 6.87 | 6.91 | 6.96 | 6.87 | 7.11 | 7.41 | 7.19 |
| Temperature - EPA 170.1, °C | 22.7 | 29.9 | 28.3 | 25.5 | 31.3 | 27.3 | 30.4 | 25 | 23.7 | 32.1 | 24.2 |

**Notes:**
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
$g/cm^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between meth
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 2 | | | Transect 2 | | | Transect 2 | | | Transect 2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-202DC-06 | OU2B-SED-202DC-08 | OU2B-SED-202DC-09 | OU2B-SED-202DNE-06 | OU2B-SED-202DNE-08 | OU2B-SED-202DNE-09 | OU2B-SED-202DNW-06 | OU2B-SED-202DNW-08 | OU2B-SED-202DNW-09 | OU2B-SED-202DSE-06 | OU2B-SED-202DSE-08 | OU2B-SED-202DSE-09 |
| Sample Date: | 05/20/2006 | 06/09/2008 | 06/06/2009 | 05/20/2006 | 06/09/2008 | 06/06/2009 | 05/20/2006 | 06/09/2008 | 06/06/2009 | 05/20/2006 | 06/09/2008 | 06/06/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | 15.3 | 46.9 | 6.19 | 26.5 | 71.2 | 9.3 | 15.8 | 81.6 | 5.6 | 14.4 | 15.2 | 11.1 |
| Grain Size - ASTMD422, % | | | | | | | | | | | | |
| Grain Size - Clay | 27.5 | 15.2 | 14.3 | 25.7 | 25.4 | 9.6 | 22.4 | 21.5 | 9.4 | 23.4 | 13.8 | 11.5 |
| Grain Size - Gravel | NA | < 0.010 | < 0.01 | NA | < 0.010 | 1.3 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 |
| Grain Size - Sand | 26.5 | 25.9 | 42.8 | 20.4 | 18.8 | 53.4 | 29.4 | 20.6 | 56.2 | 31.9 | 39.1 | 54.3 |
| Grain Size - Silt | 46 | 58.9 | 42.9 | 53.9 | 55.8 | 35.6 | 48.2 | 57.9 | 34.4 | 44.7 | 47.1 | 34.2 |
| Bulk Density - SM 2710FM, g/cm$^3$ | 1.17 | 1.22 | 1.59 | 1.5 | 1.23 | 1.6 | 1.68 | 1.27 | 2 | 1.55 | 1.36 | 1.67 |
| Mercury, Total - SW846 7471, mg/kg | 22.3 | 79.9 | 34 | 26 | 100 | 22.5 | 12.3 | 172 | 12.6 | 17 | 139 | 60.5 |
| Methylmercury - E1630, mg/kg | 0.00579 | 0.0076 | 0.00432 | 0.00455 | 0.0067 | 0.0034 | 0.00425 | 0.00713 | 0.00219 | 0.00469 | 0.00806 | 0.00445 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | | | |
| Iron | 16,343 | NA | NA | 17,990 | NA | NA | 15,505 | NA | NA | 16,418 | NA | NA |
| Manganese | 242 | NA | NA | 302 | NA | NA | 256 | NA | NA | 260 | NA | NA |
| Molybdenum | NA | < 8.56 | NA | NA | < 9.28 | NA | NA | < 11.3 | NA | NA | < 9.37 | NA |
| Selenium | NA | < 5.99 | NA | NA | < 6.49 | NA | NA | < 7.93 | NA | NA | < 6.56 | NA |
| Percent Moisture - D2216, % | 45.7 | 36.52 | 60.2 | 55.3 | 38.51 | 44.6 | 43.6 | 41.95 | 33.1 | 50.2 | 34.83 | 70.6 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | | | |
| Cadmium | 0.000556 | < 0.000198 | 0.000756 | 0.00126 | 0.000488 | 0.000341 | 0.000706 | < 0.000198 | 0.000799 | < 0.000541 | < 0.000198 | 0.000457 |
| Copper | 0.0206 | 0.0743 | 0.0336 | 0.0287 | < 0.00772 | 0.0189 | 0.0363 | < 0.00772 | 0.0162 | 0.0159 | 0.0029 J | 0.0194 |
| Lead | 0.0315 | 0.0456 | 0.0214 | 0.034 | 0.0582 | 0.0244 | 0.0276 | 0.0771 | 0.0109 | 0.0266 | 0.0245 | 0.0182 |
| Nickel | 0.0361 | 0.0697 | 0.0302 | 0.0572 | 0.0916 | 0.0222 | 0.0548 | 0.1 | 0.0199 | 0.0409 | 0.0316 | 0.0258 |
| Zinc | 0.34 | 0.619 | 0.235 | 0.72 | 0.756 | 0.184 | 0.89 | 0.97 | 0.136 | 0.33 | 0.312 | 0.157 |
| Sulfate, Total - SW846 9038, mg/kg | 2,370 J | 2,440 | < 1240 | 3,420 J | 2,540 | NA | 2,730 J | 4,840 | NA | 3,160 J | 3,940 | NA |
| Sulfide, Total - SW846 9030A, mg/kg | 360 J | 550 | 800 | 800 J | 1,000 | NA | 560 J | 590 | NA | 640 J | 590 | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 5,500 | 9,140 | 3,210 | 7,600 | 9,890 | 644 | 7,300 | 7,800 | 10,500 | 7,200 | 10,500 | 2,940 |
| **FIELD PARAMETER:** | | | | | | | | | | | | |
| Oxidation-Reduction Potential - A2580A, mV | -396 | -459 | -377 | -419 | -450 | -382 | -382 | -448 | -413 | -366 | -448 | -402 |
| pH - EPA 150.1, pH Units | 6.94 | 6.6 | 7.01 | 6.97 | 6.67 | 7.06 | 6.73 | 6.56 | 7.17 | 6.85 | 6.53 | 7.02 |
| Temperature - EPA 170.1, °C | 23.3 | 31.9 | 25.2 | 24.1 | 31.3 | 26.5 | 24.3 | 30.1 | 26.5 | 22.7 | 29.8 | 26 |

**Notes:**
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
g/cm$^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between meth
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 2 | | | Transect 2 | | | Transect 2 | | | Transect 2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-202DSW-06 | OU2B-SED-202DSW-08 | OU2B-SED-202DSW-09 | OU2B-SED-203DC-06 | OU2B-SED-203DC-08 | OU2-SED-203DC-09 | OU2B-SED-203DNE-06 | OU2B-SED-203DNE-08 | OU2B-SED-203DNE-09 | OU2B-SED-203DNW-06 | OU2B-SED-203DNW-08 | OU2B-SED-203DNW-09 |
| Sample Date: | 05/20/2006 | 06/09/2008 | 06/06/2009 | 05/21/2006 | 06/10/2008 | 06/07/2009 | 05/21/2006 | 06/10/2008 | 06/07/2009 | 05/21/2006 | 06/10/2008 | 06/07/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **<u>FIXED BASE LABORATORY ANALYSIS:</u>** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | 19.3 | 22.6 | 9.7 J | 39.4 | 31.6 | 43.8 | 19.1 | 38.4 | 87.4 | 20.8 | 28.1 | 84.1 |
| <u>Grain Size - ASTMD422, %</u> | | | | | | | | | | | | |
| Grain Size - Clay | 24.5 | 15.5 | 16.6 | 31.7 | 36.1 | 26.5 | 29.1 | 40.3 | 35.6 | 37.9 | 30.2 | 34 |
| Grain Size - Gravel | NA | < 0.010 | 0.3 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 |
| Grain Size - Sand | 28.6 | 43.7 | 48.9 | 6 | 8.4 | 7.2 | 5.3 | 7.3 | 7.9 | 4.9 | 10.3 | 10.5 |
| Grain Size - Silt | 46.9 | 40.8 | 34.2 | 62.3 | 55.5 | 66.3 | 65.6 | 52.3 | 56.6 | 57.2 | 59.5 | 55.4 |
| Bulk Density - SM 2710FM, g/cm$^3$ | 1.46 | 1.46 | 1.71 | 1.4 | 1.22 | 1.21 | 1.24 | 1.28 | 1.31 | 1.24 | 1.2 | 1.26 |
| Mercury, Total - SW846 7471, mg/kg | 21.3 | 31.2 | 46.4 | 53.3 | 37.8 | 85.1 | 33.1 | 37.6 | 96.5 | 32 | 37 | 116 |
| Methylmercury - E1630, mg/kg | 0.00525 | 0.00541 | 0.00487 | 0.0086 | 0.00818 | 0.0115 | 0.00802 | 0.00754 | 0.0128 | 0.00887 | 0.00903 | 0.0119 |
| <u>Metals, Total - EPA 6010BM, mg/kg</u> | | | | | | | | | | | | |
| Iron | 16,768 | NA | NA | 26,766 | NA | NA | 25,668 | NA | NA | 25,102 | NA | NA |
| Manganese | 247 | NA | NA | 387 | NA | NA | 439 | NA | NA | 441 | NA | NA |
| Molybdenum | NA | < 7.32 | NA | NA | < 9.43 | NA | NA | < 7.77 | NA | NA | < 9.75 | NA |
| Selenium | NA | < 5.12 | NA | NA | < 6.6 | NA | NA | < 5.44 | NA | NA | < 6.82 | NA |
| Percent Moisture - D2216, % | 44.4 | 31.83 | 35.7 | 59.4 | 40.93 | 53.4 | 57.0 | 40.63 | 55.5 | 56.0 | 42.32 | 55.8 |
| <u>Pesticides - SW846 8081, mg/kg</u> | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | 0.110 | 0.172 | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | 0.171 | 0.191 | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | 0.0434 | 0.0368 | NA | NA | NA | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | NA | 0.233 | NA | NA | NA | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | NA | 0.507 | NA | NA | NA | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | NA | <0.0067 | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | 0.980 | 0.867 | NA | NA | NA | NA | NA | NA |
| <u>Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g</u> | | | | | | | | | | | | |
| Cadmium | < 0.000541 | < 0.000198 | 0.00038 | 0.00082 | 0.000205 | 0.00106 | 0.00142 | < 0.000198 | 0.000894 | 0.000558 | < 0.000198 | 0.00102 |
| Copper | 0.00907 | 0.0476 | 0.0229 | 0.0671 | < 0.00772 | 0.0113 J | 0.295 | 0.0556 | 0.0208 | 0.0629 | 0.0347 | 0.031 |
| Lead | 0.0261 | 0.0355 | 0.02 | 0.0687 | 0.0709 | 0.0475 | 0.0768 | 0.0767 | 0.0668 | 0.0979 | 0.063 | 0.0457 |
| Nickel | 0.0482 | 0.0358 | 0.0181 | 0.164 | 0.0713 | 0.0703 | 0.0924 | 0.131 | 0.0968 | 0.0758 | 0.0756 | 0.0965 |
| Zinc | 0.34 | 0.251 | 0.105 | 0.665 | 0.435 | 0.377 | 0.711 | 0.429 | 0.448 | 0.55 | 0.423 | 0.366 |
| Sulfate, Total - SW846 9038, mg/kg | 2,610 J | 2,410 | NA | 2,880 J | 1,540 | NA | < 924 J | < 918 | NA | < 861 J | 1,500 | NA |
| Sulfide, Total - SW846 9030A, mg/kg | 420 J | 480 | NA | 510 J | 980 | NA | 800 J | 980 | NA | 730 J | 1,000 | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 5,800 | 8,100 | 2,940 | 8,600 | 6,610 | 5,740 | 9,200 | 14,900 | 5,970 | 8,100 | 8,190 | 5,880 |
| **<u>FIELD PARAMETER:</u>** | | | | | | | | | | | | |
| Oxidation-Reduction Potential - A2580A, mV | -393 | -426 | -419 | -197 | -333 | -296 | -246 | -344 | -304 | -376 | -340 | -313 |
| pH - EPA 150.1, pH Units | 6.98 | 6.55 | 7.09 | 7.07 | 6.63 | 6.98 | 6.95 | 6.87 | 6.99 | 7.06 | 6.71 | 7.02 |
| Temperature - EPA 170.1, °C | 22.6 | 30.2 | 26.5 | 22.5 | 35 | 25.6 | 22.8 | 29.4 | 24.8 | 22.9 | 30 | 24.5 |

**<u>Notes:</u>**
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
g/cm$^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between metho
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 2 | | | Transect 2 | | | Transect 2 | | | Transect 2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-203DSE-06 | OU2B-SED-203DSE-08 | OU2B-SED-203DSE-09 | OU2B-SED-203DSW-06 | OU2B-SED203DSW-08 | OU2-SED203DSW-09 | OU2B-SED-204C-06 | OU2B-SED-204C-08 | OU2B-SED-204C-09 | OU2B-SED-205C-06 | OU2B-SED-205C-08 | OU2B-SED-205C-09 |
| Sample Date: | 05/21/2006 | 06/10/2008 | 06/07/2009 | 05/21/2006 | 06/10/2008 | 06/07/2009 | 06/29/2006 | 06/09/2008 | 06/07/2009 | 05/21/2006 | 06/09/2008 | 06/08/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | 26.5 | 26.5 | 35.7 | 25 | 26.1 | 55.1 | 103.5 J | 108 | 62.7 J | 26.5 | 38.2 | 30 |
| Grain Size - ASTMD422, % | | | | | | | | | | | | |
| Grain Size - Clay | 23.4 | 33.3 | 35.4 | 31.6 | 34.4 | 28 | 61.8 | 47.1 | 30.6 | 40.4 | 41.2 | 29.6 |
| Grain Size - Gravel | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | 0.3 |
| Grain Size - Sand | 6.3 | 8.5 | 6.4 | 6.4 | 7.6 | 8.7 | 1.6 | 2.7 | 2.6 | 4.1 | 2.3 | 3.7 |
| Grain Size - Silt | 70.3 | 58.2 | 58.2 | 62 | 58 | 63.4 | 36.6 | 50.2 | 66.8 | 55.5 | 56.5 | 66.4 |
| Bulk Density - SM 2710FM, g/cm$^3$ | 1.12 | 1.46 | 1.24 | 1.11 | 1.29 | 1.39 | 1.3 | 0.845 | 1.13 | 1.06 | 1.19 | 1.29 |
| Mercury, Total - SW846 7471, mg/kg | 38.9 | 34.8 | 103 | 41.5 | 31.7 | 84.2 | 95.3 | 93.2 J | 39.7 | 7.04 | 7.98 | 7.1 |
| Methylmercury - E1630, mg/kg | 0.0101 | 0.00661 | 0.0127 | 0.001 | 0.0097 | 0.0127 | 0.00973 | 0.00746 | 0.00469 | 0.00345 | 0.00405 | 0.00302 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | | | |
| Iron | 23,860 | NA | NA | 25,543 | NA | NA | 40,318 | NA | NA | 31,880 | NA | NA |
| Manganese | 424 | NA | NA | 468 | NA | NA | 649 | NA | NA | 691 | NA | NA |
| Molybdenum | NA | < 9.01 | NA | NA | < 8.39 | NA | NA | < 14 | NA | NA | < 10.7 | NA |
| Selenium | NA | < 6.31 | NA | NA | < 5.87 | NA | NA | < 9.79 | NA | NA | < 7.51 | NA |
| Percent Moisture - D2216, % | 54.6 | 40.83 | 52.8 | 57.6 | 41.18 | 53.6 | 62.9 | 50.5 | 69.9 | 59.2 | 48.69 | 55.5 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | 0.628 | NA | NA | NA |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | | | |
| Cadmium | 0.000882 | 0.000168 J | 0.000857 | 0.00157 | 0.000455 | 0.00105 | 0.0021 J | 0.0007 J | 0.00252 | 0.00145 | < 0.000198 | 0.00131 |
| Copper | 0.14 | 0.102 | 0.0268 | 0.157 | 0.0876 | 0.0169 | 0.0508 J | 0.121 J | 0.0144 J | 0.0141 | < 0.00772 | 0.0129 |
| Lead | 0.103 | 0.0658 | 0.0572 | 0.104 | 0.0848 | 0.0543 | 0.0732 J | 0.0558 | 0.0465 | 0.0397 | 0.0393 | 0.0358 |
| Nickel | 0.122 | 0.0764 | 0.0747 | 0.124 | 0.0908 | 0.0801 | 0.153 J | 0.128 | 0.105 | 0.077 | 0.0762 | 0.074 |
| Zinc | 0.484 | 0.475 | 0.313 | 0.544 | 0.49 | 0.38 | 0.841 J | 1.28 | 0.904 | 0.631 | 0.717 | 0.534 |
| Sulfate, Total - SW846 9038, mg/kg | 1,400 J | 1,110 | NA | < 1010 J | 914 | NA | 5,280 JL | 4,110 | < 1650 | 4,020 J | 1,670 | NA |
| Sulfide, Total - SW846 9030A, mg/kg | 90 J | 950 | NA | < 59 J | 910 | NA | 1,500 JL | 70 J | 1,600 | 310 J | 790 | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 7,300 | 8,080 | 6,520 | 8,000 | 8,360 | 6,350 | 15,000 | 15,400 | 10,600 | 11,000 | 12,300 | 7,450 |
| **FIELD PARAMETER:** | | | | | | | | | | | | |
| Oxidation-Reduction Potential - A2580A, mV | -334 | -351 | -368 | -334 | -352 | -371 | -287 | -378 | -364 | -264 | -380 | -333 |
| pH - EPA 150.1, pH Units | 6.89 | 7.11 | 6.98 | 6.89 | 6.94 | 6.97 | 6.29 | 6.81 | 6.65 | 6.97 | 6.48 | 6.81 |
| Temperature - EPA 170.1, °C | 22.6 | 28.8 | 25.4 | 23.4 | 29.2 | 25.1 | 31 | 30.8 | 23.8 | 24.1 | 33 | 26.5 |

**Notes:**
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
g/cm$^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between meth
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 3 | | | Transect 3 | | | Transect 3 | | | Transect 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-301C-06 | OU2B-SED-301C-08 | OU2B-SED-301C-09 | OU2B-SED-302C-06 | OU2B-SED-302C-08 | OU2B-SED-302C-09 | OU2B-SED-303DC-06 | OU2B-SED-303DC-08 | OU2B-SED-303DC-09 | OU2B-SED-303DNE-06 | OU2B-SED-303DNE-08 | OU2-SED-303DNE-09 |
| Sample Date: | 05/23/2006 | 06/10/2008 | 06/03/2009 | 05/20/2006 | 06/10/2008 | 06/08/2009 | 05/21/2006 | 06/10/2008 | 06/07/2009 | 05/21/2006 | 06/10/2008 | 06/07/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | 3.73 | 3.5 | 5.4 | 3.5 | 2.38 J | 1.13 | 11.7 | 17.7 | 11.8 | 6.67 | 18.3 | 8.93 |
| Grain Size - ASTMD422, % | | | | | | | | | | | | |
| Grain Size - Clay | 12.4 | 7.3 | 10.8 | 14.3 | 5.3 | 2.7 | 23.4 | 24.1 | 6.7 | 27.4 | 21.8 | 13.8 |
| Grain Size - Gravel | NA | 0.7 | < 0.01 | NA | 2.4 | < 0.01 | NA | < 0.010 | < 0.01 | NA | 8.9 | < 0.01 |
| Grain Size - Sand | 63.4 | 78.2 | 26.4 | 67.4 | 81.2 | 84.1 | 17.1 | 19.3 | 33.8 | 13.9 | 17 | 29.5 |
| Grain Size - Silt | 24.2 | 13.7 | 62.8 | 18.3 | 11.1 | 13.2 | 59.5 | 56.6 | 59.5 | 58.7 | 52.3 | 56.6 |
| Bulk Density - SM 2710FM, g/cm$^3$ | 1.31 | 1.02 | 1.43 | 1.82 | 1 | 1.77 | 1.45 | 1.02 | 1.53 | 1.51 | 1.02 | 1.38 |
| Mercury, Total - SW846 7471, mg/kg | 11 | 5.82 | 20.9 | 27.1 | 3.46 | 2.01 | 6.81 | 19.8 | 18.1 | 8.2 | 19.8 | 13.2 |
| Methylmercury - E1630, mg/kg | 0.0026 | 0.004 | 0.00337 | 0.00328 | 0.00206 J | 0.00142 | 0.00503 | 0.00573 | 0.00445 | 0.00464 | 0.00717 | 0.00756 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | | | |
| Iron | 11,150 | NA | NA | 11,000 | NA | NA | 18,124 | NA | NA | 18,854 | NA | NA |
| Manganese | 135 | NA | NA | 146 | NA | NA | 285 | NA | NA | 297 | NA | NA |
| Molybdenum | NA | < 6.13 | NA | NA | < 5.43 | NA | NA | < 7 | NA | NA | < 6.75 | NA |
| Selenium | NA | < 4.29 | NA | NA | < 3.8 | NA | NA | < 4.9 | NA | NA | < 4.73 | NA |
| Percent Moisture - D2216, % | 27.0 | 25.02 | 36.7 | 33.2 | 23.63 | 30.5 | 47.1 | 35.58 | 40.4 | 49.0 | 35.62 | 38.3 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | 0.061 | 0.259 | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | 0.181 | 0.480 | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | 0.0214 | <0.0569 | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | 0.336 | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | 1.60 | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | <0.0284 | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | 3.35 | < 0.0069 | NA | 34.1 | 8.90 | NA | NA | NA |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | | | |
| Cadmium | < 0.000541 | < 0.000198 | 0.00103 | < 0.000541 | < 0.000198 J | 0.000314 J | 0.001 | 0.000825 | 0.000921 | 0.00128 | 0.000599 | 0.000834 |
| Copper | 0.0197 | 0.00344 J | 0.0376 | 0.0062 | 0.0307 J | 0.0128 J | 0.0459 | 0.0479 | 0.0238 | 0.0279 | 0.0606 | 0.0277 |
| Lead | 0.0189 | 0.0117 | 0.0217 | 0.0142 | 0.00845 J | 0.00603 J | 0.0271 | 0.0397 | 0.0222 | 0.0321 | 0.0361 | 0.0215 |
| Nickel | 0.0136 | 0.00988 | 0.0333 | 0.0121 | 0.00965 J | 0.00868 | 0.0573 | 0.0683 | 0.03 | 0.0592 | 0.0422 | 0.028 |
| Zinc | 0.358 | 0.162 | 0.247 | 0.136 | 0.119 | 0.086 | 0.561 | 0.511 | 0.274 | 0.601 | 0.478 | 0.24 |
| Sulfate, Total - SW846 9038, mg/kg | 2,030 | < 677 | NA | 1,310 J | < 678 | NA | 2,750 J | 884 | NA | 2,460 J | 1,220 | NA |
| Sulfide, Total - SW846 9030A, mg/kg | 87 J | 110 J | NA | 87 J | 250 J | NA | < 47 J | 580 J | NA | 330 J | < 38 J | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 6,100 | 3,990 | 3,720 | 2,800 | 2,220 J | 1,550 | 7,200 | 6,750 | 7,240 | 8,600 | 6,570 | 4,440 |
| **FIELD PARAMETER:** | | | | | | | | | | | | |
| Oxidation-Reduction Potential - A2580A, mV | -146 | -329 | -165 | -184.3 | -314 | -368 | -317.8 | -323 | -368 | -387 | -326 | -395 |
| pH - EPA 150.1, pH Units | 6.58 | 6.77 | 7 | 6.98 | 7.22 | 7 | 7.15 | 7.27 | 6.81 | 6.79 | 7.19 | 6.95 |
| Temperature - EPA 170.1, °C | 26.7 | 32.3 | 24.3 | 24.1 | 32.5 | 26.5 | 23.5 | 29.9 | 26.2 | 23.2 | 29.4 | 26.7 |

Notes:
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
g/cm$^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between meth
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 3 | | | Transect 3 | | | Transect 3 | | | Transect 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-303DNW-06 | OU2B-SED-303DNW-08 | OU2B-SED-303DNW-09 | OU2B-SED-303DSE-06 | OU2B-SED-303DSE-08 | OU2B-SED-303DSE-09 | OU2B-SED-303DSW-06 | OU2B-SED-303DSW-08 | OU2B-SED-303DSW-09 | OU2B-SED-304C-06 | OU2B-SED-304C-08 | OU2B-SED-304C-09 |
| Sample Date: | 05/21/2006 | 06/10/2008 | | 05/21/2006 | 06/10/2008 | 06/07/2009 | 05/21/2006 | 06/10/2008 | 06/07/2009 | 05/22/2006 | 06/10/2008 | 06/09/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **<u>FIXED BASE LABORATORY ANALYSIS:</u>** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | 11.1 | 17.2 | 7.99 | 23 | 23.8 | 17.3 | 19.2 | 27.1 | 5.7 | 28 | 40.2 | 32.3 |
| <u>Grain Size - ASTMD422, %</u> | | | | | | | | | | | | |
| Grain Size - Clay | 19.2 | 29.6 | 14.3 | 25.4 | 27.6 | 11.1 | 31.7 | 21.3 | 28 | 31.7 | 27.2 | 27.3 |
| Grain Size - Gravel | NA | 1.1 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 |
| Grain Size - Sand | 16.3 | 17.2 | 32.9 | 16.1 | 17.5 | 40.4 | 14.2 | 2.3 | 8.7 | 11.3 | 17.8 | 4.3 |
| Grain Size - Silt | 64.5 | 52.1 | 52.8 | 58.5 | 54.9 | 48.5 | 54.1 | 57.4 | 63.4 | 57 | 55 | 68.4 |
| Bulk Density - SM 2710FM, g/cm$^3$ | 1.34 | 1.02 | 1.59 | 1.42 | 1.58 | 1.67 | 1.73 | 1.36 | 1.63 | 1.42 | 1.17 | 1.38 |
| Mercury, Total - SW846 7471, mg/kg | 7.35 | 22.8 | 14.8 | 6.45 | 37 | 15.4 | 14.6 | 18.3 | 7.5 | 10.9 | 25 J | 18.6 |
| Methylmercury - E1630, mg/kg | 0.00431 | 0.00495 | 0.00634 | 0.00463 | 0.00618 | 0.00669 | 0.00521 | 0.00496 | 0.00377 | 0.00544 | 0.00465 | 0.00359 |
| <u>Metals, Total - EPA 6010BM, mg/kg</u> | | | | | | | | | | | | |
| Iron | 19,138 | NA | NA | 20,955 | NA | NA | 22,195 | NA | NA | 26,796 | NA | NA |
| Manganese | 327 | NA | NA | 294 | NA | NA | 311 | NA | NA | 489 | NA | NA |
| Molybdenum | NA | < 5.82 | NA | NA | < 6.51 | NA | NA | < 7.45 | NA | NA | < 8.87 | NA |
| Selenium | NA | < 4.07 | NA | NA | < 4.56 | NA | NA | < 5.21 | NA | NA | < 6.21 | NA |
| Percent Moisture - D2216, % | 53.6 | 36.34 | 41.8 | 44.0 | 38.8 | 42.3 | 51.2 | 36.0 | 30.7 | 60.4 | 46.6 | 59.7 |
| <u>Pesticides - SW846 8081, mg/kg</u> | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| <u>Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g</u> | | | | | | | | | | | | |
| Cadmium | 0.00159 | < 0.000198 | 0.000883 | 0.00103 | 0.000783 | 0.000715 | 0.00123 | 0.000794 | 0.000745 | 0.00201 | 0.000985 | 0.0024 |
| Copper | 0.0413 | 0.0697 | 0.0308 | 0.0288 | 0.0345 | 0.0137 | 0.0283 | 0.0241 | 0.0217 | 0.0511 | < 0.00772 J | 0.0291 J |
| Lead | 0.0273 | 0.0405 | 0.0187 | 0.0294 | 0.0408 | 0.0256 | 0.0361 | 0.0358 | 0.0155 | 0.0384 | 0.036 | 0.0395 |
| Nickel | 0.0541 | 0.0362 | 0.0235 | 0.0662 | 0.0508 | 0.0241 | 0.0649 | 0.0465 | 0.019 | 0.102 | 0.0661 | 0.103 |
| Zinc | 0.537 | 0.361 | 0.285 | 0.59 | 0.485 | 0.247 | 0.518 | 0.541 | 0.172 | 1.15 | 0.976 J | 0.941 |
| Sulfate, Total - SW846 9038, mg/kg | 2,800 J | < 858 | NA | 2,500 J | < 813 | NA | 3,100 J | 808 | NA | 3,200 J | 1,330 J | NA |
| Sulfide, Total - SW846 9030A, mg/kg | 400 J | 930 J | NA | 190 J | 670 | NA | 250 J | 590 | NA | 500 J | 1,100 J | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 8,500 | 7,850 | 3,930 | 8,600 | 10,300 | 4,350 | 10,000 | 6,520 | 4,540 | 14,000 | 11,300 | 11,200 |
| **<u>FIELD PARAMETER:</u>** | | | | | | | | | | | | |
| Oxidation-Reduction Potential - A2580A, mV | -242 | -327 | -410 | -525 | -326 | -395 | -519 | -324 | -410 | -210 | -307 | -380 |
| pH - EPA 150.1, pH Units | 7.07 | 7.21 | 6.99 | 7.05 | 7.14 | 6.88 | 7.03 | 7.14 | 6.97 | 6.7 | 7.21 | 6.83 |
| Temperature - EPA 170.1, °C | 24 | 29.5 | 27.9 | 23.6 | 29.5 | 27.4 | 24 | 29.5 | 22.9 | 25.1 | 30.8 | 25.3 |

<u>Notes:</u>
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
g/cm$^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between meth
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

PREPARED BY/DATE: <u>AES 12/17/09</u>
CHECKED BY/DATE: <u>JAB 1/28/10</u>

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 4 | | Transect 4 | | Transect 4 | | Transect 4 | | Transect 5 | | Transect 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-401C-08 | OU2B-SED-401C-09 | OU2B-SED-402C-08 | OU2B-SED-402C-09 | OU2B-SED-403C-08 | OU2B-SED-403C-09 | OU2B-SED-404C-08 | OU2B-SED-404C-09 | OU2B-SED-501DC-08 | OU2B-SED-501DC-09 | OU2B-SED-501DNE-08 | OU2B-SED-501DNE-09 |
| Sample Date: | 06/06/2008 | 06/09/2009 | 06/06/2008 | 06/09/2009 | 06/06/2008 | 06/09/2009 | 06/06/2008 | 06/09/2009 | 06/06/2008 | 06/07/2009 | 06/06/2008 | 06/07/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | NA | NA | NA | NA | 73.4 | 53.5 | NA | NA | NA | NA | NA | NA |
| Grain Size - ASTMD422, % | | | | | | | | | | | | |
| Grain Size - Clay | 29.2 | 25.6 | 64.9 | 54.8 | 59.3 | 37.6 | 64.8 | 31 | 79.5 | 54.6 | 68.5 | < 0.01 |
| Grain Size - Gravel | < 0.010 | < 0.01 | 10.1 | < 0.01 | < 0.010 | < 0.01 | 0.4 | 0.5 | < 0.010 | < 0.01 | 7.6 | 0.6 |
| Grain Size - Sand | 22.4 | 3.6 | 4.6 | 8.8 | 2.7 | 1.4 | 11.6 | 15.6 | 1.4 | 0.7 | 7.4 | 50 |
| Grain Size - Silt | 48.4 | 70.8 | 20.4 | 36.4 | 38 | 61 | 23.2 | 52.9 | 19.1 | 44.6 | 16.5 | 49.4 |
| Bulk Density - SM 2710FM, $g/cm^3$ | NA | NA | NA | NA | 1.08 | 1.31 | NA | NA | NA | NA | NA | NA |
| Mercury, Total - SW846 7471, mg/kg | 33.6 | 24.6 | 18.2 | 27.1 | 33.1 | 35.7 | 0.965 | 18.9 | 18.1 | 24.9 | 27.4 | 24.7 |
| Methylmercury - E1630, mg/kg | 0.00893 | 0.00286 | 0.00436 | 0.00381 | 0.00631 | 0.00538 | 0.00281 | 0.0257 | 0.00346 | 0.0031 | 0.00322 | 0.00329 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | | | |
| Iron | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Manganese | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Molybdenum | NA | NA | < 21.1 | NA | < 18.5 | NA | NA | NA | NA | NA | NA | NA |
| Selenium | NA | NA | < 14.8 | NA | < 13 | NA | NA | NA | NA | NA | NA | NA |
| Percent Moisture - D2216, % | 63.7 | 75.3 | 77.7 | 77.6 | 74.5 | 74.2 | 42.1 | 76.7 | 79.6 | 76.9 | 80.3 | 77 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | <0.0149 | <0.0147 | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | 0.0185 | 0.019 | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | <0.0149 | <0.0147 | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDD | | NA | | 0.0099 | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDE | | NA | | 0.0311 | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDT | | NA | | <0.0074 | NA | NA | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | <1.48 | 0.0221 | <1.30 | 0.0313 | NA | NA | NA | NA | NA | NA |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | | | |
| Cadmium | NA | NA | NA | NA | 0.00108 | 0.00303 | NA | NA | NA | NA | NA | NA |
| Copper | NA | NA | NA | NA | 0.0703 | 0.0315 | NA | NA | NA | NA | NA | NA |
| Lead | NA | NA | NA | NA | 0.0757 | 0.0572 | NA | NA | NA | NA | NA | NA |
| Nickel | NA | NA | NA | NA | 0.142 | 0.128 | NA | NA | NA | NA | NA | NA |
| Zinc | NA | NA | NA | NA | 1.53 | 1.1 | NA | NA | NA | NA | NA | NA |
| Sulfate, Total - SW846 9038, mg/kg | NA | NA | 7,160 | NA | 5,910 | NA | NA | NA | NA | NA | NA | NA |
| Sulfide, Total - SW846 9030A, mg/kg | NA | NA | 2,400 | NA | 1,900 | NA | NA | NA | NA | NA | NA | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 30,000 | 2,630 | 17,100 | 12,300 | 14,400 | 13,800 | 15,700 | 60,500 | 20,700 | 41,600 | 17,200 | 13,800 |
| **FIELD PARAMETER:** | | | | | | | | | | | | |
| Oxidation Reduction Potential - A2580A, mV | -396 | -423 | -396 | -440 | -369 | -436 | -371 | -431 | -350 | -384 | -342 | -386 |
| pH - EPA 150.1, pH Units | 6.63 | 6.88 | 6.7 | 8.81 | 6.65 | 6.81 | 6.77 | 6.93 | 6.68 | 6.63 | 6.69 | 6.67 |
| Temperature - EPA 170.1, °C | 30.0 | 24.9 | 26.7 | 26.6 | 33.5 | 26.4 | 33.8 | 26.6 | 25.6 | 27.8 | 25.2 | 24.2 |

**Notes:**
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
$g/cm^3$ - grams per cubic centimeter
in - inch
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
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 5 | | Transect 5 | | Transect 5 | | Transect 5 | | Transect 5 | | Transect 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-501DNW-08 | OU2B-SED-501DNW-09 | OU2B-SED-501DSE-08 | OU2B-SED-501DSE-09 | OU2B-SED-501DSW-08 | OU2B-SED-501DSW-09 | OU2B-SED-502DC-08 | OU2B-SED-502DC-09 | OU2B-SED-502DNE-08 | OU2B-SED-502DNE-09 | OU2B-SED-502DNW-08 | OU2B-SED-502DNW-09 |
| Sample Date: | 06/06/2008 | 06/07/2009 | 06/06/2008 | 06/07/2009 | 06/06/2008 | 06/07/2009 | 06/05/2008 | 05/07/2009 | 06/05/2008 | 06/07/2009 | 06/05/2008 | 06/07/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Grain Size - ASTMD422, % | | | | | | | | | | | | |
| Grain Size - Clay | 79.5 | 49.7 | 74.7 | 52.6 | 73.3 | 54.9 | 51.1 | 28.4 | 50 | 34.6 | NA | 39 |
| Grain Size - Gravel | < 0.010 | < 0.01 | < 0.010 | < 0.01 | < 0.010 | < 0.01 | < 0.010 | 0.3 | 1.6 | < 0.01 | NA | < 0.01 |
| Grain Size - Sand | 1 | 0.1 | 1 | 0.1 | 0.8 | 0.3 | 18 | 15.2 | 15 | 15.6 | NA | 13.8 |
| Grain Size - Silt | 19.5 | 50.2 | 24.2 | 47.3 | 25.9 | 44.8 | 30.9 | 56.1 | 33.4 | 49.8 | NA | 47.2 |
| Bulk Density - SM 2710FM, $g/cm^3$ | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mercury, Total - SW846 7471, mg/kg | 17.5 | 26.2 | 23.4 | 25.5 | 18.2 | 26.5 | 22.4 | 88.7 | 213 | 86.2 | 59.2 | 112 |
| Methylmercury - E1630, mg/kg | 0.00295 | 0.00352 | 0.00399 | 0.00378 | 0.00336 | 0.0195 | 0.0189 | 0.0186 | 0.0234 | 0.0238 | 0.0117 | 0.0147 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | | | |
| Iron | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Manganese | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Molybdenum | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Selenium | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Percent Moisture - D2216, % | 79.8 | 77.4 | 79.9 | 78 | 78.9 | 77.7 | 72.2 | 73.3 | 70.3 | 74.4 | 70.8 | 75.4 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | | NA | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | | | |
| Cadmium | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Copper | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Lead | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nickel | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Zinc | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Sulfate, Total - SW846 9038, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Sulfide, Total - SW846 9030A, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 16,100 | 14,200 | 17,800 | 13,800 | 16,800 | 15,200 | 59,900 | 12,600 | 36,200 | 53,600 | 41,600 | 41,700 |
| **FIELD PARAMETER:** | | | | | | | | | | | | |
| Oxidation Reduction Potential - A2580A, mV | -329 | -389 | -354 | -393 | -353 | -397 | -290 | -352 | -292 | -377 | -295 | -387 |
| pH - EPA 150.1, pH Units | 6.66 | 6.71 | 6.69 | 6.69 | 6.7 | 6.71 | 7.06 | 6.77 | 7.08 | 6.77 | 7.02 | 6.81 |
| Temperature - EPA 170.1, °C | 24.2 | 23.7 | 24 | 22.7 | 24.1 | 22.6 | 32.1 | 25.3 | 31.2 | 25.4 | 29.4 | 24.3 |

**Notes:**
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
$g/cm^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between metho
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Transect 5 | | Transect 5 | | Round Pond | | | Round Pond | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2B-SED-502DSE-08 | OU2B-SED-502DSE-09 | OU2B-SED-502DSW-08 | OU2B-SED-502DSW-09 | OU2R-SED-101DC-06 | OU2R-SED-101DC-08 | OU2R-SED-101DC-09 | OU2R-SED-101DNE-06 | OU2R-SED-101DNE-08 | OU2R-SED-101DNE-09 |
| Sample Date: | 06/05/2008 | 06/07/2009 | 06/05/2008 | 06/07/2009 | 05/23/2006 | 06/05/2008 | 06/05/2009 | 05/23/2006 | 06/05/2008 | 06/05/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | NA | NA | NA | NA | 53.7 | 120 | 83.8 | 73.4 | 137 | 51.4 |
| Grain Size - ASTMD422, % | | | | | | | | | | |
| Grain Size - Clay | 55.2 | 35.2 | 55.2 | 37.4 | 51.6 | 54.9 | 47.2 | 54.8 | 54.9 | 51.6 |
| Grain Size - Gravel | < 0.010 | < 0.01 | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 |
| Grain Size - Sand | 4.4 | 12.4 | 6.8 | 8.7 | 7.1 | 1.1 | 3.6 | 2.9 | 17.1 | 2.2 |
| Grain Size - Silt | 40.4 | 52.4 | 38 | 53.9 | 41.3 | 44.1 | 49.1 | 42.3 | 28.1 | 46.2 |
| Bulk Density - SM 2710FM, $g/cm^3$ | NA | NA | NA | NA | 1.14 | 1.26 | 1.13 | 1 | 0.839 | 1.12 |
| Mercury, Total - SW846 7471, mg/kg | 72 | 90.8 | 96.9 | 37.9 | 8.61 | 26.3 | 21.9 | 8.42 | 26.7 | 24.8 |
| Methylmercury - E1630, mg/kg | 0.00867 | 0.0214 | 0.0125 | 0.00378 | 0.00531 | 0.00466 | 0.00599 | 0.00561 | 0.0052 | 0.00584 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | |
| Iron | NA | NA | NA | NA | 56372 | NA | NA | 54963 | NA | NA |
| Manganese | NA | NA | NA | NA | 586 | NA | NA | 558 | NA | NA |
| Molybdenum | NA | NA | NA | NA | NA | < 23.5 | NA | NA | < 22.7 | NA |
| Selenium | NA | NA | NA | NA | NA | < 16.5 | NA | NA | < 15.9 | NA |
| Percent Moisture - D2216, % | 67.6 | 71.4 | 68.7 | < 0.1 | 80.2 | 79.2 | 77.4 | 79.3 | 80.7 | 81.4 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | <0.016 | 0.0438 J | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | <0.0434 | 0.0509 J | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | <0.016 | 0.0292 J | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | NA | NA | 0.0325 J | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | NA | NA | 0.0652 J | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | NA | NA | < 0.0085 | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | |
| Cadmium | NA | NA | NA | NA | 0.00435 | 0.0042 | NA | 0.00482 | 0.00445 | 0.00377 |
| Copper | NA | NA | NA | NA | 0.121 | 0.0936 | NA | 0.189 | 0.0077 J | 0.0946 |
| Lead | NA | NA | NA | NA | 0.0686 | 0.0884 | NA | 0.0717 | 0.0803 | 0.0599 |
| Nickel | NA | NA | NA | NA | 0.15 | 0.21 | NA | 0.169 | 0.274 | 0.134 |
| Zinc | NA | NA | NA | NA | 1.61 | 2.17 | NA | 1.74 | 2.02 | 1.35 |
| Sulfate, Total - SW846 9038, mg/kg | NA | NA | NA | NA | 6,500 | 5,050 | < 2200 | 5,920 | 6,480 | NA |
| Sulfide, Total - SW846 9030A, mg/kg | NA | NA | NA | NA | < 130 J | 1,400 | 2,100 | < 120 | 3,200 | NA |
| Total Organic Carbon - SW846 9060, mg/kg | 28,400 | 38,800 | 38,100 | 45,100 | 34,000 | 25,500 | 30,400 | 34,000 | 26,600 | 32,800 |
| **FIELD PARAMETER:** | | | | | | | | | | |
| Oxidation Reduction Potential - A2580A, mV | -298 | -368 | -359 | -363 | -488 | -253 | -366 | -513 | -285 | -372 |
| pH - EPA 150.1, pH Units | 7.01 | 6.85 | 7.22 | 6.91 | 6.97 | 6.68 | 6.85 | 6.84 | 6.68 | 6.91 |
| Temperature - EPA 170.1, °C | 28.5 | 24.6 | 28.0 | 24.3 | 24.7 | 30.9 | 22.5 | 24.4 | 27.6 | 22.6 |

**Notes:**
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
$g/cm^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between meth
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

**TABLE A-5**

**SEDIMENT ANALYTICAL RESULTS - 2006, 2008, AND 2009**
**Feasibility Study**
**Olin McIntosh OU-2**

| | Round Pond | | | Round Pond | | | Round Pond | | | Round Pond | | Deep Hole |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID: | OU2R-SED-101DNW-06 | OU2R-SED-101DNW-08 | OU2R-SED-101DNW-09 | OU2R-SED-101DSE-06 | OU2R-SED-101DSE-08 | OU2R-SED-101DSE-09 | OU2R-SED-101DSW-06 | OU2R-SED-101DSW-08 | OU2R-SED-101DSW-09 | OU2R-SED-102DC-08 | OU2R-SED-102DC-09 | OU2B-SED-DHC-09 |
| Sample Date: | 05/23/2006 | 06/05/2008 | 06/05/2009 | 05/23/2006 | 06/05/2008 | 06/05/2009 | 05/23/2006 | 06/05/2008 | 06/05/2009 | 06/05/2008 | 06/05/2009 | 06/05/2009 |
| Sample Depth (in.): | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | | |
| Acid Volatile Sulfide, Allan et. al., 1991, umole/g | 70.5 | 147 | 40.8 | 67.5 | 106 | 105 | 67.9 | 141 | 118 | NA | NA | 87.9 |
| Grain Size - ASTMD422, % | | | | | | | | | | | | |
| Grain Size - Clay | 38.8 | 48 | 40.6 | 50.7 | 55.2 | 51.6 | 44.8 | 57.4 | 56.1 | 57.1 | 40.7 | 66 |
| Grain Size - Gravel | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | NA | < 0.010 | < 0.01 | < 0.010 | < 0.01 | < 0.01 |
| Grain Size - Sand | 5.8 | 21.6 | 2.2 | 9.2 | 9.1 | 1.7 | 8.9 | 9.9 | 2.2 | 6.7 | 6.3 | < 0.01 |
| Grain Size - Silt | 55.4 | 30.3 | 57.2 | 40.1 | 35.7 | 45.8 | 46.3 | 32.7 | 41.6 | 36.1 | 53 | 34 |
| Bulk Density - SM 2710FM, $g/cm^3$ | 0.996 | 1.02 | 1.19 | 1.15 | 0.929 | 1.12 | 1.31 | 1.08 | 1.07 | NA | NA | 1.13 |
| Mercury, Total - SW846 7471, mg/kg | 7.96 | 20.3 | 20.1 | 7.77 | 15.8 | 22.8 | 8.58 | 21.9 | 32.1 | 15.6 | 14.1 | 29.1 |
| Methylmercury - E1630, mg/kg | 0.0048 | 0.00319 | 0.00565 | 0.0108 | 0.00447 | 0.0064 | 0.011 | 0.00309 | 0.00451 | 0.00715 | 0.00535 | 0.00431 |
| Metals, Total - EPA 6010BM, mg/kg | | | | | | | | | | | | |
| Iron | 54927 | NA | NA | 57005 | NA | NA | 56020 | NA | NA | NA | NA | NA |
| Manganese | 552 | NA | NA | 633 | NA | NA | 619 | NA | NA | NA | NA | NA |
| Molybdenum | NA | NA | NA | NA | < 22.6 | NA | NA | < 24.4 | NA | NA | NA | NA |
| Selenium | NA | NA | NA | NA | < 15.8 | NA | NA | < 17.1 | NA | NA | NA | NA |
| Percent Moisture - D2216, % | 80.4 | 79.4 | 78.7 | 79.9 | 79.5 | 80.9 | 80.2 | 79.9 | 78 | 76.6 | 78.1 | 79.6 |
| Pesticides - SW846 8081, mg/kg | | | | | | | | | | | | |
| 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene, - SW846 8270, mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Simultaneously Extracted Metals - EPA 1638M-SEM, umole/g | | | | | | | | | | | | |
| Cadmium | 0.00454 | 0.00339 | 0.00335 | 0.00629 | 0.0036 | 0.00404 | 0.00951 | 0.00336 | 0.00363 | NA | NA | 0.00246 |
| Copper | 0.0801 | 0.276 | 0.077 | 0.153 | 0.0427 | 0.0355 | 0.0595 | 0.285 | 0.0366 | NA | NA | 0.0152 |
| Lead | 0.0693 | 0.0814 | 0.0517 | 0.0921 | 0.0785 | 0.0606 | 0.0847 | 0.0946 | 0.0583 | NA | NA | 0.0616 |
| Nickel | 0.206 | 0.223 | 0.128 | 0.233 | 0.185 | 0.185 | 0.243 | 0.189 | 0.159 | NA | NA | 0.118 |
| Zinc | 1.71 | 2.2 | 1.25 | 2.13 | 2.14 | 1.58 | 2.15 | 2.28 | 1.43 | NA | NA | 0.896 |
| Sulfate, Total - SW846 9038, mg/kg | 4,390 | 5,560 | NA | 5,450 | 7,310 | NA | 5,810 | 6,720 | NA | NA | NA | < 2,440 |
| Sulfide, Total - SW846 9030A, mg/kg | 1,200 J | 2,600 | NA | 430 J | 3,000 | NA | 1,300 J | 2,900 | NA | NA | NA | 3,300 |
| Total Organic Carbon - SW846 9060, mg/kg | 39,000 | 23,700 | 29,000 | 41,000 | 20,700 | 30,100 | 41,000 | 25,600 | 30,600 | 45,700 | 39,000 | 14,400 |
| **FIELD PARAMETER:** | | | | | | | | | | | | |
| Oxidation Reduction Potential - A2580A, mV | -505 | -260 | -382 | -421 | -293 | -380 | -441 | -329 | -373 | -345 | -360 | -393 |
| pH - EPA 150.1, pH Units | 6.74 | 6.72 | 6.9 | 6.78 | 6.94 | 6.29 | 6.89 | 6.85 | 6.88 | 6.64 | 6.67 | 6.55 |
| Temperature - EPA 170.1, °C | 24.3 | 27.6 | 23.5 | 24.3 | 26.9 | 23.1 | 24.4 | 26.4 | 24.2 | 31.1 | 23.6 | 24.4 |

Notes:
ASTM - American Standard Test Method
°C - degrees Celsius
EPA - Environmental Protection Agency
$g/cm^3$ - grams per cubic centimeter
in - inch
J - estimated concentration based on data quality evaluation or result between meth
mg/kg - milligram per kilogram
mV - millivolt
NA - Not Analyzed
SW846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*
ug/kg - microgram per kilogram
umole/g - micromole per gram
% - percent
< - Result less than the Reporting Limit

PREPARED BY/DATE: AES 12/17/09
CHECKED BY/DATE: JAB 1/28/10

**TABLE A-6**

**SEDIMENT DATA SUMMARY BY TRANSECT, SHOWING AVERAGE AND RANGES OF CONCENTRATIONS, 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
Transect 4 - samples OU2B-SED-401 to 404
Transect 1 - samples OU2B-SED-101 to 106
Transect 2 - samples OU2B-SED-201 to 205
Transect 3 - samples OU2B-SED-301 to 304

PREPARED BY/DATE: RMR 9/2/09
CHECKED BY/DATE: AES 9/24/09

**TABLE A-7**

**SEDIMENT CORE ANALYTICAL RESULTS - COARSE CORES**
**Feasibility Study**
**Olin McIntosh OU-2**

| Location ID: | Beginning Depth (ft) | Ending Depth (ft) | Sample Date | Sample ID: | 2,4'-DDD | 2,4'-DDE | 2,4'-DDT | 4,4'-DDD | 4,4'-DDE | 4,4'-DDT | Density | Grain Size - Clay | Grain Size - Coarse Sand | Grain Size - Fine Sand | Grain Size - Gravel | Grain Size - Medium Sand | Grain Size - Sand | Grain Size - Silt | Hexachlorobenzene | Mercury | Percent Moisture | Percent Solids | Mercury SPLP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | $g/cm^3$ | % | % | % | % | % | % | % | mg/kg | mg/kg | % | % | mg/l |
| SDCR-1 | 0 | 1.2 | 06/03/2009 | SDCR-1-CA-060309 | NA | NA | NA | NA | NA | NA | 1.51 | 55.1 | NA | NA | 0 | NA | 5.4 | 39.4 | 1.3 | 121 | 41.75 | 58.25 | NA |
| SDCR-1 | 1.2 | 2.3 | 06/03/2009 | SDCR-1-CB-060309 | NA | NA | NA | NA | NA | NA | 1.18 | 59.1 | NA | NA | 0 | NA | 9.1 | 31.8 | 0.0153 J | 29.6 | 41.44 | 58.56 | NA |
| SDCR-1 | 2.3 | 3.5 | 06/03/2009 | SDCR-1-CC-060309 | NA | NA | NA | NA | NA | NA | 1.32 | 41.6 | NA | NA | 0 | NA | 35.9 | 22.5 | 0.0055 | 51.6 | 39.77 | 60.23 | NA |
| SDCR-1 | 2.3 | 3.5 | 06/03/2009 | SDCR1-C-FD-060309 | NA | NA | NA | NA | NA | NA | 1.32 | 41.6 | NA | NA | 0 | NA | 35.9 | 22.5 | 0.005 | 53.7 | 37.99 | 62.01 | NA |
| SDCR-1 | 3.5 | 4.6 | 06/03/2009 | SDCR-1-CD-060309 | NA | NA | NA | NA | NA | NA | 1.32 | 49.2 | NA | NA | 0 | NA | 10 | 40.8 | <0.0031 | 115 | 46.81 | 53.19 | NA |
| SDCR-1 | 4.6 | 5.8 | 06/03/2009 | SDCR-1-CE-060309 | NA | NA | NA | NA | NA | NA | 1.28 | 61.5 | NA | NA | 0 | NA | 0.6 | 37.9 | <0.0028 | 22.2 | 39.64 | 60.36 | NA |
| SDCR-1 | 5.8 | 6.96 | 06/03/2009 | SDCR-1-CF-060309 | NA | NA | NA | NA | NA | NA | 1.11 | 75.4 | NA | NA | 0 | NA | 0 | 24.6 | 0.0036 | 0.166 | 46.98 | 53.02 | NA |
| SDCR-2 | 0 | 1 | 09/24/2009 | SDCR2-CA-092409 | NA | NA | NA | NA | NA | NA | 1.73 | 16.9 | 0.8 | 57.3 | 0 | 5.2 | NA | 19.9 | 330 | NA | 31 | 69 | NA |
| SDCR-2 | 1 | 2 | 09/24/2009 | SDCR2-CB-092409 | NA | NA | NA | NA | NA | NA | 1.53 | 22.4 | 0.1 | 45.9 | 0 | 3.2 | NA | 28.5 | 320 | NA | 36 | 64 | NA |
| SDCR-2 | 1.5 | 2 | 09/24/2009 | SDCR2-CC-092409 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 23 | 37 | 63 | NA |
| SDCR-2 | 2 | 3 | 09/24/2009 | SDCR2-CD-092409 | NA | NA | NA | NA | NA | NA | 1.49 | 24.7 | 0 | 9.3 | 0 | 0.4 | NA | 65.6 | 120 | 42 | 46 | 54 | NA |
| SDCR-2 | 3 | 4 | 09/24/2009 | SDCR2-CE-092409 | NA | NA | NA | NA | NA | NA | 1.46 | 55.8 | 0 | 5 | 0 | 0.5 | NA | 38.7 | 9.9 | 18 | 44 | 56 | NA |
| SDCR-2 | 4 | 5 | 09/24/2009 | SDCR2-CF-092409 | NA | NA | NA | NA | NA | NA | 1.60 | 66.2 | 0 | 0.4 | 0 | 0 | NA | 33.3 | 0.25 | 0.17 | 43 | 57 | NA |
| SDCR-2 | 5 | 6 | 09/24/2009 | SDCR2-CG-092409 | NA | NA | NA | NA | NA | NA | 1.41 | 65.4 | 0 | 1.7 | 0 | 0 | NA | 32.8 | 0.46 | 0.38 | 41 | 59 | NA |
| SDCR-2 | 6 | 7 | 09/24/2009 | SDCR2-CH-092409 | NA | NA | NA | NA | NA | NA | 1.18 | 63.3 | 0 | 1.9 | 0 | 0 | NA | 34.8 | 0.031 | 0.07 | 41 | 59 | NA |
| SDCR-2 | 7 | 8 | 09/24/2009 | SDCR2-CI-092409 | NA | NA | NA | NA | NA | NA | 1.38 | 62.1 | 0 | 0.4 | 0 | 0 | NA | 37.5 | <0.022 | 0.06 | 40 | 60 | NA |
| SDCR-2 | 8 | 9 | 09/24/2009 | SDCR2-CJ-092409 | NA | NA | NA | NA | NA | NA | 1.43 | 64.9 | 0 | 0.2 | 0 | 0 | NA | 35 | <0.022 | 0.057 | 41 | 59 | NA |
| SDCR-2 | 9 | 10 | 09/24/2009 | SDCR2-CK-092409 | NA | NA | NA | NA | NA | NA | 1.42 | 66 | 0 | 0.2 | 0 | 0 | NA | 33.7 | <0.022 | 0.055 | 41 | 59 | NA |
| SDCR-3 | 0 | 1 | 09/27/2009 | SDCR3-CA-092709 | 0.11 | 0.31 | <0.034 | 0.44 | <0.034 | <0.034 | 1.33 | 55.9 | 0.2 | 1.4 | 0.5 | 0.6 | NA | 41.4 | <0.034 | 76 | 62 | 38 | 0.034 |
| SDCR-3 | 1 | 2 | 09/27/2009 | SDCR3-CB-092709 | <0.035 | <0.035 | <0.035 | 0.33 | <0.035 | <0.035 | 1.32 | 66.2 | 0.1 | 0.6 | 0 | 0.8 | NA | 32.3 | <0.035 | NA | 62 | 38 | NA |
| SDCR-3 | 1.5 | 2 | 09/27/2009 | SDCR3-CC-092709 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 5.2 | 58 | 42 | NA |
| SDCR-3 | 2 | 3 | 09/27/2009 | SDCR3-CD-092709 | <0.0072 | <0.0072 | <0.0072 | 0.0041 JQ | <0.0072 | <0.0072 | 1.39 | 76.1 | 0 | 0.2 | 0 | 0.2 | NA | 23.5 | <0.0072 | 0.53 | 54 | 46 | NA |
| SDCR-3 | 3 | 4 | 09/27/2009 | SDCR3-CE-092709 | <0.026 | <0.026 | <0.026 | <0.026 | <0.026 | <0.026 | 1.41 | 72.5 | 0.1 | 0.2 | 0 | 0.1 | NA | 27.2 | <0.026 | 0.5 | 49 | 51 | NA |
| SDCR-3 | 4 | 5 | 09/27/2009 | SDCR3-CF-092709 | <0.0068 | <0.0068 | <0.0068 | 0.0023 JQ | <0.0068 | <0.0068 | 1.43 | 74.2 | 0 | 0.1 | 0 | 0.1 | NA | 25.7 | <0.0068 | 0.13 | 51 | 49 | NA |
| SDCR-3 | 5 | 6 | 09/27/2009 | SDCR3-CG-092709 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | 1.44 | 72 | 0 | 0.1 | 0 | 0.1 | NA | 27.8 | <0.025 | 0.19 | 47 | 53 | NA |
| SDCR-3 | 6 | 7 | 09/27/2009 | SDCR3-CH-092709 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | 1.39 | 67.6 | 0 | 0.2 | 0 | 0.1 | NA | 32.1 | <0.025 | 0.13 | 48 | 52 | NA |
| SDCR-3 | 7 | 8 | 09/27/2009 | SDCR3-CI-092709 | <0.024 | <0.024 | <0.024 | <0.024 | <0.024 | <0.024 | 1.38 | 54.4 | 0 | 0.3 | 0 | 0.1 | NA | 45.2 | <0.024 | 0.07 | 45 | 55 | NA |
| SDCR-3 | 8 | 9 | 09/27/2009 | SDCR3-CJ-092709 | <0.023 | <0.023 | <0.023 | <0.023 | <0.023 | <0.023 | 1.53 | 39 | 0 | 1.2 | 0 | 0.1 | NA | 59.8 | <0.023 | 0.074 | 43 | 57 | NA |
| SDCR-3 | 9 | 10 | 09/27/2009 | SDCR3-CK-092709 | <0.021 | <0.021 | <0.021 | <0.021 | <0.021 | <0.021 | 1.74 | 26.2 | 0 | 10.6 | 0 | 0.1 | NA | 63.1 | <0.021 | 0.14 | 36 | 64 | NA |
| SDCR-4 | 0 | 1 | 09/27/2009 | SDCR4-CA-092709 | NA | NA | NA | NA | NA | NA | 1.24 | 48.6 | 0 | 1.3 | 0 | 0.7 | NA | 49.4 | NA | 23 | 71 | 29 | NA |
| SDCR-4 | 1 | 2 | 09/27/2009 | SDCR4-CB-092709 | NA | NA | NA | NA | NA | NA | 1.21 | 50.7 | 0.1 | 0.5 | 0 | 0.4 | NA | 48.2 | NA | 16 | 72 | 28 | NA |
| SDCR-4 | 2 | 3 | 09/27/2009 | SDCR4-CC-092709 | NA | NA | NA | NA | NA | NA | 1.34 | 70.4 | 0 | 0.3 | 0 | 0.3 | NA | 29.1 | NA | 230 | 60 | 40 | NA |
| SDCR-4 | 3 | 4 | 09/27/2009 | SDCR4-CD-092709 | NA | NA | NA | NA | NA | NA | 1.40 | 64.8 | 0 | 1.2 | 0 | 0.4 | NA | 33.5 | NA | 64 | 54 | 46 | NA |
| SDCR-4 | 4 | 5 | 09/27/2009 | SDCR4-CE-092709 | NA | NA | NA | NA | NA | NA | 1.40 | 76 | 0 | 0.4 | 0 | 0.2 | NA | 23.5 | NA | 17 | 56 | 44 | NA |
| SDCR-4 | 5 | 6 | 09/27/2009 | SDCR4-CF-092709 | NA | NA | NA | NA | NA | NA | 1.32 | 83.1 | 0 | 0.2 | 0 | 0.1 | NA | 16.7 | NA | 1.7 | 55 | 45 | NA |
| SDCR-4 | 6 | 7 | 09/27/2009 | SDCR4-CG-092709 | NA | NA | NA | NA | NA | NA | 1.37 | 83.1 | 0 | 0.1 | 0 | 0.2 | NA | 16.6 | NA | 0.69 | 55 | 45 | NA |
| SDCR-4 | 7 | 8 | 09/27/2009 | SDCR4-CH-092709 | NA | NA | NA | NA | NA | NA | 1.33 | 81 | 0 | 0.1 | 0 | 0.1 | NA | 18.7 | NA | 0.43 | 54 | 46 | NA |
| SDCR-4 | 8 | 9 | 09/27/2009 | SDCR4-CI-092709 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.11 | 52 | 48 | NA |
| SDCR-5 | 0 | 1 | 09/27/2009 | SDCR5-CA-092709 | NA | NA | NA | NA | NA | NA | 1.14 | 54.3 | 0.2 | 0.4 | 0 | 0.2 | NA | 44.9 | NA | 20 | 76 | 24 | NA |
| SDCR-5 | 1 | 2 | 09/27/2009 | SDCR5-CB-092709 | NA | NA | NA | NA | NA | NA | 1.12 | 45.1 | 0 | 0.1 | 0 | 0 | NA | 54.8 | NA | 18 | 75 | 25 | NA |
| SDCR-5 | 2 | 3 | 09/27/2009 | SDCR5-CC-092709 | NA | NA | NA | NA | NA | NA | 1.20 | 42.5 | 0 | 0.2 | 0 | 0.6 | NA | 56.7 | NA | 19 | 73 | 27 | NA |
| SDCR-5 | 3 | 4 | 09/27/2009 | SDCR5-CD-092709 | NA | NA | NA | NA | NA | NA | 1.29 | 58.6 | 0.1 | 0.3 | 0 | 0 | NA | 41 | NA | 300 | 64 | 36 | NA |
| SDCR-5 | 4 | 5 | 09/27/2009 | SDCR5-CE-092709 | NA | NA | NA | NA | NA | NA | 1.45 | 72.3 | 0.1 | 0.8 | 0 | 0.4 | NA | 26.4 | NA | 96 | 53 | 47 | NA |
| SDCR-5 | 5 | 6 | 09/27/2009 | SDCR5-CF-092709 | NA | NA | NA | NA | NA | NA | 1.47 | 75.9 | 0 | 0.5 | 0 | 0.2 | NA | 23.4 | NA | 120 | 52 | 48 | NA |
| SDCR-5 | 6 | 7 | 09/27/2009 | SDCR5-CG-092709 | NA | NA | NA | NA | NA | NA | 1.36 | 79.2 | 0 | 0.3 | 0 | 0.1 | NA | 20.4 | NA | 9 | 57 | 43 | NA |
| SDCR-5 | 7 | 8 | 09/27/2009 | SDCR5-CH-092709 | NA | NA | NA | NA | NA | NA | 1.38 | 74.5 | 0 | 0.3 | 0 | 0.1 | NA | 25.2 | NA | 1 | 57 | 43 | NA |
| SDCR-5 | 8 | 9 | 09/27/2009 | SDCR5-CI-092709 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.55 | 52 | 48 | NA |
| SDCR-6 | 0 | 1 | 09/27/2009 | SDCR6-CA-092709 | NA | NA | NA | NA | NA | NA | 1.26 | 50 | 0 | 1.4 | 0 | 1.8 | NA | 46.7 | NA | 61 | 70 | 30 | NA |
| SDCR-6 | 1 | 2 | 09/27/2009 | SDCR6-CB-092709 | NA | NA | NA | NA | NA | NA | 1.38 | 73.3 | 0 | 0.7 | 0 | 0.6 | NA | 25.5 | NA | 52 | 62 | 38 | NA |
| SDCR-6 | 2 | 3 | 09/27/2009 | SDCR6-CC-092709 | NA | NA | NA | NA | NA | NA | 1.38 | 77.3 | 0 | 0.3 | 0 | 0.1 | NA | 22.3 | NA | 1.5 | 54 | 46 | NA |
| SDCR-6 | 3 | 4 | 09/27/2009 | SDCR6-CD-092709 | NA | NA | NA | NA | NA | NA | 1.30 | 78 | 0 | 0.3 | 0 | 0.1 | NA | 21.6 | NA | 1.7 | 52 | 48 | NA |
| SDCR-6 | 4 | 5 | 09/27/2009 | SDCR6-CE-092709 | NA | NA | NA | NA | NA | NA | 1.40 | 76.6 | 0 | 0.2 | 0 | 0.1 | NA | 23.1 | NA | 0.64 | 53 | 47 | NA |
| SDCR-6 | 5 | 6 | 09/27/2009 | SDCR6-CF-092709 | NA | NA | NA | NA | NA | NA | 1.40 | 84.9 | 0 | 0.1 | 0 | 0.1 | NA | 14.9 | NA | 0.49 | 51 | 49 | NA |
| SDCR-6 | 6 | 7 | 09/27/2009 | SDCR6-CG-092709 | NA | NA | NA | NA | NA | NA | 1.47 | 78.9 | 0 | 0.1 | 0 | 0 | NA | 21 | NA | 0.06 | 49 | 51 | NA |
| SDCR-6 | 7 | 8 | 09/27/2009 | SDCR6-CH-092709 | NA | NA | NA | NA | NA | NA | 1.37 | 76.5 | 0 | 0.2 | 0 | 0.1 | NA | 23.3 | NA | 0.073 | 51 | 49 | NA |
| SDCR-7 | 0 | 1 | 09/27/2009 | SDCR7-CA-092709 | NA | NA | NA | NA | NA | NA | 1.28 | 63.2 | 0.1 | 0.6 | 0 | 0.9 | NA | 35.2 | NA | 88 | 65 | 35 | NA |
| SDCR-7 | 1 | 2 | 09/27/2009 | SDCR7-CB-092709 | NA | NA | NA | NA | NA | NA | 1.44 | 78.4 | 0 | 0.2 | 0 | 0.1 | NA | 21.3 | NA | 2.6 | 55 | 45 | NA |
| SDCR-7 | 2 | 3 | 09/27/2009 | SDCR7-CC-092709 | NA | NA | NA | NA | NA | NA | 1.48 | 74.8 | 0.1 | 0.1 | 0 | 0.1 | NA | 25 | NA | 0.55 | 52 | 48 | NA |
| SDCR-7 | 3 | 4 | 09/27/2009 | SDCR7-CD-092709 | NA | NA | NA | NA | NA | NA | 1.40 | 74.4 | 0 | 0 | 0 | 0.1 | NA | 25.5 | NA | 0.16 | 49 | 51 | NA |
| SDCR-7 | 4 | 5 | 09/27/2009 | SDCR7-CE-092709 | NA | NA | NA | NA | NA | NA | 1.45 | 59 | 0 | 0.1 | 0 | 0 | NA | 40.9 | NA | 0.076 | 48 | 52 | NA |
| SDCR-7 | 5 | 6 | 09/27/2009 | SDCR7-CF-092709 | NA | NA | NA | NA | NA | NA | 1.50 | 33.4 | 0 | 1.6 | 0 | 0.2 | NA | 64.8 | NA | 0.018 JQ | 39 | 61 | NA |
| SDCR-7 | 6 | 7 | 09/27/2009 | SDCR7-CG-092709 | NA | NA | NA | NA | NA | NA | 1.47 | 29.3 | 0 | 6.2 | 0 | 0.3 | NA | 64.3 | NA | 0.063 | 34 | 66 | NA |
| SDCR-7 | 7 | 8 | 09/27/2009 | SDCR7-CH-092709 | NA | NA | NA | NA | NA | NA | 1.44 | 28.1 | 0 | 10.1 | 0 | 0.4 | NA | 61.4 | NA | 0.059 | 36 | 64 | NA |

**TABLE A-7**

**SEDIMENT CORE ANALYTICAL RESULTS - COARSE CORES**
**Feasibility Study**
**Olin McIntosh OU-2**

| Location ID: | Beginning Depth (ft) | Ending Depth (ft) | Sample Date | Sample ID: | 2,4'-DDD mg/kg | 2,4'-DDE mg/kg | 2,4'-DDT mg/kg | 4,4'-DDD mg/kg | 4,4'-DDE mg/kg | 4,4'-DDT mg/kg | Density g/cm$^3$ | Grain Size - Clay % | Grain Size - Coarse Sand % | Grain Size - Fine Sand % | Grain Size - Gravel % | Grain Size - Medium Sand % | Grain Size - Sand % | Grain Size - Silt % | Hexachlorobenzene mg/kg | Mercury mg/kg | Percent Moisture % | Percent Solids % | Mercury SPLP mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDCR-8 | 0 | 1 | 09/28/2009 | SDCR8-CA-092809 | <0.11 | <0.11 | <0.11 | 0.094 JQ | <0.11 | <0.11 | 1.18 | 76.8 | 0 | 0.4 | 0 | 0.1 | NA | 22.6 | <0.11 | NA | 71 | 29 | NA |
| SDCR-8 | 1 | 2 | 09/28/2009 | SDCR8-CB-092809 | 0.049 JQ | 0.15 | 0.013 JQ | 0.094 | <0.05 | <0.05 | 1.14 | 45.2 | 0 | 0.5 | 0 | 0.5 | NA | 53.8 | 0.11 | NA | 73 | 27 | NA |
| SDCR-8 | 1.5 | 2 | 09/28/2009 | SDCR8-CC-092809 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 39 | 71 | 29 | NA |
| SDCR-8 | 2 | 3 | 09/28/2009 | SDCR8-CD-092809 | <0.051 | 0.23 | <0.051 | <0.051 | <0.051 | <0.051 | 1.07 | 43.5 | 0 | 0.9 | 0 | 0.1 | NA | 55.4 | <0.051 | 24 | 74 | 26 | NA |
| SDCR-8 | 3 | 4 | 09/28/2009 | SDCR8-CE-092809 | 0.069 | 0.93 | <0.048 | 0.42 | 0.58 | <0.048 | 1.20 | 36.5 | 0 | 0.4 | 0 | 0 | NA | 63.1 | <0.048 | 15 | 73 | 27 | NA |
| SDCR-8 | 4 | 5 | 09/28/2009 | SDCR8-CF-092809 | <0.048 | 1.5 | <0.048 | <0.048 | <0.048 | <0.048 | 1.23 | 63.8 | 0 | 0.2 | 0 | 0.1 | NA | 35.8 | 0.093 | 94 | 72 | 28 | NA |
| SDCR-8 | 5 | 6 | 09/28/2009 | SDCR8-CG-092809 | <0.39 | 2.3 | <0.39 | <0.39 | 2 | <0.39 | 1.35 | 77.8 | 0 | 1.8 | 0 | 0.2 | NA | 20.1 | 0.62 | 440 | 58 | 42 | NA |
| SDCR-8 | 6 | 7 | 09/28/2009 | SDCR8-CH-092809 | 0.58 | 1.1 | <0.24 | <0.24 | 0.79 | <0.24 | 1.50 | 59.9 | 0 | 4.9 | 0 | 0.2 | NA | 34.9 | 0.51 | 120 | 45 | 55 | NA |
| SDCR-8 | 7 | 8 | 09/28/2009 | SDCR8-CI-092809 | 0.53 | 1.6 | 0.12 JQ | <0.25 | 1 | <0.25 | 1.46 | 65.2 | 0 | 3.5 | 0 | 0.4 | NA | 30.8 | 0.29 | 120 | 46 | 54 | NA |
| SDCR-8 | 8 | 9 | 09/28/2009 | SDCR8-CJ-092809 | <6.4 | 17 | <6.4 | 2.2 JQ | 15 | <6.4 | 1.42 | 73.3 | 0 | 0.6 | 0 | 0.1 | NA | 26 | <6.4 | 230 | 49 | 51 | NA |
| SDCR-8 | 9 | 10 | 09/28/2009 | SDCR8-CK-092809 | 0.48 | 1.1 | <0.26 | 0.56 | 1.1 | <0.26 | 1.43 | 79.1 | 0 | 0.1 | 0 | 0 | NA | 20.7 | <0.26 | 170 | 49 | 51 | NA |
| SDCR-8 | 10 | 11 | 09/28/2009 | SDCR8-CL-092809 | 0.088 J | 0.48 J | <0.065 J | 0.093 J | 0.36 J | <0.065 J | 1.53 | 76.2 | 0 | 0 | 0 | 0.3 | NA | 23.5 | NA | 63 | 49 | 51 | NA |
| SDCR-9 | 0 | 1 | 09/26/2009 | SDCR9-CA-092609 | 0.6 J | 0.96 J | <0.13 | <0.13 | <0.13 | <0.13 | 1.16 | 69.1 | 1.6 | 2.2 | 0 | 1.6 | NA | 25.5 | NA | 120 J | 74 | 26 | 0.03 |
| SDCR-9 | 1 | 2 | 09/26/2009 | SDCR9-CB-092609 | 0.55 | 0.4 | 0.038 JQ | 0.0048 JQ | <0.045 | 0.021 JQ | 1.22 | 79.6 | 0.2 | 0.8 | 0 | 0.7 | NA | 18.7 | NA | 170 | 71 | 29 | NA |
| SDCR-9 | 2 | 3 | 09/26/2009 | SDCR9-CC-092609 | 0.0087 JQ | <0.0091 | <0.0091 | 0.016 | <0.0091 | <0.0091 | 1.27 | 82.5 | 0 | 0.8 | 0 | 0.3 | NA | 16.4 | NA | 15 | 64 | 36 | NA |
| SDCR-9 | 3 | 4 | 09/26/2009 | SDCR9-CD-092609 | <0.0080 | <0.0080 | <0.0080 | 0.021 | <0.008 | <0.0080 | 1.39 | 84.2 | 0.1 | 0.5 | 0 | 0.2 | NA | 15 | NA | 3.1 | 59 | 41 | NA |
| SDCR-9 | 4 | 5 | 09/26/2009 | SDCR9-CE-092609 | <0.0077 | <0.0077 | <0.0077 | 0.0032 JQ | <0.0077 | <0.0077 | 1.38 | 85.8 | 0.1 | 0.4 | 0 | 0.2 | NA | 13.5 | NA | 0.25 | 57 | 43 | NA |
| SDCR-9 | 5 | 6 | 09/26/2009 | SDCR9-CF-092609 | <0.0074 J | <0.0074 J | <0.0074 J | <0.0074 J | <0.0074 J | <0.0074 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.14 | 56 | 44 | NA |
| SDCR-10 | 0 | 1 | 09/26/2009 | SDCR10-CA-092609 | NA | NA | NA | NA | NA | NA | 1.19 | 51.3 | 0 | 1.6 | 0 | 0.8 | NA | 46.3 | NA | 19 | 77 | 23 | NA |
| SDCR-10 | 1 | 2 | 09/26/2009 | SDCR10-CB-092609 | NA | NA | NA | NA | NA | NA | 1.27 | 70.4 | 0 | 0.4 | 0 | 0.1 | NA | 29.1 | NA | 25 | 71 | 29 | NA |
| SDCR-10 | 2 | 3 | 09/26/2009 | SDCR10-CC-092609 | NA | NA | NA | NA | NA | NA | 1.18 | 70.5 | 0 | 0.2 | 0 | 0.1 | NA | 29.1 | NA | 24 | 71 | 29 | NA |
| SDCR-10 | 3 | 4 | 09/26/2009 | SDCR10-CD-092609 | NA | NA | NA | NA | NA | NA | 1.22 | 80.1 | 0 | 0.5 | 0 | 0.2 | NA | 19.3 | NA | 30 | 65 | 35 | NA |
| SDCR-10 | 4 | 5 | 09/26/2009 | SDCR10-CE-092609 | NA | NA | NA | NA | NA | NA | 1.39 | 86 | 0 | 0 | 0 | 0.1 | NA | 14 | NA | 2.6 J | 58 | 42 | NA |
| SDCR-10 | 5 | 6 | 09/26/2009 | SDCR10-CF-092609 | NA | NA | NA | NA | NA | NA | 1.34 | 86.1 | 0 | 0.2 | 0 | 0.4 | NA | 13.3 | NA | 0.35 | 58 | 42 | NA |
| SDCR-11 | 0 | 1 | 09/26/2009 | SDCR11-CA-092609 | NA | NA | NA | NA | NA | NA | 1.33 | 70.4 | 0 | 0.5 | 0 | 0.2 | NA | 28.9 | NA | NA | NA | NA | NA |
| SDCR-11 | 1 | 2 | 09/26/2009 | SDCR11-CB-092609 | NA | NA | NA | NA | NA | NA | 1.39 | 76.9 | 0 | 0.3 | 0 | 0 | NA | 22.8 | NA | NA | NA | NA | NA |
| SDCR-11 | 1.5 | 2 | 09/26/2009 | SDCR11-CC-092609 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.14 | 53 | 47 | NA |
| SDCR-11 | 2 | 3 | 09/26/2009 | SDCR11-CD-092609 | NA | NA | NA | NA | NA | NA | 1.55 | 30.7 | 0 | 1.6 | 0 | 0.1 | NA | 67.6 | NA | 0.13 J | 40 | 60 | NA |
| SDCR-11 | 3 | 4 | 09/26/2009 | SDCR11-CE-092609 | NA | NA | NA | NA | NA | NA | 1.65 | 23.5 | 0 | 4.9 | 0 | 0 | NA | 71.6 | NA | 1.3 | 35 | 65 | NA |
| SDCR-11 | 4 | 5 | 09/26/2009 | SDCR11-CF-092609 | NA | NA | NA | NA | NA | NA | 1.61 | 25.2 | 0 | 4.5 | 0 | 0.1 | NA | 70.1 | NA | 0.066 | 37 | 63 | NA |
| SDCR-12 | 0 | 1 | 09/25/2009 | SDCR12-CA-092509 | NA | NA | NA | NA | NA | NA | 1.27 | 83.2 | 0 | 0.4 | 0 | 0.2 | NA | 16.2 | NA | NA | NA | NA | NA |
| SDCR-12 | 1 | 2 | 09/25/2009 | SDCR12-CB-092509 | NA | NA | NA | NA | NA | NA | 1.25 | 78.5 | 0.2 | 1.1 | 0 | 0.7 | NA | 19.5 | NA | NA | NA | NA | NA |
| SDCR-12 | 1.5 | 2 | 09/25/2009 | SDCR12-CC-092509 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.38 | 70 | 30 | NA |
| SDCR-12 | 2 | 3 | 09/25/2009 | SDCR12-CD-092509 | NA | NA | NA | NA | NA | NA | 1.19 | 69 | 0.5 | 5.2 | 0 | 4.7 | NA | 20.7 | NA | 0.68 | 69 | 31 | NA |
| SDCR-12 | 3 | 4 | 09/25/2009 | SDCR12-CE-092509 | NA | NA | NA | NA | NA | NA | 1.31 | 68.9 | 0 | 1.9 | 0 | 1.7 | NA | 27.5 | NA | 0.17 | 62 | 38 | NA |
| SDCR-12 | 4 | 5 | 09/25/2009 | SDCR12-CF-092509 | NA | NA | NA | NA | NA | NA | 1.28 | 62.3 | 0.5 | 1 | 0 | 0.5 | NA | 35.7 | NA | 0.094 | 64 | 36 | NA |
| SDCR-12 | 5 | 6 | 09/25/2009 | SDCR12-CG-092509 | NA | NA | NA | NA | NA | NA | 1.33 | 60.4 | 0 | 0.2 | 0 | 0.2 | NA | 39.2 | NA | 0.088 | 62 | 38 | NA |
| SDCR-13 | 0 | 1 | 09/26/2009 | SDCR13-CA-092609 | <0.051 | <0.051 | <0.051 | <0.051 | <0.051 | <0.051 | 1.16 | 78.3 | 0.4 | 3.7 | 0 | 3.8 | NA | 13.8 | NA | 18 | 74 | 26 | NA |
| SDCR-13 | 1 | 2 | 09/26/2009 | SDCR13-CB-092609 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | 1.21 | 81.8 | 0.3 | 0.9 | 0 | 0.8 | NA | 16.1 | NA | 0.3 | 68 | 32 | NA |
| SDCR-13 | 2 | 3 | 09/26/2009 | SDCR13-CC-092609 | <0.012 | <0.012 | <0.012 | <0.012 | <0.012 | <0.012 | 1.21 | 57.2 | 0.1 | 7.9 | 0 | 6.8 | NA | 28 | NA | 0.27 | 72 | 28 | NA |
| SDCR-13 | 3 | 4 | 09/26/2009 | SDCR13-CD-092609 | <0.037 | <0.037 | <0.037 | <0.037 | <0.037 | <0.037 | 1.30 | 65.7 | 0 | 5.8 | 0 | 4.2 | NA | 24.2 | NA | 0.17 | 64 | 36 | NA |
| SDCR-13 | 4 | 5 | 09/26/2009 | SDCR13-CE-092609 | <0.016 | <0.016 | <0.016 | <0.016 | <0.016 | <0.016 | 1.34 | 59 | 0.2 | 0.5 | 0 | 0.2 | NA | 40.1 | NA | 0.092 | 60 | 40 | NA |

**Notes:**
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethylene
DDT - dichlorodiphenyltrichloroethane
ft - feet
g/cm$^3$ - gram per cubic centimeter
J - estimated; based on QC data
JQ - estimated; constituent was detected between the reporting limit and the method detection limit
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NA - not analyzed
SPLP - synthetic precipitation leaching procedure
% - percent
< - less than the reporting limit

PREPARED BY/DATE: RMR 4/7/2011
CHECKED BY/DATE: KPH 4/7/2011

**TABLE A-8**

**FINE SEDIMENT CORE ANALYTICAL RESULTS**
**Feasibility Study**
**Olin McIntosh OU-2**

| Location ID: | Beginning Depth (in) | Ending Depth (in) | Sample Date | Sample ID: | Mercury mg/kg | | Methylmercury mg/kg | | Percent Methylmercury | Percent Moisture % | Percent Solids % | Total Organic Carbon (TOC) mg/kg | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDCR-1 | 0 | 2.4 | 06/03/2009 | SDCR-1-FA-060309 | 46.7 | | 0.00672 | | 0.01% | NA | NA | 10700 | |
| SDCR-1 | 2.4 | 4.8 | 06/03/2009 | SDCR-1-FB-060309 | 128 | | 0.00675 | | 0.01% | NA | NA | 4330 | |
| SDCR-1 | 4.8 | 9.6 | 06/03/2009 | SDCR-1-FC-060309 | 96.6 | | 0.00254 | | 0.00% | NA | NA | 5100 | |
| SDCR-1 | 9.6 | 14.4 | 06/03/2009 | SDCR-1-FD-060309 | 36.6 | | 0.00482 | | 0.01% | NA | NA | 3410 | |
| SDCR-1 | 14.4 | 21.6 | 06/03/2009 | SDCR-1-FE-060309 | 17.6 | | 0.00148 | | 0.01% | NA | NA | 1320 | |
| SDCR-2 | 0 | 2 | 09/23/2009 | SDCR2-FSA-092309 | 2.5 | | 0.00136 | | 0.05% | 27 | 73 | 3300 | |
| SDCR-2 | 2 | 4 | 09/23/2009 | SDCR2-FSB-092309 | 7.7 | | 0.00117 | | 0.02% | 23 | 77 | 1600 | JQ |
| SDCR-2 | 4 | 8 | 09/23/2009 | SDCR2-FSC-092309 | 28 | | 0.0167 | | 0.06% | 33 | 67 | 5900 | |
| SDCR-2 | 8 | 12 | 09/23/2009 | SDCR2-FSD-092309 | 24 | | 0.0132 | | 0.06% | 37 | 63 | 3100 | |
| SDCR-2 | 12 | 18 | 09/23/2009 | SDCR2-FSE-092309 | 15 | | 0.00405 | | 0.03% | 30 | 70 | 2500 | |
| SDCR-3 | 0 | 2 | 09/23/2009 | SDCR3-FSA-092309 | 29 | | 0.00373 | | 0.01% | 67 | 33 | 14000 | |
| SDCR-3 | 2 | 4 | 09/23/2009 | SDCR3-FSB-092309 | 110 | | 0.00566 | | 0.01% | 58 | 42 | 14000 | |
| SDCR-3 | 4 | 8 | 09/23/2009 | SDCR3-FSC-092309 | 0.41 (A) | | 0.0131 | | -- | 61 | 39 | 9000 | |
| SDCR-3 | 8 | 12 | 09/23/2009 | SDCR3-FSD-092309 | 30 | | 0.00818 | | 0.03% | 60 | 40 | 14000 | |
| SDCR-3 | 12 | 18 | 09/23/2009 | SDCR3-FSE-092309 | 0.37 | J | 0.000308 | | 0.08% | 54 | 46 | 13000 | |
| SDCR-8 | 0 | 2 | 09/24/2009 | SDCR8-FSA-092409 | 24 | | 0.00446 | | 0.02% | 78 | 22 | 23000 | |
| SDCR-8 | 2 | 4 | 09/24/2009 | SDCR8-FSB-092409 | 26 | | 0.00436 | | 0.02% | 76 | 24 | 21000 | |
| SDCR-8 | 4 | 8 | 09/24/2009 | SDCR8-FSC-092409 | 26 | | 0.00321 | | 0.01% | 72 | 28 | 22000 | |
| SDCR-8 | 8 | 12 | 09/24/2009 | SDCR8-FSD-092409 | 18 | | 0.00313 | | 0.02% | 68 | 32 | 20000 | |
| SDCR-8 | 12 | 18 | 09/24/2009 | SDCR8-FSE-092409 | 15 | | 0.00271 | | 0.02% | 74 | 26 | 19000 | |
| SDCR-11 | 0 | 2 | 09/25/2009 | SDCR11-FSA-092509 | 33 | | 0.00579 | | 0.02% | 79 | 21 | 31000 | |
| SDCR-11 | 2 | 4 | 09/25/2009 | SDCR11-FSB-092509 | 40 | | 0.0068 | | 0.02% | 73 | 27 | 25000 | |
| SDCR-11 | 4 | 8 | 09/25/2009 | SDCR11-FSC-092509 | 36 | | 0.00589 | | 0.02% | 70 | 30 | 24000 | |
| SDCR-11 | 8 | 12 | 09/25/2009 | SDCR11-FSD-092509 | 200 | | 0.014 | | 0.01% | 66 | 34 | 16000 | |
| SDCR-11 | 12 | 18 | 09/25/2009 | SDCR11-FSE-092509 | 46 | J | 0.00369 | | 0.01% | 61 | 39 | 18000 | |
| SDCR-12 | 0 | 2 | 09/25/2009 | SDCR12-FSA-092509 | 12 | | 0.00324 | | 0.03% | 85 | 15 | 38000 | |
| SDCR-12 | 2 | 4 | 09/25/2009 | SDCR12-FSB-092509 | 17 | | 0.00282 | | 0.02% | 78 | 22 | 34000 | |
| SDCR-12 | 4 | 8 | 09/25/2009 | SDCR12-FSC-092509 | 19 | | 0.00189 | | 0.01% | 77 | 23 | 33000 | |
| SDCR-12 | 8 | 12 | 09/25/2009 | SDCR12-FSD-092509 | 67 | | 0.006 | | 0.01% | 74 | 26 | 27000 | |
| SDCR-12 | 12 | 18 | 09/25/2009 | SDCR12-FSE-092509 | 0.38 | | 0.000222 | JB | 0.06% | 67 | 33 | 21000 | |

**Notes:**
(A) - anomalous data point
in - inch
mg/kg - milligram per kilogram
% - percent
J - estimated; based on QC data
JB - estimated; possibly biased high or false positive based on blank data
JQ - estimated; constituent was detected between the reporting limit and the method detection limit
NA - not analyzed

PREPARED BY/DATE: RMR 4/5/2010
CHECKED BY/DATE: AES 4/5/2010

**TABLE A-9**

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

| | Transect 1 | | | | | | Transect 1 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Deep Samples | | | Shallow Samples | | | 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 | OU2B-SW-103DD-06 | OU2B-SW-103DD-08 | OU2B-SW-103DD-09 | OU2B-SW-103DS-06 | OU2B-SW-103DS-08 | OU2B-SW-103DS-09 |
| Sample Date: | 05/22/2006 | 06/04/2008 | 06/04/2009 | 05/22/2006 | 06/04/2008 | 06/04/2009 | 05/23/2006 | 06/04/2008 | 06/04/2009 | 05/23/2006 | 06/04/2008 | 06/04/2009 |
| Sample Depth (ft.): | 8 | 9 | 13 | 2 | 2 | 3.5 | 9 | 10 | 15 | 2 | 3 | 4 |
| Depth to Bottom (ft.): | 10 | 11.3 | 16.6 | 10 | 11.3 | 16.6 | 11.9 | 13.4 | 19.3 | 11.9 | 13.4 | 19.3 |
| **FIXED BASE LABORATORY ANALYSIS:** | | | | | | | | | | | | |
| Alkalinity - EPA 310.1, SM 2320B, mg/L | 39 | 53.5 | 31.8 | 39 | 53.5 | 31.8 | 37.4 | 53.5 | 33.9 | 39 | 55.8 | 31.8 |
| Dissolved Organic Carbon - SM 5310B, SW846 9060, mg/L | 13 | 8.7 | 16 | 10 | 8.9 | 16 | 3.3 | 7.6 | 16 | 3.4 | 4.3 | 16 |
| Hardness, Total - EPA 130.2, SM 2340C, mg/L | 64 | 72 | 36 | 60 | 74 | 36 | 62 | 72 | 36 | 58 | 78 | 38 |
| Mercury - SW846 7470, EPA 1631, µg/L[1] | | | | | | | | | | | | |
| Mercury, Filtered | < 0.2 | 0.0121 | 0.0142 | < 0.2 | 0.014 | 0.00457 | < 0.2 | 0.0109 | 0.0124 | < 0.2 | 0.0183 | 0.00427 |
| Mercury, Unfiltered | < 0.2 | 0.292 | 0.0547 | < 0.2 | 0.137 | 0.0106 | < 0.2 | 0.269 | 0.095 | < 0.2 | 0.264 | 0.0128 |
| Methylmercury - EPA 1630, µg/L | | | | | | | | | | | | |
| Methylmercury, Filtered | 0.000396 | 0.000883 | 0.00048 | 0.000244 | 0.000867 | 0.000461 | 0.000234 | 0.000838 | 0.000452 | 0.000209 | 0.0000807 | 0.000426 |
| Methylmercury, Unfiltered | 0.000487 | 0.00301 | 0.000693 | 0.000435 | 0.00308 | 0.000782 | 0.000514 | 0.00291 | 0.000613 | 0.000505 | 0.00249 | 0.000734 |
| Sulfate, Total - SW846 9038, mg/L | 35.1 | NA | NA | 29.9 | NA | NA | 31.4 | NA | NA | 29 | NA | NA |
| Sulfide, Total - SW846 9030A, mg/L | < 1 | NA | NA | 4.4 | NA | NA | < 1 | NA | NA | 1.9 | NA | NA |
| Total Dissolved Solids - EPA 160.1, SM 2540C, mg/L | 140 | 420 | 55 | 136 | 410 | 57.5 | 160 | 445 | 55 | 164 | 415 | 45 |
| Total Suspended Solids - EPA 160.2, SM 2540D, mg/L | 7 | 7 | < 4 | 12 | 12 | 4.5 | 34 | 7 | < 4 | 6 | 13 | 4 |
| **FIELD PARAMETERS:** | | | | | | | | | | | | |
| Dissolved Oxygen - EPA 360.1, mg/L | 4.25 | 1.78 | 1.86 | 9.64 | 11.1 | 5.3 | 4.8 | 0.68 | 2.28 | 6.4 | 9.04 | 9.15 |
| Oxidation Reduction Potential - A2580A, mV | 215 | 33.4 | 304 | 204 | -19.1 | 292 | 192 | 38.2 | 289 | 140 | 3.70 | 269 |
| pH - EPA 150.1, pH Units | 6.78 | 7.46 | 6.35 | 7.29 | 8.06 | 6.72 | 6.99 | 7.29 | 6.30 | 8.73 | 7.99 | 6.76 |
| Specific Conductance - EPA 120.1, mS/cm | 2.95 | 0.668 | 0.129 | 2.67 | 0.655 | 0.123 | 3.77 | 0.689 | 0.132 | 3.71 | 0.660 | 0.125 |
| Temperature - EPA 170.1, °C | 21.9 | 27.0 | 22.9 | 25.0 | 29.9 | 24.4 | 21.8 | 26.6 | 22.8 | 29.6 | 29.9 | 25.2 |
| Turbidity - EPA 180.1, NTU | 17.8 | 4.3 | 11.8 | 14.4 | 8.8 | 6.8 | 20.1 | 6.8 | 11.4 | 11.2 | 10.4 | 6.3 |

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 A-9**

**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 r
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 A-9**

**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 r
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 A-9**

**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 r
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 A-9**

**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 n
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.

PREPARED BY/DATE: AES 9/2/2009
CHECKED BY/DATE: RMR 12/9/2009

**TABLE A-10**

**2010 VEGETATION ANALYTICAL RESULTS**
**Feasibility Study**
**Olin McIntosh OU-2**

| 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 |
| **<u>Mercury, EPA 245.6, mg/Kg</u>** | | | | | | | | | | | | |
| Mercury | < 0.017 | < 0.017 | < 0.017 | < 0.017 | < 0.017 | < 0.017 | < 0.017 | < 0.017 | < 0.017 | NA | < 0.017 | < 0.017 |
| **<u>Methylmercury, EPA 1630, mg/Kg</u>** | | | | | | | | | | | | |
| 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 |
| **<u>Percent Lipids, %</u>** | | | | | | | | | | | | |
| 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 |
| **<u>Pesticides - SW846 8081, mg/Kg</u>** | | | | | | | | | | | | |
| 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).

PREPARED BY/DATE: <u>KPH 03/14/11</u>
CHECKED BY/DATE: <u>RRP 3/15/11</u>

**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 A-11**

**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

PREPARED BY/DATE: KPH 03/14/11
CHECKED BY/DATE: RRP 3/15/11

**TABLE A-12**

**2010 FLOODPLAIN SOIL ANALYTICAL RESULTS**
**Feasibility Study**
**Olin McIntosh OU-2**

| Sample ID | OU2B-FPSB1-10-0-1 | OU2B-FPSB1-10-1-2 | OU2B-FPSB1-10-2-6 | OU2B-FPSB1-10-6-12 | OU2B-FPSB2-10-0-1 | OU2B-FPSB2-10-1-2 | OU2B-FPSB2-10-2-6 | OU2B-FPSB2-10-6-12 | OU2B-FPSB3-10-0-1 | OU2B-FPSB3-10-1-2 | OU2B-FPSB3-10-2-6 | OU2B-FPSB3-10-6-12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample date | 7/11/2010 | 7/11/2010 | 7/11/2010 | 7/11/2010 | 7/11/2010 | 7/11/2010 | 7/11/2010 | 7/11/2010 | 7/10/2010 | 7/10/2010 | 7/10/2010 | 7/10/2010 |
| Sample depth (in) | 0-1 | 1-2 | 2-6 | 6-12 | 0-1 | 1-2 | 2-6 | 6-12 | 0-1 | 1-2 | 2-6 | 6-12 |
| Mercury (mg/kg) | 0.31 | 0.43 | 0.78 | 0.12 | 0.38 | 0.35 | 0.37 | 0.36 | 0.2 | 0.14 | 0.22 | 0.93 |
| Methylmercury (ng/g) | 2.98 | 1.8 | NA | NA | 4.79 | 2.21 | NA | NA | 2.57 | 1.66 | NA | NA |
| Hexachlorobenzene (ug/kg) | 12.4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| DDTR (ug/kg) | 2209.1 | NA | NA | NA | 87.1 | NA | NA | NA | 48.5 | NA | NA | NA |
| DDTRa (ug/kg) | 2209.1 | NA | NA | NA | 87.1 | NA | NA | NA | 48.5 | NA | NA | NA |

| Sample ID | OU2B-FPSB4-10-0-1 | OU2B-FPSB4-10-1-2 | OU2B-FPSB4-10-2-6 | OU2B-FPSB4-10-6-12 | OU2B-FPSB5-10-0-1 | OU2B-FPSB5-10-1-2 | OU2B-FPSB5-10-2-6 | OU2B-FPSB5-10-6-12 | OU2B-FPSB6-10-0-1 | OU2B-FPSB6-10-1-2 | OU2B-FPSB6-10-2-6 | OU2B-FPSB6-10-6-12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample date | 7/10/2010 | 7/10/2010 | 7/10/2010 | 7/10/2010 | 7/9/2010 | 7/9/2010 | 7/9/2010 | 7/9/2010 | 7/10/2010 | 7/10/2010 | 7/10/2010 | 7/10/2010 |
| Sample depth (in) | 0-1 | 1-2 | 2-6 | 6-12 | 0-1 | 1-2 | 2-6 | 6-12 | 0-1 | 1-2 | 2-6 | 6-12 |
| Mercury (mg/kg) | 0.061 | 0.11 | 0.14 | 0.082 | 2.4 | 2.1 | 2.8 | 3.6 | 0.36 | 0.14 | 0.19 | 0.17 |
| Methylmercury (ng/g) | 0.367 | 0.767 | NA | NA | 7.03 | 8.22 | NA | NA | 0.442 | 0.176 | NA | NA |
| Hexachlorobenzene (ug/kg) | 1.2 | NA | NA | NA | 3.5 | NA | NA | NA | < 1.0 | NA | NA | NA |
| DDTR (ug/kg) | 9.8 | NA | NA | NA | NA | NA | NA | NA | 0 | NA | NA | NA |
| DDTRa (ug/kg) | 11.12 | NA | NA | NA | NA | NA | NA | NA | 4.5 | NA | NA | NA |

| Sample ID | OU2B-FPSS1-10 | OU2B-FPSS2-10 | OU2B-FPSS3-10 | OU2B-FPSS4-10 | OU2B-FPSS5-10 | OU2B-FPSS6-10 | OU2B-FPSS7-10 | OU2B-FPSS8-10 | OU2B-FPSS9-10 | OU2B-FPSS10-10 | OU2B-FPSS11-10 | OU2B-FPSS12-10 | OU2B-FPSS13-10 | OU2B-FPSS14-10 | OU2B-FPSS15-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample date | 7/9/2010 | 7/11/2010 | 7/11/2010 | 7/9/2010 | 7/11/2010 | 7/9/2010 | 7/9/2010 | 7/9/2010 | 7/11/2010 | 7/9/2010 | 7/9/2010 | 7/12/2010 | 7/8/2010 | 7/8/2010 | 7/12/2010 |
| Sample depth (in) | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 |
| Mercury (mg/kg) | 0.69 | 8.9 | 1.6 | 0.2 | 0.47 | 0.16 | 1.1 | 0.15 | 0.84 | 0.13 | 1 | 0.42 | 1.6 | 1.7 | 2.5 |
| Methylmercury (ng/g) | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Hexachlorobenzene (ug/kg) | NA | NA | NA | NA | NA | NA | NA | NA | NA | 1.1 | 5.7 | < 0.76 | NA | 275 | 135 |
| DDTR (ug/kg) | 2230.2 | NA | 328.6 | 93.3 | NA | 215.7 | 55.3 | 294.7 | 13.1 | 1 | 35 | 5.58 | NA | NA | NA |
| DDTRa (ug/kg) | 2230.2 | NA | 335.2 | 93.95 | NA | 215.7 | 55.3 | 294.7 | 16.1 | 3.75 | 35.87 | 5.96 | NA | NA | NA |

Notes:
FPSS2-10 is part of the channel between Round Pond and the Basin and will be included in the sediment remediation footprint
DDTR - sum of detected 2,4' - and 4,4' - isomers of DDD, DDE, and DDT
DDTRa - sum of all 2,4' - and 4,4' - isomers of DDD, DDE, and DDT. Includes half the reporting limit for samples below detection.

Prepared by: JAN 3-18-2012
Checked by: ELF 03-19-2012

**TABLE A-13**
**GATE OVERFLOW SAMPLING ANALYTICAL RESULTS**
**Updated RI Addendum - Including 2010 ESPP Results**
**Olin McIntosh OU-2**

| **Basin Samples** | | | | |
|---|---|---|---|---|
| Event Date | **Gate Samples Event 1: November 2, 2009** | | | |
| Basin Elevation (ft NAVD 88) | 10-11 | | 8-9 | 6-7 |
| Sample ID | OU2B-SW-GATE-1-110209 | OU2B-SW-GATE-1-110209B | NS | NS |
| Mercury, unfiltered (µg/L) | 0.0358 | 0.0384 | NS | NS |
| Mercury, filtered (µg/L) | 0.00508 | 0.00574 | NS | NS |
| Methylmercury, unfiltered (µg/L) | NA[1] | NA[1] | NS | NS |
| Methylmercury, filtered (µg/L) | NA[1] | NA[1] | NS | NS |
| Total Dissolved Solids (mg/L) | 652 | NA | NS | NS |
| Total Suspended Solids (mg/L) | 9.5 | NA | NS | NS |

| **Basin Samples** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Event Date | **Gate Samples Event 2: November 30, 2009 - December 2, 2009** | | | | | | |
| Basin Elevation (ft NAVD 88) | 10-11 | | | 8-9 | | | 6-7 |
| Sample ID | OU2B-SW-GATE-1A-113009 | OU2B-SW-GATE-1B-113009 | NS | OU2B-SW-GATE-2A-120209 | OU2B-SW-GATE-2B-120209 | OU2B-SW-GATE-2C-120209 | NS |
| Mercury, unfiltered (µg/L) | 0.0551 | 0.0574 | NS | 0.0873 | 0.08 | 0.0835 | NS |
| Mercury, filtered (µg/L) | 0.00651 | 0.00589 | NS | 0.00711 | 0.00746 | 0.00765 | NS |
| Methylmercury, unfiltered (µg/L) | 0.000947 | 0.000838 | NS | 0.000837 | 0.00088 | 0.000765 | NS |
| Methylmercury, filtered (µg/L) | 0.000613 | 0.000693 | NS | 0.000581 | 0.000687 | 0.000486 | NS |
| Total Dissolved Solids (mg/L) | 110 | NA | NS | 67.5 | NA | NA | NS |
| Total Suspended Solids (mg/L) | 9.5 | NA | NS | 7.5 | NA | NA | NS |

| **Tombigbee River Samples** | | | | |
|---|---|---|---|---|
| Event Date | **Tombigbee River Samples Event 1: November 2, 2009** | | | |
| Basin Elevation (ft NAVD 88) | 10-11 | | 8-9 | 6-7 |
| Sample ID | OU2B-SW-TBR-1-110209 | OU2B-SW-TBR-1-110209B | NS | NS |
| Mercury, unfiltered (µg/L) | 0.00507 | 0.00621 | NS | NS |
| Mercury, filtered (µg/L) | 0.00139 | NA | NS | NS |
| Methylmercury, unfiltered (µg/L) | NA[1] | NA[1] | NS | NS |
| Methylmercury, filtered (µg/L) | NA[1] | NA[1] | NS | NS |
| Total Dissolved Solids (mg/L) | 108 | NA | NS | NS |
| Total Suspended Solids (mg/L) | 65 | NA | NS | NS |

| **Basin Samples** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Event Date | **Gate Samples Event 3: January 12, 2010 - January 18, 2010** | | | | | | | | |
| Basin Elevation (ft NAVD 88) | 10-11 | | | 8-9 | | | 6-7 | | |
| Sample ID | OU2B-SW-GATE-1A-011210 | OU2B-SW-GATE-1B-011210 | OU2B-SW-GATE-1C-011210 | OU2B-SW-GATE-2A-011410 | OU2B-SW-GATE-2B-011410 | OU2B-SW-GATE-2C-011410 | OU2B-SW-GATE-3A-011810 | OU2B-SW-GATE-3B-011810 | OU2B-SW-GATE-3C-011810 |
| Mercury, unfiltered (µg/L) | 0.0183 | 0.0185 | 0.0179 | 0.0194 | 0.018 | 0.0183 | 0.0296 | 0.0324 | 0.0314 |
| Mercury, filtered (µg/L) | 0.00304 | 0.00346 | 0.00324 | 0.00368 | 0.00368 | 0.00361 | 0.00461 | 0.00464 | 0.00571 |
| Methylmercury, unfiltered (µg/L) | 0.000246 | 0.000299 | 0.000348 | 0.000294 | 0.000284 | 0.000302 | 0.000343 | 0.000297 | 0.000334 |
| Methylmercury, filtered (µg/L) | 0.000166 | 0.000251 | 0.000206 | 0.000177 | 0.000246 | 0.000207 | 0.000234 | 0.000204 | 0.000213 |
| Total Dissolved Solids (mg/L) | 82.5 | NA | NA | 70 | NA | NA | 70 | NA | NA |
| Total Suspended Solids (mg/L) | NA | NA | NA | NA | NA | NA | 5.5 | NA | NA |

| **Basin Samples** | | | |
|---|---|---|---|
| Event Date | **Gate Samples Event 4: March 9, 2010** | | |
| Basin Elevation (ft NAVD 88) | 8-9 | | |
| Sample ID | OU2B-SW-GATE-2A-030910 | OU2B-SW-GATE-2B-030910 | OU2B-SW-GATE-2C-030910 |
| Mercury, unfiltered (µg/L) | 0.0679 | 0.0700 | 0.0734 |
| Mercury, filtered (µg/L) | 0.00795 | 0.00854 | 0.00938 |
| Methylmercury, unfiltered (µg/L) | 0.000391 | 0.000362 | 0.000387 |
| Methylmercury, filtered (µg/L) | 0.000198 | 0.000187 | 0.000162 |
| Total Dissolved Solids (mg/L) | 110 | NA | NA |
| Total Suspended Solids (mg/L) | 12.0 | NA | NA |

| **Basin Samples** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Event Date | **Gate Samples Event 5: June 2, 2010 - June 7, 2010** | | | | | | | | |
| Basin Elevation (ft NAVD 88) | 10-11 | | | 8-9 | | | 6-7 | | |
| Sample ID | OU2B-SW-GATE-1A-060210 | OU2B-SW-GATE-1B-060210 | OU2B-SW-GATE-1C-060210 | OU2B-SW-GATE-2A-060410 | OU2B-SW-GATE-2B-060410 | OU2B-SW-GATE-2C-060410 | OU2B-SW-GATE-3A-060710 | OU2B-SW-GATE-3B-060710 | OU2B-SW-GATE-3C-060710 |
| Mercury, unfiltered (µg/L) | 0.0735 | 0.0744 | 0.0765 | 0.115 | 0.109 | 0.110 | 0.125 | 0.119 | 0.134 |
| Mercury, filtered (µg/L) | 0.0101 | 0.012 | 0.0106 | 0.0116 | 0.0126 | 0.0127 | 0.0125 | 0.012 | 0.0143 |
| Methylmercury, unfiltered (µg/L) | 0.000811 | 0.000695 | 0.00071 | 0.000571 | 0.000602 | 0.000578 | 0.000452 | 0.000369 | 0.00039 |
| Methylmercury, filtered (µg/L) | 0.000292 | 0.000324 | 0.000267 | 0.000184 | 0.000227 | 0.000183 | 0.000184 | 0.000209 | 0.000153 |
| Total Dissolved Solids (mg/L) | 141 | NA | NA | 137 | NA | NA | 128 | NA | NA |
| Total Suspended Solids (mg/L) | 12.0 | NA | NA | 14.0 | NA | NA | 11.0 | NA | NA |

**Notes:**

[1] - Misinterpretation of the chain-of-custody resulted in insufficient sample volume for methylmercury analysis.
ft NAVD88 - feet in the North American Vertical Datum of 1988
µg/L - microgram per liter
mg/L - milligram per liter
NA - sample was not anlyzed for this constituent.
NS - sample was not collected
Samples analyzed for mercury (filtered and unfiltered) and methylmercury (filtered and unfiltered) are collected in triplicate and are identified as A, B and C.

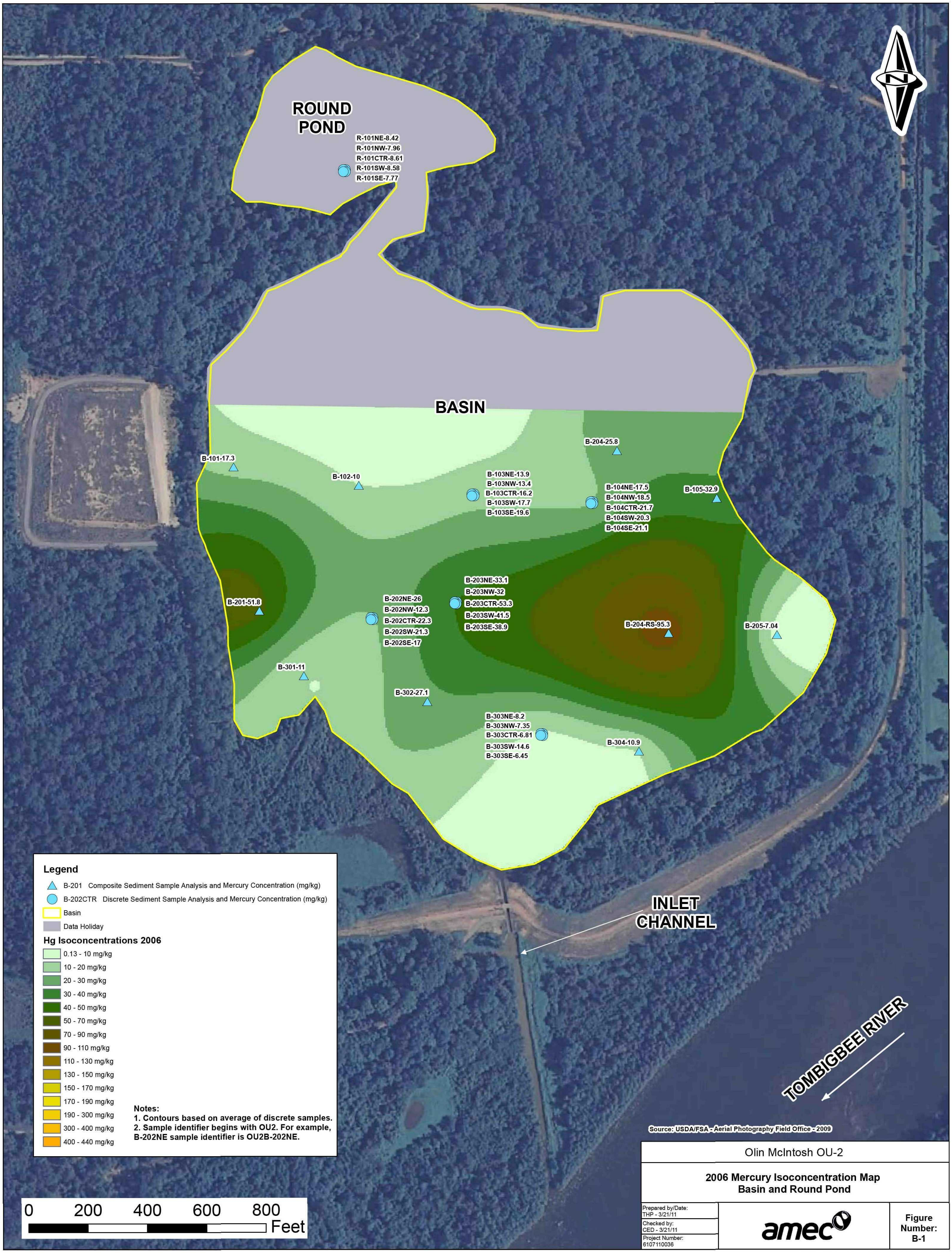
PRREPARED BY/DATE: MBR 09/09/2010
CHECKED BY/DATE: RMR 09/22/2010

# APPENDIX B

# REMEDIAL INVESTIGATION FIGURES

## APPENDIX B – LIST OF FIGURES

**Figures**

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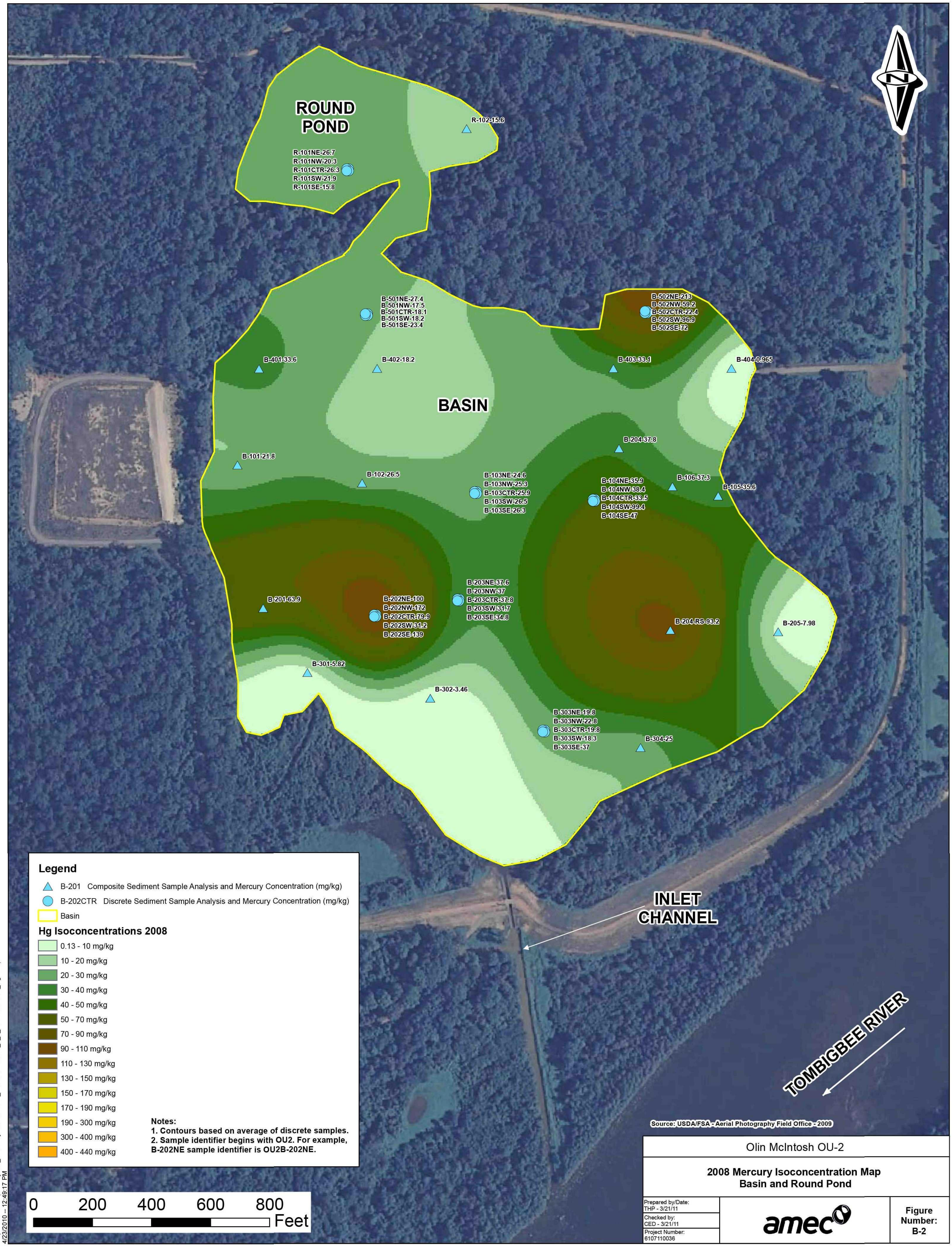


Olin McIntosh OU-2

**2008 Mercury Isoconcentration Map**
**Basin and Round Pond**

Prepared by/Date: THP - 3/21/11
Checked by: CED - 3/21/11
Project Number: 6107110036

amec

Figure Number: B-2

Map Document: (G:\Projects_GIS\Projects2007\olin_mcintosh\recont_3_9_10\mxds\2008_Hg.mxd)
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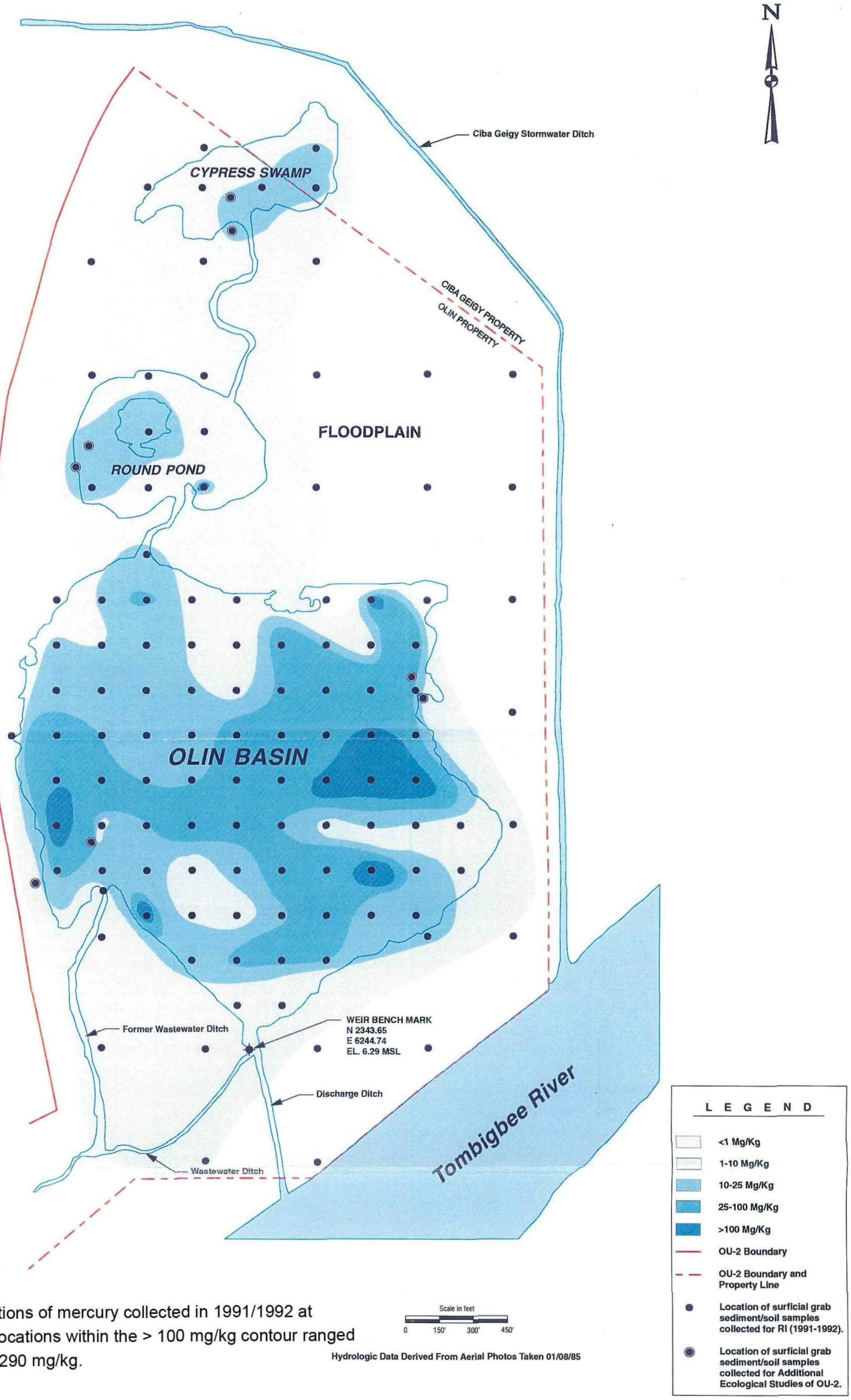
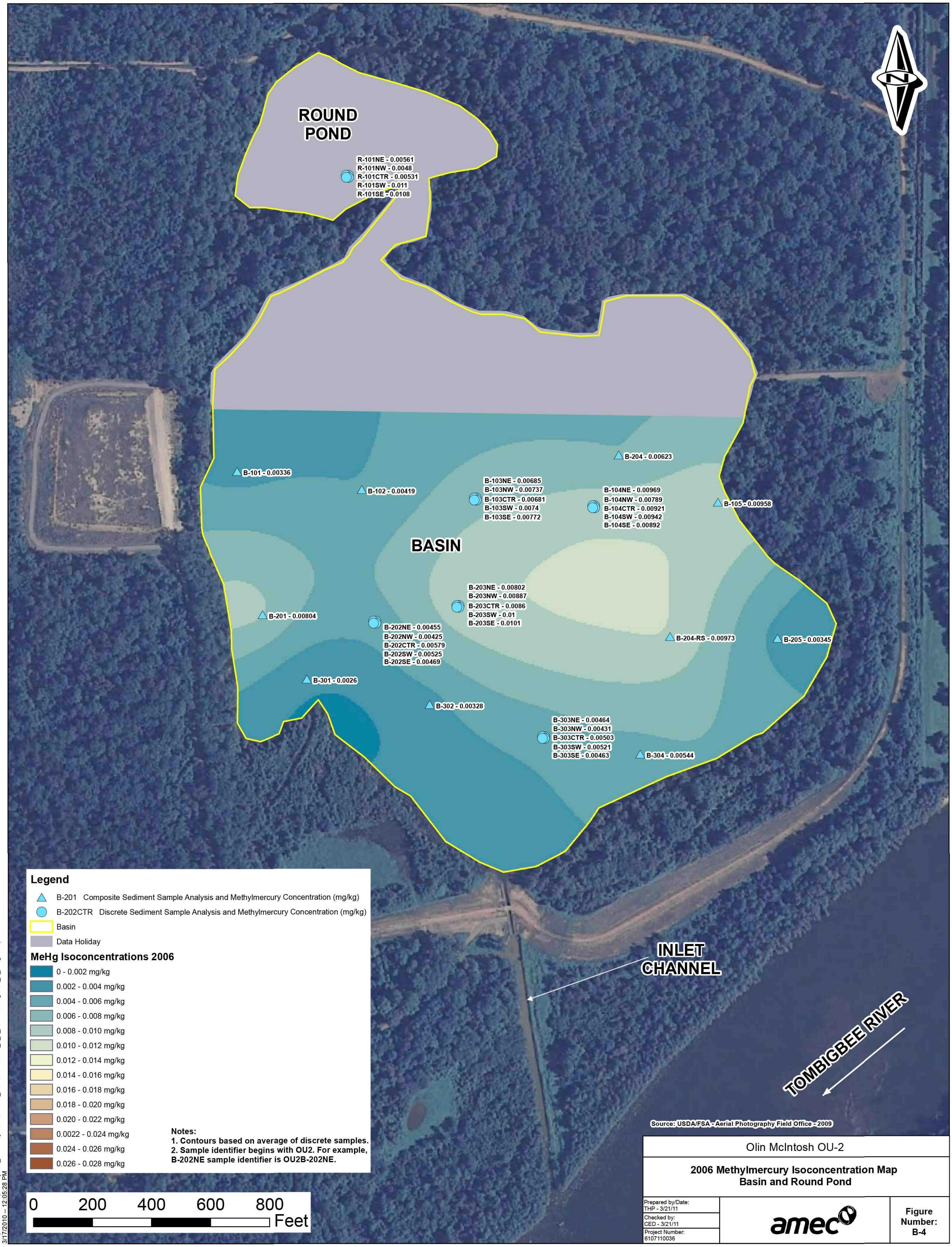



Note: Concentrations of mercury collected in 1991/1992 at sampling locations within the > 100 mg/kg contour ranged from 116-290 mg/kg.

WCC FILE: C:\DRAW\FILE\OLIN\04-6

| | | | |
|---|---|---|---|
| RI/FS McINTOSH PLANT SITE<br>Olin CHEMICALS<br>CHARLESTON, TENNESSEE | Woodward-Clyde<br>Engineering & sciences applied to the earth & its environment<br>Baton Rouge, Louisiana<br>SCALE: 1" = 450' · DRAWN BY: D.OLSON · DATE: 11/02/94 · CHKD. BY: W.BEAL · DATE: 11/03/94 | 1991<br>DISTRIBUTION OF MERCURY IN OU-2 | FILE NO. 93N063C<br>FIG. NO. B - 3 |

Source: WCC, 1994. Additional Ecological Studies of OU-2. Volumes 1 and 2. McIntosh Plant Site, Olin Corporation, McIntosh, Alabama November.




Map Document: (G:\Projects_GIS\Projects2007\olin_mcintosh\recont_3_9_10\mxds\Figure4_4_MHg.mxd)
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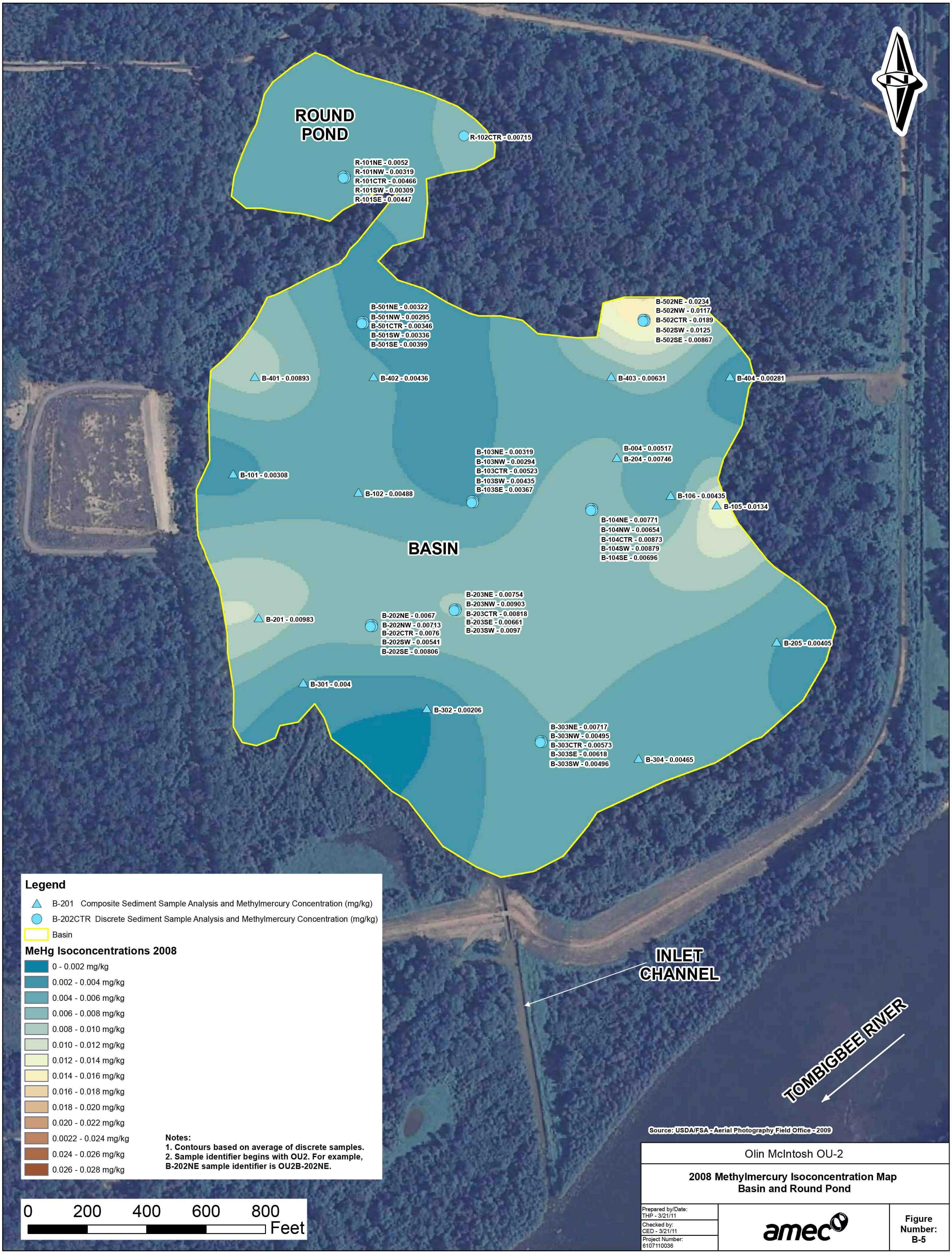



Olin McIntosh OU-2

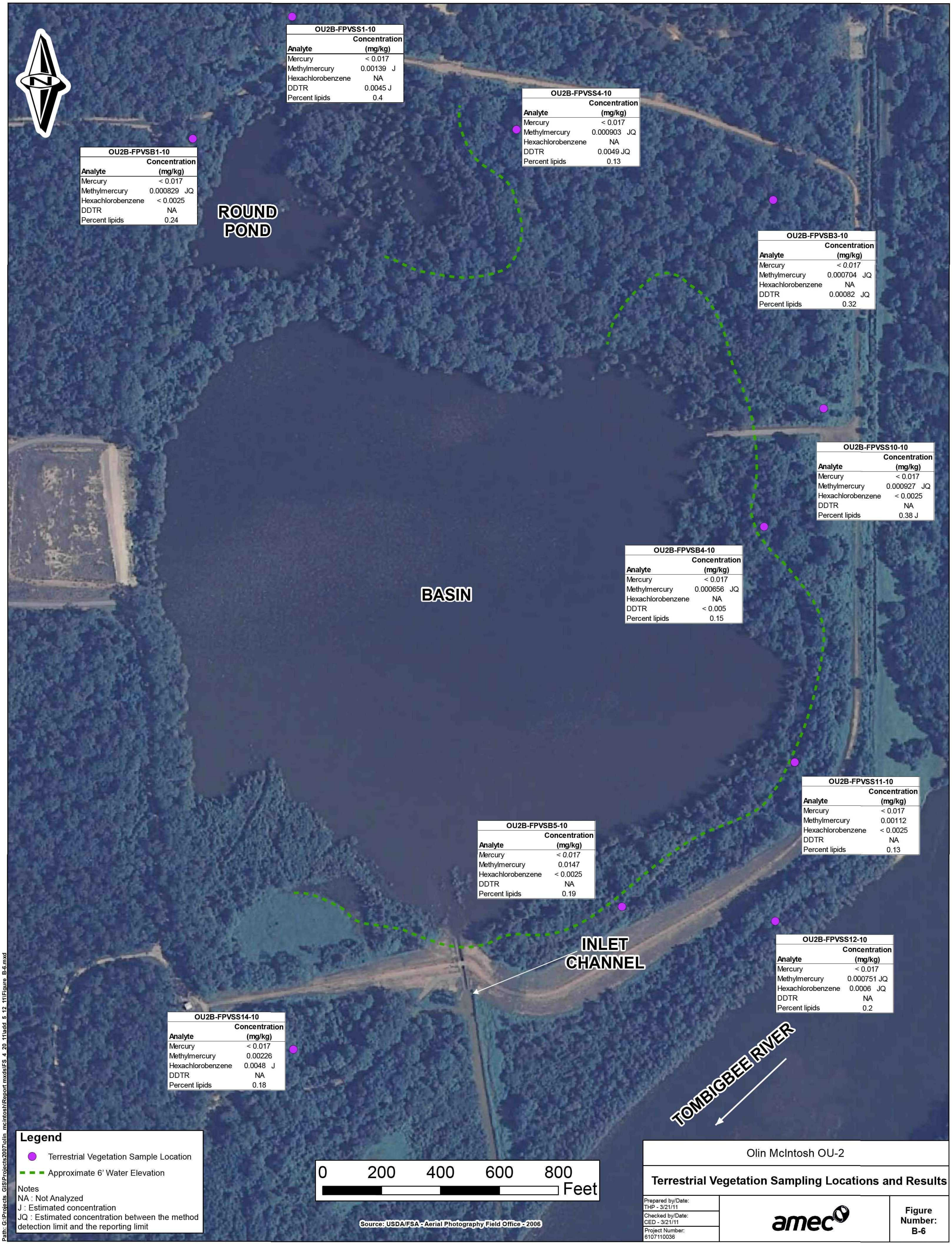
**2008 Methylmercury Isoconcentration Map
Basin and Round Pond**

Prepared by/Date: THP - 3/21/11
Checked by: CED - 3/21/11
Project Number: 6107110036

amec

Figure Number: B-5

Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\add_5_12_11\Figure_B-5.mxd




Olin McIntosh OU-2

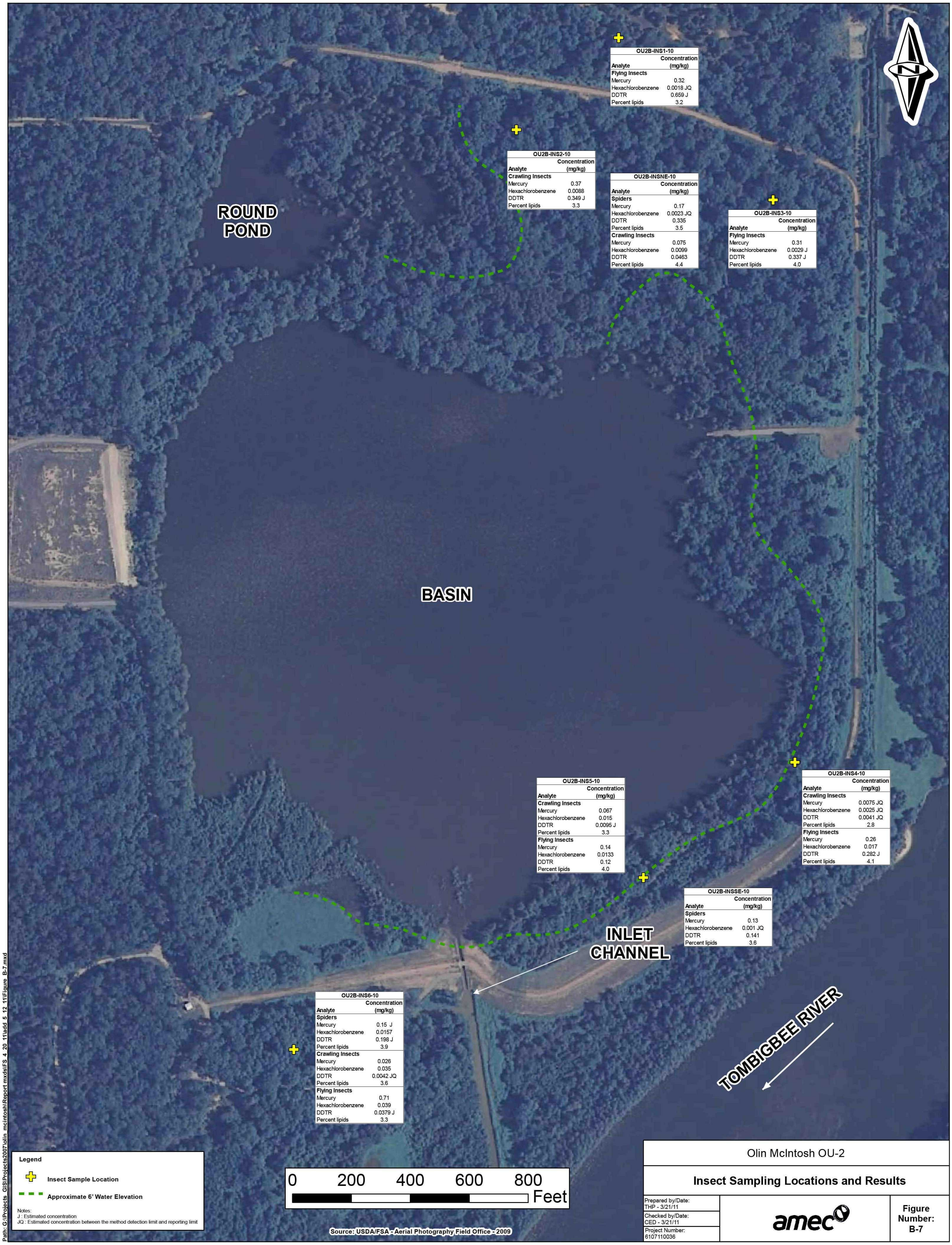
Terrestrial Vegetation Sampling Locations and Results

Prepared by/Date: THP - 3/21/11
Checked by/Date: CED - 3/21/11
Project Number: 6107110036

amec

Figure Number: B-6

Path: G:\Projects_GIS\Projects2007\olin_mcintosh\Report mxds\FS_4_20_11\add_5_12_11\Figure_B-6.mxd


OU2B-INS1-10
Analyte | Concentration (mg/kg)
Flying Insects
Mercury 0.32
Hexachlorobenzene 0.0018 JQ
DDTR 0.659 J
Percent lipids 3.2
OU2B-INS2-10
Analyte | Concentration (mg/kg)
Crawling Insects
Mercury 0.37
Hexachlorobenzene 0.0088
DDTR 0.349 J
Percent lipids 3.3
OU2B-INSNE-10
Analyte | Concentration (mg/kg)
Spiders
Mercury 0.17
Hexachlorobenzene 0.0023 JQ
DDTR 0.335
Percent lipids 3.5
Crawling Insects
Mercury 0.075
Hexachlorobenzene 0.0099
DDTR 0.0463
Percent lipids 4.4
OU2B-INS3-10
Analyte | Concentration (mg/kg)
Flying Insects
Mercury 0.31
Hexachlorobenzene 0.0029 J
DDTR 0.337 J
Percent lipids 4.0
ROUND POND
BASIN
OU2B-INS5-10
Analyte | Concentration (mg/kg)
Crawling Insects
Mercury 0.067
Hexachlorobenzene 0.015
DDTR 0.0095 J
Percent lipids 3.3
Flying Insects
Mercury 0.14
Hexachlorobenzene 0.0133
DDTR 0.12
Percent lipids 4.0
OU2B-INS4-10
Analyte | Concentration (mg/kg)
Crawling Insects
Mercury 0.0075 JQ
Hexachlorobenzene 0.0025 JQ
DDTR 0.0041 JQ
Percent lipids 2.8
Flying Insects
Mercury 0.26
Hexachlorobenzene 0.017
DDTR 0.282 J
Percent lipids 4.1
OU2B-INSSE-10
Analyte | Concentration (mg/kg)
Spiders
Mercury 0.13
Hexachlorobenzene 0.001 JQ
DDTR 0.141
Percent lipids 3.6
INLET CHANNEL
OU2B-INS6-10
Analyte | Concentration (mg/kg)
Spiders
Mercury 0.15 J
Hexachlorobenzene 0.0157
DDTR 0.198 J
Percent lipids 3.9
Crawling Insects
Mercury 0.026
Hexachlorobenzene 0.035
DDTR 0.0042 JQ
Percent lipids 3.6
Flying Insects
Mercury 0.71
Hexachlorobenzene 0.039
DDTR 0.0379 J
Percent lipids 3.3
TOMBIGBEE RIVER
N
Legend
Insect Sample Location
Approximate 6' Water Elevation
Notes:
J : Estimated concentration
JQ : Estimated concentration between the method detection limit and reporting limit
0 200 400 600 800 Feet
Source: USDA/FSA - Aerial Photography Field Office - 2009
Olin McIntosh OU-2
Insect Sampling Locations and Results
Prepared by/Date: THP - 3/21/11
Checked by/Date: CED - 3/21/11
Project Number: 6107110036
amec
Figure Number: B-7
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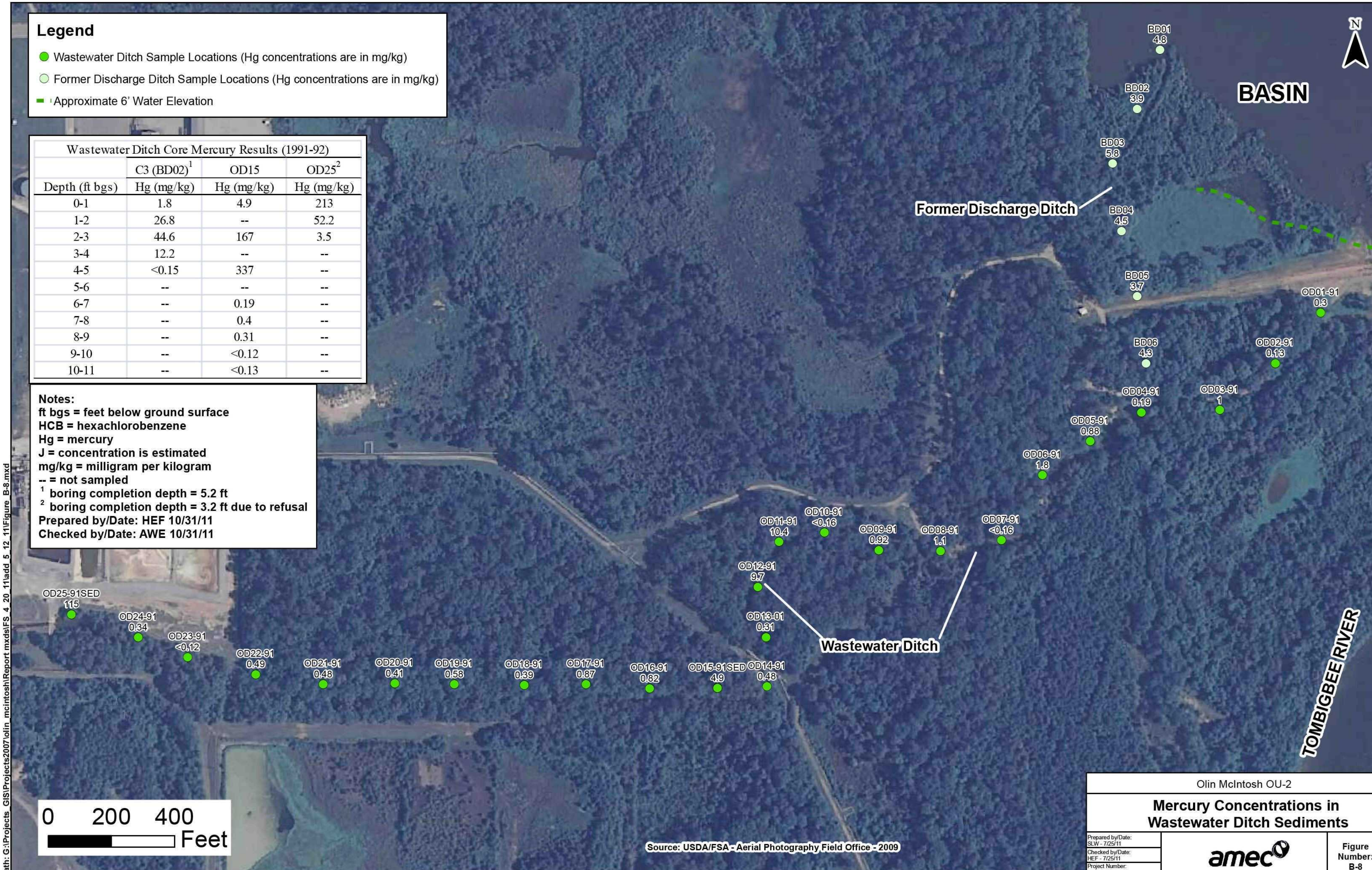


**Legend**

- Wastewater Ditch Sample Locations (Hg concentrations are in mg/kg)
- Former Discharge Ditch Sample Locations (Hg concentrations are in mg/kg)
- Approximate 6' Water Elevation

Wastewater Ditch Core Mercury Results (1991-92)

| | C3 (BD02)[1] | OD15 | OD25[2] |
|---|---|---|---|
| Depth (ft bgs) | Hg (mg/kg) | Hg (mg/kg) | Hg (mg/kg) |
| 0-1 | 1.8 | 4.9 | 213 |
| 1-2 | 26.8 | -- | 52.2 |
| 2-3 | 44.6 | 167 | 3.5 |
| 3-4 | 12.2 | -- | -- |
| 4-5 | <0.15 | 337 | -- |
| 5-6 | -- | -- | -- |
| 6-7 | -- | 0.19 | -- |
| 7-8 | -- | 0.4 | -- |
| 8-9 | -- | 0.31 | -- |
| 9-10 | -- | <0.12 | -- |
| 10-11 | -- | <0.13 | -- |

**Notes:**
**ft bgs = feet below ground surface**
**HCB = hexachlorobenzene**
**Hg = mercury**
**J = concentration is estimated**
**mg/kg = milligram per kilogram**
**-- = not sampled**
**[1] boring completion depth = 5.2 ft**
**[2] boring completion depth = 3.2 ft due to refusal**
**Prepared by/Date: HEF 10/31/11**
**Checked by/Date: AWE 10/31/11**

Olin McIntosh OU-2

**Mercury Concentrations in Wastewater Ditch Sediments**

Prepared by/Date: SLW - 7/25/11
Checked by/Date: HEF - 7/25/11
Project Number: 6107110036

amec

Figure Number: B-8

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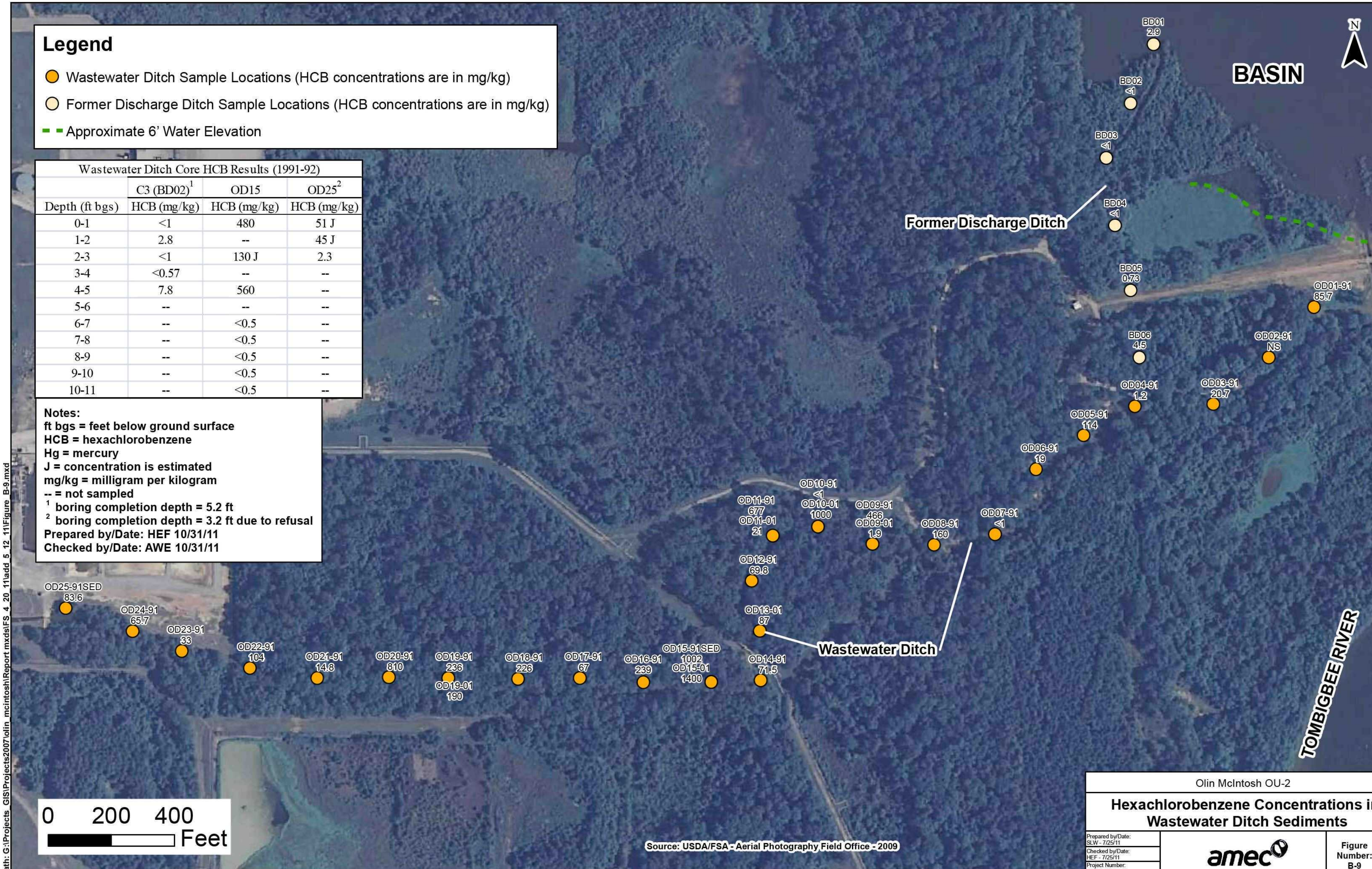


Wastewater Ditch Core HCB Results (1991-92)

| | C3 (BD02)[1] | OD15 | OD25[2] |
|---|---|---|---|
| Depth (ft bgs) | HCB (mg/kg) | HCB (mg/kg) | HCB (mg/kg) |
| 0-1 | <1 | 480 | 51 J |
| 1-2 | 2.8 | -- | 45 J |
| 2-3 | <1 | 130 J | 2.3 |
| 3-4 | <0.57 | -- | -- |
| 4-5 | 7.8 | 560 | -- |
| 5-6 | -- | -- | -- |
| 6-7 | -- | <0.5 | -- |
| 7-8 | -- | <0.5 | -- |
| 8-9 | -- | <0.5 | -- |
| 9-10 | -- | <0.5 | -- |
| 10-11 | -- | <0.5 | -- |

**Notes:**
**ft bgs = feet below ground surface**
**HCB = hexachlorobenzene**
**Hg = mercury**
**J = concentration is estimated**
**mg/kg = milligram per kilogram**
**-- = not sampled**
**[1] boring completion depth = 5.2 ft**
**[2] boring completion depth = 3.2 ft due to refusal**
**Prepared by/Date: HEF 10/31/11**
**Checked by/Date: AWE 10/31/11**

Olin McIntosh OU-2

## Hexachlorobenzene Concentrations in Wastewater Ditch Sediments

Prepared by/Date: SLW - 7/25/11
Checked by/Date: HEF - 7/25/11
Project Number: 6107110036

amec

Figure Number: B-9

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# APPENDIX C

# ESTIMATION FOR Kds

**APPENDIX C**

**Estimation of $K_d$'s**

The Steady-State Cap Design Model (Lampert and Reible, 2008), referred to as the Reible model, was used to evaluate whether a cap, with or without amendments, would be effective as an isolation barrier at OU-2.

Solid/aqueous partition coefficients ($K_d$'s) at a specific porewater concentration were estimated for each of three modeled cap materials for input into the Reible model. The $K_d$'s were estimated by calculating the ratio of mercury concentrations in cap material to porewater mercury concentrations for each potential cap material.

$$K_d = \frac{Cap\ Material\ Concentration}{Porewater\ Concentration\ of\ Interest}$$

Three cap materials were modeled under mid-level, less, and more conservative scenarios. The three cap materials modeled are listed below.

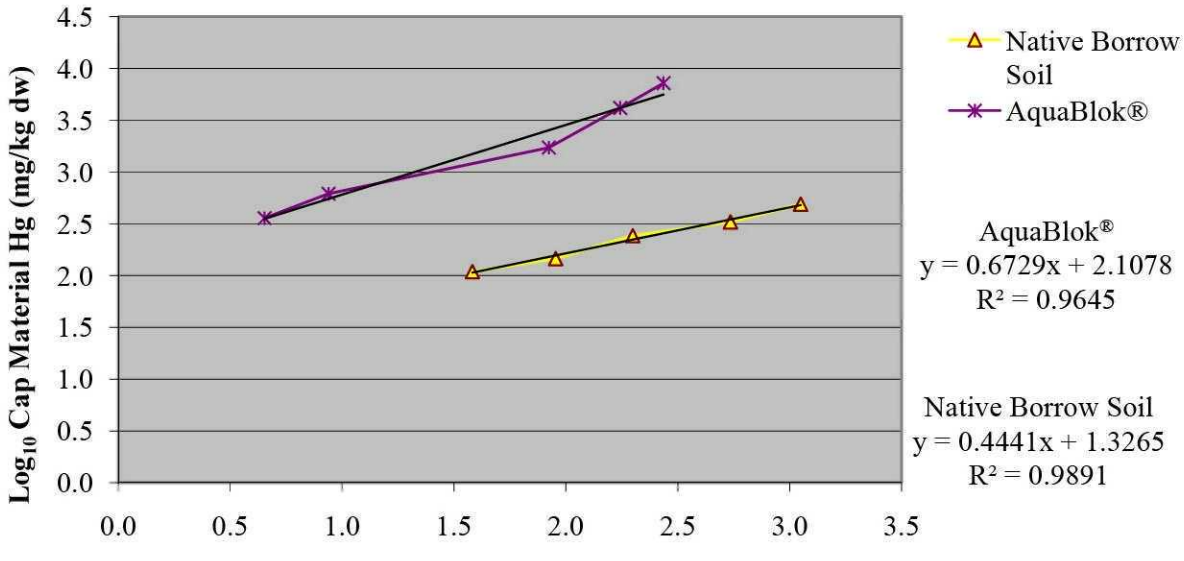
1. Native borrow soil for the cap material and a habitat layer of native borrow soil
2. AquaBlok® for the cap material and a habitat layer of native borrow soil mixed
3. Native borrow soil mixed with activated carbon (50/50 mix) for the cap material and a habitat layer of native borrow soil

$K_d$ for Native Borrow Soil

The $K_d$ for the mid-level conservative scenario was calculated using the average porewater concentration from 2009 fine core results for the top 1 foot of sediment from the south-central portion of the Basin (0.75 µg/L), where mercury concentrations are relatively higher. The $K_d$ for the less conservative scenario was calculated using the minimum value of porewater mercury concentrations from the 2009 fine core results for the top 1 foot of sediment (0.64 µg/L). The $K_d$ for the more conservative scenario was calculated using the maximum value of pore water mercury concentration (2.2 µg/L).

Bench scale studies were conducted by Battelle (Battelle, 2010), in which the OU-2 native borrow soil and AquaBlok® were spiked with mercury at concentrations of 50 milligrams per liter (mg/L), 100 mg/L, 200 mg/L, 500 mg/L, and 1,000 mg/L. The $\log_{10}$-transformed average mercury concentrations for the potential cap materials, native borrow soil and AquaBlok®, were plotted versus the $\log_{10}$ of the average mercury concentration of the spiked cap material porewater, resulting in acceptable linear relationships for predictive use. The plot and linear equations are shown on Figure C-1.

**Figure C-1**
**$Log_{10}$ Cap Material Versus $Log_{10}$ Aqueous Concentrations**




Notes:
dw - dry weight
Hg - mercury
mg/kg - milligram per kilogram
mg/L - milligram per liter

PREPARED/DATE: NTG 4/14/11
CHECKED/DATE: FKM 4/15/11

Cap material mercury concentrations for native borrow soil were predicted from porewater concentrations using the regression equations in Figure C-1 for mid-level (0.75 μg/L), less (0.64 μg/L), and more (2.2 μg/L) conservative porewater mercury concentrations. The resulting estimated $K_d$'s are presented in Table C-1.

**TABLE C-1**

**Predicted Cap Material Concentrations and $K_d$ of Native Borrow Soil at Selected Porewater Concentrations**

| Cap Material and Regression Equation | Porewater Concentration of Interest | | Predicted Cap Material Concentration | | | |
|---|---|---|---|---|---|---|
| | (mg/L) | $log_{10}$ (mg/L) | (mg/kg) | $log_{10}$ (mg/kg) | $K_d$ | $Log_{10}$ ($K_d$) |
| Native Borrow Soil<br>y = 0.4441x + 1.3265 | 0.00064 | -3.19 | 0.809 | -0.0919 | 1,265 | 3.10 |
| | 0.00075 | -3.12 | 0.868 | -0.0613 | 1,158 | 3.06 |
| | 0.0022 | -2.66 | 1.40 | 0.146 | 637 | 2.80 |

PREPARED/DATE: NTG 4/14/2011
CHECKED/DATE: FKM 4/15/2011

$K_d$ for AquaBlok®

Cap material mercury concentrations for AquaBlok® were also predicted from porewater concentrations using the regression equations in Figure C-1 for mid-level (0.75 µg/L), less (0.64 µg/L), and more (2.2 µg/L) conservative porewater mercury concentrations. The resulting estimated $K_d$'s are presented in Table C-2.

**TABLE C-2**

**Predicted Cap Material Concentrations and $K_d$ of AquaBlok® at Selected Porewater Concentrations**

| Cap Material and Regression Equation | Porewater Concentration of Interest | | Predicted Cap Material Concentration | | | |
|---|---|---|---|---|---|---|
| | (mg/L) | $log_{10}$ (mg/L) | (mg/kg) | $log_{10}$ (mg/kg) | $K_d$ | $Log_{10}$ ($K_d$) |
| AquaBlok®<br>y = 0.6729x + 2.1078 | 0.00064 | -3.19 | 0.909 | -0.041 | 1,421 | 3.15 |
| | 0.00075 | -3.12 | 1.01 | 0.00503 | 1,349 | 3.13 |
| | 0.0022 | -2.66 | 2.09 | 0.320 | 949 | 2.98 |

PREPARED/DATE: NTG 4/14/2011
CHECKED/DATE: FKM 4/15/2011

$K_d$ for Activated Carbon/Native Borrow Soil (50/50 Mix)

Cap material mercury concentrations for activated carbon were derived from data available in Rao et al. (2009) and USEPA (1997) and predicted using the Freundlich equation. Rao et al. (2009) investigated removal of mercury from aqueous solutions using activated carbon prepared from *Ceiba pentandra* hulls (ACPH), *Phaseolus aureus* hulls (ACCPAH) and *Cicer arietinum* waste (ACCAW). The estimated cap material concentrations and resulting $K_d$'s for the various types of activated carbon are presented in Table C-3.

**TABLE C-3**

**Predicted Cap Material Concentrations and $K_d$ of Various Types of Activated Carbon at Selected Porewater Concentrations**

| Activated Carbon Coefficients for the Freundlich Equation<br>q=Kf * Ce^(1/n) | Porewater Concentration of Interest (Ce)<br>(mg/L) | Predicted Cap Material Concentration (q)<br>(mg/g) | $K_d$ |
|---|---|---|---|
| ACCPH<br>Kf=11.24, n=4.11 | 0.00064 | 1.88 | 2,934 |
| | 0.00075 | 1.95 | 2,602 |
| | 0.0022 | 2.54 | 1,153 |
| ACPAH<br>Kf=9.51, n=3.73 | 0.00064 | 1.32 | 2,069 |
| | 0.00075 | 1.38 | 1,842 |
| | 0.0022 | 1.84 | 838 |
| ACCAW<br>Kf=8.36, n=3.64 | 0.00064 | 1.11 | 1,732 |
| | 0.00075 | 1.16 | 1,544 |
| | 0.0022 | 1.56 | 707 |
| EPA -625-R97-004<br>Kf=4.68, n=3.16 | 0.00064 | 0.457 | 713 |
| | 0.00075 | 0.480 | 640 |
| | 0.0022 | 0.675 | 307 |

PREPARED/DATE: NTG 4/14/2011
CHECKED/DATE: FKM 4/15/2011

The modeled scenario for native borrow soil and activated carbon used a 50/50 mix of these materials for the cap layer. To calculate the $K_d$ for this material, the median $K_d$'s of the activated carbon presented in Table C-3 were averaged with the $K_d$'s for the native borrow soil estimated from the regression equation in Figure C-1 to calculate a mixed native soil/activated carbon $K_d$. These calculated $K_d$'s are presented in Table C-4.

**TABLE C-4**

**$K_d$ of Native Borrow Soil Mixed with Activated Carbon (50/50 Mix) at Selected Porewater Concentrations**

| Aqueous Concentration of Interest | Median Activated Carbon $K_d$ | Native Borrow Soil $K_d$ | $K_d$ of Native Soil Mixed with Activated Carbon | $Log_{10}$ ($K_d$) of Native Soil Mixed with Activated Carbon |
|---|---|---|---|---|
| 0.00064 mg/L | 1,901 | 1,265 | 1,583 | 3.20 |
| 0.00075 mg/L | 1,693 | 1,158 | 1,425 | 3.15 |
| 0.0022 mg/L | 773 | 637 | 705 | 2.85 |

PREPARED/DATE: NTG 4/14/2011
CHECKED/DATE: FKM 4/15/2011

# APPENDIX D

# DARCY VELOCITY CALCULATIONS

# APPENDIX D

## Darcy Velocity Calculations

Darcy velocity (V) uses Darcy's Law to calculate the groundwater seepage velocity for steady flow in an aquifer. The Darcy groundwater velocity in the Reible model represents the flow through the cap material, which is governed by the groundwater velocity through the clay underlying the Basin/Round Pond. This velocity is a product of the hydraulic gradient ($i$) across the distance being evaluated and the hydraulic conductivity (K) of the material being evaluated. The hydraulic gradient is a vector gradient between two or more hydraulic head measurements over the length of the flow path, also called the Darcy slope. The hydraulic conductivity describes the ease with which water can move through pore spaces or fractures, which depends on the intrinsic permeability of the material.

$$V = Ki$$

| | | |
|---|---|---|
| $V = Ki$ | V | Darcy velocity |
| | K | hydraulic conductivity |
| | $i$ | hydraulic gradient |

The Darcy velocity is an input to the Reible model. Based on the boring logs for sediment cores collected in the Basin/Round Pond, three Darcy velocities were used in the model to represent the varying hydraulic conductivity of the geologic material: a more conservative scenario, a mid-level conservative scenario, and a less conservative scenario. The hydraulic conductivities were based on the descriptions of sediment cores collected from the Basin/Round Pond and are reported here in centimeters per second (cm/s). Sediments at the top of the sediment cores were described as silty clays (corresponding with a hydraulic conductivity of $1.0 \times 10^{-5}$ cm/s in Bear, 1972). Sediments in the middle of the sediment cores were described as soft, clays (corresponding with a hydraulic conductivity of $1.0 \times 10^{-7}$ cm/s in Bear, 1972). Sediments at the bottom of the cores were described as firm clays (corresponding with a hydraulic conductivity of $1.0 \times 10^{-11}$ cm/s in Bear, 1972). The estimates listed below are consistent with values agreed upon with USEPA on May 4, 2011, during a conference call between MACTEC and USEPA representatives:

| | |
|---|---|
| More Conservative Scenario | $1.0 \times 10^{-5}$ cm/s = 315.36 centimeters per year (cm/yr) |
| Mid-level Conservative Scenario | $1.0 \times 10^{-7}$ cm/s = 3.15 cm/yr |
| Less Conservative Scenario | $1.0 \times 10^{-11}$ cm/s = $3.15 \times 10$-4 cm/yr |

The Darcy velocity input into the Reible model evaluates the contribution of groundwater upwelling to "push" a contaminant into a cap. The lowest hydraulic conductivity controls this flow. The hydraulic conductivity at the bottom of a sediment core ($10^{-11}$ cm/s) thus controls the movement of groundwater into the cap material. Modeling Darcy velocities using hydraulic conductivities greater than those at the bottom of the sediment adds additional layers of conservatism to the model results. AquaBlok® was modeled using a hydraulic conductivity of AquaBlok® ($10^{-11}$ cm/s) in each scenario as specified in the manufacturer's recommendations. The hydraulic conductivity of $10^{-11}$ cm/s controls the upward movement of a contaminant through the cap irrespective of the hydraulic conductivity of the material beneath it.

The hydraulic gradient is the difference in water levels divided by the distance between the measuring points. The distance between MW-BA1 and the Basin, which is 200 feet, was used for the model. The groundwater elevation difference between these two wells was 3 feet, yielding a hydraulic gradient of 0.015, during non-flood conditions when no minimum water level is held at the gate. The gradient of 3 feet/200 feet is extremely conservative because this difference in hydraulic head assumes that there is a direct connection between groundwater along the bluff and the Basin and that the water level at the Basin is 3 feet NAVD88. Dense clay surrounds the Basin such that groundwater flow is directed beneath or around the Basin. The hydraulic gradient would be expected to be similar or less during flood conditions when the Basin water levels rise. A minimum water level of 6 feet NAVD88 is currently held at the Basin so that no difference in hydraulic head would be observed, resulting in no groundwater discharge into the Basin. A minimum 6-foot elevation is currently held at the gate, which yields a hydraulic gradient of 0. Therefore, the hydraulic gradient used in the model is very conservative. Using the three hydraulic conductivities for the varying scenarios with the hydraulic gradient yields the following Darcy velocities:

| | |
|---|---|
| More Conservative Scenario | 315.36 cm/yr × 0.015 = 4.73 cm/yr |
| Mid-level Conservative Scenario | 3.15 cm/yr × 0.015 = 0.0473 cm/yr |
| Less Conservative Scenario | $3.15\times10^{-4}$ cm/yr × 0.015 = $4.73\times10^{-6}$ cm/yr |

# APPENDIX E

# REIBLE MODEL RUNS AND SENSITIVITY ANALYSIS

**NATIVE BORROW SOIL**

**MODELING SCENARIOS**

# Steady State Cap Design Model Inputs
## Mid Level Conservative Scenario with Native Borrow Soil - 8 Inch Cap Thickness
## Feasibility Study
## OU - 2 McIntosh

| | Contaminant Properties | Values | Units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.06 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |
| | | | | |
| | **Sediment Properties** | | | |
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E-02 | cm/yr | See note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr | 0.3 inch *2.54 cm/inch - Overall Basin average (MACTEC, 2011) |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | Model Default |
| | | | | |
| | **Cap Properties** | | | |
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 20.32 | cm | 8 inch cap *2.54 cm/in = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent), 4/13/11 |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent), 4/13/11 |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | Fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

**Notes:**

cm - Centimeter
cm/hr - Centimeter per hour
$cm^2/s$ - Square centimeter per second
cm/yr - Centimeter per year
$cm^2/yr$ - Squared centimeter per year
$g/cm^3$ - Gram per cubic centimeter
Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligram per liter
ug/L - Microgram per liter
$yr^{-1}$ - Per year

(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).

(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.
(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin where sediment concentrations are higher = 0.75 ug/L, and maximum mercury concentrations and maximum average mercury concentration = 2.2 ug/L
(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.

# Steady State Cap Design Model - Native Borrow Soil - Mid Level Conservative Scenario - 8 Inch Cap Thickness
## From Lampert and Reible (2008)* Version 1.13
## 11/12/2008

**Contaminant Properties**

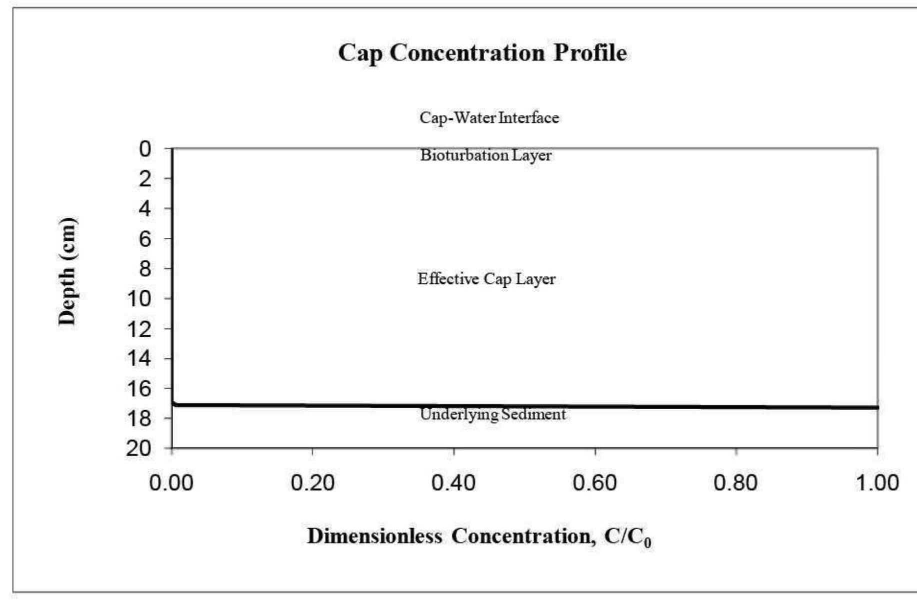
| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient, $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26717933 | cm |




**Output**

| | | | | | |
|---|---|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 6.0788E-98 | ug/L | | Sediment Concentration: 7.038E-95 | ug/kg |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg | | | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg | | | |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ | | | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 6.079E-98 | ug/L | | |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 1.22E-101 | ug/L | | |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 8.51E-99 | ug/L | | |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr | | | |

**Model Equations**

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o\frac{Pe_2}{Pe_1}e^{\frac{Pe_1}{2}}\beta\sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_o e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -223.56 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1{}^2$/4+$Da$) | 111.78 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.11 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1{}^2$/4+$Da$) | 3.553 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff., $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff., $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 133.3 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

cm - Centimeter

cm/hr - Centimeter per hour

$cm^2/s$ - Square centimeter per second

cm/yr - Centimeter per year

$cm^2/yr$ - Squared centimeter per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligrams per liter

ug/kg - Microgram per kilogram

ug/L - Microgram per liter

$ug/m^2/L$ - Mircrogram per meter squared per year

$yr^{-1}$ - Year 1

yr - Year

z/hcap - cap thickness at depth

# Steady State Cap Design Model Inputs
## Mid Level Conservative Scenario with Native Borrow Soil - 12 Inch Cap Thickness
## Feasibility Study
## OU - 2 McIntosh

| | Contaminant Properties | Values | units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.06 | log L/kg | See Note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |
| | **Sediment Properties** | | | |
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E-02 | cm/yr | See note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr | 0.3 inch *2.54 cm/inch - Overall Basin average (MACTEC, 2011) |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | Model Default |
| | **Cap Properties** | | | |
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 30.48 | cm | 8 inch cap *2.54 cm/in = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 4.572 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent), 4/13/11 |
| 19 | Underlying sediment consolidation due to cap placement | 15.24 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent), 4/13/11 |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

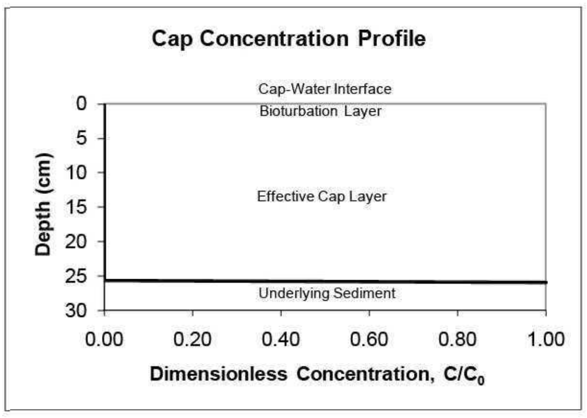
**Notes:**

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

cm - Centimeter
cm/hr - Centimeter per hour
$cm^2/s$ - Square centimeter per second
cm/yr - Centimeter per year
$cm^2/yr$ - Squared centimeter per year
$g/cm^3$ - Gram per cubic centimeter
Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligram per liter
ug/L - Microgram per liter
$yr^{-1}$ - Per year
(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for
(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient
(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L,
(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and

**Steady State Cap Design Model - Native Borrow Soil - Mid Level Conservative Scenario - 12 Inch Cap Thickness from Lampert and Reible (2008)***

**Version 1.13**




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, $\log K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, $\log K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 30.48 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 4.572 | cm |
| Underlying sediment consolidation due to cap placement | 15.24 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 25.900769 | cm |

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

**Output**

| | | |
|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 2.8600E-213 | ug/L |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 2.9E-213 ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 5.8E-217 ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 4E-214 ug/L |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr |

Sediment Concentration

3.3E-210 ug/kg

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -489.11 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2$/4+$Da$) | 244.56 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.11 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2$/4+$Da$) | 3.553 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 16 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.21 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -20.9 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 638.0 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

cm - Centimeter

cm/hr - Centimeter per hour

$cm^2/s$ - Square centimeter per second

cm/yr - Centimeter per year

$cm^2/yr$ - Squared centimeter per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligrams per liter

ug/kg - Microgram per kilogram

ug/L - Microgram per liter

$ug/m^2/L$ - Mircrogram per meter squared per year

$yr^{-1}$ - Year 1

yr - Year

z/hcap - cap thickness at depth

# Steady State Cap Design Model Inputs
## Mid Level Conservative Scenario with Native Borrow Soil - 16 Inch Cap Thickness
## Feasibility Study
## OU-2 McIntosh

| | Contaminant Properties | Values | Units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.06 | log L/kg | See Note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |

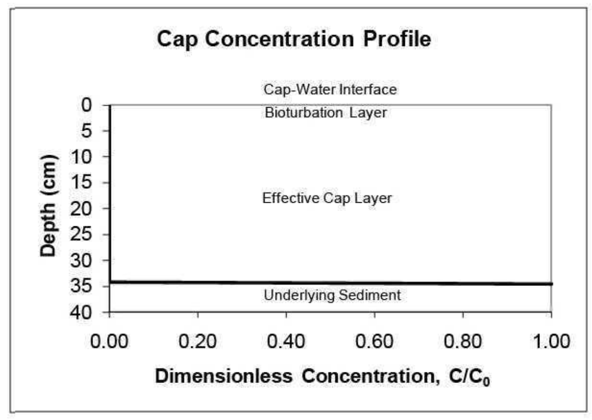
| | Sediment Properties | | | |
|---|---|---|---|---|
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E-02 | cm/yr | See note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr | 0.3 inch *2.54 cm/inch - Overall Basin average (MACTEC, 2011) |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | Model Default |

| | Cap Properties | | | |
|---|---|---|---|---|
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 40.64 | cm | 8 inch cap *2.54 cm/in = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 6.096 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent), 4/13/11 |
| 19 | Underlying sediment consolidation due to cap placement | 20.32 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent), 4/13/11 |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

**Notes:**
cm - Centimeter
cm/hr - Centimeter per hour
$cm^2/s$ - Square centimeter per second
cm/yr - Centimeter per year
$cm^2/yr$ - Squared centimeter per year
$g/cm^3$ - Gram per cubic centimeter
Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligram per liter
ug/L - Microgram per liter
$yr^{-1}$ - Per year
(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for
for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech* . 43(9): 3183-
average mercury concentration in porewater from southern portion of the Basin where
(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and

**Steady State Cap Design Model - Native Borrow Soil - Mid Level Conservative Scenario - 16 Inch Cap Thickness**
**from Lampert and Reible (2008)***
**Version 1.13**




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, log$K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log$K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{P}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 40.64 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 6.096 | cm |
| Underlying sediment consolidation due to cap placement | 20.32 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 34.53435867 | cm |

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

**Output**

| | | | |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 0.0000E+00 | ug/L | |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg | |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | | 0 ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | | 0 ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | | 0 ug/L |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr | |

<u>Sediment Concentration</u>
0 ug/kg

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta\sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -754.60 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2$/4+$Da$) | 377.30 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.11 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2$/4+$Da$) | 3.553 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 25 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.33 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -32.2 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 1518.8 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

cm - Centimeter
cm/hr - Centimeter per hour
$cm^2/s$ - Square centimeter per second
cm/yr - Centimeter per year
$cm^2/yr$ - Squared centimeter per year
$g/cm^3$ - Gram per cubic centimeter
Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligrams per liter
ug/kg - Microgram per kilogram
ug/L - Microgram per liter
$ug/m^2/L$ - Mircrogram per meter squared per year
$yr^{-1}$ - Year 1
yr - Year
z/hcap - cap thickness at depth

# Steady State Cap Design Model Inputs
# Less Conservative Scenario With Native Borrow Soil
# Feasibility Study
# OU-2 McIntosh

| | Contaminant Properties | Values | Units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.10 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |

| | Sediment Properties | | | |
|---|---|---|---|---|
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.64 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E-06 | cm/yr | Seed note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 5.08 | cm/yr | 2 inch/year as measured in southern portion of Basin |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | Model Default |

| | Cap Properties | | | |
|---|---|---|---|---|
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 20.32 | cm | 8 inch cap *2.54 cm/in = 20.328 cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent), 4/13/11 |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent), 4/13/11 |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | Fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

**Notes:**

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

cm - Centimeter
$cm^2/s$ - Square centimeters per second
cm/yr - Centimeter per year
$cm^2/yr$ - Squared centimeters per year
$g/cm^3$ - Gram per cubic centimeter
Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligram per liter
ug/L - Microgram per liter
$yr^{-1}$ - Per year

(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).

(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.

(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin where sediment concentrations are higher = 0.75 ug/L, and maximum mercury concentrations and maximum average mercury concentration = 2.2 ug/L

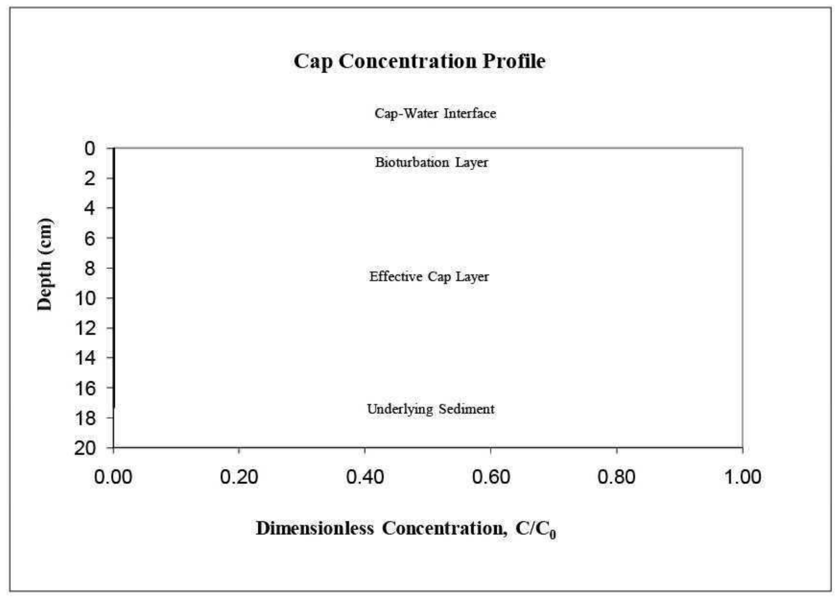
(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.

**Steady State Cap Design Model - Native Borrow Soil - Less Conservative Scenario**
**From Lampert and Reible (2008)* Version 1.13**
**11/12/2008**

| **Contaminant Properties** | | |
|---|---|---|
| Contaminant | Mercury | Units |
| Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

| **Sediment Properties** | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.64 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 4.7304E-06 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 5.08 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

| **Cap Properties** | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient, $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26758611 | cm |




| **Output** | | | Sediment Concentration |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | #NUM! | ug/L | #NUM! |
| Loading at Depth, $W(z)$ | #NUM! | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | #NUM! | ug/kg | |
| Flux to Overlying Water Column, $J$ | #NUM! | $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | #NUM! | #NUM! | ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | #NUM! | #NUM! | ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | #NUM! | #NUM! | ug/L |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr | |

| **Dimensionless Parameters** | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -1628.08 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2$/4+$Da$) | 814.04 |
| Bioturbation Layer Peclet No., $Pe_2$ | -47.65 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2$/4+$Da$) | 23.825 |
| Sherwood Number at Interface, $Sh$ | 26.7 |

| **Other Parameters** | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,302 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,302 | |
| Effective Advective Velocity, $U$ | -1.E+04 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff., $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff., $D_2$ | 2454 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -1.4 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 145.6 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Model Equations**

$$C_2 = \frac{C_{bl}e^{-\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{-\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4}+Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

cm - Centimeter
$cm^2/s$ - Square centimeters per second
cm/yr - Centimeter per year
$cm^2/yr$ - Squared centimeters per year
$g/cm^3$ - Gram per cubic centimeter
Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligram per liter
ug/L - Microgram per liter
$yr^{-1}$ - Per year
ug/L - Microgram per liter
$ug/m^2/L$ - Mircrogram per meter squared per year
$yr^{-1}$ - Year 1
yr - Year
z/hcap - cap thickness at depth
#NUM! - Numerical difficulties in the model due to division by very small numbers, model assumes division by zero

# Steady State Cap Design Model Inputs
## More Conservative Scenario with Native Borrow Soil
## Feasibility Study
## OU - 2 McIntosh

| | Contaminant Properties | Values | Units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 2.80 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |
| | | | | |
| | **Sediment Properties** | | | |
| 6 | Contaminant Pore Water Concentration, $C_0$ | 2.2 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E+00 | cm/yr | Seed note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0 | cm/yr | 0 (no deposition) |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{P}$ | 1 | $cm^2/yr$ | Model Default |
| | | | | |
| | **Cap Properties** | | | |
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 20.32 | cm | 8 inch cap 2.54 cm/in = 20.32cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent), 4/13/11 |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent), 4/13/11 |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | Fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

**Notes:**

cm - Centimeter
$cm^2/s$ - Square centimeters per second
cm/yr - Centimeter per year
$cm^2/yr$ - Squared centimeters per year
$g/cm^3$ - Gram per cubic centimeter
Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligram per liter
ug/L - Microgram per liter
$yr^{-1}$ - Per year

(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).

(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.

(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin where sediment concentrations are higher = 0.75 ug/L, and maximum mercury concentrations and maximum average mercury concentration = 2.2 ug/L

(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.

# Steady State Cap Design Model - Native Borrow Soil - More Conservative Scenario
## From Lampert and Reible (2008)* Version 1.13
## 11/12/2008

**Contaminant Properties**

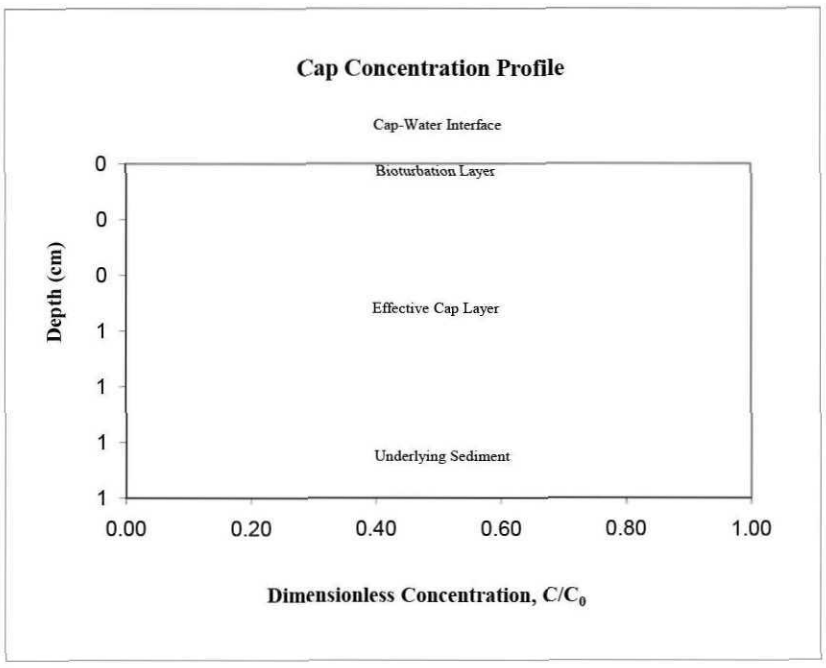
| | | |
|---|---|---|
| Contaminant | Mercury | Units |
| Organic Carbon Partition Coefficient, log $K_{oc}$ | 2.8E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 2.2 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 4.7304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}{}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}{}^{p}$ | 1.00 | $cm^2/yr$ |

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient, $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26323585 | cm |




**Output**

| | | | |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 1.5969E-01 | ug/L | |
| Loading at Depth, $W(z)$ | 101.6890 | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 52.1605 | ug/kg | |
| Flux to Overlying Water Column, $J$ | 209.1504 | $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 7.26% | 0.159689 | ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.15% | 0.003193 | ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 3.72% | 0.081911 | ug/L |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | 70 | yr | |

Sediment Concentration
101.689 ug/kg

**Model Equations**

$$C_2 = \frac{C_{bl}e^{-\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{-\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh + \frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2} + \frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2} + Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | 0.65 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1{}^2$/4+$Da$) | 0.33 |
| Bioturbation Layer Peclet No., $Pe_2$ | 0.04 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| $g$ = SQRT($Pe_1{}^2$/4+$Da$) | 0.018 |
| Sherwood Number at Interface, $Sh$ | 49.9 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 1,159 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 1,159 | |
| Effective Advective Velocity, $U$ | 5.E+00 | cm/yr |
| Dispersivity, $\alpha$ | 0.11 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff., $D_1$ | 53 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff., $D_2$ | 1312 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | 1780.0 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 72.5 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

cm - Centimeter

$cm^2/s$ - Square centimeters per second

cm/yr - Centimeter per year

$cm^2/yr$ - Squared centimeters per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligram per liter

ug/L - Microgram per liter

$yr^{-1}$ - Per year

ug/L - Microgram per liter

$ug/m^2/L$ - Mircrogram per meter squared per year

$yr^{-1}$ - Year 1

yr - Year

z/hcap - cap thickness at depth

# ACTIVATED CARBON/NATIVE BORROW SOIL (50/50 MIX)

# MODELING SCENARIOS

# Steady State Cap Design Model
## Mid Level Conservative Scernario with Activated Carbon and Native Borrow Soil (50/50 Mix)
## Feasibility Study
## OU - 2 McIntosh

| | Contaminant Properties | Values | Units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.15 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |

| | Sediment Properties | | | |
|---|---|---|---|---|
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E-02 | cm/yr | Seed note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr | 0.3 inch *2.54 cm/inch - Overall Basin average (MACTEC, 2011) |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | Model Default |

| | Cap Properties | | | |
|---|---|---|---|---|
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 20.32 | cm | 8 inch cap *2.54 cm/in = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent), 4/13/11 |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent), 4/13/11 |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

Prepared by/Date: NTG 4/21/11

Checked by/Date: HEF 4/22/11

**Notes:**

Activated carbon Kd from USEPA 1997; Rao et al 2009

cm - Centimeter

$cm^2/s$ - Square centimeters per second

cm/yr - Centimeter per year

$cm^2/yr$ - Squared centimeters per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligram per liter

ug/L - Microgram per liter

$yr^{-1}$ - Per year

(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).

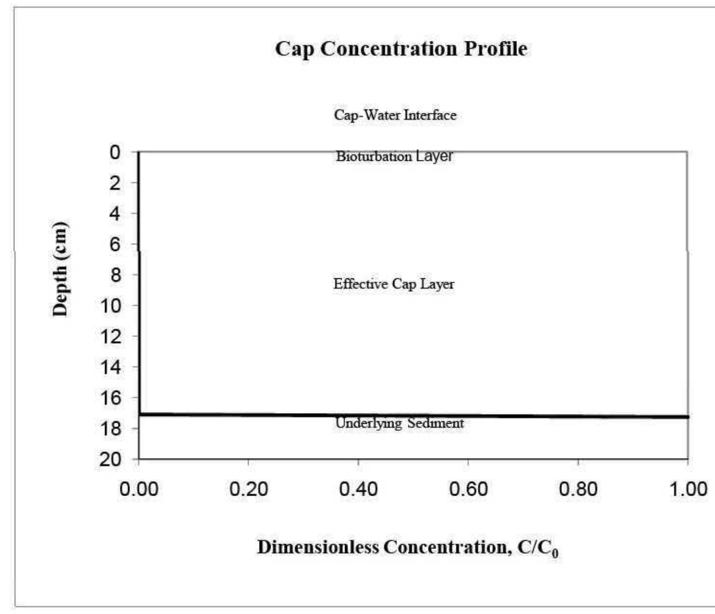
(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.

(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin where sediment concentrations are higher = 0.75 ug/L, and maximum mercury concentrations and maximum average mercury concentration = 2.2 ug/L

(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.

## Steady State Cap Design Model - Activated Carbon and Native Borrow Soil (50/50 Mix)
## Mid Level Conservative Model
## from Lampert and Reible (2008)* Version 1.13
## 11/12/2008

| **Contaminant Properties** | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.2E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |




| **Sediment Properties** | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.0473 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

| **Cap Properties** | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient, $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26808426 | cm |

| **Output** | | | | |
|---|---|---|---|---|
| | | | Sediment Concentration | |
| Pore Water Concentration at Depth, $C(z)$ | 2.1248E-120 | ug/L | 3E-117 | |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg | | |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ | | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 2.1E-120 | ug/L | |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 4.8E-124 | ug/L | |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 2.9E-121 | ug/L | |
| Time to Approach Steady State, $t_{adv/diff}$ | Never Breakthrough | yr | | |

**Model Equations**

$$C_2 = \frac{C_{bl} e^{\frac{Pe_2}{2}} - C_{bio} e^{-\gamma}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio} e^{\gamma} - C_{bl} e^{\frac{Pe_2}{2}}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

$$Pe_2 = \frac{U h_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon \lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

| **Dimensionless Parameters** | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -275.27 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2/4+Da$) | 137.63 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.20 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2/4+Da$) | 3.599 |
| Sherwood Number at Interface, $Sh$ | 23.8 |

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

| **Other Parameters** | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,595 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,595 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff., $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff., $D_2$ | 2747 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 164.1 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

Activated carbon Kd from USEPA 1997; Rao et al 2009

cm - Centimeter

$cm^2/s$ - Square centimeters per second

cm/yr - Centimeter per year

$cm^2/yr$ - Square centimeters per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligram per liter

ug/L - Microgram per liter

$ug/m^2/L$ - Mircrogram per meter squared per year

$yr^{-1}$ - Per year

yr - Year

z/hcap - cap thickness at depth

# Steady State Cap Design Model Inputs
## Less Conservative Scenario with Activated Carbon and Native Borrow Soil (50/50 Mix)
## Feasibility Study
## OU - 2 McIntosh

| | Contaminant Properties | Values | Units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.20 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |

| | Sediment Properties | | | |
|---|---|---|---|---|
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.64 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E-06 | cm/yr | Seed note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 5.08 | cm/yr | 2 inch/year as measured in southern portion of Basin (MACTEC, 2011) |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | Model Default |

| | Cap Properties | | | |
|---|---|---|---|---|
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 20.32 | cm | 8 inch cap *2.54 cm/in = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent) |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent) |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | Fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

**Notes:**

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

Activated carbon Kd from USEPA 1997; Rao et al 2009

cm - Centimeter

$cm^2/s$ - Square centimeters per second

cm/yr - Centimeter per year

$cm^2/yr$ - Squared centimeters per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligram per liter

ug/L - Microgram per liter

$yr^{-1}$ - Per year

(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).

(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.

(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin where sediment concentrations are higher = 0.75 ug/L, and maximum mercury concentrations and maximum average mercury concentration = 2.2 ug/L

(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.

# Steady State Cap Design - Activated Carbon and Native Borrow Soil (50/50 Mix)
## Less Conservative Model
## From Lampert and Reible (2008)* Version 1.13
## 11/12/2008

**Contaminant Properties**

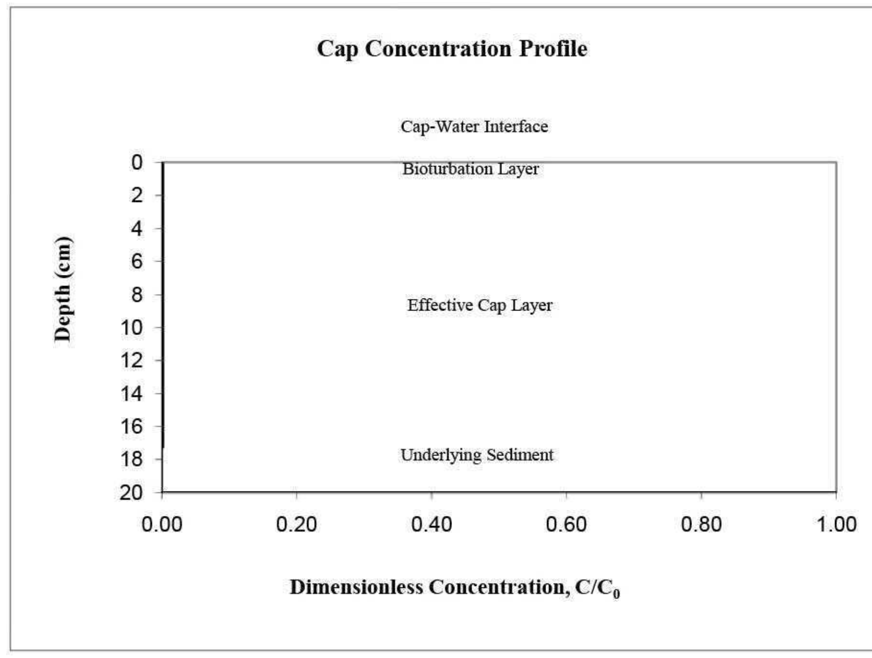
| | | | |
|---|---|---|---|
| Contaminant | Mercury | Unit | |
| Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.2E+00 | log L/kg | |
| Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.0E+00 | log L/kg | |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ | |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ | |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ | |

**Sediment Properties**

| | | | |
|---|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.64 | ug/L | |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | |
| Darcy Velocity, $V$ (positive is upwelling) | 0.00000473 | cm/yr | |
| Depositional Velocity, $V_{dep}$ | 5.08 | cm/yr | |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm | |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ | |
| Particle Biodiffusion Coefficient, $D_{bio}^{P}$ | 1.00 | $cm^2/yr$ | |

**Cap Properties**

| | | | |
|---|---|---|---|
| Depth of Interest, $z$ | 10 | cm | |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | |
| Conventional Cap placed depth | 20.32 | cm | |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | |
| Cap consolidation depth | 3.048 | cm | |
| Underlying sediment consolidation due to cap placement | 10.16 | cm | |
| Porosity, e | 0.3 | | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | |
| Boundary Layer Mass Transfer Coefficient, $k_{bl}$ | 0.75 | cm/hr | |
| Cap thickness, $h_{cap}$ | 17.2684781 | cm | |




**Output**

| | | | |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | #NUM! | ug/L | #NUM! |
| Loading at Depth, $W(z)$ | #NUM! | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | #NUM! | ug/kg | |
| Flux to Overlying Water Column, $J$ | #NUM! | $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | #NUM! | #NUM! | ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | #NUM! | #NUM! | ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | #NUM! | #NUM! | ug/L |
| Time to Approach Steady State, $t_{adv/diff}$ | Never Breakthrough | yr | |

**Model Equations**

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4}+Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

| | | |
|---|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -2040.73 | |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 | |
| b = SQRT($Pe_1^2$/4+$Da$) | 1020.36 | |
| Bioturbation Layer Peclet No., $Pe_2$ | -48.25 | |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 | |
| g = SQRT($Pe_1^2$/4+$Da$) | 24.127 | |
| Sherwood Number at Interface, $Sh$ | 21.6 | |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,885 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,885 | |
| Effective Advective Velocity, $U$ | -1.E+04 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff., $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff., $D_2$ | 3037 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -1.4 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 182.5 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

Activated carbon Kd from USEPA 1997; Rao et al 2009

cm - Centimeter

$cm^2/s$ - Square centimeters per second

cm/yr - Centimeter per year

$cm^2/yr$ - Square centimeters per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligram per liter

ug/L - Microgram per liter

$ug/m^2/L$ - Mircrogram per meter squared per year

$yr^{-1}$ - Per year

yr - Year

z/hcap - cap thickness at depth

#NUM! - Numerical difficulties in the model due to division by very small numbers, model assumes division by zero

# Steady State Cap Design Model
# More Conservative Scenario with Activated Carbon and Native Borrow Soil (50/50 Mix)
# Feasibility Study
# OU - 2 McIntosh

| | Contaminant Properties | Values | Units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 2.85 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |

| | Sediment Properties | | | |
|---|---|---|---|---|
| 6 | Contaminant Pore Water Concentration, $C_0$ | 2.2 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E+00 | cm/yr | Seed note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0 | cm/yr | 0 (no deposition) |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | Model Default |

| | Cap Properties | | | |
|---|---|---|---|---|
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 20.32 | cm | 8 inch cap *2.54 cm/in = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent), 4/13/11 |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent), 4/13/11 |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | Fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

**Notes:**

Activated carbon Kd from USEPA 1997; Rao et al 2009

cm - Centimeter

$cm^2/s$ - Square centimeters per second

cm/yr - Centimeter per year

$cm^2/yr$ - Squared centimeters per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligram per liter

ug/L - Microgram per liter

$yr^{-1}$ - Per year

(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).

(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.

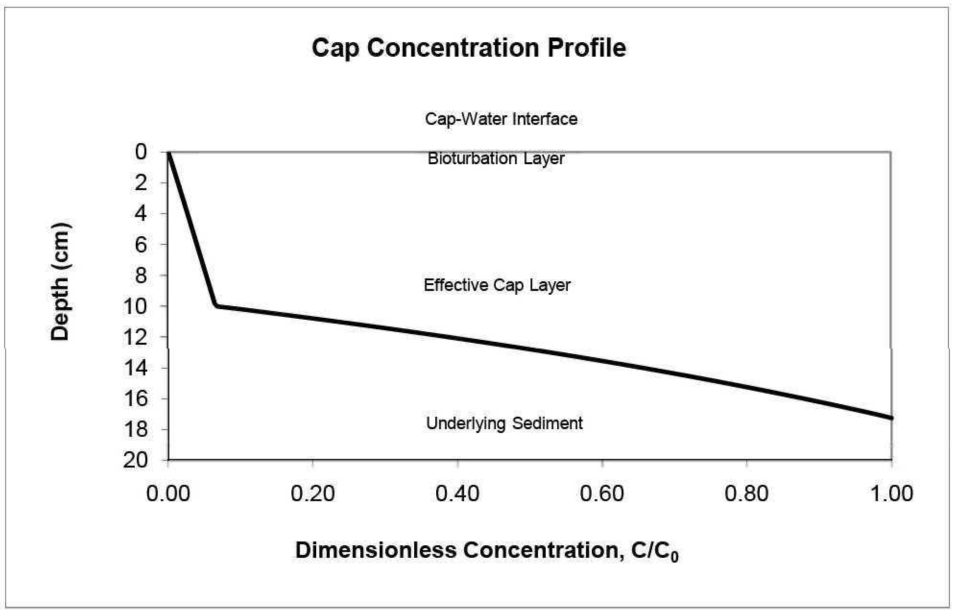
(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin where sediment concentrations are higher = 0.75 ug/L, and maximum mercury concentrations and maximum average mercury concentration = 2.2 ug/L

(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.

# Steady State Cap Design Model - Activated Carbon and Native Borrow Soil (50/50 Mix)
## More Conservative Scenario
## From Lampert and Reible (2008)* Version 1.13
## 11/12/2008

| Contaminant Properties | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, log $K_{oc}$ | 2.9E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

| Sediment Properties | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 2.2 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 4.73 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |




| Cap Properties | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient, $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26411646 | cm |

| Output | | | | |
|---|---|---|---|---|
| | | | Sediment Concentration | |
| Pore Water Concentration at Depth, $C(z)$ | 1.4632E-01 | ug/L | 103.5874 | |
| Loading at Depth, $W(z)$ | 103.5874 | ug/kg | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 53.2045 | ug/kg | | |
| Flux to Overlying Water Column, $J$ | 209.8158 | $ug/m^2/yr$ | | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 6.65% | 0.146321 | ug/L | |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.15% | 0.003203 | ug/L | |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 3.42% | 0.075153 | ug/L | |
| Time to Approach Steady State, $t_{adv/diff}$ | 77 | yr | | |

**Model Equations**

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh + \frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_o e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2} + \frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2} + Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

| Dimensionless Parameters | | |
|---|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | 0.65 | |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 | |
| b = SQRT($Pe_1^2$/4+$Da$) | 0.33 | |
| Bioturbation Layer Peclet No., $Pe_2$ | 0.03 | |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 | |
| g = SQRT($Pe_1^2$/4+$Da$) | 0.017 | |
| Sherwood Number at Interface, $Sh$ | 45.4 | |

| Other Parameters | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 1,289 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 1,289 | |
| Effective Advective Velocity, $U$ | 5.E+00 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff., $D_1$ | 53 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff., $D_2$ | 1441 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | 1979.2 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 80.6 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

Activated carbon Kd from USEPA 1997; Rao et al 2009

cm - Centimeter

$cm^2/s$ - Square centimeters per second

cm/yr - Centimeter per year

$cm^2/yr$ - Square centimeters per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligram per liter

ug/L - Microgram per liter

$ug/m^2/L$ - Mircrogram per meter squared per year

$yr^{-1}$ - Per year

yr - Year

z/hcap - cap thickness at depth

**AQUABLOK®**

**MODELING SCENARIOS**

# Steady State Cap Design Model Inputs
# Mid Level Conservative Scenario with AquaBlok®
# OU - 2 McIntosh

| | Contaminant Properties | Values | Units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.13 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |

| | Sediment Properties | | | |
|---|---|---|---|---|
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E-06 | cm/yr | Seed note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr | 0.3 inch *2.54 cm/inch - Overall Basin average (MACTEC, 2011) |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | Model Default |

| | Cap Properties | | | |
|---|---|---|---|---|
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 20.32 | cm | 8 inch cap *2.54 cm/in = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent), 4/13/11 |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent), 4/13/11 |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

**Notes:**
cm - Centimeter
$cm^2/s$ - Square centimeters per second
cm/yr - Centimeter per year
$cm^2/yr$ - Square centimeters per year
$g/cm^3$ - Gram per cubic centimeter
Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligram per liter
ug/L - Microgram per liter
$yr^{-1}$ - Per year

(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).

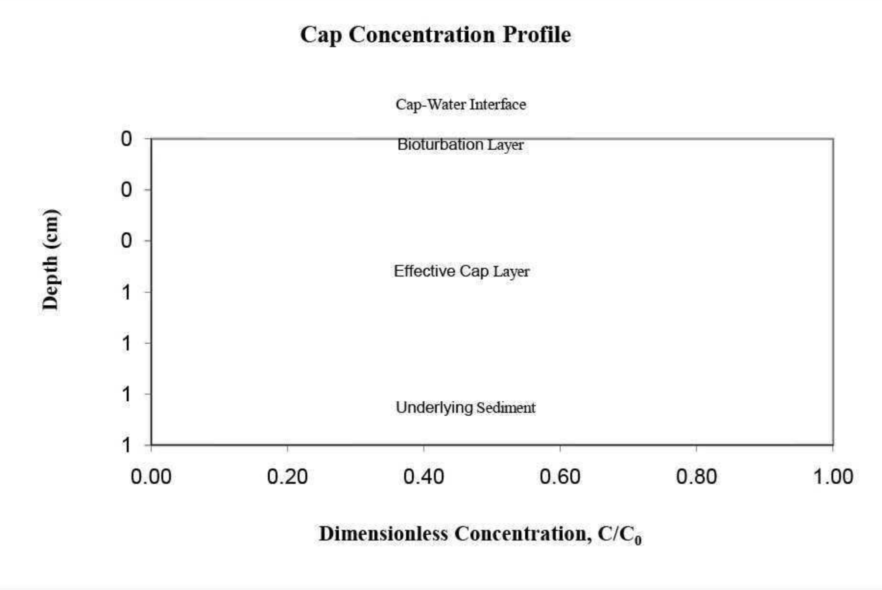
(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.

(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin where sediment concentrations are higher = 0.75 ug/L, and maximum mercury concentrations and maximum average mercury concentration = 2.2 ug/L

(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.

(e) - The porosity of 0.001 (0.1%) for an AquaBlok® cap would not run in the model due to numerical problems; in its place the model default of 0.3 (30%) was utilized.

# Steady State Cap Design Model - AquaBlok®
## Mid Level Conservative Scenario
## From Lampert and Reible (2008)* Version 1.13
## 11/12/2008




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.00000473 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{P}$ | 1.00 | $cm^2/yr$ |

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient, $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.2678622 | cm |

**Output**

| | | | | |
|---|---|---|---|---|
| | | | Sediment Concentration | |
| Pore Water Concentration at Depth, $C(z)$ | 5.4039E-114 | ug/L | 7.3E-111 | ug/kg |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg | | |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ | | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 5.4E-114 | ug/L | |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 1.2E-117 | ug/L | |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 7.5E-115 | ug/L | |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr | | |

**Model Equations**

$$C_2 = \frac{C_{bl}e^{-\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{-\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

| | | |
|---|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -260.52 | |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 | |
| b = SQRT($Pe_1^2$/4+$Da$) | 130.26 | |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.18 | |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 | |
| g = SQRT($Pe_1^2$/4+$Da$) | 3.588 | |
| Sherwood Number at Interface, $Sh$ | 25.1 | |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,455 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,455 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff., $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff., $D_2$ | 2607 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 155.3 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

cm - Centimeter
$cm^2$/s - Square centimeters per second
cm/yr - Centimeter per year
$cm^2$/yr - Squared centimeters per year
$g/cm^3$ - Gram per cubic centimeter
Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligram per liter
ug/L - Microgram per liter
$yr^{-1}$ - Per year
ug/L - Microgram per liter
ug/$m^2$/L - Mircrogram per meter squared per year
$yr^{-1}$ - Year 1
yr - Year
z/hcap - cap thickness at depth

# Steady State Cap Design Model Inputs
# Less Conservative Scenario with AquaBlok®
# OU - 2 McIntosh

| | Contaminant Properties | Values | Units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.15 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |

| | Sediment Properties | | | |
|---|---|---|---|---|
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.64 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E-06 | cm/yr | Seed note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 5.08 | cm/yr | 2 inch/year as measured in southern portion of Basin (MACTEC, 2011) |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | Model Default |

| | Cap Properties | | | |
|---|---|---|---|---|
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 20.32 | cm | 8 inch cap *2.54 cm/in = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent) |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent) |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

**Notes:**

cm - Centimeter

$cm^2/s$ - Square centimeters per second

cm/yr - Centimeter per year

$cm^2/yr$ - Square centimeters per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligram per liter

ug/L - Microgram per liter

$yr^{-1}$ - Per year

(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).

(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.

(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin where sediment concentrations are higher = 0.75 ug/L, and maximum mercury concentrations and maximum average mercury concentration = 2.2 ug/L

(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.

(e) - The porosity of 0.001 (0.1%) for an AquaBlok® cap would not run in the model due to numerical problems; in its place the model default of 0.3 (30%) was utilized.

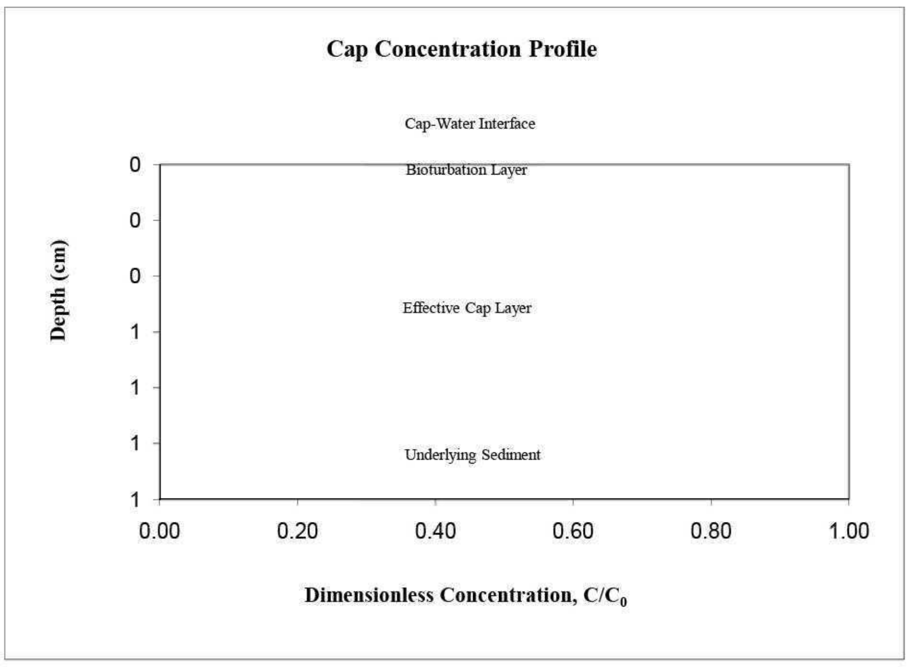
# Steady State Cap Design Model - AquaBlok®
## Less Conservative Scenario
## From Lampert and Reibel (2008)* Version 1.13
## 11/12/2008

**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.2E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.64 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 4.7304E-06 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 5.08 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |




**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient, $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26806657 | cm |

**Output**

| | | | | |
|---|---|---|---|---|
| | | | Sediment Concentration | |
| Pore Water Concentration at Depth, $C(z)$ | #NUM! | ug/L | #NUM! | |
| Loading at Depth, $W(z)$ | #NUM! | ug/kg | | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | #NUM! | ug/kg | | |
| Flux to Overlying Water Column, $J$ | #NUM! | $ug/m^2/yr$ | | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | #NUM! | #NUM! | ug/L | |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | #NUM! | #NUM! | ug/L | |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | #NUM! | #NUM! | ug/L | |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr | | |

**Model Equations**

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4}+Da_2}$$

$$C_{bio} = \frac{C_o\frac{Pe_2}{Pe_1}e^{\frac{Pe_1}{2}}\beta\sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_o e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

| | | |
|---|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -1827.09 | |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 | |
| b = SQRT($Pe_1^2$/4+$Da$) | 913.55 | |
| Bioturbation Layer Peclet No., $Pe_2$ | -47.97 | |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 | |
| g = SQRT($Pe_1^2$/4+$Da$) | 23.987 | |
| Sherwood Number at Interface, $Sh$ | 23.9 | |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,583 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,583 | |
| Effective Advective Velocity, $U$ | -1.E+04 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff., $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff., $D_2$ | 2735 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -1.4 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 163.4 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

cm - Centimeter

$cm^2/s$ - Square centimeters per second

cm/yr - Centimeter per year

$cm^2/yr$ - Squared centimeters per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligram per liter

ug/L - Microgram per liter

$yr^{-1}$ - Per year

ug/L - Microgram per liter

$ug/m^2/L$ - Mircrogram per meter squared per year

$yr^{-1}$ - Year 1

yr - Year

z/hcap - cap thickness at depth

#NUM! - Numerical difficulties in the model due to division by very small numbers, model assumes division by zero

# Steady State Cap Design Model
## More Conservative Scenario with AquaBlok®
## OU - 2 McIntosh

| | Contaminant Properties | Values | Units | Comments |
|---|---|---|---|---|
| | Contaminant | Mercury | | |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 2.98 | log L/kg | See note (a) |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | Included in Log Koc. |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | Based on Kuss et al 2009, See note (b) |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | No decay |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | No decay |

| | Sediment Properties | | | |
|---|---|---|---|---|
| 6 | Contaminant Pore Water Concentration, $C_0$ | 2.2 | ug/L | See note (c) |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | Assume 1.0 for inorganics |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | Included in Kd |
| 9 | Darcy Velocity, $V$ (positive is upwelling) | 4.73E-06 | cm/yr | Seed note (d) |
| 10 | Depositional Velocity, $V_{dep}$ | 0 | cm/yr | 0 (no deposition) |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | ~4 inches (based on Boudreau, 1998) |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | Model Default |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | Model Default |

| | Cap Properties | | | |
|---|---|---|---|---|
| 14 | Depth of Interest, $z$ | 10 | cm | |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | Koc versus Kd adjustment |
| 16 | Conventional Cap placed depth | 20.32 | cm | 8 inch cap *2.54 cm/in = 20.32 cm (includes habitat layer) |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | Native Sediment = C |
| 18 | Cap consolidation depth | 3.048 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (10 percent), 4/13/11 |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | cm | Based on correspondance with Dr. Sandip Chattapadhyay (25 percent), 4/13/11 |
| 20 | Porosity, e | 0.3 | fraction | Model Default |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | Model Default |
| 22 | Fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | Koc adjustment for Kd |

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

**Notes:**

cm - Centimeter

$cm^2/s$ - Square centimeters per second

cm/yr - Centimeter per year

$cm^2/yr$ - Square centimeters per year

$g/cm^3$ - Gram per cubic centimeter

Kd - Partition coeffecient

Log/L Kg - Log 10 of Liters/Kilograms

mg/L - Milligram per liter

ug/L - Microgram per liter

$yr^{-1}$ - Per year

(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).

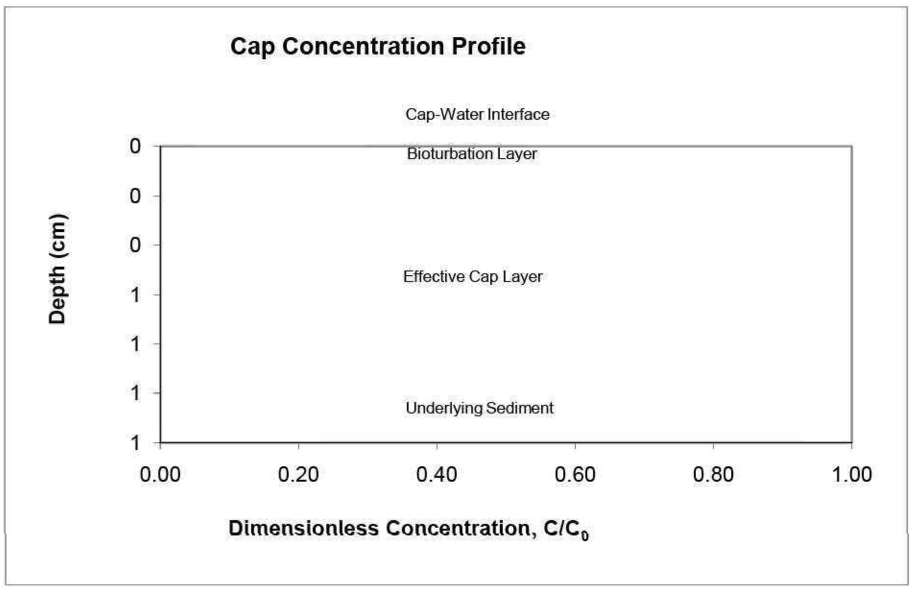
(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.

(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin where sediment concentrations are higher = 0.75 ug/L, and maximum mercury concentrations and maximum average mercury concentration = 2.2 ug/L

(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.

(e) - The porosity of 0.001 (0.1%) for an AquaBlok® cap would not run in the model due to numerical problems; in its place the model default of 0.3 (30%) was utilized.

**Steady State Cap Design Model - AquaBlok®**
**More Conservative Scenario**
**From Lampert and Reible (2008)* Version 1.13**
**11/12/2008**




| | | | |
|---|---|---|---|
| **Contaminant Properties** | | | |
| Contaminant | Mercury | | |
| Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.0E+00 | log L/kg | |
| Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.0E+00 | log L/kg | |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ | |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ | |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ | |
| **Sediment Properties** | | | |
| Contaminant Pore Water Concentration, $C_0$ | 2.2 | ug/L | |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | |
| Darcy Velocity, $V$ (positive is upwelling) | 0.00000473 | cm/yr | |
| Depositional Velocity, $V_{dep}$ | 0 | cm/yr | |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm | |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ | |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ | |
| **Cap Properties** | | | |
| Depth of Interest, $z$ | 10 | cm | |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | |
| Conventional Cap placed depth | 20.32 | cm | |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | |
| Cap consolidation depth | 3.048 | cm | |
| Underlying sediment consolidation due to cap placement | 10.16 | cm | |
| Porosity, e | 0.3 | | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | |
| Boundary Layer Mass Transfer Coefficient, $k_{bl}$ | 0.75 | cm/hr | |
| Cap thickness, $h_{cap}$ | 17.26611499 | cm | |
| **Output** | | | |
| Pore Water Concentration at Depth, $C(z)$ | 8.3267E-02 | ug/L | |
| Loading at Depth, $W(z)$ | 78.9721 | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 40.5874 | ug/kg | |
| Flux to Overlying Water Column, $J$ | 152.0389 | $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 3.78% | 0.083267 | ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.11% | 0.002323 | ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 1.95% | 0.042795 | ug/L |
| Time to Containment Breakthrough, $t_{adv/diff}$ | 109 | yr | |
| **Dimensionless Parameters** | | | |
| Effective Cap Layer Peclet No., $Pe_1$ | 0.00 | | |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 | | |
| b = SQRT($Pe_1^2$/4+$Da$) | 0.00 | | |
| Bioturbation Layer Peclet No., $Pe_2$ | 0.00 | | |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 | | |
| g = SQRT($Pe_1^2$/4+$Da$) | 0.003 | | |
| Sherwood Number at Interface, $Sh$ | 34.9 | | |
| **Other Parameters** | | | |
| Cap Effective Depth, $h_{eff}$ | 7 | cm | |
| Containment Layer Retardation Factor, $R_1$ | 1,726 | | |
| Bioturbation Layer Retardation Factor, $R_2$ | 1,726 | | |
| Effective Advective Velocity, $U$ | 5.E-06 | cm/yr | |
| Dispersivity, $\alpha$ | 0.12 | cm | |
| Effective Cap Layer Diffusion/Dispersion Coeff., $D_1$ | 52 | $cm^2/yr$ | |
| Bioturbation Layer Diffusion/Dispersion Coeff., $D_2$ | 1878 | $cm^2/yr$ | |
| Characteristic Advection Time-cap layer, $t_{adv}$ | 2652088350.6 | yr | |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 109.2 | yr | |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr | |

Sediment Concentration
78.97207 ug/kg

**Model Equations**

$$C_2 = \frac{C_{bl}e^{-\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{-\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh + \frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2} + \frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2} + Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Notes:**

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, (under review).

cm - Centimeter
$cm^2/s$ - Square centimeters per second
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Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligram per liter
ug/L - Microgram per liter
$yr^{-1}$ - Per year
ug/L - Microgram per liter
$ug/m^2/L$ - Mircrogram per meter squared per year
$yr^{-1}$ - Year 1
yr - Year
z/hcap - cap thickness at depth

# SENSITIVITY ANALYSES

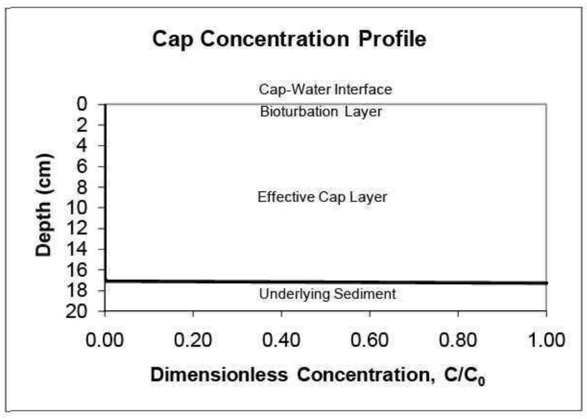
# Steady State Cap Design Model Inputs
## Sensitivity Analysis with Native Borrow Soil
## Feasibility Study
## OU-2 McIntosh

| | Contaminant Properties | Base Values | Units | Sensitivity values | | Pore Water Concentration at Depth, *C(z)* - Compare Result to Base Case Porewater Concentration of 1.2E-226 µg/L | |
|---|---|---|---|---|---|---|---|
| | Contaminant | Mercury | | Sensitivity Value 1 | Sensitivity Value 2 | Sensitivity Value 1 | Sensitivity Value 2 |
| 1 | Organic Carbon Partition Coefficient, log $K_{oc}$ | 3.06 | log L/kg | 3.102 | 2.804 | 9.145E-208 | 1.622E-114 |
| 2 | Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | 0.00 | log L/kg | | - | - | - |
| 3 | Water Diffusivity, $D_w$ | 1.88E-05 | $cm^2/s$ | | - | - | - |
| 4 | Cap Decay Rate, $l_1$ | 0.00E+00 | $yr^{-1}$ | | - | - | - |
| 5 | Bioturbation Layer Decay Rate, $l_2$ | 0.00E+00 | $yr^{-1}$ | | - | - | - |
| | **Sediment Properties** | | | | | | |
| 6 | Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L | 0.64 | 2.2 | 9.823E-227 | 3.377E-226 |
| 7 | Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | | | - | - | - |
| 8 | Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L | | - | - | - |
| 9 | Darcy Velocity, *V (*positive is upwelling) | 4.73E-02 | cm/yr | 4.73E-06 | 4.73E+00 | 1.162E-226 | 1.283E-226 |
| 10 | Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr | 0 | 5.08 | 1.055E-02 | < 1E-308 - numerical problems |
| 11 | Bioturbation Layer Thickness, $h_{bio}$ | 10 | cm | | - | - | - |
| 12 | Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100 | $cm^2/yr$ | | - | - | - |
| 13 | Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1 | $cm^2/yr$ | | - | - | - |
| | **Cap Properties** | | | | | | |
| 14 | Depth of Interest, *z* | 10 | cm | | - | - | - |
| 15 | Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | | | - | - | - |
| 16 | Conventional Cap placed depth | 20.32 | cm | | - | - | - |
| 17 | Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | | | G | | - |
| 18 | Cap consolidation depth | 3.048 | cm | 1.06 | - | 4.348E-125 | - |
| 19 | Underlying sediment consolidation due to cap placement | 10.16 | cm | 3.05 | - | 5.479E-98 | - |
| 20 | Porosity, e | 0.35 | fraction | 0.25 | 0.35 | 4.844E-139 | 3.902E-71 |
| 21 | Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ | | - | - | - |
| 22 | fraction organic carbon, $(f_{oc})_{eff}$ | 1 | | | - | - | - |

**Notes:**
cm - Centimeter
$cm^2/s$ - Square centimeters per second
cm/yr - Centimeter per year
$cm^2/yr$ - Squared centimeters per year
$g/cm^3$ - Gram per cubic centimeter
Kd - Partition coeffecient
Log/L Kg - Log 10 of Liters/Kilograms
mg/L - Milligram per liter
ug/L - Microgram per liter
$yr^{-1}$ - Per year
(a) - Partition coefficient ($K_d$) is input since the fraction of organic content is set to 1.0 for modeling inorganic constituents. See Appendix C for calculation of $K_d$ based on raw data from Battelle (Battelle, 2010).
(b) - Kuss, J., J. Holzmann, and R. Ludwig. 2009. An Elemental Mercury Diffusion Coefficient for Natural Waters Determined by Molecular Dynamics. *Environ. Sci. Tech*. 43(9): 3183-3186.
(c) - Average mercury concentration in porewater from fine cores (0-12 inches) = 0.64 ug/L, average mercury concentration in porewater from southern portion of the Basin where sediment concentrations are higher = 0.75 ug/L, and maximum mercury concentrations and maximum average mercury concentration = 2.2 ug/L
(d) - See Appendix D for calculation of Darcy velocity as a function of hydraulic gradient and hydraulic conductivity.

Prepared by/Date: NTG 4/21/11
Checked by/Date: HEF 4/22/11

**Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil**
**Organic Carbon Partition Coefficient, Sensitivity Value 1**
**From Lampert and Reible (2008)* Version 1.13**




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, log$K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log$K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26758611 | cm |

$$C_2 = \frac{C_{bl} e^{\frac{Pe_2}{2}} - C_{bio} e^{-\gamma}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio} e^{\gamma} - C_{bl} e^{\frac{Pe_2}{2}}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

**Output**

| | | | |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 6.7383E-107 ug/L | | |
| Loading at Depth, $W(z)$ | 0.0000 ug/kg | | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 ug/kg | | |
| Flux to Overlying Water Column, $J$ | 0.0000 $ug/m^2/yr$ | | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 6.7E-107 ug/L | |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 1.4E-110 ug/L | |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 9.4E-108 ug/L | |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr | |

Sediment Concentration
8.5E-104 ug/kg

$$Pe_2 = \frac{U h_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon \lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh + \frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2} + \frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2} + Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

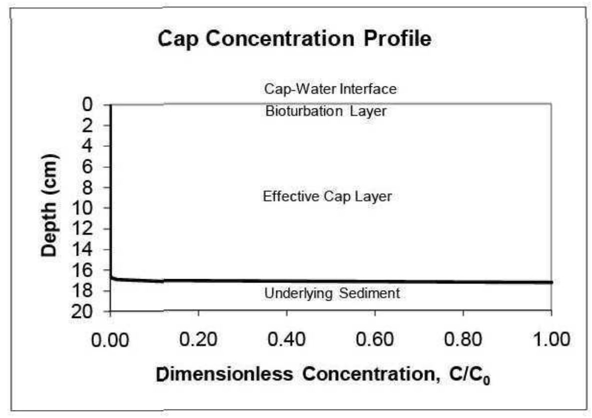
| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -244.18 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2$/4+$Da$) | 122.09 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.15 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2$/4+$Da$) | 3.574 |
| Sherwood Number at Interface, $Sh$ | 26.7 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,302 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,302 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2454 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 145.6 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat
Sediments," Soil & Sediment Contamination, (under review).

**Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil**
**Organic Carbon Partition Coefficient, Sensitivity Value 2**
**From Lampert and Reible (2008)* Version 1.13**




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, $\log K_{oc}$ | 2.8E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, $\log K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.35 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26255899 | cm |

$$C_2 = \frac{C_{bl} e^{\frac{Pe_2}{2}} - C_{bio} e^{-\gamma}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio} e^{\gamma} - C_{bl} e^{\frac{Pe_2}{2}}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

**Output**

| | | |
|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 1.8082E-39 | ug/L |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 1.81E-39 ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 3.1E-43 ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 2.72E-40 ug/L |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr |

Sediment Concentration
1.15E-36 ug/kg

$$Pe_2 = \frac{U h_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon \lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

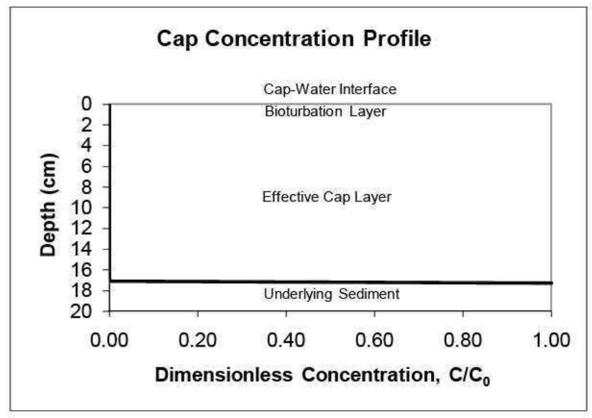
| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -88.92 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1{}^2$/4+$Da$) | 44.46 |
| Bioturbation Layer Peclet No., $Pe_2$ | -6.60 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1{}^2$/4+$Da$) | 3.298 |
| Sherwood Number at Interface, $Sh$ | 52.7 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 1,076 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 1,076 | |
| Effective Advective Velocity, $U$ | -8.E+02 | cm/yr |
| Dispersivity, $\alpha$ | 0.11 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 67 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 1243 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 53.0 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat
Sediments," Soil & Sediment Contamination, (under review).

## Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil
## Porewater Concentration, Sensitivity Value 1
## From Lampert and Reible (2008)* Version 1.13




| **Contaminant Properties** | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, log$K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log$K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |
| **Sediment Properties** | | |
| Contaminant Pore Water Concentration, $C_0$ | 0.64 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |
| **Cap Properties** | | |
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26717933 | cm |

**Model Equations**

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

| **Output** | | |
|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 5.1872E-98 ug/L | |
| Loading at Depth, $W(z)$ | 0.0000 ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 ug/kg | |
| Flux to Overlying Water Column, $J$ | 0.0000 $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 5.19E-98 ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 1E-101 ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 7.3E-99 ug/L |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr |

Sediment Concentration
6.01E-95 ug/kg

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

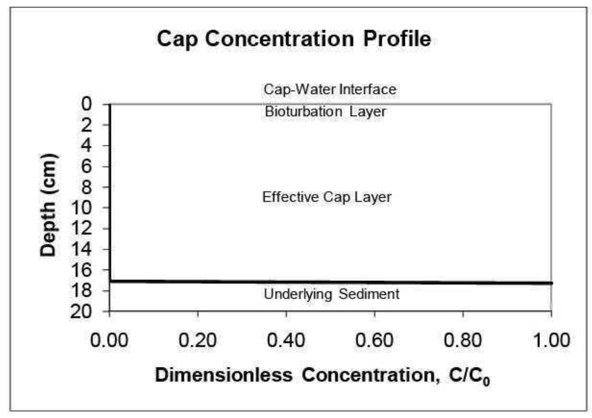
| **Dimensionless Parameters** | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -223.56 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2$/4+$Da$) | 111.78 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.11 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2$/4+$Da$) | 3.553 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

| **Other Parameters** | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 133.3 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat
Sediments," Soil & Sediment Contamination, (under review).

**Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil**
**Porewater Concentration, Sensitivity Value 2**
**From Lampert and Reible (2008)* Version 1.13**

| **Contaminant Properties** | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, $\log K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, $\log K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |




| **Sediment Properties** | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 2.2 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

| **Cap Properties** | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26717933 | cm |

$$C_2 = \frac{C_{bl} e^{\frac{Pe_2}{2}} - C_{bio} e^{-\gamma}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio} e^{\gamma} - C_{bl} e^{\frac{Pe_2}{2}}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

| **Output** | | |
|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 1.7831E-97 | ug/L |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 1.78E-97 ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 3.6E-101 ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 2.5E-98 ug/L |
| Time to Approach Steady State Conditons, $t_{adv/diff}$ | Never Breakthrough | yr |

Sediment Concentration
2.06E-94 ug/kg

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

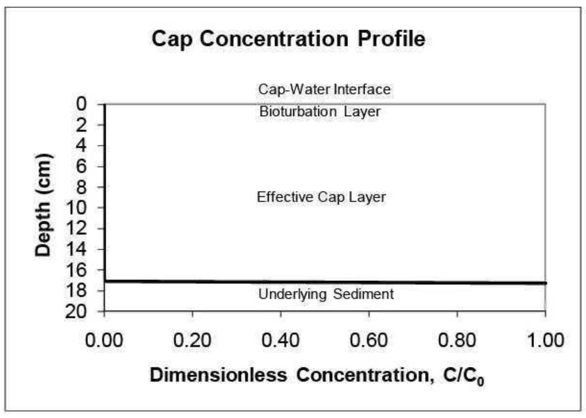
$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

| **Dimensionless Parameters** | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -223.56 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2/4+Da$) | 111.78 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.11 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2/4+Da$) | 3.553 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

| **Other Parameters** | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 133.3 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |


*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat
Sediments," Soil & Sediment Contamination, (under review).

## Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil
## Darcy Velocity, Sensitivity Value 1
## From Lampert and Reible (2008)* Version 1.13




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, $\log K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, $\log K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 4.7304E-06 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26717933 | cm |

$$C_2 = \frac{C_{bl} e^{\frac{Pe_2}{2}} - C_{bio} e^{-\gamma}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2} + \gamma\right)\frac{h_{bio} - z}{h_{bio}}\right] + \frac{C_{bio} e^{\gamma} - C_{bl} e^{\frac{Pe_2}{2}}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2} - \gamma\right)\frac{h_{bio} - z}{h_{bio}}\right]$$

**Output**

| | | | |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 5.8998E-98 ug/L | | |
| Loading at Depth, $W(z)$ | 0.0000 ug/kg | | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 ug/kg | | |
| Flux to Overlying Water Column, $J$ | 0.0000 $ug/m^2/yr$ | | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 5.9E-98 ug/L | |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 1.2E-101 ug/L | |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 8.3E-99 ug/L | |
| Time to Approach Steady State Conditons, $t_{adv/diff}$ | Never Breakthrough | yr | |

Sediment Concentration
6.83E-95 ug/kg

$$Pe_2 = \frac{U h_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon \lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh + \frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1 + Pe_2}{2}}}{\left(\frac{Pe_1}{2} + \frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2} + Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -223.59 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2$/4+$Da$) | 111.80 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.11 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2$/4+$Da$) | 3.553 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

**Other Parameters**

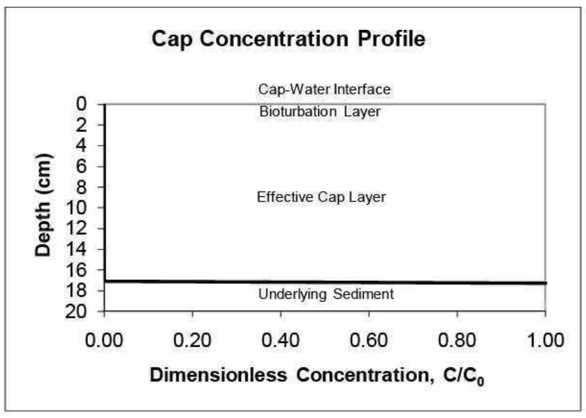
| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 133.3 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat
Sediments," Soil & Sediment Contamination, (under review).

**Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil**
**Darcy Velocity, Sensitivity Value 2**
**From Lampert and Reible (2008)* Version 1.13**

**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, $\log K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, $\log K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |




**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 4.7304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26717933 | cm |

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

**Output**

| | | | |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 1.1375E-96 | ug/L | |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg | |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | | 1.14E-96 ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | | 2.3E-100 ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | | 1.6E-97 ug/L |
| Time to Approach Steady State Conditons, $t_{adv/diff}$ | Never Breakthrough | yr | |

Seciment Concentration
1.32E-93 ug/kg

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2 \sinh\beta}{\left(Sh + \frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2} + \frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2} + Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

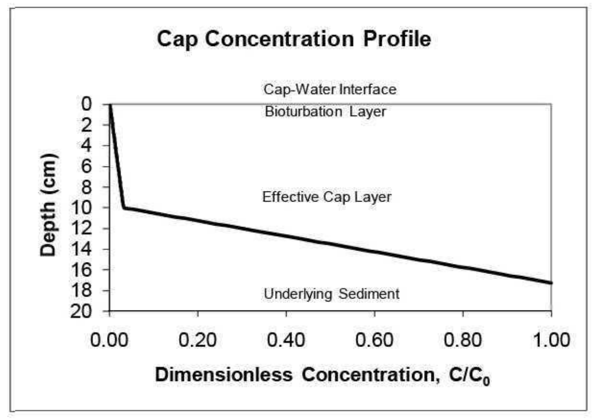
| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -220.63 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2/4+Da$) | 110.32 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.08 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2/4+Da$) | 3.542 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 53 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2260 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer $t_{adv}$ | -9.6 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 131.9 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat Sediments," Soil & Sediment Contamination, (under review).

## Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil
## Depositional Velocity, Sensitivity Value 1
## From Lampert and Reible (2008)* Version 1.13




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, log$K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log$K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26717933 | cm |

$$C_2 = \frac{C_{bl} e^{\frac{Pe_2}{2}} - C_{bio} e^{-\gamma}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio} e^{\gamma} - C_{bl} e^{\frac{Pe_2}{2}}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

**Output**

| | | |
|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 2.3957E-02 ug/L | |
| Loading at Depth, $W(z)$ | 27.7389 ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 14.3327 ug/kg | |
| Flux to Overlying Water Column, $J$ | 52.3306 $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 3.19% | 0.023957 ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.11% | 0.000799 ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 1.65% | 0.012379 ug/L |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | 133 yr | |

Sediment Concentration
27.73895 ug/kg

$$Pe_2 = \frac{U h_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon \lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2 \sinh\beta}{\left(Sh + \frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2} + \frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2} + Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

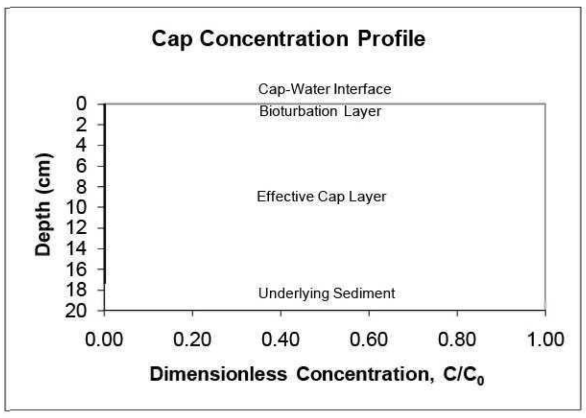
| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | 0.01 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2$/4+$Da$) | 0.00 |
| Bioturbation Layer Peclet No., $Pe_2$ | 0.00 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2$/4+$Da$) | 0.003 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | 5.E-02 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | 323783.5 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 133.3 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminate
Sediments," Soil & Sediment Contamination, (under review).

## Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil
## Depositional Velocity, Sensitivity Value 2
## From Lampert and Reible (2008)* Version 1.13




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, $\log K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, $\log K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 5.08 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26717933 | cm |

$$C_2 = \frac{C_{bl} e^{-\frac{Pe_2}{2}} - C_{bio} e^{-\gamma}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio} e^{\gamma} - C_{bl} e^{-\frac{Pe_2}{2}}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

$$Pe_2 = \frac{U h_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon \lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

**Output**

| | | | |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | #NUM! | ug/L | |
| Loading at Depth, $W(z)$ | #NUM! | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | #NUM! | ug/kg | |
| Flux to Overlying Water Column, $J$ | #NUM! | $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | #NUM! | #NUM! | ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | #NUM! | #NUM! | ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | #NUM! | #NUM! | ug/L |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr | |

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

**Dimensionless Parameters**

| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -1490.44 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2/4+Da$) | 745.22 |
| Bioturbation Layer Peclet No., $Pe_2$ | -47.38 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2/4+Da$) | 23.689 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

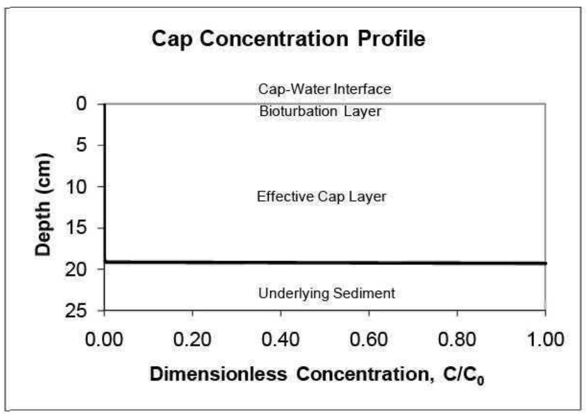
**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -1.E+04 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer $t_{adv}$ | -1.4 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 133.3 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat
Sediments," Soil & Sediment Contamination, (under review).

#NUM! - Numerical difficulties in the model due to division by very small numbers; model assumes division by zero

**Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil Cap Material**
**From Lampert and Reible (2008)* Version 1.13**




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, $\log K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, $\log K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 1.016 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 19.29917933 | cm |

**Output**

| | | | |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 4.3480E-125 | ug/L | |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg | |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 4.3E-125 ug/L | |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 8.7E-129 ug/L | |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 6.1E-126 ug/L | |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr | |

Sediment Concentration
5E-122 ug/kg

**Dimensionless Parameters**

| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -286.07 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2/4+Da$) | 143.03 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.11 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2/4+Da$) | 3.553 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 9 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.14 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer $t_{adv}$ | -12.2 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 218.2 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

**Model Equations**

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

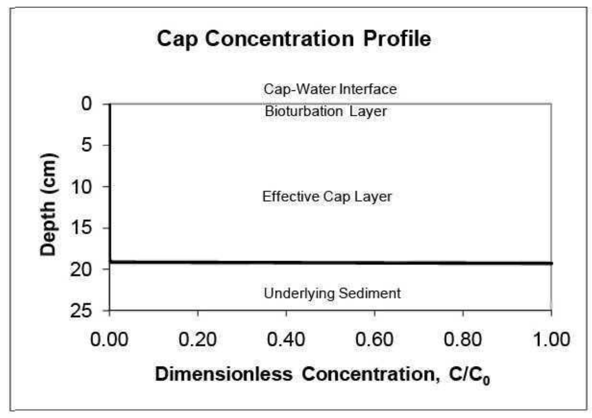
$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4}+Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat
Sediments," Soil & Sediment Contamination, (under review).

## Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil
## Cap Consolidation Depth
## From Lampert and Reible (2008)* Version 1.13




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, $\log K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, $\log K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 1.016 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 19.29917933 | cm |

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

**Output**

| | | | |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 4.3480E-125 | ug/L | |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg | |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | | 4.3E-125 ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | | 8.7E-129 ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | | 6.1E-126 ug/L |
| Time to Approach Steady-State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr | |

Sediment Concentration
5E-122 ug/kg

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o\frac{Pe_2}{Pe_1}e^{\frac{Pe_1}{2}}\beta\sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

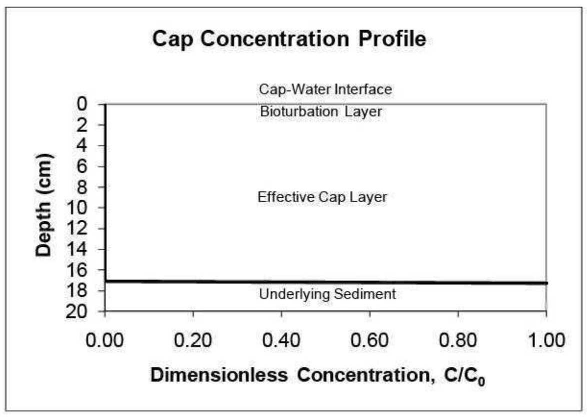
| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -286.07 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2/4+Da$) | 143.03 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.11 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2/4+Da$) | 3.553 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 9 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.14 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer $t_{adv}$ | -12.2 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 218.2 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat Sediments," Soil & Sediment Contamination, (under review).

**Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil**
**Underlying Sediment Consolidation due to Cap Placement**
**From Lampert and Reible (2008)* Version 1.13**




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, $\log K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, $\log K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 3.048 | cm |
| Porosity, e | 0.3 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.2705538 | cm |

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

**Output**

| | | | |
|---|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 5.4794E-98 ug/L | | |
| Loading at Depth, $W(z)$ | 0.0000 ug/kg | | |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 ug/kg | | |
| Flux to Overlying Water Column, $J$ | 0.0000 $ug/m^2/yr$ | | |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 5.48E-98 ug/L | |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 1.1E-101 ug/L | |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 7.7E-99 ug/L | |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr | |

Sediment Concentrations
6.34E-95 ug/kg

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4}+Da_2}$$

$$C_{bio} = \frac{C_o\frac{Pe_2}{Pe_1}e^{\frac{Pe_1}{2}}\beta\sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma+\gamma\cosh\gamma}}$$

**Dimensionless Parameters**

| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -223.66 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2$/4+$Da$) | 111.83 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.11 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2$/4+$Da$) | 3.553 |
| Sherwood Number at Interface, $Sh$ | 29.0 |

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta}+\left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma}+\frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta}+\cosh\beta\cosh\gamma}$$

**Other Parameters**

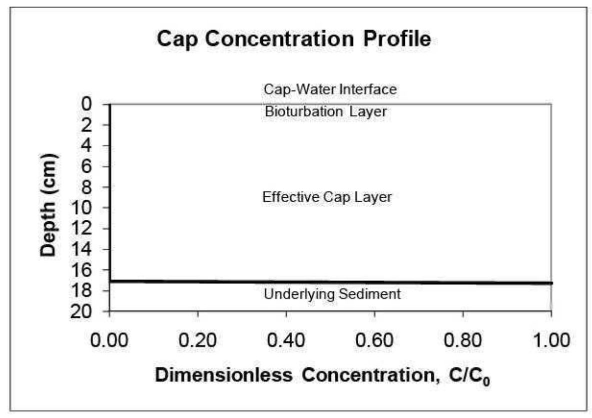
| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,108 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,108 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 52 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2259 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 133.4 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat
Sediments," Soil & Sediment Contamination, (under review).

**Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil**
**Porosity, Sensitivity Value 1**
**From Lampert and Reible (2008)* Version 1.13**

**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, log$K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, log$K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |




**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.25 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.26750057 | cm |

$$C_2 = \frac{C_{bl}e^{\frac{Pe_2}{2}} - C_{bio}e^{-\gamma}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio}e^{\gamma} - C_{bl}e^{\frac{Pe_2}{2}}}{2\sinh\gamma}\exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

**Output**

| | | |
|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 4.8443E-139 | ug/L |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 4.8E-139 ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 9.7E-143 ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 6.7E-140 ug/L |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr |

Sediment Concentration
5.6E-136 ug/kg

$$Pe_2 = \frac{Uh_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon\lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4}+Da_2}$$

$$C_{bio} = \frac{C_o\frac{Pe_2}{Pe_1}e^{\frac{Pe_1}{2}}\beta\sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh+\frac{Pe_2}{2}\right)\sinh\gamma+\gamma\cosh\gamma}}$$

**Dimensionless Parameters**

| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -318.19 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2$/4+$Da$) | 159.10 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.18 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2$/4+$Da$) | 3.589 |
| Sherwood Number at Interface, $Sh$ | 27.3 |

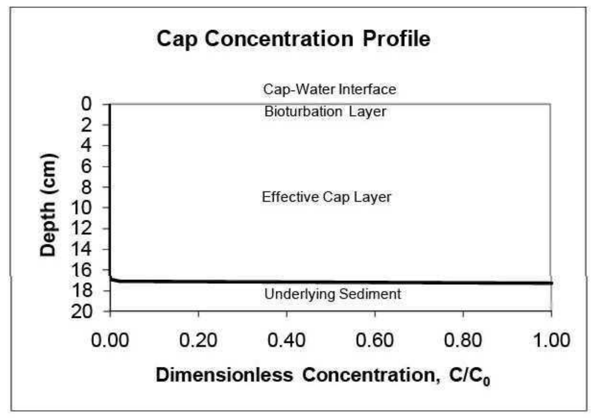
$$C_{bl} = \frac{C_o e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2}+\frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2}+Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 2,258 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 2,258 | |
| Effective Advective Velocity, $U$ | -2.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 39 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2397 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer $t_{diff}$ | 189.7 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |


*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat
Sediments," Soil & Sediment Contamination, (under review).

**Steady State Cap Design Model - Sensitivity Analysis using Native Borrow Soil**
**Porosity, Sensitivity Value 2**
**From Lampert and Reible (2008)* Version 1.13**




**Contaminant Properties**

| | | |
|---|---|---|
| Contaminant | Mercury | |
| Organic Carbon Partition Coefficient, $\log K_{oc}$ | 3.1E+00 | log L/kg |
| Colloidal Organic Carbon Partition Coefficient, $\log K_{DOC}$ | 0.0E+00 | log L/kg |
| Water Diffusivity, $D_w$ | 1.9E-05 | $cm^2/s$ |
| Cap Decay Rate, $l_1$ | 0.0E+00 | $yr^{-1}$ |
| Bioturbation Layer Decay Rate, $l_2$ | 0.0E+00 | $yr^{-1}$ |

**Sediment Properties**

| | | |
|---|---|---|
| Contaminant Pore Water Concentration, $C_0$ | 0.75 | ug/L |
| Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$ | 1 | |
| Colloidal Organic Carbon Concentration, $r_{DOC}$ | 0 | mg/L |
| Darcy Velocity, $V$ (positive is upwelling) | 0.047304 | cm/yr |
| Depositional Velocity, $V_{dep}$ | 0.762 | cm/yr |
| Bioturbation Layer Thickness, $h_{bio}$ | 10.00 | cm |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | 100.00 | $cm^2/yr$ |
| Particle Biodiffusion Coefficient, $D_{bio}^{P}$ | 1.00 | $cm^2/yr$ |

**Model Equations**

**Cap Properties**

| | | |
|---|---|---|
| Depth of Interest, $z$ | 10 | cm |
| Fraction organic carbon at depth of interest, $f_{oc}(z)$ | 1 | |
| Conventional Cap placed depth | 20.32 | cm |
| Cap Materials -Granular (G) or Consolidated Silty/Clay (C) | C | |
| Cap consolidation depth | 3.048 | cm |
| Underlying sediment consolidation due to cap placement | 10.16 | cm |
| Porosity, e | 0.35 | |
| Particle Density, $\rho_P$ | 2.6 | $g/cm^3$ |
| fraction organic carbon, $(f_{oc})_{eff}$ | 1 | |
| Boundary Layer Mass Transfer Coefficient $k_{bl}$ | 0.75 | cm/hr |
| Cap thickness, $h_{cap}$ | 17.2668087 | cm |

$$C_2 = \frac{C_{bl} e^{\frac{Pe_2}{2}} - C_{bio} e^{-\gamma}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}+\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right] + \frac{C_{bio} e^{\gamma} - C_{bl} e^{\frac{Pe_2}{2}}}{2\sinh\gamma} \exp\left[\left(\frac{Pe_2}{2}-\gamma\right)\frac{h_{bio}-z}{h_{bio}}\right]$$

**Output**

| | | |
|---|---|---|
| Pore Water Concentration at Depth, $C(z)$ | 3.9017E-71 | ug/L |
| Loading at Depth, $W(z)$ | 0.0000 | ug/kg |
| Average Bioturbation Layer Loading, $(W_{bio})_{avg}$ | 0.0000 | ug/kg |
| Flux to Overlying Water Column, $J$ | 0.0000 | $ug/m^2/yr$ |
| Cap-Bioturbation Interface Concentration, $C_{bio}/C_0$, $C_{bio}$ | 0.00% | 3.9E-71 ug/L |
| Cap-Water Interface Concentration, $C_{bl}/C_0$, $C_{bl}$ | 0.00% | 7.94E-75 ug/L |
| Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$ | 0.00% | 5.53E-72 ug/L |
| Time to Approach Steady State Conditions, $t_{adv/diff}$ | Never Breakthrough | yr |

Sediment Concentration
4.52E-68 ug/kg

$$Pe_2 = \frac{U h_{bio}}{D_2} \qquad Da_2 = \frac{\varepsilon \lambda_2 h_{bio}^2}{D_2} \qquad \gamma = \sqrt{\frac{Pe_2^2}{4} + Da_2}$$

$$C_{bio} = \frac{C_o \frac{Pe_2}{Pe_1} e^{\frac{Pe_1}{2}} \beta \sinh\gamma}{\frac{Pe_2}{Pe_1}\beta\cosh\beta\sinh\gamma + \gamma\sinh\beta\cosh\gamma - \frac{\gamma^2\sinh\beta}{\left(Sh + \frac{Pe_2}{2}\right)\sinh\gamma + \gamma\cosh\gamma}}$$

$$C_{bl} = \frac{C_0 e^{\frac{Pe_1+Pe_2}{2}}}{\left(\frac{Pe_1}{2} + \frac{Pe_1 Sh}{Pe_2}\right)\frac{\sinh\beta\cosh\gamma}{\beta} + \left(\frac{Pe_2}{2} + Sh\right)\frac{\cosh\beta\sinh\gamma}{\gamma} + \frac{Pe_1\gamma\sinh\gamma\sinh\beta}{Pe_2\beta} + \cosh\beta\cosh\gamma}$$

**Dimensionless Parameters**

| | |
|---|---|
| Effective Cap Layer Peclet No., $Pe_1$ | -161.83 |
| Effective Cap Layer Damkohler No., $Da_1$ | 0.00 |
| b = SQRT($Pe_1^2$/4+$Da$) | 80.92 |
| Bioturbation Layer Peclet No., $Pe_2$ | -7.02 |
| Bioturbation Layer Damkohler No., $Da_2$ | 0.00 |
| g = SQRT($Pe_1^2$/4+$Da$) | 3.510 |
| Sherwood Number at Interface, $Sh$ | 30.8 |

**Other Parameters**

| | | |
|---|---|---|
| Cap Effective Depth, $h_{eff}$ | 7 | cm |
| Containment Layer Retardation Factor, $R_1$ | 1,957 | |
| Bioturbation Layer Retardation Factor, $R_2$ | 1,957 | |
| Effective Advective Velocity, $U$ | -1.E+03 | cm/yr |
| Dispersivity, $\alpha$ | 0.12 | cm |
| Effective Cap Layer Diffusion/Dispersion Coeff. $D_1$ | 67 | $cm^2/yr$ |
| Bioturbation Layer Diffusion/Dispersion Coeff. $D_2$ | 2124 | $cm^2/yr$ |
| Characteristic Advection Time-cap layer, $t_{adv}$ | -9.5 | yr |
| Characteristic Diffusion Time-cap layer, $t_{diff}$ | 96.5 | yr |
| Characteristic Reaction Time-cap layer, $t_{decay}$ | infinity | yr |

*Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminat Sediments," Soil & Sediment Contamination, (under review).

# APPENDIX F

# COST ASSUMPTIONS

**Alternative 2A - Native Soil**
**Capital Cost Sub-Element**
**INSTITUTIONAL CONTROLS**

# COST WORKSHEET

Prepared by: JDD  Date: 3/23/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Implementation of institutional controls such as signs, security, deed restrictions, etc.

Cost Analysis:
Cost per IC implementation.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Institutional Controls | 1 | LS | $0.00 | $0.00 | $1,000.00 | $0.00 | $1,000.00 | $1,000.00 | Signs, Fencing, Security, etc. |
| Environmental Contractor | 1 | LS | $600.00 | $0.00 | $0.00 | $0.00 | $600.00 | $600.00 | Contractor for implementation |
| **Total** | | | **$600.00** | **$0.00** | **$1,000.00** | **$0.00** | **$1,600.00** | **$1,600.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil**
**Capital Cost Sub-Element**
**REMEDIAL DESIGN AND TREATABILITY STUDIES**

COST WORKSHEET

Prepared by: JDD  Date: 3/23/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Remedial Design/Treatability Study

Cost Analysis:
Cost per remedial design

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Remedial Design Deliverable | 1 | LS | $45,000.00 | $0.00 | $0.00 | $0.00 | $45,000.00 | $45,000.00 | Remedial design document |
| Treatability Studies | 1 | LS | $8,000.00 | $1,000.00 | $1,000.00 | $0.00 | $10,000.00 | $10,000.00 | Treatability studies and report |
| Update Health and Safety Plan, QAPP | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Updates to HASP/QAPP |
| **Total** | | | **$58,000.00** | **$1,000.00** | **$1,000.00** | **$0.00** | **$60,000.00** | **$60,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil**
**Capital Cost Sub-Element**
**CAP PLACEMENT**

COST WORKSHEET

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

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

Work Statement:
Construction and support activities for cap placement.

Cost Analysis:
Cost per cap placement.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | UNIT COST CONVERSION[2] | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| Mobilization | 1 | LS | $78,871.67 | $5,407.95 | $52,685.24 | $246,918.66 | $383,883.52 | $383,883.52 | - | Mobilization of heavy equipment to jobsite. Installation of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| General Conditions | 1 | LS | $1,174,385.01 | $0.00 | $8,092.51 | $875,516.04 | $2,057,993.55 | $2,057,993.55 | $170,000 per month | Supervision of field activities. Includes labor cost, living expenses, travel expenses for the project manager and oversight staff. 12 months. |
| Temporary Facilities | 1 | LS | $0.00 | $317,744.30 | $104,782.71 | $0.00 | $422,527.02 | $422,527.02 | $35,000 per month | Maintenance and upkeep of temporary site facilities including monthly fees for utilities, restrooms, etc., maintenance fluids for equipment and general housekeeping activities. 12 months. |
| Site Preparation | 1 | LS | $79,332.04 | $34,504.36 | $465,210.66 | $215,800.26 | $794,847.32 | $794,847.32 | Road Prep: 5 Acres<br>Silt Fencing: 2800 ft<br>Silt Curtain: 7500 ft<br>Paving: 40,000 $ft^2$ | Grading and clearing, construction of access roads and staging area, silt fence and curtain installation. |
| Material Transfer Line from Shore to Spreader | 1 | LS | $82,728.54 | $27,936.67 | $102,643.27 | $21,821.26 | $235,129.74 | $235,129.74 | $110 per ft | Install a 14" pipe from onshore mixer to the spreader system on the barge. 2175 ft. |
| Surveying | 1 | LS | $100,478.33 | $28,773.37 | $0.00 | $346,958.86 | $476,210.55 | $476,210.55 | $79,000 per month | Up-front survey prior to capping, surveying at intervals during capping layout, and 2 weeks of surveying after cap placement. 6 months. |
| Operations Maintenance | 1 | LS | $279,418.18 | $202,622.06 | $89,485.17 | $0.00 | $571,525.41 | $571,525.41 | $64,000 per month | Full-time crew providing maintenance and mobilization of barge and spreader units. 9 months. |
| Cap Material Handling, Stockpiling, and Testing | 1 | LS | $214,727.82 | $140,414.04 | $231,030.96 | $20,680.86 | $606,853.67 | $606,853.67 | - | Sand and stone, material testing and handling operations. |
| Capping Operations | 1 | LS | $1,019,802.28 | $827,821.30 | $4,085,694.75 | $89,916.77 | $6,023,235.10 | $6,023,235.10 | $83,000 per acre | Slurry capping material on shore. Pump slurry to barge and spreader. Place over 72.5 acres. |
| Venting Mechanisms | 1% | % | $10,198.02 | $8,278.21 | $40,856.95 | $899.17 | $60,232.35 | $60,232.35 | - | Estimated as 1% of capping operations cost |
| Site Restoration | 1 | LS | $10,478.18 | $6,494.15 | $7,283.26 | $14,986.13 | $39,241.72 | $39,241.72 | $8000 per acre | Re-grade 5-acre staging area and borrow pit with existing site material and apply hydroseed. Asphalt pavement will remain in place. |
| Demobilization | 1 | LS | $101,239.15 | $33,196.79 | $18,758.14 | $162,636.67 | $315,830.75 | $315,830.75 | - | Demobilization of heavy equipment from jobsite. Removal of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| **Total** | | | | | | | | **$11,987,510.70** | | |

1 - Includes costs associated with subcontracted services and equipment
2 - Unit cost conversions provided, where appropriate, for comparison purposes. Unit cost conversions rounded to 2 significant figures.

**Source of Cost Data:** Quote from Alan Elia, Jr., Sevenson Environmental Services, tel no. 716-284-0431.

**Alternative 2A - Native Soil**
**Periodic Cost Sub-Element**
**SURFACE WATER SAMPLING**

# COST WORKSHEET

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

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

Work Statement:
Sampling of surface water for low-level mercury. Five project samples plus 5 QC samples analyzed per event.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $5,140.00 | $500.00 | $0.00 | $3,354.00 | $8,994.00 | $8,994.00 | Labor, travel, equipment, and field supply costs for 3 people to sample from boat. Travel costs listed as "Other." |
| Analysis | 10 | LS | $0.00 | $0.00 | $0.00 | $136.50 | $136.50 | $1,365.00 | Laboratory costs for sample analysis. Laboratory analysis costs listed as "Other." |
| **Total** | | | **$5,140.00** | **$500.00** | **$0.00** | **$3,490.50** | **$9,130.50** | **$10,359.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil**
**Periodic Cost Sub-Element**
**SEDIMENT CORE SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sediment core sampling for mercury. Five cores collected per event, two sections analyzed per core.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $7,605.00 | $500.00 | $0.00 | $11,844.00 | $19,949.00 | $19,949.00 | Labor, travel, equipment, and field supply costs for 3 sampling personnel plus boat and divers to assist with sample collection. Travel expenses listed as "Other." |
| Analysis | 14 | LS | $0.00 | $0.00 | $0.00 | $18.90 | $18.90 | $264.60 | Laboratory costs for sample analysis listed as "Other." 10 samples plus 4 QA/QC samples. |
| **Total** | | | **$7,605.00** | **$500.00** | **$0.00** | **$11,862.90** | **$19,967.90** | **$20,213.60** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil**
**Annual Cost Sub-Element**
**INSPECTION AND MAINTENANCE**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Annual maintenance.

Cost Analysis:
Annual cost

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Inspection | 1 | LS | $0.00 | $0.00 | $0.00 | $1,500.00 | $1,500.00 | $1,500.00 | Personnel to perform on-site inspection. "Other" refers to subcontracted services |
| Maintenance | 1 | LS | $0.00 | $0.00 | $0.00 | $2,000.00 | $2,000.00 | $2,000.00 | As-needed maintenance, such as mowing, re-seeding, re-grading. "Other" refers to subcontracted services |
| **Total** | | | **$0.00** | **$0.00** | **$0.00** | **$3,500.00** | **$3,500.00** | **$3,500.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil**
**Periodic Cost Sub-Element**
**FISH TISSUE SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN    Date: 3/28/2012
Checked by: KPW    Date: 3/29/2012

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

Work Statement:
Sampling and analysis of largemouth bass and bluegill fish tissue. Two size ranges of each fish. Largemouth bass to have filet and filet/offal reconstituted analyzed.
Largemouth Bass: 5 locations x 2 size ranges x filet and filet/offal = 20 samples
Bluegill: 5 locations x 2 size ranges = 10 samples

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $4,435.00 | $250.00 | $0.00 | $3,354.00 | $8,039.00 | $8,039.00 | Labor, travel, equipment, and field supply costs for 3 field personnel to collect fish samples from boat. Travel expenses are listed as "Other." |
| Analysis | 30 | LS | $0.00 | $0.00 | $0.00 | $39.90 | $39.90 | $1,197.00 | Laboratory costs for sample analysis are listed as "Other." |
| **Total** | | | **$4,435.00** | **$250.00** | **$0.00** | **$3,393.90** | **$8,078.90** | **$9,236.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil**
**Periodic Cost Sub-Element**
**SPIDER AND INSECT SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling of spider and insect tissue for Hg and DDTR. 3 samples each of spiders and insects to be analyzed.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling* | 1 | LS | $7,550.00 | $0.00 | $0.00 | $2,586.00 | $10,136.00 | $10,136.00 | Labor, travel, equipment, and field supply costs for 3 personnel to perform spider and insect sampling. Travel expenses are listed as "Other." |
| Analysis | 6 | LS | $0.00 | $0.00 | $0.00 | $197.40 | $197.40 | $1,184.40 | Laboratory costs for sample analysis listed as "Other." |
| **Total** | | | **$7,550.00** | **$0.00** | **$0.00** | **$2,783.40** | **$10,333.40** | **$11,320.40** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil**
**Periodic Cost Sub-Element**
**CAP SURVEY**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Field costs for cap sampling.

Cost Analysis:
Cost per survey

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Survey | 1 | LS | $0.00 | $0.00 | $0.00 | $2,520.00 | $2,520.00 | $2,520.00 | Surveyor costs are listed as "Other." |
| Divers | 1 | LS | $0.00 | $0.00 | $0.00 | $4,000.00 | $4,000.00 | $4,000.00 | Divers to assist surveyor are listed as "Other." |
| Environmental Consultant | 1 | LS | $2,750.00 | $0.00 | $0.00 | $800.00 | $3,550.00 | $3,550.00 | Schedule survey, provide oversight, and interpret results |
| **Total** | | | **$2,750.00** | **$0.00** | **$0.00** | **$7,320.00** | **$10,070.00** | **$10,070.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil**
**Periodic Cost Sub-Element**
**PERIODIC COSTS**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Preparation and submittal of 5-year Review Report

Cost Analysis:
Cost per 5-Year Review Report.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Five Year Review Report | 1 | LS | $4,800.00 | $0.00 | $200.00 | $0.00 | $5,000.00 | $5,000.00 | Data analysis, report preparation, and submittal. |
| **Total** | | | **$4,800.00** | **$0.00** | **$200.00** | **$0.00** | **$5,000.00** | **$5,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets**
**Capital Cost Sub-Element**
**INSTITUTIONAL CONTROLS**

# COST WORKSHEET

Prepared by: JDD  Checked by: KPW
Date: 3/23/2012  Date: 3/29/2012

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

Work Statement:
Implementation of institutional controls such as signs, security, deed restrictions, etc.

Cost Analysis:
Cost per IC implementation.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Institutional Controls | 1 | LS | $0.00 | $0.00 | $1,000.00 | $0.00 | $1,000.00 | $1,000.00 | Signs, Fencing, Security, etc. |
| Environmental Contractor | 1 | LS | $0.00 | $0.00 | $0.00 | $600.00 | $600.00 | $600.00 | Contractor for implementation |
| | | | | | | | | $0.00 | |
| | | | | | | | | $0.00 | |
| **Total** | | | **$0.00** | **$0.00** | **$1,000.00** | **$600.00** | **$1,600.00** | **$1,600.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets**
**Capital Cost Sub-Element**
**REMEDIAL DESIGN/TREATABILITY STUDY**

# COST WORKSHEET

Prepared by: JDD Checked by: KPW
Date: 3/23/2012 Date: 3/29/2012

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

Work Statement:
Remedial Design

Cost Analysis:
Cost per remedial design

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Remedial Design Deliverable | 1 | LS | $45,000.00 | $0.00 | $0.00 | $0.00 | $45,000.00 | $45,000.00 | Remedial design document |
| Treatability Studies | 1 | LS | $8,000.00 | $1,000.00 | $1,000.00 | $0.00 | $10,000.00 | $10,000.00 | Treatability studies and report |
| Update Health and Safety Plan, QAPP | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Updates to HASP/QAPP |
| **Total** | | | **$58,000.00** | **$1,000.00** | **$1,000.00** | **$0.00** | **$60,000.00** | **$60,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets**
**Capital Cost Sub-Element**
**CAP PLACEMENT**

COST WORKSHEET

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

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

Work Statement:
Construction and support activities for cap placement.

Cost Analysis:
Cost per cap placement.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | UNIT COST CONVERSION[2] | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| MOBILIZATION | 1 | LS | $79,753.35 | $5,468.41 | $53,274.18 | $249,678.86 | $388,174.79 | $388,174.79 | - | Mobilization of heavy equipment to jobsite. Installation and removal of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| GENERAL CONDITIONS | 1 | LS | $769,684.34 | $0.00 | $5,303.78 | $584,179.38 | $1,359,167.50 | $1,359,167.50 | $170,000 per month | Supervision of field activities for. Includes labor cost, living expenses, travel expenses for the project manager and oversight staff. 8 months. |
| TEMPORARY FACILITIES | 1 | LS | $0.00 | $196,013.11 | $69,694.07 | $0.00 | $265,707.18 | $265,707.18 | $33,000 per month | Maintenance and upkeep of temporary site facilitiesincluding monthly fees for utilities, restrooms, etc., maintenance fluids for equipment and general housekeeping activities. 8 months. |
| SITE PREPARATION | 1 | LS | $80,703.39 | $35,140.28 | $454,531.65 | $224,472.00 | $794,847.32 | $794,847.32 | Road Prep: 5 Acres<br>Silt Fencing: 2800 ft<br>Silt Curtain: 7500 ft<br>Paving: 40,000 $ft^2$ | Grading and clearing, construction of acces roads and staging area, silt fence and curtain installation. |
| MATERIAL TRANSFER LINE FROM SHORE TO SPREADER BARGE | 1 | LS | $82,728.54 | $27,936.67 | $102,643.27 | $21,821.26 | $235,129.74 | $235,129.74 | $110 per foot | Install a 14" pipe from onshore mixer to the spreader system on the barge. 2,175 feet. |
| SURVEY | 1 | LS | $83,821.26 | $24,003.39 | $0.00 | $246,162.00 | $353,986.65 | $353,986.65 | $71,000 per month | Up-front survey prior to capping, surveying at intervals during capping layout, and 2 weeks of surveying after cap placement. 5 months. |
| MAINTENANCE OPERATION | 1 | LS | $233,096.88 | $184,306.73 | $63,754.45 | $0.00 | $481,158.06 | $481,158.06 | $74,000 per month | Full-time crew providing maintenance and mobilization of barge and spreader units. 6.5 months. |
| CAP MATERIAL HANDLING, STOCKPILING AND TESTING | 1 | LS | $179,130.74 | $117,136.52 | $187,771.94 | $10,910.63 | $494,949.84 | $494,949.84 | - | Material testing and handling operations. |
| CAPPING OPERATIONS - NATIVE SOIL AND STONE | 1 | LS | $438,260.95 | $355,756.95 | $2,042,669.44 | $27,276.58 | $2,863,963.91 | $2,863,963.91 | $39,500 per acre | Slurry native soil capping layers on shore. Pump slurry to barge and spreader. Place over 72.5 acres. |
| CAPPING OPERATIONS - BENTONITE PELLETS | 1 | LS | $222,471.27 | $290,484.62 | $7,218,492.27 | $0.00 | $7,731,448.16 | $7,731,448.16 | $110,000 per acre | Slurry bentonite pellet capping material on shore. Pump slurry to barge and spreader. Place over 72.5 acres. |
| CAP VENTING MECHANISMS | 1% | % | | | | | | $60,232.35 | - | See venting costs for Alternative 2A - Native Soil Cap |
| SITE RESTORATION | 1 | LS | $10,595.31 | $6,566.74 | $7,364.68 | $15,153.65 | $39,680.39 | $39,680.39 | $8000 per acre | Re-grade 5-acre staging area with existing site material and apply hydroseed. Asphalt pavement will remain in place. |
| DEMOBILIZATION | 1 | LS | $102,370.86 | $33,567.89 | $37,152.21 | $164,454.72 | $337,545.68 | $337,545.68 | - | Demobilization of heavy equipment from jobsite. Removal of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| **Total** | | | | | | | | **$15,405,991.57** | | |

1 - Includes costs associated with subcontracted services and equipment
2 - Unit cost conversions provided, where appropriate, for comparison purposes. Unit cost conversions rounded to 2 significant figures.

**Source of Cost Data:** Quote from Alan Elia, Jr., Sevenson Environmental Services, tel no. 716-284-0431.

**Alternative 2A - Bentonite Pellets**
**Periodic Cost Sub-Element**
**SURFACE WATER SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN Date: 3/28/2012
Checked by: KPW Date: 3/29/2012

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

Work Statement:
Sampling of surface water for low-level mercury. Five project samples plus 5 QC samples analyzed per event.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $5,140.00 | $500.00 | $0.00 | $3,354.00 | $8,994.00 | $8,994.00 | Labor, travel, equipment, and field supply costs associated with surface water sampling. |
| Analysis | 10 | LS | $0.00 | $0.00 | $0.00 | $136.50 | $136.50 | $1,365.00 | Laboratory costs for sample analysis. |
| **Total** | | | **$5,140.00** | **$500.00** | **$0.00** | **$3,490.50** | **$9,130.50** | **$10,359.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Bentonite Pellets**
**Periodic Cost Sub-Element**
**SEDIMENT CORE SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN  Date: 3/28/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Sediment core sampling for mercury. Five cores collected per event, two sections analyzed per core.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $7,605.00 | $500.00 | $0.00 | $11,844.00 | $19,949.00 | $19,949.00 | Labor, travel, equipment, and field supply costs for 3 sampling personnel plus boat and divers to assist with sample collection. Travel expenses listed as "Other." |
| Analysis | 14 | LS | $0.00 | $0.00 | $0.00 | $18.90 | $18.90 | $264.60 | Laboratory costs for sample analysis listed as "Other." 10 samples plus 4 QA/QC samples. |
| **Total** | | | **$7,605.00** | **$500.00** | **$0.00** | **$11,862.90** | **$19,967.90** | **$20,213.60** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets**
**Annual Cost Sub-Element**
**INSPECTION AND MAINTENANCE**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Annual maintenance.

Cost Analysis:
Annual cost

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Inspection | 1 | LS | $0.00 | $0.00 | $0.00 | $1,500.00 | $1,500.00 | $1,500.00 | Personnel to perform on-site inspection. "Other" refers to subcontracted services. |
| Maintenance | 1 | LS | $0.00 | $0.00 | $0.00 | $2,000.00 | $2,000.00 | $2,000.00 | As-needed maintenance, such as mowing, re-seeding, re-grading. "Other" refers to subcontracted services. |
| **Total** | | | **$0.00** | **$0.00** | **$0.00** | **$3,500.00** | **$3,500.00** | **$3,500.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets**
**Periodic Cost Sub-Element**
**FISH TISSUE SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN    Checked by: KPW
Date: 3/28/2012    Date: 3/29/2012

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

Work Statement:
Sampling and analysis of largemouth bass and bluegill fish tissue. Two size ranges of each fish. Largemouth bass to have filet and filet/offal reconstituted analyzed.
Largemouth Bass: 5 locations x 2 size ranges x filet and filet/offal = 20 samples
Bluegill: 5 locations x 2 size ranges = 10 samples

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $4,435.00 | $250.00 | $0.00 | $3,354.00 | $8,039.00 | $8,039.00 | Labor, travel, equipment, and field supply costs for 3 field personnel to collect fish samples from boat. Travel expenses are listed as "Other." |
| Analysis | 30 | LS | $0.00 | $0.00 | $0.00 | $39.90 | $39.90 | $1,197.00 | Laboratory costs for sample analysis are listed as "Other." |
| **Total** | | | **$4,435.00** | **$250.00** | **$0.00** | **$3,393.90** | **$8,078.90** | **$9,236.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Bentonite Pellets**
**Periodic Cost Sub-Element**
**SPIDER AND INSECT SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN    Date: 3/28/2012
Checked by: KPW    Date: 3/29/2012

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

Work Statement:
Sampling of spider and insect tissue for Hg and DDTR. 3 samples each of spiders and insects to be analyzed.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling* | 1 | LS | $7,550.00 | $0.00 | $0.00 | $2,586.00 | $10,136.00 | $10,136.00 | Labor, travel, equipment, and field supply costs for 3 personnel to perform spider and insect sampling. Travel expenses are listed as "Other." |
| Analysis | 6 | LS | $0.00 | $0.00 | $0.00 | $197.40 | $197.40 | $1,184.40 | Laboratory costs for sample analysis listed as "Other." |
| **Total** | | | **$7,550.00** | **$0.00** | **$0.00** | **$2,783.40** | **$10,333.40** | **$11,320.40** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Bentonite Pellets**
**Periodic Cost Sub-Element**
**CAP SURVEY**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Survey of cap surface.

Cost Analysis:
Cost per survey.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Survey | 1 | LS | $0.00 | $0.00 | $0.00 | $2,520.00 | $2,520.00 | $2,520.00 | Surveyor costs are listed as "Other." |
| Divers | 1 | LS | $0.00 | $0.00 | $0.00 | $4,000.00 | $4,000.00 | $4,000.00 | Divers to assist surveyor are listed as "Other." |
| Environmental Consultant | 1 | LS | $1,750.00 | $0.00 | $0.00 | $0.00 | $1,750.00 | $1,750.00 | Schedule survey, provide oversight, and interpret results. |
| **Total** | | | **$1,750.00** | **$0.00** | **$0.00** | **$6,520.00** | **$8,270.00** | **$8,270.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets**
**Periodic Cost Sub-Element**
**FIVE YEAR REVIEW REPORT**

# COST WORKSHEET

Prepared by: JDD  Date: 3/23/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Preparation and submittal of 5-year Review Report

Cost Analysis:
Cost per 5-Year Review Report.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Five Year Review Report | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Data analysis, report preparation, and submittal. |
| **Total** | | | **$5,000.00** | **$0.00** | **$0.00** | **$0.00** | **$5,000.00** | **$5,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil with Polishing Layer**
**Capital Cost Sub-Element**
**INSTITUTIONAL CONTROLS**

# COST WORKSHEET

Prepared by: JDD  Date: 3/23/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Implementation of institutional controls such as signs, security, deed restrictions, etc.

Cost Analysis:
Cost per IC implementation.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Institutional Controls | 1 | LS | $0.00 | $0.00 | $1,000.00 | $0.00 | $1,000.00 | $1,000.00 | Signs, Fencing, Security, etc. |
| Environmental Contractor | 1 | LS | $600.00 | $0.00 | $0.00 | $0.00 | $600.00 | $600.00 | Contractor for implementation |
| **Total** | | | **$600.00** | **$0.00** | **$1,000.00** | **$0.00** | **$1,600.00** | **$1,600.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil with Polishing Layer**
**Capital Cost Sub-Element**
**REMEDIAL DESIGN AND TREATABILITY STUDIES**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Remedial Design/Treatability Study

Cost Analysis:
Cost per remedial design

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Remedial Design Deliverable | 1 | LS | $45,000.00 | $0.00 | $0.00 | $0.00 | $45,000.00 | $45,000.00 | Remedial design document |
| Treatability Studies | 1 | LS | $8,000.00 | $1,000.00 | $1,000.00 | $0.00 | $10,000.00 | $10,000.00 | Treatability studies and report |
| Update Health and Safety Plan, QAPP | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Updates to HASP/QAPP |
| **Total** | | | **$58,000.00** | **$1,000.00** | **$1,000.00** | **$0.00** | **$60,000.00** | **$60,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil with Polishing Layer**
**Capital Cost Sub-Element**
**CAP PLACEMENT**

COST WORKSHEET

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

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

Work Statement:
Construction and support activities for cap placement.

Cost Analysis:
Cost per cap placement.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | UNIT COST CONVERSION[2] | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| Mobilization | 1 | LS | $78,871.67 | $5,407.95 | $52,685.24 | $246,918.66 | $383,883.52 | $383,883.52 | - | Mobilization of heavy equipment to jobsite. Installation of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| General Conditions | 1 | LS | $1,174,385.01 | $0.00 | $8,092.51 | $875,516.04 | $2,057,993.55 | $2,057,993.55 | $170,000 per month | Supervision of field activities. Includes labor cost, living expenses, travel expenses for the project manager and oversight staff. 12 months. |
| Temporary Facilities | 1 | LS | $0.00 | $317,744.30 | $104,782.71 | $0.00 | $422,527.02 | $422,527.02 | $35,000 per month | Maintenance and upkeep of temporary site facilities including monthly fees for utilities, restrooms, etc., maintenance fluids for equipment and general housekeeping activities. 12 months. |
| Site Preparation | 1 | LS | $79,332.04 | $34,504.36 | $465,210.66 | $215,800.26 | $794,847.32 | $794,847.32 | Road Prep: 5 Acres<br>Silt Fencing: 2800 ft<br>Silt Curtain: 7500 ft<br>Paving: 40,000 $ft^2$ | Grading and clearing, construction of access roads and staging area, silt fence and curtain installation. |
| Material Transfer Line from Shore to Spreader | 1 | LS | $81,813.98 | $27,627.83 | $101,508.55 | $21,580.03 | $232,530.38 | $232,530.38 | $110 per foot | Install a 14" pipe from onshore mixer to the spreader system on the barge. 2,150 feet. |
| Surveying | 1 | LS | $100,478.33 | $28,773.37 | $0.00 | $346,958.86 | $476,210.56 | $476,210.56 | $79,000 per month | Up-front survey prior to capping, surveying at intervals during capping layout, and 2 weeks of surveying after cap placement. 6 months. |
| Operations Maintenance | 1 | LS | $279,418.18 | $202,622.06 | $89,485.17 | $0.00 | $571,525.41 | $571,525.41 | $74,000 per month | Full-time crew providing maintenance and mobilization of barge and spreader units. |
| Cap Material, Handling, Stockpiling, and Testing | 1 | LS | $214,727.82 | $140,414.04 | $231,030.96 | $20,680.86 | $606,853.67 | $606,853.67 | - | Material testing and handling operations. |
| Capping Operations | 1 | LS | $1,019,802.28 | $827,821.30 | $4,085,694.75 | $89,916.77 | $6,023,235.10 | $6,023,235.10 | $83,000 per acre | Slurry capping material on shore. Pump slurry to barge and spreader. Place over 72.5 acres. |
| Capping Operations - Polishing Layer | 1 | LS | $899,729.31 | $730,352.45 | $3,604,639.24 | $79,329.85 | $5,314,050.84 | $5,314,050.84 | $354,000 per acre | Slurry polishing layer material on shore. Pump slurry to barge and spreader. Place over 15 acres. Includes cost of polishing layer material at $600/ton. |
| Venting Mechanisms | 1% | % | | | | | | $60,232.35 | - | See Venting Costs for Alternative 2A - Native Soil Cap |
| Site Restoration | 1 | LS | $10,478.18 | $6,494.15 | $7,283.26 | $14,986.13 | $39,241.72 | $39,241.72 | $8,000 per acre | Re-grade 5-acre staging area with existing site material and apply hydroseed. Asphalt pavement will remain in place. |
| Demobilization | 1 | LS | $101,239.15 | $33,196.79 | $18,758.14 | $162,636.67 | $315,830.75 | $315,830.75 | - | Demobilization of heavy equipment from jobsite. Removal of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| **Total** | | | | | | | | **$17,298,962.17** | | |

1 - Includes costs associated with subcontracted services and equipment
2 - Unit cost conversions provided, where appropriate, for comparison purposes. Unit cost conversions rounded to two significant figures.

**Source of Cost Data:** Quote from Alan Elia, Jr., Sevenson Environmental Services, tel no. 716-284-0431.

**Alternative 2A - Native Soil with Polishing Layer**
**Periodic Cost Sub-Element**
**SURFACE WATER SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012
Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling of surface water for low-level mercury. Five project samples plus 5 QC samples analyzed per event.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $5,140.00 | $500.00 | $0.00 | $3,354.00 | $8,994.00 | $8,994.00 | Labor, travel, equipment, and field supply costs for 3 people to sample from boat. Travel costs listed as "Other." |
| Analysis | 10 | LS | $0.00 | $0.00 | $0.00 | $136.50 | $136.50 | $1,365.00 | Laboratory costs for sample analysis. Laboratory analysis costs listed as "Other." |
| **Total** | | | **$5,140.00** | **$500.00** | **$0.00** | **$3,490.50** | **$9,130.50** | **$10,359.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Native Soil with Polishing Layer**
**Periodic Cost Sub-Element**
**SEDIMENT CORE SAMPLING**

COST WORKSHEET

Prepared by: JAN  Date: 3/28/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Sediment core sampling for mercury. Five cores collected per event, two sections analyzed per core.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $7,605.00 | $500.00 | $0.00 | $11,844.00 | $19,949.00 | $19,949.00 | Labor, travel, equipment, and field supply costs for 3 sampling personnel plus boat and divers to assist with sample collection. Travel expenses listed as "Other." |
| Analysis | 14 | LS | $0.00 | $0.00 | $0.00 | $18.90 | $18.90 | $264.60 | Laboratory costs for sample analysis listed as "Other." 10 samples plus 4 QA/QC samples. |
| **Total** | | | **$7,605.00** | **$500.00** | **$0.00** | **$11,862.90** | **$19,967.90** | **$20,213.60** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Native Soil with Polishing Layer**
**Annual Cost Sub-Element**
**INSPECTION AND MAINTENANCE**

# COST WORKSHEET

Prepared by: JDD  Date: 3/23/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Annual maintenance.

Cost Analysis:
Annual cost

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Inspection | 1 | LS | $0.00 | $0.00 | $0.00 | $1,500.00 | $1,500.00 | $1,500.00 | Personnel to perform on-site inspection. "Other" refers to subcontracted services. |
| Maintenance | 1 | LS | $0.00 | $0.00 | $0.00 | $2,000.00 | $2,000.00 | $2,000.00 | As-needed maintenance, such as mowing, re-seeding, re-grading. "Other" refers to subcontracted services. |
| **Total** | | | **$0.00** | **$0.00** | **$0.00** | **$3,500.00** | **$3,500.00** | **$3,500.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil with Polishing Layer**
**Periodic Cost Sub-Element**
**FISH TISSUE SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN Date: 3/28/2012
Checked by: KPW Date: 3/29/2012

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

Work Statement:
Sampling and analysis of largemouth bass and bluegill fish tissue. Two size ranges of each fish. Largemouth bass to have filet and filet/offal reconstituted analyzed.
Largemouth Bass: 5 locations x 2 size ranges x filet and filet/offal = 20 samples
Bluegill: 5 locations x 2 size ranges = 10 samples

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $4,435.00 | $250.00 | $0.00 | $3,354.00 | $8,039.00 | $8,039.00 | Labor, travel, equipment, and field supply costs for 3 field personnel to collect fish samples from boat. Travel expenses are listed as "Other." |
| Analysis | 30 | LS | $0.00 | $0.00 | $0.00 | $39.90 | $39.90 | $1,197.00 | Laboratory costs for sample analysis are listed as "Other." |
| **Total** | | | **$4,435.00** | **$250.00** | **$0.00** | **$3,393.90** | **$8,078.90** | **$9,236.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Native Soil with Polishing Layer**
**Periodic Cost Sub-Element**
**SPIDER AND INSECT SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN  Date: 3/28/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Sampling of spider and insect tissue for Hg and DDTR. 3 samples each of spiders and insects to be analyzed.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling* | 1 | LS | $7,550.00 | $0.00 | $0.00 | $2,586.00 | $10,136.00 | $10,136.00 | Labor, travel, equipment, and field supply costs for 3 personnel to perform spider and insect sampling. Travel expenses are listed as "Other." |
| Analysis | 6 | LS | $0.00 | $0.00 | $0.00 | $197.40 | $197.40 | $1,184.40 | Laboratory costs for sample analysis listed as "Other." |
| **Total** | | | **$7,550.00** | **$0.00** | **$0.00** | **$2,783.40** | **$10,333.40** | **$11,320.40** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Native Soil with Polishing Layer**
**Periodic Cost Sub-Element**
**CAP SURVEY**

# COST WORKSHEET

Prepared by: JDD Date: 3/23/2012
Checked by: KPW Date: 3/29/2012

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

Work Statement:
Survey of cap surface.

Cost Analysis:
Cost per survey.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Survey | 1 | LS | $0.00 | $0.00 | $0.00 | $2,520.00 | $2,520.00 | $2,520.00 | Surveyor costs are listed as "Other." |
| Divers | 1 | LS | $0.00 | $0.00 | $0.00 | $4,000.00 | $4,000.00 | $4,000.00 | Divers to assist surveyor are listed as "Other." |
| Environmental Consultant | 1 | LS | $1,750.00 | $0.00 | $0.00 | $0.00 | $1,750.00 | $1,750.00 | Schedule survey, provide oversight, and interpret results |
| **Total** | | | **$1,750.00** | **$0.00** | **$0.00** | **$6,520.00** | **$8,270.00** | **$8,270.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Native Soil with Polishing Layer**
**Periodic Cost Sub-Element**
**FIVE YEAR REVIEW REPORT**

# COST WORKSHEET

Prepared by: JDD Date: 3/23/2012
Checked by: KPW Date: 3/29/2012

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

Work Statement:
Preparation and submittal of 5-year Review Report

Cost Analysis:
Cost per 5-Year Review Report.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Five Year Review Report | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Data analysis, report preparation, and submittal. |
| **Total** | | | **$5,000.00** | **$0.00** | **$0.00** | **$0.00** | **$5,000.00** | **$5,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**Capital Cost Sub-Element**
**INSTITUTIONAL CONTROLS**

# COST WORKSHEET

Prepared by: JDD  Date: 3/23/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Implementation of institutional controls such as signs, security, deed restrictions, etc.

Cost Analysis:
Cost per IC implementation.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Institutional Controls | 1 | LS | $0.00 | $0.00 | $1,000.00 | $0.00 | $1,000.00 | $1,000.00 | Signs, Fencing, Security, etc. |
| Environmental Contractor | 1 | LS | $600.00 | $0.00 | $0.00 | $0.00 | $600.00 | $600.00 | Contractor for implementation |
| **Total** | | | **$600.00** | **$0.00** | **$1,000.00** | **$0.00** | **$1,600.00** | **$1,600.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**Capital Cost Sub-Element**
**REMEDIAL DESIGN AND TREATABILITY STUDIES**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Remedial Design/Treatability Study

Cost Analysis:
Cost per remedial design.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Remedial Design Deliverable | 1 | LS | $45,000.00 | $0.00 | $0.00 | $0.00 | $45,000.00 | $45,000.00 | Remedial design document |
| Treatability Studies | 1 | LS | $8,000.00 | $1,000.00 | $1,000.00 | $0.00 | $10,000.00 | $10,000.00 | Treatability studies and report |
| Update Health and Safety Plan, QAPP | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Updates to HASP/QAPP |
| **Total** | | | **$58,000.00** | **$1,000.00** | **$1,000.00** | **$0.00** | **$60,000.00** | **$60,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**Capital Cost Sub-Element**
**CAP PLACEMENT**

COST WORKSHEET

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

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

Work Statement:
Construction and support activities for cap placement.

Cost Analysis:
Cost per cap placement.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | UNIT COST CONVERSION[2] | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| MOBILIZATION | 1 | LS | $80,026.22 | $5,487.12 | $53,456.46 | $250,533.14 | $389,502.95 | $389,502.95 | - | Mobilization of heavy equipment to jobsite. Installation and removal of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| GENERAL CONDITIONS | 1 | LS | $772,317.84 | $0.00 | $5,321.93 | $657,184.21 | $1,434,823.97 | $1,434,823.97 | $180,000 per month | Supervision of field activities for. Includes labor cost, living expenses, travel expenses for the project manager and oversight staff. 8 months. |
| TEMPORARY FACILITIES | 1 | LS | $0.00 | $196,683.77 | $69,932.53 | $0.00 | $266,616.31 | $266,616.31 | $33,000 per month | Maintenance and upkeep of temporary site facilitiesincluding monthly fees for utilities, restrooms, etc., maintenance fluids for equipment and general housekeeping activities. 8 months. |
| SITE PREPARATION | 1 | LS | $78,721.40 | $34,277.28 | $443,368.86 | $218,959.22 | $775,326.76 | $775,326.76 | Road Prep: 5 Acres<br>Silt Fencing: 2800 ft<br>Silt Curtain: 7500 ft<br>Paving: 40,000 ft$^2$ | Grading and clearing, construction of acces roads and staging area, silt fence and curtain installation. |
| MATERIAL TRANSFER LINE FROM SHORE TO SPREADER BARGE | 1 | LS | $83,011.60 | $28,032.25 | $102,994.47 | $21,895.92 | $235,934.24 | $235,934.24 | $110 per ft | Install a 14" pipe from onshore mixer to the spreader system on the barge. 2,175 feet. |
| SURVEY | 1 | LS | $84,108.06 | $24,085.51 | $0.00 | $247,004.25 | $355,197.83 | $355,197.83 | $71,000 per month | Up-front survey prior to capping, surveying at intervals during capping layout, and 2 weeks of surveying after cap placement. 5 months. |
| MAINTENANCE OPERATION | 1 | LS | $233,894.43 | $184,937.34 | $63,972.59 | $0.00 | $482,804.36 | $482,804.36 | $74,000 per month | Full-time crew providing maintenance and mobilization of barge and spreader units. 6.5 months. |
| CAP MATERIAL HANDLING, STOCKPILING AND | 1 | LS | $179,743.64 | $117,537.31 | $188,414.41 | $10,947.96 | $496,643.33 | $496,643.33 | - | Material testing and handling operations |
| CAPPING OPERATIONS - POLISHING LAYER | 1 | LS | $594,970.05 | $482,965.07 | $7,044,562.86 | $27,369.90 | $8,149,867.88 | $8,149,867.88 | $540,000 per acre | Slurry polishing layer material on shore. Pump slurry to barge and spreader. Place over 15 acres. Includes cost of polishing layer material at $600/ton. |
| CAPPING OPERATIONS | 1 | LS | $223,232.47 | $291,478.52 | $7,243,190.56 | $0.00 | $7,757,901.54 | $7,757,901.54 | $110,000 per acre | Slurry capping material (bentonite pellets and native soil for mixing zone and habitat layer) on shore. Pump slurry to barge and spreader. Place over 72.5 acres. |
| CAP VENTING MECHANISMS | 1% | % | | | | | | $60,232.35 | - | See venting costs for Alternative 2A - Native Soil Cap |
| SITE RESTORATION | 1 | LS | $10,631.57 | $6,589.21 | $7,389.87 | $15,205.50 | $39,816.15 | $39,816.15 | $8,000 per acre | Re-grade 5-acre staging area with existing site material and apply hydroseed. Asphalt pavement will remain in place. |
| DEMOBILIZATION | 1 | LS | $102,721.13 | $33,682.74 | $37,279.33 | $165,017.40 | $338,700.60 | $338,700.60 | - | Demobilization of heavy equipment from jobsite. Removal of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| **Total** | | | | | | | | **$20,783,368.27** | | |

1 - Includes costs associated with subcontracted services and equipment
2 - Unit cost conversions provided, where appropriate, for comparison purposes. Calculated unit costs rounded to two significant figures.

**Source of Cost Data:** Quote from Alan Elia, Jr., Sevenson Environmental Services, tel no. 716-284-0431.

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**Periodic Cost Sub-Element**
**SURFACE WATER SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling of surface water for low-level mercury. Five project samples plus 5 QC samples analyzed per event.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $5,140.00 | $500.00 | $0.00 | $3,354.00 | $8,994.00 | $8,994.00 | Labor, travel, equipment, and field supply costs for 3 people to sample from boat. Travel costs listed as "Other." |
| Analysis | 10 | LS | $0.00 | $0.00 | $0.00 | $136.50 | $136.50 | $1,365.00 | Laboratory costs for sample analysis. Laboratory analysis costs listed as "Other." |
| **Total** | | | **$5,140.00** | **$500.00** | **$0.00** | **$3,490.50** | **$9,130.50** | **$10,359.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**Periodic Cost Sub-Element**
**SEDIMENT CORE SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sediment core sampling for mercury. Five cores collected per event, two sections analyzed per core.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $7,605.00 | $500.00 | $0.00 | $11,844.00 | $19,949.00 | $19,949.00 | Labor, travel, equipment, and field supply costs for 3 sampling personnel plus boat and divers to assist with sample collection. Travel expenses listed as "Other." |
| Analysis | 14 | LS | $0.00 | $0.00 | $0.00 | $18.90 | $18.90 | $264.60 | Laboratory costs for sample analysis listed as "Other." 10 samples plus 4 QA/QC samples. |
| **Total** | | | **$7,605.00** | **$500.00** | **$0.00** | **$11,862.90** | **$19,967.90** | **$20,213.60** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**Annual Cost Sub-Element**
**INSPECTION AND MAINTENANCE**

COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Annual maintenance.

Cost Analysis:
Annual cost

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Inspection | 1 | LS | $0.00 | $0.00 | $0.00 | $1,500.00 | $1,500.00 | $1,500.00 | Personnel to perform on-site inspection. "Other" refers to subcontracted services. |
| Maintenance | 1 | LS | $0.00 | $0.00 | $0.00 | $2,000.00 | $2,000.00 | $2,000.00 | As-needed maintenance, such as mowing, re-seeding, re-grading. "Other" refers to subcontracted services. |
| **Total** | | | **$0.00** | **$0.00** | **$0.00** | **$3,500.00** | **$3,500.00** | **$3,500.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**Periodic Cost Sub-Element**
**FISH TISSUE SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling and analysis of largemouth bass and bluegill fish tissue. Two size ranges of each fish. Largemouth bass to have filet and filet/offal reconstituted analyzed.
Largemouth Bass: 5 locations x 2 size ranges x filet and filet/offal = 20 samples
Bluegill: 5 locations x 2 size ranges = 10 samples

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $4,435.00 | $250.00 | $0.00 | $3,354.00 | $8,039.00 | $8,039.00 | Labor, travel, equipment, and field supply costs for 3 field personnel to collect fish samples from boat. Travel expenses are listed as "Other." |
| Analysis | 30 | LS | $0.00 | $0.00 | $0.00 | $39.90 | $39.90 | $1,197.00 | Laboratory costs for sample analysis are listed as "Other." |
| **Total** | | | **$4,435.00** | **$250.00** | **$0.00** | **$3,393.90** | **$8,078.90** | **$9,236.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**Periodic Cost Sub-Element**
**SPIDER AND INSECT SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling of spider and insect tissue for Hg and DDTR. 3 samples each of spiders and insects to be analyzed.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $7,550.00 | $0.00 | $0.00 | $2,586.00 | $10,136.00 | $10,136.00 | Labor, travel, equipment, and field supply costs for 3 personnel to perform spider and insect sampling. Travel expenses are listed as "Other." |
| Analysis | 6 | LS | $0.00 | $0.00 | $0.00 | $197.40 | $197.40 | $1,184.40 | Laboratory costs for sample analysis listed as "Other." |
| **Total** | | | **$7,550.00** | **$0.00** | **$0.00** | **$2,783.40** | **$10,333.40** | **$11,320.40** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**Periodic Cost Sub-Element**
**CAP SURVEY**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Survey of cap surface.

Cost Analysis:
Cost per survey

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Survey | 1 | LS | $0.00 | $0.00 | $0.00 | $2,520.00 | $2,520.00 | $2,520.00 | Surveyor costs are listed as "Other." |
| Divers | 1 | LS | $0.00 | $0.00 | $0.00 | $4,000.00 | $4,000.00 | $4,000.00 | Divers to assist surveyor are listed as "Other." |
| Environmental Consultant | 1 | LS | $1,750.00 | $0.00 | $0.00 | $0.00 | $1,750.00 | $1,750.00 | Schedule survey, provide oversight, and interpret results |
| **Total** | | | **$1,750.00** | **$0.00** | **$0.00** | **$6,520.00** | **$8,270.00** | **$8,270.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2A - Bentonite Pellets with Polishing Layer**
**Periodic Cost Sub-Element**
**FIVE YEAR REVIEW REPORT**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Preparation and submittal of 5-year Review Report

Cost Analysis:
Cost per 5-Year Review Report.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Five Year Review Report | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Data analysis, report preparation, and submittal. |
| **Total** | | | **$5,000.00** | **$0.00** | **$0.00** | **$0.00** | **$5,000.00** | **$5,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2B**
**Capital Cost Sub-Element**
**INSTITUTIONAL CONTROLS**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Implementation of institutional controls such as signs, security, deed restrictions, etc.

Cost Analysis:
Cost per IC implementation.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Institutional Controls | 1 | LS | $0.00 | $0.00 | $1,000.00 | $0.00 | $1,000.00 | $1,000.00 | Signs, Fencing, Security, etc. |
| Environmental Contractor | 1 | LS | $0.00 | $0.00 | $0.00 | $600.00 | $600.00 | $600.00 | Contractor for implementation |
| | | | | | | | | $0.00 | |
| | | | | | | | | $0.00 | |
| **Total** | | | **$0.00** | **$0.00** | **$1,000.00** | **$600.00** | **$1,600.00** | **$1,600.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2B**
**Capital Cost Sub-Element**
**REMEDIAL DESIGN AND TREATABILITY STUDIES**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Remedial Design/Treatability Study

Cost Analysis:
Cost per remedial design

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Remedial Design Deliverable | 1 | LS | $45,000.00 | $0.00 | $0.00 | $0.00 | $45,000.00 | $45,000.00 | Remedial design document |
| Treatability Studies | 1 | LS | $8,000.00 | $1,000.00 | $1,000.00 | $0.00 | $10,000.00 | $10,000.00 | Treatability studies and report |
| Update Health and Safety Plan, QAPP | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Updates to HASP/QAPP |
| | | | | | | | | $0.00 | |
| **Total** | | | **$58,000.00** | **$1,000.00** | **$1,000.00** | **$0.00** | **$60,000.00** | **$60,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2B**
**Capital Cost Sub-Element**
**CAP PLACEMENT**

COST WORKSHEET

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

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

Work Statement:
Construction of cap

Cost Analysis:
Cost per each mobilization and demobilization.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | UNIT COST CONVERSION[2] | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| MOBILIZATION | 1 | LS | $79,392.89 | $5,443.69 | $53,033.40 | $269,686.52 | $407,556.49 | $407,556.49 | - | Mobilization of heavy equipment to jobsite. Installation of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| GENERAL CONDITIONS | 1 | LS | $678,639.26 | $0.00 | $4,676.40 | $511,094.99 | $1,194,410.65 | $1,194,410.65 | $170,000 per month | Supervision of field activities. Includes labor cost, living expenses, travel expenses for the project manager and oversight staff. 7 months. |
| TEMPORARY FACILITIES | 1 | LS | $0.00 | $186,575.71 | $61,059.91 | $0.00 | $247,635.63 | $247,635.63 | $35,000 per month | Maintenance and upkeep of temporary site facilities including monthly fees for utilities, restrooms, etc., maintenance fluids for equipment and general housekeeping activities. 7 months. |
| CLEARING AND GRUBBING | 1 | LS | $63,042.82 | $35,088.33 | $21,964.00 | $120,077.90 | $240,173.05 | $240,173.05 | $17,000 per acre | Clearing and grubbing in preparation for staging area and road construction. 14 acres. |
| SITE PREPARATION | 1 | LS | $60,280.02 | $21,009.29 | $351,849.37 | $0.00 | $433,138.67 | $433,138.67 | - | Grading and construction of access roads and staging area, silt fence and curtain installation. |
| SURVEY | 1 | LS | $7,585.67 | $2,172.26 | $0.00 | $152,064.48 | $161,822.42 | $161,822.42 | $32,000 per month | Up-front survey prior to construction, surveying at intervals during construction, and 2 weeks of surveying after construction. 5 months. |
| DEWATER BASIN & WATER HANDLING ACTIVITIES | 1 | LS | $0.00 | $391,007.43 | $1,227,811.61 | $543,065.88 | $2,161,884.93 | $2,161,884.93 | - | Install portadams, pump water out of construction area. |
| BORROW AREA SOIL EXCAVATION / TRANSPORT / BACKFILL BASIN - DRY | 1 | LS | $720,348.22 | $723,345.05 | $3,716,478.89 | $43,445.27 | $5,203,617.42 | $5,203,617.42 | $110,000 per acre | Excavate native soil from borrow area, transport to dry areas of basin and apply cap to a depth of 24." 210,000 cubic yards of soil placed over 49.5 acres. |
| MATERIAL TRANSFER LINE FROM SHORE TO SPREADER BARGE | 1 | LS | $82,354.13 | $27,809.80 | $102,178.45 | $21,722.64 | $234,065.01 | $234,065.01 | $110 per foot | Install a 14" pipe from onshore mixer to the spreader system on the barge. 2,175 feet. |
| MAINTENANCE OPERATION | 1 | LS | $94,926.83 | $195,914.27 | $53,160.72 | $0.00 | $344,001.82 | $344,001.82 | $49,000 per month | Full-time crew providing maintenance and mobilization of barge and spreader units. 7 months. |
| CAPPING OPERATIONS | 1 | LS | $288,714.81 | $234,363.34 | $1,098,134.12 | $18,102.20 | $1,639,314.46 | $1,639,314.46 | $71,000 per acre | Slurry capping material on shore. Pump slurry to barge and spreader. Place over 23 acres. |
| CAP VENTING MECHANISMS | 1% | % | | | | | | $60,232.35 | - | Estimated as 1% of capping operations cost |
| CAP MATERIAL HANDLING, STOCKPILING AND TESTING | 1 | LS | $60,791.29 | $39,752.42 | $44,395.64 | $20,817.53 | $165,756.88 | $165,756.88 | - | Material testing and handling operations. |
| SITE RESTORATION | 1 | LS | $32,387.80 | $19,550.37 | $32,176.65 | $33,790.77 | $117,905.59 | $117,905.59 | $8,000 per acre | Re-grade staging area and borrow pit with existing site material and apply hydroseed. Asphalt pavement will remain in place. 14 acres. |
| DEMOBILIZATION | 1 | LS | $76,552.00 | $6,694.31 | $5,667.50 | $167,469.45 | $256,383.26 | $256,383.26 | - | Demobilization of heavy equipment from jobsite. Removal of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| **Total** | | | | | | | | **$12,867,898.64** | | |

1 - Includes costs associated with subcontracted services and equipment
2 - Unit cost conversions given, where appropriate, for comparison purposes. Calculated unit costs rounded to two significant figures.

**Source of Cost Data:** Quote from Alan Elia, Jr., Sevenson Environmental Services, tel no. 716-284-0431.

**Alternative 2B**
**Periodic Cost Sub-Element**
**SURFACE WATER SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN Date: 3/28/2012
Checked by: KPW Date: 3/29/2012

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

Work Statement:
Sampling of surface water for low-level mercury. Five project samples plus 5 QC samples analyzed per event.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $5,140.00 | $500.00 | $0.00 | $3,354.00 | $8,994.00 | $8,994.00 | Labor, travel, equipment, and field supply costs for 3 people to sample from boat. Travel costs listed as "Other." |
| Analysis | 10 | LS | $0.00 | $0.00 | $0.00 | $136.50 | $136.50 | $1,365.00 | Laboratory costs for sample analysis. Laboratory analysis costs listed as "Other." |
| **Total** | | | **$5,140.00** | **$500.00** | **$0.00** | **$3,490.50** | **$9,130.50** | **$10,359.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2B**
**Periodic Cost Sub-Element**
**SEDIMENT CORE SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sediment core sampling for mercury. Five cores collected per event, two sections analyzed per core.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $7,605.00 | $500.00 | $0.00 | $11,844.00 | $19,949.00 | $19,949.00 | Labor, travel, equipment, and field supply costs for 3 sampling personnel plus boat and divers to assist with sample collection. Travel expenses listed as "Other." |
| Analysis | 14 | LS | $0.00 | $0.00 | $0.00 | $18.90 | $18.90 | $264.60 | Laboratory costs for sample analysis listed as "Other." 10 samples plus 4 QA/QC samples. |
| **Total** | | | **$7,605.00** | **$500.00** | **$0.00** | **$11,862.90** | **$19,967.90** | **$20,213.60** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2B**
**Annual Cost Sub-Element**
**INSPECTION AND MAINTENANCE**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Annual maintenance.

Cost Analysis:
Annual cost

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Inspection | 1 | LS | $0.00 | $0.00 | $0.00 | $1,500.00 | $1,500.00 | $1,500.00 | Personnel to perform on-site inspection. "Other" refers to subcontracted services. |
| Maintenance | 1 | LS | $0.00 | $0.00 | $0.00 | $2,000.00 | $2,000.00 | $2,000.00 | As-needed maintenance, such as mowing, re-seeding, re-grading. "Other" refers to subcontracted services. |
| | | | | | | | $0.00 | $0.00 | |
| **Total** | | | **$0.00** | **$0.00** | **$0.00** | **$3,500.00** | **$3,500.00** | **$3,500.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2B**
**Periodic Cost Sub-Element**
**FISH TISSUE SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling and analysis of largemouth bass and bluegill fish tissue. Two size ranges of each fish. Largemouth bass to have filet and filet/offal reconstituted analyzed.
Largemouth Bass: 5 locations x 2 size ranges x filet and filet/offal = 20 samples
Bluegill: 5 locations x 2 size ranges = 10 samples

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $4,435.00 | $250.00 | $0.00 | $3,354.00 | $8,039.00 | $8,039.00 | Labor, travel, equipment, and field supply costs for 3 field |
| Analysis | 30 | LS | $0.00 | $0.00 | $0.00 | $39.90 | $39.90 | $1,197.00 | Laboratory costs for sample analysis are listed as "Other." |
| **Total** | | | **$4,435.00** | **$250.00** | **$0.00** | **$3,393.90** | **$8,078.90** | **$9,236.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2B**
**Periodic Cost Sub-Element**
**SPIDER AND INSECT SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling of spider and insect tissue for Hg and DDTR. 3 samples each of spiders and insects to be analyzed.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling* | 1 | LS | $7,550.00 | $0.00 | $0.00 | $2,586.00 | $10,136.00 | $10,136.00 | Labor, travel, equipment, and field supply costs for 3 personnel to perform spider and insect sampling. Travel expenses are listed as "Other." |
| Analysis | 6 | LS | $0.00 | $0.00 | $0.00 | $197.40 | $197.40 | $1,184.40 | Laboratory costs for sample analysis listed as "Other." |
| **Total** | | | **$7,550.00** | **$0.00** | **$0.00** | **$2,783.40** | **$10,333.40** | **$11,320.40** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2B**
**Periodic Cost Sub-Element**
**CAP SURVEY**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Field costs for cap sampling.

Cost Analysis:
Cost per survey

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Survey | 1 | LS | $0.00 | $0.00 | $0.00 | $2,520.00 | $2,520.00 | $2,520.00 | Surveyor costs are listed as "Other." |
| Divers | 1 | LS | $0.00 | $0.00 | $0.00 | $4,000.00 | $4,000.00 | $4,000.00 | Divers to assist surveyor are listed as "Other." |
| Environmental Consultant | 1 | LS | $1,750.00 | $0.00 | $0.00 | $0.00 | $1,750.00 | $1,750.00 | Schedule survey, provide oversight, and interpret results |
| **Total** | | | **$1,750.00** | **$0.00** | **$0.00** | **$6,520.00** | **$8,270.00** | **$8,270.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2B**
**Periodic Cost Sub-Element**
**FIVE YEAR REVIEW REPORT**

# COST WORKSHEET

Prepared by: JDD Checked by: KPW
Date: 3/23/2012 Date: 3/29/2012

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

Work Statement:
Preparation and submittal of 5-year Review Report

Cost Analysis:
Cost per 5-Year Review Report.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Five Year Review Report | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Data analysis, report preparation, and submittal. |
| **Total** | | | **$5,000.00** | **$0.00** | **$0.00** | **$0.00** | **$5,000.00** | **$5,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2C**
**Capital Cost Sub-Element**
**REMEDIAL DESIGN AND TREATABILITY STUDIES**

# COST WORKSHEET

Prepared by: JDD Date: 3/23/2012
Checked by: KPW Date: 3/29/2012

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

Work Statement:
Remedial Design/Treatability Study

Cost Analysis:
Cost per remedial design

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Remedial Design Deliverable | 1 | LS | $45,000.00 | $0.00 | $0.00 | $0.00 | $45,000.00 | $45,000.00 | Remedial design document |
| Treatability Studies | 1 | LS | $8,000.00 | $1,000.00 | $1,000.00 | $0.00 | $10,000.00 | $10,000.00 | Treatability studies and report |
| Update Health and Safety Plan, QAPP | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Updates to HASP/QAPP |
| | | | | | | | | $0.00 | |
| **Total** | | | **$58,000.00** | **$1,000.00** | **$1,000.00** | **$0.00** | **$60,000.00** | **$60,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2C**
**Capital Cost Sub-Element**
**CAP PLACEMENT**

COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Construction and support activities for cap placement.

Cost Analysis:
Cost per cap placement.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | UNIT COST CONVERSION[2] | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| MOBILIZATION | 1 | LS | $79,457.71 | $5,448.14 | $53,076.70 | $269,906.72 | $407,889.28 | $407,889.28 | - | Mobilization of heavy equipment to jobsite. Installation of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| GENERAL CONDITIONS | 1 | LS | $679,193.39 | $0.00 | $4,680.22 | $511,512.31 | $1,195,385.92 | $1,195,385.92 | $170,000 per month | Supervision of field activities. Includes labor cost, living expenses, travel expenses for the project manager and oversight staff. 7 months. |
| TEMPORARY FACILITIES | 1 | LS | $0.00 | $186,728.06 | $61,109.77 | $0.00 | $247,837.83 | $247,837.83 | $35,000 per month | Maintenance and upkeep of temporary site facilities including monthly fees for utilities, restrooms, etc., maintenance fluids for equipment and general housekeeping activities. 7 months. |
| CLEARING AND GRUBBING | 1 | LS | $63,094.30 | $35,116.98 | $21,981.93 | $120,175.95 | $240,369.16 | $240,369.16 | $17,000 per acre | Clearing and grubbing in preparation for staging area and road construction. 14 acres. |
| SITE PREPARATION | 1 | LS | $60,329.24 | $21,026.44 | $352,136.66 | $0.00 | $433,492.34 | $433,492.34 | - | Grading and construction of access roads and staging area, silt fence and curtain installation. |
| SURVEY | 1 | LS | $7,591.87 | $2,174.04 | $0.00 | $152,188.65 | $161,954.55 | $161,954.55 | $41,000 per month | Up-front survey prior to construction, surveying at intervals during construction, and 2 weeks of surveying after construction. 4 months. |
| DEWATER BASIN & WATER HANDLING ACTIVITIES | 1 | LS | $0.00 | $391,326.70 | $1,228,814.16 | $543,509.31 | $2,163,650.17 | $2,163,650.17 | - | Install portadams, pump water out of construction area. |
| BORROW AREA SOIL EXCAVATION / TRANSPORT / BACKFILL BASIN | 1 | LS | $1,426,836.03 | $1,460,531.38 | $5,399,803.03 | $57,974.33 | $8,345,144.77 | $8,345,144.77 | $120,000 per acre | Excavate native soil from borrow area, transport to dry areas of basin and apply cap to a depth of 24". 410,000 cubic yards of soil placed over 72.5 acres. |
| SITE RESTORATION | 1 | LS | $32,414.24 | $19,566.34 | $32,202.93 | $33,818.36 | $118,001.86 | $118,001.86 | $8,000 per acre | Re-grade staging area and borrow pit with existing site material and apply hydroseed. Asphalt pavement will remain in place. 14 acres. |
| DEMOBILIZATION | 1 | LS | $76,614.51 | $6,699.78 | $5,672.12 | $167,606.19 | $256,592.60 | $256,592.60 | - | Demobilization of heavy equipment from jobsite. Removal of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| CAP VENTING MECHANISMS | 1% | % | | | | | | $60,232.36 | - | See venting costs for Alternative 2A - Native Soil Cap |
| **Total** | | | | | | | | **$13,630,550.84** | | |

1 - Includes costs associated with subcontracted services and equipment
2 - Unit cost conversions given, where appropriate, for comparison purposes

**Source of Cost Data:** Quote from Alan Elia, Jr., Sevenson Environmental Services, tel no. 716-284-0431.

**Alternative 2C**
**Periodic Cost Sub-Element**
**SURFACE WATER SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN  Date: 3/28/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Sampling of surface water for low-level mercury. Five project samples plus 5 QC samples analyzed per event.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $5,140.00 | $500.00 | $0.00 | $3,354.00 | $8,994.00 | $8,994.00 | Labor, travel, equipment, and field supply costs for 3 people to sample from boat. Travel costs listed as "Other." |
| Analysis | 10 | LS | $0.00 | $0.00 | $0.00 | $136.50 | $136.50 | $1,365.00 | Laboratory costs for sample analysis. Laboratory analysis costs listed as "Other." |
| **Total** | | | **$5,140.00** | **$500.00** | **$0.00** | **$3,490.50** | **$9,130.50** | **$10,359.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2C**
**Periodic Cost Sub-Element**
**SEDIMENT CORE SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN Date: 3/28/2012
Checked by: KPW Date: 3/29/2012

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

Work Statement:
Sediment core sampling for mercury. Five cores collected per event, two sections analyzed per core.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $7,605.00 | $500.00 | $0.00 | $11,844.00 | $19,949.00 | $19,949.00 | Labor, travel, equipment, and field supply costs for 3 sampling personnel plus boat and divers to assist with sample collection. Travel expenses listed as "Other." |
| Analysis | 14 | LS | $0.00 | $0.00 | $0.00 | $18.90 | $18.90 | $264.60 | Laboratory costs for sample analysis listed as "Other." 10 samples plus 4 QA/QC samples. |
| **Total** | | | **$7,605.00** | **$500.00** | **$0.00** | **$11,862.90** | **$19,967.90** | **$20,213.60** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2C**
**Annual Cost Sub-Element**
**INSPECTION AND MAINTENANCE**

COST WORKSHEET

Prepared by: JDD Date: 3/23/2012
Checked by: KPW Date: 3/29/2012

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

Work Statement:
Annual maintenance.

Cost Analysis:
Annual cost

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Inspection | 1 | LS | $0.00 | $0.00 | $0.00 | $1,500.00 | $1,500.00 | $1,500.00 | Personnel to perform on-site inspection. "Other" refers to subcontracted services. |
| Maintenance | 1 | LS | $0.00 | $0.00 | $0.00 | $2,000.00 | $2,000.00 | $2,000.00 | As-needed maintenance, such as mowing, re-seeding, re-grading. "Other" refers to subcontracted services. |
| | | | | | | | $0.00 | $0.00 | |
| **Total** | | | **$0.00** | **$0.00** | **$0.00** | **$3,500.00** | **$3,500.00** | **$3,500.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2C**
**Periodic Cost Sub-Element**
**FISH TISSUE SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling and analysis of largemouth bass and bluegill fish tissue. Two size ranges of each fish. Largemouth bass to have filet and filet/offal reconstituted analyzed.
Largemouth Bass: 5 locations x 2 size ranges x filet and filet/offal = 20 samples
Bluegill: 5 locations x 2 size ranges = 10 samples

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $4,435.00 | $250.00 | $0.00 | $3,354.00 | $8,039.00 | $8,039.00 | Labor, travel, equipment, and field supply costs for 3 field personnel to collect fish samples from boat. Travel expenses are listed as "Other." |
| Analysis | 30 | LS | $0.00 | $0.00 | $0.00 | $39.90 | $39.90 | $1,197.00 | Laboratory costs for sample analysis are listed as "Other." |
| **Total** | | | **$4,435.00** | **$250.00** | **$0.00** | **$3,393.90** | **$8,078.90** | **$9,236.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2C**
**Periodic Cost Sub-Element**
**SPIDER AND INSECT SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling of spider and insect tissue for Hg and DDTR. 3 samples each of spiders and insects to be analyzed.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling* | 1 | LS | $7,550.00 | $0.00 | $0.00 | $2,586.00 | $10,136.00 | $10,136.00 | Labor, travel, equipment, and field supply costs for 3 personnel to perform spider and insect sampling. Travel expenses are listed as "Other." |
| Analysis | 6 | LS | $0.00 | $0.00 | $0.00 | $197.40 | $197.40 | $1,184.40 | Laboratory costs for sample analysis listed as "Other." |
| **Total** | | | **$7,550.00** | **$0.00** | **$0.00** | **$2,783.40** | **$10,333.40** | **$11,320.40** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 2C**
**Periodic Cost Sub-Element**
**CAP SURVEY**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Survey of cap surface.

Cost Analysis:
Cost per survey

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Survey | 1 | LS | $0.00 | $0.00 | $0.00 | $2,520.00 | $2,520.00 | $2,520.00 | Surveyor costs are listed as "Other." |
| Divers | 1 | LS | $0.00 | $0.00 | $0.00 | $4,000.00 | $4,000.00 | $4,000.00 | Divers to assist surveyor are listed as "Other." |
| Environmental Consultant | 1 | LS | $1,750.00 | $0.00 | $0.00 | $0.00 | $1,750.00 | $1,750.00 | Schedule survey, provide oversight, and interpret results |
| **Total** | | | **$1,750.00** | **$0.00** | **$0.00** | **$6,520.00** | **$8,270.00** | **$8,270.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 2C**
**Periodic Cost Sub-Element**
**FIVE YEAR REVIEW REPORT**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Preparation and submittal of 5-year Review Report

Cost Analysis:
Cost per 5-Year Review Report.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Five Year Review Report | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Data analysis, report preparation, and submittal. |
| **Total** | | | **$5,000.00** | **$0.00** | **$0.00** | **$0.00** | **$5,000.00** | **$5,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 3 - With Onsite Disposal**
**Capital Cost Sub-Element**
**INSTITUTIONAL CONTROLS**

# COST WORKSHEET

Prepared by: JDD    Checked by: KPW
Date: 3/23/2012    Date: 3/29/2012

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

Work Statement:
Implementation of institutional controls such as signs, security, deed restrictions, etc.

Cost Analysis:
Cost per IC implementation.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Institutional Controls | 1 | LS | $0.00 | $0.00 | $1,000.00 | $0.00 | $1,000.00 | $1,000.00 | Signs, Fencing, Security, etc. |
| Environmental Contractor | 1 | LS | $0.00 | $0.00 | $0.00 | $600.00 | $600.00 | $600.00 | Contractor for implementation |
| | | | | | | | | $0.00 | |
| | | | | | | | | $0.00 | |
| **Total** | | | **$0.00** | **$0.00** | **$1,000.00** | **$600.00** | **$1,600.00** | **$1,600.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 3 - With Onsite Disposal**
**Capital Cost Sub-Element**
**REMEDIAL DESIGN AND TREATABILITY STUDIES**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012
Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Remedial Design/Treatability Study

Cost Analysis:
Cost per remedial design

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Remedial Design Deliverable | 1 | LS | $45,000.00 | $0.00 | $0.00 | $0.00 | $45,000.00 | $45,000.00 | Remedial design document |
| Treatability Studies | 1 | LS | $8,000.00 | $1,000.00 | $1,000.00 | $0.00 | $10,000.00 | $10,000.00 | Treatability studies and report |
| Update Health and Safety Plan, QAPP | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Updates to HASP/QAPP |
| **Total** | | | **$58,000.00** | **$1,000.00** | **$1,000.00** | **$0.00** | **$60,000.00** | **$60,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 3 - With Onsite Disposal**
**Capital Cost Sub-Element**
**DREDGING OPERATIONS**

COST WORKSHEET

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

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

Work Statement:
Mobilization, facilities and infrastructure for remedial activities, site preparation, construction, debris removal, hydraulic dredging, water treatment, disposal, and demobilization.

Cost Analysis:
Cost per dredging implementation.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | UNIT COST CONVERSION[2] | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| MOBILIZATION | 1 | LS | $80,372.04 | $5,510.83 | $54,237.22 | $435,261.21 | $575,381.30 | $575,381.30 | - | Mobilization of heavy equipment to jobsite. Installation and of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| GENERAL CONDITIONS | 1 | LS | $1,573,472.02 | $0.00 | $10,842.56 | $1,230,527.10 | $2,814,841.68 | $2,814,841.68 | $160,000 per month | Supervision of field activities. Includes labor cost, living expenses, travel expenses for the project manager and oversight staff. 17 months. |
| TEMPORARY FACILITIES | 1 | LS | $0.00 | $458,700.68 | $152,471.41 | $0.00 | $611,172.09 | $611,172.09 | $35,000 per month | Maintenance and upkeep of temporary site facilities including monthly fees for utilities, restrooms, etc., maintenance fluids for equipment and general housekeeping activities. 17 months. |
| SITE PREPARATION | 1 | LS | $80,841.16 | $35,160.74 | $475,793.59 | $219,905.40 | $811,700.89 | $811,700.89 | Road Prep: 5 Acres<br>Silt Fencing: 2800 ft<br>Silt Curtain: 7500 ft<br>Paving: 60,000 ft2 | Grading and clearing, construction of access roads and staging area, silt fence and curtain installation. |
| DREDGE PIPE LINE | 1 | LS | $83,370.32 | $28,153.39 | $104,768.13 | $21,990.54 | $238,282.37 | $238,282.37 | $110 per foot | Furnish and install 14" HDPE dredge pipeline. 2,175 linear feet. |
| SURVEY | 1 | LS | $127,987.14 | $36,650.90 | $0.00 | $469,436.95 | $634,074.99 | $634,074.99 | $44,000 per month | Up-front bathymetric survey prior to dredging, surveying full time during dredging. 14 months. |
| DEBRIS REMOVAL OPERATION AND MAINTENANCE CREW FULL TIME | 1 | LS | $1,414,000.36 | $959,819.64 | $509,833.57 | $157,843.21 | $3,041,496.78 | $3,041,496.78 | $230,000 per month | Crew to work concurrently with dredging crew, removing debris with excavator and grapple or rake. 13 months. |
| HYDRAULIC DREDGING | 1 | LS | $2,280,036.21 | $741,696.94 | $3,142,790.27 | $42,759.38 | $6,207,282.81 | $6,207,282.81 | $10 per cubic yard | Hydraulic dredging using horizontal auger, pumping sediment to land-based dewatering area. 590,000 cubic yards (in-place). |
| FILTER PRESS DEWATERING | 1 | LS | $5,112,749.09 | $9,291,578.32 | $5,066,882.89 | $128,278.15 | $19,599,488.45 | $19,599,488.45 | $8 per cubic yard | Dewatering of dredged sediments via filter press. 2,390,000 cubic yards of dredged sediment. |
| WATER HANDLING | 1 | LS | $480,713.88 | $142,205.49 | $41,212.72 | $0.00 | $664,132.09 | $664,132.09 | - | Pump decant water to water treatment facility. |
| CONSTRUCTION OF LANDBASED CONTAINMENT CELL | 1 | LS | $320,464.57 | $130,513.86 | $3,667,785.41 | $2,474,595.49 | $6,593,359.32 | $6,593,359.32 | - | Construct landfill cell and cap to contain dredged and dewatered sediments. |
| TRANSPORTATION AND DISPOSAL OF NON-HAZARDOUS DEBRIS | 1 | LS | $109,092.82 | $33,022.46 | $25,234.14 | $2,219,822.87 | $2,387,172.29 | $2,387,172.29 | $100 per ton | Transport and dispose of debris removed prior to dredging. 23,000 tons. |
| SITE RESTORATION | 1 | LS | $10,677.51 | $6,617.69 | $8,118.17 | $15,271.21 | $40,684.58 | $40,684.58 | $8,000 per acre | Re-grade 5-acre staging area with existing site material and apply hydroseed. Asphalt pavement will remain in place. |
| DEMOBILIZATION | 1 | LS | $103,165.01 | $33,828.29 | $39,153.85 | $349,375.93 | $525,523.09 | $525,523.09 | - | Demobilization of heavy equipment from jobsite. Removal of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| PLACEMENT OF DEWATERED SEDIMENT INTO LANDBASED CELL | 1 | LS | $1,684,405.71 | $988,397.57 | $16,615.07 | $12,216.97 | $2,701,635.33 | $2,701,635.33 | $6 per ton | Transporation and placement of dewatered sediment into onsite containment cell. 422,000 tons. |
| WATER TREATMENT - 500 GAL. PER MINUTE | 1 | LS | $368,341.17 | $376,282.58 | $222,795.94 | $82,098.02 | $1,049,517.70 | $1,049,517.70 | $3 per 1000 gallons | Treatment of water from dredged sediment via settling tank and active carbon units. 400,000,000 gallons. |
| **Total** | | | | | | | | **$48,495,745.74** | | |

1 - Includes costs associated with subcontracted services and equipment
2 - Unit cost conversions given, where appropriate, for comparison purposes. Unit cost conversions rounded to two significant figures.

**Source of Cost Data:** Quote from Alan Elia, Jr., Sevenson Environmental Services, tel no. 716-284-0431

**Alternative 3 - With Onsite Disposal**
**Periodic Cost Sub-Element**
**SURFACE WATER SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling of surface water for low-level mercury. Five project samples plus 5 QC samples analyzed per event.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $5,140.00 | $500.00 | $0.00 | $3,354.00 | $8,994.00 | $8,994.00 | Labor, travel, equipment, and field supply costs for 3 people to sample from boat. Travel costs listed as "Other." |
| Analysis | 10 | LS | $0.00 | $0.00 | $0.00 | $136.50 | $136.50 | $1,365.00 | Laboratory costs for sample analysis. Laboratory analysis costs listed as "Other." |
| **Total** | | | **$5,140.00** | **$500.00** | **$0.00** | **$3,490.50** | **$9,130.50** | **$10,359.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 3 - With Onsite Disposal**
**Periodic Cost Sub-Element**
**SEDIMENT CORE SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sediment core sampling for mercury. Five cores collected per event, two sections analyzed per core.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $7,605.00 | $500.00 | $0.00 | $11,844.00 | $19,949.00 | $19,949.00 | Labor, travel, equipment, and field supply costs for 3 sampling personnel plus boat and divers to assist with sample collection. Travel expenses listed as "Other." |
| Analysis | 14 | LS | $0.00 | $0.00 | $0.00 | $18.90 | $18.90 | $264.60 | Laboratory costs for sample analysis listed as "Other." 10 samples plus 4 QA/QC samples. |
| **Total** | | | **$7,605.00** | **$500.00** | **$0.00** | **$11,862.90** | **$19,967.90** | **$20,213.60** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 3 - With Onsite Disposal**
**Annual Cost Sub-Element**
**INSPECTION AND MAINTENANCE**

COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Annual maintenance.

Cost Analysis:
Annual cost

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Inspection | 1 | LS | $0.00 | $0.00 | $0.00 | $1,500.00 | $1,500.00 | $1,500.00 | Personnel to perform on-site inspection. "Other" refers to subcontracted services. |
| Maintenance | 1 | LS | $0.00 | $0.00 | $0.00 | $2,000.00 | $2,000.00 | $2,000.00 | As-needed maintenance, such as mowing, re-seeding, re-grading. "Other" refers to subcontracted services. |
| | | | | | | | $0.00 | $0.00 | |
| **Total** | | | **$0.00** | **$0.00** | **$0.00** | **$3,500.00** | **$3,500.00** | **$3,500.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 3 - With Onsite Disposal**
**Periodic Cost Sub-Element**
**FISH TISSUE SAMPLING AND ANALYSIS**

# COST WORKSHEET

Prepared by: JAN  Date: 3/28/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Sampling and analysis of largemouth bass and bluegill fish tissue. Two size ranges of each fish. Largemouth bass to have filet and filet/offal reconstituted analyzed.
Largemouth Bass: 5 locations x 2 size ranges x filet and filet/offal = 20 samples
Bluegill: 5 locations x 2 size ranges = 10 samples

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $4,435.00 | $250.00 | $0.00 | $3,354.00 | $8,039.00 | $8,039.00 | Labor, travel, equipment, and field supply costs for 3 field personnel to collect fish samples from boat. Travel expenses are listed as "Other." |
| Analysis | 30 | LS | $0.00 | $0.00 | $0.00 | $39.90 | $39.90 | $1,197.00 | Laboratory costs for sample analysis are listed as "Other." |
| **Total** | | | **$4,435.00** | **$250.00** | **$0.00** | **$3,393.90** | **$8,078.90** | **$9,236.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 3 - With Onsite Disposal**
**Periodic Cost Sub-Element**
**SPIDER AND INSECT SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling of spider and insect tissue for Hg and DDTR. 3 samples each of spiders and insects to be analyzed.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling* | 1 | LS | $7,550.00 | $0.00 | $0.00 | $2,586.00 | $10,136.00 | $10,136.00 | Labor, travel, equipment, and field supply costs for 3 personnel to perform spider and insect sampling. Travel expenses are listed as "Other." |
| Analysis | 6 | LS | $0.00 | $0.00 | $0.00 | $197.40 | $197.40 | $1,184.40 | Laboratory costs for sample analysis listed as "Other." |
| **Total** | | | **$7,550.00** | **$0.00** | **$0.00** | **$2,783.40** | **$10,333.40** | **$11,320.40** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 3 - With Onsite Disposal**
**Periodic Cost Sub-Element**
**FIVE YEAR REVIEW REPORT**

# COST WORKSHEET

Prepared by: JDD  Checked by: KPW
Date: 3/23/2012  Date: 3/29/2012

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

Work Statement:
Preparation and submittal of 5-year Review Report

Cost Analysis:
Cost per 5-Year Review Report.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Five Year Review Report | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Data analysis, report preparation, and submittal. |
| **Total** | | | **$5,000.00** | **$0.00** | **$0.00** | **$0.00** | **$5,000.00** | **$5,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 3 - With Offsite Disposal**
**Capital Cost Sub-Element**
**INSTITUTIONAL CONTROLS**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012
Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Implementation of institutional controls such as signs, security, deed restrictions, etc.

Cost Analysis:
Cost per IC implementation.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Institutional Controls | 1 | LS | $0.00 | $0.00 | $1,000.00 | $0.00 | $1,000.00 | $1,000.00 | Signs, Fencing, Security, etc. |
| Environmental Contractor | 1 | LS | $0.00 | $0.00 | $0.00 | $600.00 | $600.00 | $600.00 | Contractor for implementation |
| **Total** | | | **$0.00** | **$0.00** | **$1,000.00** | **$600.00** | **$1,600.00** | **$1,600.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 3 - With Offsite Disposal**
**Capital Cost Sub-Element**
**REMEDIAL DESIGN AND TREATABILITY STUDIES**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Remedial Design/Treatability Study

Cost Analysis:
Cost per remedial design

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Remedial Design Deliverable | 1 | LS | $45,000.00 | $0.00 | $0.00 | $0.00 | $45,000.00 | $45,000.00 | Remedial design document |
| Treatability Studies | 1 | LS | $8,000.00 | $1,000.00 | $1,000.00 | $0.00 | $10,000.00 | $10,000.00 | Treatability studies and report |
| Update Health and Safety Plan, QAPP | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Updates to HASP/QAPP |
| | | | | | | | | $0.00 | |
| **Total** | | | **$58,000.00** | **$1,000.00** | **$1,000.00** | **$0.00** | **$60,000.00** | **$60,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 3 - With Offsite Disposal**
**Capital Cost Sub-Element**
**DREDGING OPERATIONS**

# COST WORKSHEET

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

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

Work Statement:
Mobilization, facilities and infrastructure for remedial activities, site preparation, construction, debris removal, hydraulic dredging, water treatment, disposal, and demobilization.

Cost Analysis:
Cost per dredging implementation.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | UNIT COST CONVERSION[2] | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| MOBILIZATION | 1 | LS | $79,022.15 | $5,418.27 | $53,326.28 | $427,950.79 | $565,717.50 | $565,717.50 | - | Mobilization of heavy equipment to jobsite. Installation and of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| GENERAL CONDITIONS | 1 | LS | $1,542,249.62 | $0.00 | $10,627.41 | $1,206,109.75 | $2,758,986.78 | $2,758,986.78 | $160,000 per month | Supervision of field activities. Includes labor cost, living expenses, travel expenses for the project manager and oversight staff. 17 months. |
| TEMPORARY FACILITIES | 1 | LS | $0.00 | $450,997.60 | $149,910.92 | $0.00 | $600,908.52 | $600,908.52 | $35,000 per month | Maintenance and upkeep of temporary site facilities including monthly fees for utilities, restrooms, etc., maintenance fluids for equipment and general housekeeping activities. 17 months. |
| SITE PREPARATION | 1 | LS | $79,483.54 | $34,570.26 | $467,803.25 | $216,212.37 | $798,069.42 | $798,069.42 | Road Prep: 5 Acres<br>Silt Fencing: 2800 ft<br>Silt Curtain: 7500 ft<br>Paving: 60,000 ft2 | Grading and clearing, construction of access roads and staging area, silt fence and curtain installation. |
| DREDGE PIPE LINE | 1 | LS | $81,970.22 | $27,680.59 | $103,008.69 | $21,621.24 | $234,280.74 | $234,280.74 | $110 per linear foot | Furnish and install 14" HDPE dredge pipeline. 2,175 linear feet. |
| SURVEY | 1 | LS | $125,837.87 | $36,035.43 | $21,921.55 | $439,632.21 | $623,427.06 | $623,427.06 | $45,000 per month | Up-front bathymetric survey prior to dredging, surveying full time during dredging. 14 months. |
| DEBRIS REMOVAL AND MAINTENANCE CREW | 1 | LS | $1,390,254.94 | $943,701.32 | $501,271.90 | $155,192.54 | $2,990,420.70 | $2,990,420.70 | $230,033 per month | Crew to work concurrently with dredging crew, removing debris with excavator and grapple or rake. 13 months. |
| HYDRAULIC DREDGING | 1 | LS | $2,241,790.13 | $729,255.47 | $3,090,072.07 | $42,042.12 | $6,103,159.80 | $6,103,159.80 | $10 per cubic yard | Hydraulic dredging using horizontal auger, pumping sediment to land-based dewatering area. 590,000 cubic yards (in-place). |
| FILTER PRESS DEWATERING | 1 | LS | $5,028,020.42 | $9,137,597.94 | $4,982,914.32 | $126,152.32 | $19,274,685.00 | $19,274,685.00 | $8 per cubic yard | Dewatering of dredged sediments via filter press. 2,390,000 cubic yards. |
| WATER HANDLING | 1 | LS | $472,640.66 | $139,817.26 | $40,520.58 | $0.00 | $652,978.50 | $652,978.50 | - | Pump decant water to water treatment facility. |
| TRANSPORTATION AND DISPOSAL OF NON-HAZARDOUS SEDIMENT | 1 | LS | $1,050,315.93 | $317,931.27 | $242,947.48 | $21,371,850.26 | $22,983,044.94 | $22,983,044.94 | $55 per ton | Transport and dispose of dredged sediment. 422,000 tons. |
| TRANSPORTATION AND DISPOSAL OF NON-HAZARDOUS DEBRIS | 1 | LS | $107,211.26 | $32,452.91 | $24,798.92 | $2,181,536.90 | $2,346,000.00 | $2,346,000.00 | $100 per ton | Transport and dispose of debris removed prior to dredging. 23,000 tons. |
| SITE RESTORATION | 1 | LS | $10,498.19 | $6,506.55 | $7,981.84 | $15,014.75 | $40,001.34 | $40,001.34 | $8,000 per acre | Re-grade 5-acre staging area with existing site material and apply hydroseed. Asphalt pavement will remain in place. |
| DEMOBILIZATION | 1 | LS | $101,432.43 | $33,260.17 | $38,496.29 | $343,508.42 | $516,697.32 | $516,697.32 | - | Demobilization of heavy equipment from jobsite. Removal of temporary infrastructure such as office trailers, utilities such as phone/electricity,shoreline dock, and decon facilities. |
| WATER TREATMENT - 500 GAL. PER MINUTE | 1 | LS | $361,118.79 | $368,904.49 | $218,427.39 | $80,488.25 | $1,049,517.70 | $1,049,517.70 | $3 per 1000 gallons | Treatment of water from dredged sediment via settling tank and active carbon units. 400,000,000 gallons. |
| **Total** | | | | | | | | **$61,537,895.32** | | |

1 - Includes costs associated with subcontracted services and equipment
2 - Unit cost conversions provided, where appropriate, for comparison purposes. Unit cost conversions rounded to two significant figures.

**Source of Cost Data:** Quote from Alan Elia, Jr., Sevenson Environmental Services, tel no. 716-284-0431.

**Alternative 3 - With Offsite Disposal**
**Periodic Cost Sub-Element**
**SURFACE WATER SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling of surface water for low-level mercury. Five project samples plus 5 QC samples analyzed per event.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $5,140.00 | $500.00 | $0.00 | $3,354.00 | $8,994.00 | $8,994.00 | Labor, travel, equipment, and field supply costs for 3 people to sample from boat. Travel costs listed as "Other." |
| Analysis | 10 | LS | $0.00 | $0.00 | $0.00 | $136.50 | $136.50 | $1,365.00 | Laboratory costs for sample analysis. Laboratory analysis costs listed as "Other." |
| **Total** | | | **$5,140.00** | **$500.00** | **$0.00** | **$3,490.50** | **$9,130.50** | **$10,359.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 3 - With Offsite Disposal**
**Periodic Cost Sub-Element**
**SEDIMENT CORE SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN  Date: 3/28/2012
Checked by: KPW  Date: 3/29/2012

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

Work Statement:
Sediment core sampling for mercury. Five cores collected per event, two sections analyzed per core.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $7,605.00 | $500.00 | $0.00 | $11,844.00 | $19,949.00 | $19,949.00 | Labor, travel, equipment, and field supply costs for 3 sampling personnel plus boat and divers to assist with sample collection. Travel expenses listed as "Other." |
| Analysis | 14 | LS | $0.00 | $0.00 | $0.00 | $18.90 | $18.90 | $264.60 | Laboratory costs for sample analysis listed as "Other." 10 samples plus 4 QA/QC |
| **Total** | | | **$7,605.00** | **$500.00** | **$0.00** | **$11,862.90** | **$19,967.90** | **$20,213.60** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 3 - With Offsite Disposal**
**Annual Cost Sub-Element**
**INSPECTION AND MAINTENANCE**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012
Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Annual maintenance.

Cost Analysis:
Annual cost

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Inspection | 1 | LS | $0.00 | $0.00 | $0.00 | $1,500.00 | $1,500.00 | $1,500.00 | Personnel to perform on-site inspection. "Other" refers to subcontracted services. |
| Maintenance | 1 | LS | $0.00 | $0.00 | $0.00 | $2,000.00 | $2,000.00 | $2,000.00 | As-needed maintenance, such as mowing, re-seeding, re-grading. "Other" refers to subcontracted services. |
| | | | | | | | $0.00 | $0.00 | |
| **Total** | | | **$0.00** | **$0.00** | **$0.00** | **$3,500.00** | **$3,500.00** | **$3,500.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.

**Alternative 3 - With Offsite Disposal**
**Periodic Cost Sub-Element**
**FISH TISSUE SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling and analysis of largemouth bass and bluegill fish tissue. Two size ranges of each fish. Largemouth bass to have filet and filet/offal reconstituted analyzed.
Largemouth Bass: 5 locations x 2 size ranges x filet and filet/offal = 20 samples
Bluegill: 5 locations x 2 size ranges = 10 samples

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $4,435.00 | $250.00 | $0.00 | $3,354.00 | $8,039.00 | $8,039.00 | Labor, travel, equipment, and field supply costs for 3 field personnel to collect fish samples from boat. Travel expenses are listed as "Other." |
| Analysis | 30 | LS | $0.00 | $0.00 | $0.00 | $39.90 | $39.90 | $1,197.00 | Laboratory costs for sample analysis are listed as "Other." |
| **Total** | | | **$4,435.00** | **$250.00** | **$0.00** | **$3,393.90** | **$8,078.90** | **$9,236.00** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 3 - With Offsite Disposal**
**Periodic Cost Sub-Element**
**SPIDER AND INSECT SAMPLING AND ANALYSIS**

COST WORKSHEET

Prepared by: JAN
Date: 3/28/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Sampling of spider and insect tissue for Hg and DDTR. 3 samples each of spiders and insects to be analyzed.

Cost Analysis:
Cost per sampling event.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling | 1 | LS | $7,550.00 | $0.00 | $0.00 | $2,586.00 | $10,136.00 | $10,136.00 | Labor, travel, equipment, and field supply costs for 3 personnel to perform spider and insect sampling. Travel expenses are listed as "Other." |
| Analysis | 6 | LS | $0.00 | $0.00 | $0.00 | $197.40 | $197.40 | $1,184.40 | Laboratory costs for sample analysis listed as "Other." |
| **Total** | | | **$7,550.00** | **$0.00** | **$0.00** | **$2,783.40** | **$10,333.40** | **$11,320.40** | |

1 - Includes costs associated with subcontracted services and equipment and overhead traveling expenses

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.
**Source of Laboratory Analysis Cost Data:** TestAmerica Laboratories, tel. 866-785-LABS.

**Alternative 3 - With Offsite Disposal**
**Periodic Cost Sub-Element**
**FIVE YEAR REVIEW REPORT**

# COST WORKSHEET

Prepared by: JDD
Date: 3/23/2012

Checked by: KPW
Date: 3/29/2012

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

Work Statement:
Preparation and submittal of 5-year Review Report

Cost Analysis:
Cost per 5-Year Review Report.

| DESCRIPTION | QTY | UNIT | LABOR | EQUIP | MTRL | OTHER[1] | UNIT TOTAL | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| Five Year Review Report | 1 | LS | $5,000.00 | $0.00 | $0.00 | $0.00 | $5,000.00 | $5,000.00 | Data analysis, report preparation, and submittal. |
| **Total** | | | **$5,000.00** | **$0.00** | **$0.00** | **$0.00** | **$5,000.00** | **$5,000.00** | |

1 - Includes costs associated with subcontracted services and equipment

**Source of Cost Data:** Quote from Cynthia Draper, AMEC Environment and Infrastructure, tel. 770-421-3400.