

# Supplemental Investigation of Sediment and Soil Chemistry in the Vicinity of the Anniston PCB Site, Anniston, Alabama:

## *Data Report*

*Prepared for:*

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*Prepared August, 2015 by:*

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## List of Acronyms

ADCNR	Alabama Department of Conservation and Natural Resources
AOI	Area of Interest
cm	centimeter
COC	chain-of-custody
COPC	chemical of potential concern
CVAFS	cold vapor atomic fluorescence spectrometry
DW	dry weight
ERDC	Engineer Research and Development Center
ESRI	Environmental Systems Research Institute
FSP	Field Sampling Plan
GIS	geographic information system
GPS	global positioning system
GSA	Geological Survey of Alabama
HDPE	high-density polyethylene
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectrometry
ICP-MS	inductively-coupled plasma-mass spectrometry
km	kilometer
m	meter
mm	millimeter
MESL	MacDonald Environmental Sciences Ltd.
NIST	National Institute of Standards and Technology
NRDAR	natural resource damage assessment and restoration
NRTs	Natural Resources Trustees
OU	Operable Unit
PCB	polychlorinated biphenyl
PCDDs/PCDFs	polychlorinated dibenzo- <i>p</i> -dioxins/polychlorinated dibenzofurans
PDF	portable document format
PEC	probable effect concentration
PEC-Q <sub>Metals</sub>	probable effect concentration-quotient for metals
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RI/FS	remedial investigation/feasibility study
TOC	total organic carbon
USDOJ	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

## **Executive Summary**

The 2013 sediment and floodplain-soil sampling program for the Anniston Polychlorinated Biphenyl (PCB) Site (the Site) was conducted between November 4 and December 9, 2013. Sampling was conducted by individuals from MacDonald Environmental Sciences Ltd. (MESL), U.S. Army Engineer Research and Development Center (ERDC), and U.S. Fish and Wildlife Service (USFWS). During the data gap sampling program, a total of 61 sediment and 80 soil samples were collected from areas in Operable Unit (OU)-1/2 and OU-4 of the Site, which were identified as being either un-sampled or under-sampled based on an evaluation of the spatial distribution of existing data.

All of the sediment and soil samples were analyzed to provide supplemental information on the nature and extent of contamination within the data gap sampling study area. More specifically, the concentrations of total metals, PCB Aroclors, and total organic carbon (TOC), as well as the grain size distribution, were determined in each sediment and soil sample that was collected from the study area. The concentrations of mercury, PCB congeners, and polychlorinated dibenzo-*p*-dioxins/polychlorinated dibenzofurans (PCDDs/PCDFs) were determined in a subset of the samples. The results of this sampling program confirm that aquatic and riparian habitats have been contaminated by PCBs, PCDDs/PCDFs, and metals. The sediment chemistry and soil chemistry data that were collected during the sediment and floodplain-soil data gap sampling program provide relevant data for evaluating injuries to natural resources associated with contamination of sediments and soil at the Site.

## **Acknowledgments**

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## **1.0 Introduction**

The Anniston Polychlorinated Biphenyl (PCB) Site (the Site) is located in the north-eastern portion of Alabama in the vicinity of the municipality of Anniston in Calhoun County. Although there are a variety of land use activities within the Choccolocco Creek watershed, environmental concerns in the area have focused primarily on releases of PCBs from a PCB manufacturing facility located in Anniston, Alabama. PCBs were manufactured by Monsanto, Inc., at the Anniston facility from 1935 to 1971. During production, PCBs may have been released from the facility in production waste effluent discharges, uncontrolled releases from landfills, accidental spills, stormwater runoff, and other sources. The total mass of PCBs released from the Anniston facility is uncertain.

In response to public concerns regarding environmental contamination, a remedial investigation/feasibility study (RI/FS) is being conducted by the U.S. Environmental Protection Agency (USEPA) to assess risks to human health and ecological receptors associated with exposure to PCBs and other contaminants, and to evaluate remedial options for addressing environmental contamination at the Site. Based on the data that were reported by Blasland, Bouck, and Lee Inc. (BBL 2003), environmental media from the Anniston facility to Logan Martin Dam have been contaminated by PCBs and, hence, pose potential risks to ecological receptors. Fish tissue chemistry data collected by the Alabama Department of Environmental Management (ADEM 2011) indicate that fish collected in Lay Lake, Mitchell Lake, and/or Jordan Lake have accumulated PCBs to levels that pose potential risks to fish, piscivorous wildlife, and/or human health.

In addition to posing potential risks to human health and the environment, PCBs and other hazardous substances that have been released into the environment in the vicinity of the Site have the potential to injure natural resources, including surface water resources, groundwater resources, geologic resources, air resources, and/or biological resources. To address concerns regarding the potential effects of hazardous substance releases on trust resources, the State of Alabama, acting

through the Alabama Department of Conservation and Natural Resources (ADCNR) and the Geological Survey of Alabama (GSA), and the Secretary of the U.S. Department of the Interior (USDOl), as represented by the Regional Director of the Southeast Region of the U.S. Fish and Wildlife Service (USFWS; collectively referred to as the Natural Resources Trustees, NRTs; hereafter referred to as the Trustees) are in the process of assessing injuries to, loss of, or destruction of natural resources associated with releases of hazardous substances to the environment in the vicinity of the Site.

In conducting the natural resource damage assessment and restoration (NRDAR) process, the Trustees are relying, to the extent possible, on the data and information that have already been collected at the Site. In addition, the Trustees may conduct their own investigations to ascertain whether natural resources and the services that they provide have been injured by the release of hazardous substances, to quantify such injury, if any, and to determine natural resource damages. The 2013 sediment and floodplain-soil data gap sampling program represents one such investigation. The sampling program was conducted to address uncertainties and data gaps associated with the spatial characterization of the concentrations of PCBs and other chemicals of potential concern (COPCs) in sediments and floodplain soils in the vicinity of the Site. The supplemental sediment and floodplain-soil chemistry data are required to evaluate injuries to natural resources associated with releases of hazardous substances from the Site.

This report summarizes the results of the 2013 sediment and floodplain-soil data gap sampling program for the Site. The report includes an overview of the sampling program design, describes the sampling methods that were applied during the investigation, and presents the results of the study.

## **2.0 Materials and Methods**

The 2013 sediment and floodplain-soil data gap sampling program was conducted by the Trustees in Operable Units 1/2 and 4 (OU-1/2 and OU-4) of the Site, which is located in the vicinity of Anniston, Alabama (Figure 1). The lower reach of Snow Creek was designated as Area of Interest-1 (AOI-1) for the purposes of this sampling program. That portion of Choccolocco Creek from the backwater area located near the confluence with Snow Creek to the Coosa River was designated as AOI-2. Reach CR02 was the only portion of AOI-3 that was sampled in 2013 (Figure 1).

During the sampling program, a total of 61 sediment and 80 soil samples were collected in the data gap sampling study area (Figure 1) to address the limitations of the sediment and soil chemistry data that were generated in previous sampling programs (Echols and Orazio 2005; Gale 2006; USEPA 2011; ARCADIS 2012; ENVIRON 2014a; 2014b; Ingersoll *et al.* 2014). Quality assurance/quality control (QA/QC) samples were also collected and/or prepared to provide the information needed to assess the quality of the data resulting from the 2013 sampling program. The NRDAR sampling program was conducted between November 4 and December 9, 2013. More specifically, soil samples were collected between November 4 and 7, November 18 and 21, and December 9. Sediment samples were collected between November 18 and 22. The study team consisted of individuals from MacDonald Environmental Sciences Ltd. (MESL), U.S. Army Engineer Research and Development Center (ERDC), and USFWS. During the sampling period, the study team focused on the following activities:

- Collection of sediment and floodplain-soil samples from various locations in the data gap sampling study area;
- Processing of all sediment and soil samples (i.e., sieving of samples to <2.00 millimeters [mm]);
- Preparation of samples for transport and/or shipment, including preparation of the chain-of-custody (COC) forms and associated documentation; and,

- Transportation and/or shipment of samples to the analytical laboratory (i.e., ERDC).

The methods that were used to conduct the sampling program are summarized in Sections 2.1 to 2.5 of this report. Additional information on the design of the sampling program and associated methods is provided in the sediment and floodplain-soil data gap Field Sampling Plan (FSP; MacDonald *et al.* 2013a).

## **2.1 Study Area**

The Site is located in the north-eastern portion of Alabama in the vicinity of the municipality of Anniston in Calhoun County. In response to public concerns regarding environmental contamination, the USEPA is conducting an RI/FS to assess risks to human health and ecological receptors associated with exposure to PCBs and other contaminants, and to evaluate remedial options for addressing environmental contamination in the Site. For the purposes of the RI/FS, the USEPA has defined the Site as consisting of the area where hazardous substances, including PCBs (associated with the historical and ongoing operations at the Anniston facility by Solutia, Monsanto Company, and their predecessors), have come to be located. The area currently under investigation under the RI/FS extends from the Anniston facility to the mouth of Choccolocco Creek. This portion of the Site was divided into four operable units, including the Solutia, Inc. facility (OU-3), Anniston non-residential (OU-2), Anniston residential (OU-1), and Choccolocco Creek (OU-4; BBL 2003). Subsequently, OU-1 and OU-2 were combined (i.e., OU-1/2) to include all of the affected aquatic and floodplain areas within the Snow Creek watershed (with the exception of that portion of Snow Creek located south of Highway 202).

The nature and extent of contamination at the Site have not been fully characterized and the boundaries of the assessment area remain uncertain. For the purposes of the NRDAR, the Trustees have tentatively defined the Site as the area encompassing the 11th Street ditch, Snow Creek, Choccolocco Creek, Coosa River

(including, but not limited to, Lay Lake and Lake Logan Martin), and associated floodplains. At this time, it is uncertain if significant levels of contamination persist in surface waters downstream of Lay Lake in the Coosa River, the Alabama River, the Mobile River, the Mobile-Tensaw River Delta, and/or Mobile Bay.

For the purposes of the data gap sampling program, the study area includes the portion of Snow Creek downstream of Highway 21, Choccolocco Creek from the backwater area to the Coosa River, the Coosa River in the vicinity of the confluence with Choccolocco Creek, associated floodplain areas, and selected upland habitats. The study area was divided into a total of 12 reaches (Figure 1), including:

- Reach SC01 - Snow Creek 1 (SC01) encompasses that portion of the Snow Creek watershed from the Solutia, Inc. facility to the Highway US 4 (Quintard Road) bridge. It includes Snow Creek and the associated floodplain areas from West 16<sup>th</sup> Street (including West 9<sup>th</sup> Street Ditch and 11<sup>th</sup> Street Ditch) south to Highway 78. This is the only reach in AOI-1;
- Reach CC01 - Choccolocco Creek 1 (CC01) encompasses that portion of Snow Creek from the Highway US 4 (Quintard Road) bridge to the confluence with Choccolocco Creek. It includes Snow Creek and associated floodplain downstream of Highway 78 to Interstate 20. This area extends over approximately 71 acres and includes most of Oxford Lake Park;
- Reach CC02 – Choccolocco Creek 2 (CC02) encompasses that portion of Choccolocco Creek from the bifurcation near Jerry Avenue to the Friendship Road bridge. It includes the Choccolocco Creek backwater area north of the main Choccolocco Creek channel (the southern branch) from approximately one mile upstream of the Snow Creek confluence downstream to Friendship Road. This reach is known as the backwater area as it tends to overflow the stream banks during periods of elevated streamflows, creating numerous contiguous and off-channel wetland habitats;

- Reach CC03 – Choccolocco Creek 3 (CC03) represents the portion of Choccolocco Creek and associated riparian habitats from Friendship Road downstream to mile marker 33.5, where there is a constriction in the overall floodplain width. The reach is approximately 4.5 kilometers (km) long;
- Reach CC04 – Choccolocco Creek 4 (CC04) includes the area from mile marker 33.5 (where there is a constriction in the overall floodplain width) to just downstream of the Coldwater Creek confluence where the floodplain influence of Coldwater Creek ends (as evidenced by the constriction of the floodplain);
- Reach CC05 – Choccolocco Creek 5 (CC05) includes the area from just downstream of the Coldwater Creek confluence, where the floodplain influence of Coldwater Creek ends, to mile marker 23.5 where a small tributary enters Choccolocco Creek and the width of the floodplain decreases;
- Reach CC06 - Choccolocco Creek 6 (CC06) includes the area from mile marker 23.5, where a small tributary enters Choccolocco Creek and the width of the floodplain decreases, to mile marker 19.5, where the width of the floodplain expands again. It has fairly steep elevations surrounding the waterway and contains very few contiguous or off-channel wetland habitats;
- Reach CC07 - Choccolocco Creek 7 (CC07) includes the area from mile marker 19.5, where the width of the floodplain expands, to just downstream of the Cheaha Creek confluence. This reach runs past Eastaboga Road;
- Reach CC08 – Choccolocco Creek 8 (CC08) includes the area from just downstream of the Cheaha Creek confluence downstream to Jackson Shoals. It has a large backwater wetland area that runs towards and beside the Talladega Municipal Airport;
- Reach CC09 – Choccolocco Creek 9 (CC09) includes the area from just downstream of Jackson Shoals to Highway 77;

- Reach CC10 – Choccolocco Creek 10 (CC10) includes the area from Highway 77 to the western extent of OU-4 (i.e., the embayment at the mouth of Choccolocco Creek and Lake Logan Martin); and,
- Reach CR02 – Coosa River 2 (CR02) includes the northern portion of Lake Logan Martin and associated floodplain. Reach CR02 contains mostly deep water areas.

Reaches CC01 to CC10 make up AOI-2. CR02 was the only reach from AOI-3 sampled during the 2013 data gap sampling program.

## **2.2 Study Design**

The purpose of the 2013 sediment and floodplain-soil data gap sampling program was to address uncertainties and data gaps associated with the spatial characterization of the concentrations of PCBs and other contaminants in sediments and floodplain soils in the vicinity of the Site (i.e., within the data gap sampling study area; Figure 1). More specifically, the sampling program was designed to achieve the following objectives:

- Determine the concentrations of PCBs in sediments and floodplain soils in un-sampled and under-sampled areas within the Site;
- Determine if COPCs other than PCBs occur at concentrations sufficient to injure natural resources in the data gap sampling study area;
- Confirm that the data collected by the Potentially Responsible Party provide a reliable basis for evaluating injury to natural resources in the data gap sampling study area; and,
- Determine whether additional sampling is required to determine the nature and extent of contamination of sediments and/or floodplain soils within the Site.

A stratified-random sampling design was used to develop the 2013 data gap sampling program. Based on a review of existing data and information, a number

of candidate sampling areas (or strata) for sediment and soil were identified in the data gap sampling study area. Each of the candidate sampling areas were mapped and delineated as a discrete polygon that encapsulated a single habitat feature, such as a wetland area or a riparian area. All of the candidate sampling areas represented un-sampled or under-sampled areas from which sediment and/or soil samples needed to be collected to further characterize the nature and extent of contamination within the data gap sampling study area. A total of 191 target aquatic and riparian strata were identified within the data gap sampling study area (see MacDonald *et al.* 2013a for more information).

Sampling locations were classified as primary or secondary prior to sampling activities (MacDonald *et al.* 2013a). Samples collected from primary stations were analyzed immediately following completion of sampling, whereas samples collected from secondary stations were archived for analysis at a later date (between September, 2014 and January, 2015). A number of alternate stations were also identified in the event that field sampling crews could not safely or effectively obtain a sample from one or more of the primary or secondary sampling stations.

Primary, secondary, and alternate sampling stations were identified by randomly selecting coordinates within each of the selected polygons or strata. The sampling stations were not ground truthed prior to selection. A total of 45 primary, 44 secondary and 23 alternate sampling stations were identified to guide the collection of sediment samples within the data gap sampling study area during the sampling program (Figures 2 - 16). In addition, a total of 54 primary, 48 secondary, and 29 alternate sampling stations were identified to support the collection of floodplain soil samples (Figures 17 - 35). Accordingly, the final design of the 2013 sediment and soil sampling program targeted collection of about 89 sediment and 102 low-elevation floodplain soil samples from un-sampled and under-sampled areas within the data gap sampling study area. The sampling program design also called for collection and analysis of up to 16 QA/QC samples (e.g., matrix-spike and matrix-spike duplicates) to support evaluation of analytical accuracy and precision, as well



as trip and equipment rinsate blanks to evaluate potential sources of sample contamination.

## **2.3 Sample Collection, Handling, and Preparation**

A total of 61 sediment samples and 80 floodplain soil samples were collected within the data gap sampling study area during the 2013 sampling program. The methods that were used to collect, handle, prepare, and transport these samples are described below.

### **2.3.1 Collection, Handling, and Preparation of Sediment Samples**

Sediment sampling activities were conducted over a five day period, from November 18 to 22, 2013. During the sampling program, samples were collected from 44 of the 45 targeted primary stations and 15 of the 44 targeted secondary stations. Two additional samples were also collected; one at an alternate station and one at a new station selected in the field. For analysis, these two additional samples were classified as primary samples.

Sampling stations were located using maps and hand-held global positioning system (GPS) units, with access facilitated by canoe, pontoon boat, or on foot. Upon arrival at each sampling station, a cursory reconnaissance was conducted to determine if it was feasible and safe to collect a sediment sample. If the primary or secondary sampling station was deemed to be unacceptable for sample collection, an alternate station was selected and evaluated using the same criteria applied to the primary sampling stations (see MacDonald *et al.* 2013a for more information).

If conditions were appropriate for sample collection, multiple grab sediment samples were collected at each station and composited to support chemical characterization. These grab samples were collected within a 25 meter (m) radius of the designated sampling coordinates, targeting areas that appeared to be depositional in nature (i.e., areas with fine-grained material). The coordinates of

each sampling station were taken from the centroid of the grab sample locations using a hand-held GPS unit. Samples were collected using Lexan tubing (a two-foot length of four-inch diameter tubing) or trowel, sampling the top 10 to 15 centimeter (cm) sediment horizon. The number of grabs collected at each station generally depended on the method used to collect the sample. For surficial cores obtained using the Lexan tubing, three grabs were collected at each station. For sediments overlaying a consolidated bottom (e.g., a clay horizon), horizontal cores were obtained (i.e., the tube was passed horizontally through the top 10 cm of sediment, and material was trapped in the tube using gloved hands and/or tube caps). For stations where this method was used, a minimum of three grabs were collected to obtain the required sample volume. At least ten grabs were collected when the trowel was used to obtain the sediment sample.

Following the removal of overlying water from the sampler (if applicable), grab samples were deposited onto a stainless-steel sieve, which was placed over a 1.25 gallon high-density polyethylene (HDPE) sample bucket. Samples were generally press-sieved with a gloved hand through a 2.00 mm mesh sieve. In cases where the entire sample consisted of sediments less than 2 mm, the sample was sieved using a 1 cm sieve to remove large debris. Material that was retained on the screen was discarded at the sampling location.

Grab samples were sieved and composited until the target sediment volume (about 2 Liters) was collected at each station. The sample was then sealed, and the bucket and lid were labeled with the sample identification number, date, and initials of sampling personnel. In addition, a “P” was used to indicate primary samples (i.e., samples to be analyzed immediately upon completion of the sampling program), and an “S” was used to indicate secondary samples (i.e., samples to be archived for future analysis). A sediment sample collection form was filled out for each sample collected (Table 1; All of the completed data collection forms for sediment sampling locations are provided in Appendix 1).

Following collection of each sediment sample from a sampling station, all equipment that was used to collect and process the sample was decontaminated

prior to mobilizing to the next station. The decontamination procedure consisted of scraping excess sediment from the sampling equipment, rinsing the sampler and other equipment in site water, scrubbing the equipment with a stiff-bristled brush saturated with Liquinox solution, and rinsing all equipment in site water and then with deionized water. The decontaminated equipment was placed in clean bags to avoid contamination during travel between sampling locations. The sampling equipment was rinsed with site water at the next station prior to commencing sampling activities. Sampling personnel wore laboratory gloves while collecting and processing samples, and while decontaminating the sampling equipment.

At the end of sampling each day, samples were placed on ice in a secured cooler (i.e., a locked chest freezer). Sample buckets were checked to ensure the samples were appropriately labeled prior to placement in the cooler. On November 22, 2013, 57 sediment samples were transported in the large secured cooler to the ERDC Environmental Chemistry Laboratory in Vicksburg, MS. The remaining four samples were shipped to the ERDC laboratory on November 22, 2013, in a cooler packed with ice via FedEx. The COC forms accompanied both sets of samples (the completed COC forms for sediment samples are provided in Appendix 2).

In addition to the environmental samples, a number of quality assurance samples were prepared to support evaluation of data quality. More specifically, eight rinsate blanks were collected during the field program to evaluate possible sources of contamination related to sediment and soil sample collection, sample handling, and/or equipment decontamination procedures. De-ionized water was passed over decontaminated sediment or soil sampling and processing equipment, collected via a funnel, and stored in a one-gallon HDPE cube. These samples were placed on ice and transported to the laboratory for analysis along with the environmental samples.

### **2.3.2 Collection, Handling, and Preparation of Soil Samples**

Soil sampling activities were conducted on nine days during the period from November 4 to December 9, 2013. During the sampling program, 80 soil samples were collected from 51 targeted primary stations and 24 targeted secondary stations. Five additional samples were collected at locations identified in the field.

Sampling stations were located using maps and hand-held GPS units, with access facilitated primarily by foot and sometimes by boat. Upon arrival at each sampling station, a cursory reconnaissance was conducted to determine if it was feasible and safe to collect a soil sample. If the primary sampling station was deemed to be unacceptable for sample collection, an alternate station was selected and evaluated using the same criteria applied to the primary sampling stations (see MacDonald *et al.* 2013a for more information).

If conditions were appropriate for sample collection, multiple grab soil samples were collected and composited to support chemical characterization. More specifically, six grab soil samples were collected at each sampling station (i.e., within a 25 m radius of the designated sampling coordinates). Two grabs were taken from the station's centroid and one grab sample was taken within 25 m of the centroid in each of the four cardinal directions (North, South, East, and West). Samples were collected using a stainless steel soil coring device (bulb transplanter), which sampled the top 10 to 15 cm soil horizon. All six grab samples were placed in a 1.25 gallon HDPE bucket and combined to form a single composite sample. The bucket and lid were labeled with the sample identification number, date, and initials of sampling personnel. A soil sample collection form was filled out for each sample collected (the completed field data collection forms for the soil sampling component of the data gap sampling program are presented in Appendix 3).

To maximize efficiency in the field, the majority of soil samples were processed in the laboratory following field collection. First, each composite soil sample was mixed with a stainless steel spoon. Next, the sample was passed through a 10 mm

sieve to remove coarse debris. Finally, the soil sample was sieved to <2.00 mm to facilitate analysis of particle size distribution and chemical composition.

All soil sampling equipment was decontaminated in batches prior to mobilizing to the next sampling area. After scraping and/or rinsing (i.e., with tap water) the excess soil from the sampling equipment, samplers were scrubbed with a Liquinox solution and rinsed with distilled water. Then, soil sampling equipment was decontaminated with acetone, then by a distilled water rinse. Investigation-derived waste associated with the Liquinox cleanse and acetone rinse was collected in separate carboys and disposed of at the ERDC facility in Vicksburg, MS. This decontamination process was also applied to brushes, stainless steel spoons, sieves, buckets into which samples were sieved, and any other processing equipment that was used during the field effort. All decontaminated sampling equipment was individually wrapped in aluminum foil and placed in clean plastic bags to avoid contamination prior to use. Sampling personnel wore laboratory gloves while collecting and processing samples, and while decontaminating the sampling equipment.

At the end of sampling each day, samples were placed on ice in a secured cooler (i.e., a locked chest freezer). Sample buckets were checked to ensure the samples were appropriately labeled prior to placement in the cooler. Soil samples were transported under chain of custody on ice to ERDC's Environmental Chemistry Laboratory, Vicksburg, MS (the completed COC forms for soil samples are provided in Appendix 4).

In addition to the environmental samples, a number of quality assurance samples were prepared to support evaluation of data quality. More specifically, eight rinsate blanks were collected during the field program to provide an analytical check on possible sources of contamination related to soil and sediment sample collection, sample handling, and equipment decontamination procedures. De-ionized water was passed over decontaminated soil or sediment sampling and processing equipment, collected via a funnel, and stored in a one-gallon HDPE

cube. These samples were placed on ice and transported to the laboratory for analysis along with the environmental samples.

## **2.4 Chemical Analysis**

Chemical analysis of the sediment and floodplain soil samples collected during the sampling program was conducted at the ERDC Environmental Chemistry Laboratory in Vicksburg, MS (metals, mercury, PCB Aroclors, percent solids), or at Maxxam Analytics in Mississauga, ON (polychlorinated dibenzo-*p*-dioxins/polychlorinated dibenzofurans [PCDDs/PCDFs], PCB congeners). Samples were also analyzed for PCB congeners at TestAmerica in West Sacramento, CA, while total organic carbon (TOC) and grain size analyses were performed at TestAmerica in Earth City, MO, and ARDL, Inc. in Mount Vernon, IL, respectively. Upon receipt at the laboratory, sediment and soil samples were held at 4°C in the dark until selection for analysis. All sediment and soil samples selected for chemical characterization were submitted for analysis of total metals, PCB Aroclors, TOC, percent solids, and grain size, while a subset were analyzed for PCB congeners, PCDDs/PCDFs, and mercury. Total recoverable metals were analyzed in sediments and soils using inductively-coupled plasma-mass spectrometry (ICP-MS; EPA Method SW 846/6020 or SW 846/6010). Total mercury was analyzed by cold vapor atomic fluorescence spectrometry (CVAFS) using EPA Method 7474. PCBs, as Aroclors, were measured by gas chromatography using EPA Method 8082, while PCB congeners were measured by high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) using EPA Method 1668A. The EPA Methods 8290A and 1613B were used to measure PCDDs/PCDFs by HRGC/HRMS. Total organic carbon was measured using the Lloyd Kahn method, percent solids was measured using ASTM D2216, and grain size was measured using ASTM D422.

## **2.5 Data Evaluation and Compilation**

All of the data generated during the course of the study were reviewed relative to the performance criteria for measurement data specified in the Quality Assurance Project Plan (QAPP; MacDonald *et al.* 2013b; See Appendix 5 for the results of the data evaluation process). Following data evaluation, a relational project database was developed in MS Access format to support data compilation. All of the sediment chemistry and soil chemistry data compiled in the database were georeferenced to facilitate mapping and spatial analysis using geographic information system (GIS)-based applications. In the final step of the data compilation process, all of the data contained in the database were audited to ensure data quality.

The sediment chemistry data (total metals, PCB Aroclors, TOC, and percent solids) for the 61 sediment samples collected during the data gap sampling program were translated from MS Excel format into a relational database in MS Access format. Mercury, PCB congener, and PCDD/PCDF concentrations were translated from MS Excel format into a relational database in MS Access format for 27, 13, and 13 samples, respectively. In addition, grain size distribution data for the 61 sediment samples were translated from portable document format (PDF) into MS Access format. These sediment chemistry data were reviewed using performance criteria for measurement data documented in the QAPP (MacDonald *et al.* 2013b). The ERDC lab and their subcontractors assigned qualifier codes to the sediment chemistry data. These qualification codes were recorded in the project database for each of the original sediment samples and considered prior to use of the data.

The soil chemistry data (total metals, PCB Aroclors, TOC, and percent solids) for the 80 soil samples collected during the data gap sampling program were translated from MS Excel format into a relational database in MS Access format. Mercury, PCB congener, and PCDD/PCDF concentrations were translated from MS Excel format into a relational database in MS Access format for 42, 26, and 27 samples, respectively. In addition, grain size distribution data for the 80 soil samples were translated from PDF into MS Access format. These soil chemistry data were

reviewed using performance criteria for measurement data documented in the QAPP (MacDonald *et al.* 2013b). The ERDC lab and their subcontractors assigned qualifier codes to the soil chemistry data. These qualification codes were recorded in the project database for each of the original soil samples and considered prior to use of the data.

Data verification and auditing were conducted to ensure that the underlying data were accurate and complete. Following translation into database format, data were verified to ensure that errors had not occurred during data translation. Data verification involved comparison of data in the translated MS Excel sheets to the original data from each laboratory. Data verification initially involved 10% number-for-number checks against source data, increasing to 100% number-for-number checks if significant errors were detected in the initial verification step. For the 10% check, the data for a randomly selected set of ten out of a hundred analytes were verified against the original data. Discrepancies in the data (e.g., minor differences in sample names and values) were rectified using the original laboratory reports, and, in some cases, communication with the analytical laboratory that generated the data. Additional steps taken to verify the compiled data included cross-checking the complete list and number of samples in the database against the originally supplied data sets, checking unit consistency (e.g., sediment measurements in dry weight basis), and ensuring spatial data were all expressed in the same coordinate system in the database.

After the data were verified to be correct, some calculations were done to support subsequent interpretation of the data. Total PCBs (Aroclors) was calculated as the sum of available Aroclors. Total PCBs (homologs) was an estimate of the total PCB concentration, calculated by summing the concentrations of the 18 National Institute of Standards and Technology (NIST)-certified congeners (NIST 2008) and then multiplying by the lowest slope (i.e., 2.01) provided by Lauenstein *et al.* (1993). This procedure has been shown to provide a reliable basis for estimating the sum of 209 PCB congeners when only a selected group of congeners was measured. Mean probable effect concentration-quotient for metals ( $PEC-Q_{Metals}$ ) was calculated for sediment samples by dividing the concentrations of arsenic,



cadmium, chromium, copper, lead, nickel, and zinc by their associated probable effect concentration (PEC; MacDonald *et al.* 2000) and then taking the mean of the resulting quotients. For all calculations non-detect values were treated as half the detection limit. Non-detect values that were above the PEC were screened out and not included in the totals calculations.

Database auditing was conducted to further ensure data quality in the project database. The auditing process involved analyses of outliers (i.e., to identify inconsistencies with units) and completeness (i.e., to identify missing samples or missing data), examination of data qualifier fields (i.e., to exclude any data not meeting the performance criteria for measurement data), and checking of sample identification numbers (i.e., to ensure that data were not duplicated or missing). Summary tables (i.e., maximum and minimum values per analyte) were reviewed to identify anomalous data points (not consistent with the trend of the majority), but none were found. Statistical analyses of resultant data were conducted to evaluate data distributions, to support calculation of summary statistics, and to evaluate the variability in the observations. Implementation of this ongoing iterative process throughout the data analysis phase helped to ensure the overall accuracy and completeness of the information compiled in the database.

To support the compilation and subsequent analysis of the information on environmental quality conditions, a GIS-compatible, relational project database was developed in MS Access format. All of the data compiled in the database were georeferenced to facilitate mapping and spatial analysis using GIS-based applications (i.e., Environmental Systems Research Institute's [ESRI's] ArcMap and Spatial Analyst programs). The database structure made it possible to retrieve data in several ways, including by sample and by data type (i.e., sediment chemistry vs. soil chemistry). As such, the database facilitated a variety of data analyses. Analysis of the data compiled for the data gap sampling program necessitated a number of decisions regarding the treatment of various types of information. The data treatment procedures used in this evaluation included:

- Treatment of Spatial Data - Spatial data were obtained in various coordinate systems. To ensure the data were consistently presented on basemap layers, the data were projected using the NAD\_1983\_UTM\_ZONE\_16N coordinate system;
- Treatment of Replicate Samples/Duplicate Samples - As part of the data gap sampling program, about 5% of the samples collected were split in the laboratory and run as duplicates as part of the quality control process. These laboratory duplicates were averaged to support subsequent data analysis; and,
- Treatment of Less-Than-Detection Limit Results - The treatment of environmental data has the potential to influence the results of an assessment. In particular, the treatment of less than detection limit data can affect the preliminary screen of COPCs and identification of contaminants of concern. A number of investigators have evaluated the implications of applying various procedures for estimating the concentrations of contaminants of concern from less than detection limit data (Gaskin *et al.* 1990; Porter and Ward 1991; El-Shaawari and Esterby 1992; Clarke and Brandon 1994). While there is no consensus on which data censoring methods should be used in various applications, the simplest methods tend to be used most frequently, including deletion of non-detect values or substitution of a constant, such as zero, the detection limit, or one-half the detection limit (USACE 1995).

To address the need for guidelines for statistical treatment of less than detection limit data, the U.S. Army Corps of Engineers (USACE 1995) conducted a simulation study to assess the performance of ten methods for censoring data. The results of that investigation indicated that no single data censoring method works best in all situations. Accordingly, USACE (1995) recommended a variety of methods depending on the proportion of the data that requires censoring, the distribution and variance of the data, and the type of data transformation. For data sets for which a low to moderate

proportion of the data require censoring, substitution of the detection limit is generally the preferred method (i.e., to optimize statistical power and control Type I error rates). However, as the proportion of the data that requires censoring and the coefficient of variation of the data increases, statistical power is better maintained by substituting one-half the detection limit for the less than detection limit data, particularly for log-normally distributed and transformed data. Substitution of zero or other constants was also recommended for a variety of circumstances. Overall, it was concluded that simple substitution methods work best to maintain power and control error rates in statistical comparisons of chemical concentration data (USACE 1995).

In this analysis, decisions regarding the treatment of undetected results were taken by considering the recommendations that have emerged from previous investigations in the context of their potential effects on the results of this assessment. Including all of the sediment and soil data from the 2013 data gap sampling program that were provided by the analytical laboratory and compiled in the project database, 17% of the data were undetected results and required censoring prior to data analysis. Consistent with the guidance developed by USACE (1995), one-half of the detection limit was substituted for all undetected results in all analyses (e.g., to support calculation of total PCBs and summary statistics).

Selection of an alternate procedure for treating the undetected results has the potential for influencing the results of the analysis. For example, substitution of zero for undetected results would have skewed the distributions of the COPC concentration data for the study area (i.e., the estimated 5<sup>th</sup>, 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup>, and 95<sup>th</sup> percentile concentrations would likely have been lower than the estimates developed for the assessments). Likewise, substitution of the detection limit for the undetected results would have also skewed the distributions of the COPC concentration data (i.e., the estimated 5<sup>th</sup>, 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup>, and 95<sup>th</sup> percentile concentrations would likely have been higher than the estimates

developed for the assessments). Although the influence of these alternate methods used in estimation of the 75<sup>th</sup> or 95<sup>th</sup> percentile concentration would likely have been relatively minor, their selection could influence the identification of COPCs. Nevertheless, the potential impact of the methods that were selected for treating undetected results on the outcome of the assessment is considered to be minor.

## **3.0 Results**

The locations (i.e., coordinates) of the sampling stations where the sediment and soil samples were collected are presented in Tables 2 and 3 and depicted in Figures 36 and 37, respectively. The locations of the target sediment and soil sampling stations are shown in Figures 2 - 35. The actual sediment and soil sampling stations are presented by reach in Figures 38 to 49. All of the sediment and soil samples that were collected during the sampling program were analyzed to determine the concentrations of conventional variables (grain size, percent solids, TOC), total metals, and PCB Aroclors. The concentrations of mercury, PCB congeners, and PCDDs/PCDFs were determined in a subset of the samples. The results of these analyses are described in the following sections of this report, while the results of the QA/QC analyses are presented in Appendix 5.

### **3.1 Sediment Chemistry**

A total of 61 sediment samples were analyzed to determine the concentrations of COPCs in un-sampled and under-sampled areas within the data gap sampling study area. The sediment chemistry data generated for samples collected in reaches CC02, CC04, CC05, CC06, CC07, CC09, CC10, and CR02 are presented in Tables 4 to 11, respectively, while summary statistics calculated using these data are provided in Tables 12 to 19. Summary statistics for sediment samples collected within AOI-2 (i.e., which encompasses those reaches of Choccolocco Creek

between the backwater area near the Snow Creek confluence and the confluence with the Coosa River) and the data gap sampling study area as a whole (see Figure 1) are presented in Tables 20 and 21, respectively.

The results of this investigation indicate that sediments located within the data gap sampling study area have been contaminated by PCBs and other COPCs. The concentrations of PCBs in sediment were evaluated by measuring both Aroclor and PCB congener levels. These results showed that Aroclor 1248, 1254, and 1260 were detected in the majority of the sediment samples collected in this sampling program; however, the lower-chlorinated PCB Aroclors (i.e., Aroclors 1016, 1221, 1232, 1242) were not detected in any sediment samples. A total of 129 PCB congeners/congener combinations were detected in all sediment samples. Similarly, most of the sediment samples evaluated had detected concentrations of the majority of the PCDD/PCDF congener groups that were measured, although 2,3,7,8-tetrachlorodibenzodioxin was detected in just 15% of the sediment samples. Most metals were detected in the majority of sediment samples; however, antimony, cadmium, silver, and thallium were detected in fewer than 50% of the samples.

In this study, sediment samples were collected in seven stream reaches within Choccolocco Creek and one stream reach within the Coosa River. Among the stream reaches that were sampled (Tables 12 to 19), sediments collected in un-sampled and under-sampled off-channel aquatic habitats located downstream of the Highway 21 bridge within reach CC04 had the highest concentrations of sediment-associated PCBs, with total PCB concentrations averaging 1,870 µg/kg dry weight (DW) and ranging to 4,620 µg/kg DW (i.e., as sum of Aroclors; Table 13). Similar concentrations of total PCBs (i.e., 1,180 to 1,790 µg/kg DW, as sum of PCB Aroclors; Table 16) were measured in previously un-sampled off-channel oxbows located within reach CC07 (i.e., in Choccolocco Creek upstream of Eastaboga Road). Average concentrations of total PCBs (as sum of Aroclors) were lower in sediments from un-sampled and under-sampled areas within all of the other stream reaches investigated in this study. The spatial patterns of sediment contamination by PCDD/PCDF congeners generally tracked those exhibited by PCB Aroclors and

PCB homologs (i.e., with the highest concentrations of 2,3,7,8-tetrachlorodibenzofuran and other congeners observed in reaches CC04, CC07, and CC10; Tables 12 to 19), suggesting a common source for these two groups of contaminants.

In general, the concentrations of metals were relatively low in sediments from un-sampled and under-sampled areas within the data gap sampling study area (Tables 12 to 19; Table 21). In AOI-2 (i.e., Choccolocco Creek), the sediment samples that were analyzed (n=53) all had concentrations of arsenic, cadmium, chromium, copper, lead, nickel, and zinc that were below their respective PECs (MacDonald *et al.* 2000; Table 20). However, the concentrations of mercury in sediment samples from this portion of the data gap sampling study area ranged above the PEC, indicating that mercury concentrations reach concentrations sufficient to cause or contribute to injuries to biological resources. All of the metals measured in sediments from un-sampled or under-sampled areas within CR02 (i.e., Coosa River near the confluence with Choccolocco Creek) had metal concentrations below the PECs (Table 19).

## **3.2 Soil Chemistry**

A total of 80 soil samples were analyzed to determine COPC concentrations. The soil chemistry data generated for samples collected in reaches SC01, CC01, CC02, CC03, CC04, CC07, CC08, CC09, CC10, and CR02 are presented in Tables 22 to 31, respectively, while summary statistics calculated using these data are provided in Tables 32 to 41. Summary statistics for AOI-2 and the data gap sampling area as a whole are presented in Tables 42 and 43, respectively.

The results of this investigation indicate that floodplain soils located within un-sampled and under-sampled areas within the data gap sampling study area have been contaminated by PCBs and other COPCs. The concentrations of PCBs in soil were evaluated by measuring both Aroclor and PCB congener levels. These results showed that Aroclor 1248, 1254, and 1260 were detected in the majority of the soil

samples collected in this sampling program (i.e., 91 to 99% of the samples, depending on the Aroclor mixture under consideration; n=80). The lower-chlorinated PCB Aroclors (i.e., Aroclors 1016, 1221, 1232, 1242) were not detected in any soil samples. A total of 101 of the 175 PCB congeners/congener combinations measured were detected in all soil samples. Similarly, most of the soil samples evaluated had detected concentrations of all of the PCDD/PCDF congener groups that were measured. Most metals were detected in the majority of soil samples; however, antimony and silver were detected in fewer than 50% of the samples obtained from un-sampled and under-sampled floodplain habitats.

In this study, floodplain soil samples were collected in one stream reach in Snow Creek, eight stream reaches within Choccolocco Creek, and one stream reach within the Coosa River. Among the stream reaches that were sampled (Tables 32 to 41), soil samples collected in under-sampled habitats within the Snow Creek floodplain located between Highway 21 and I-20 (reach CC01) had the highest concentrations of soil-associated PCBs. Within this reach, total PCB concentrations averaged 47,700  $\mu\text{g}/\text{kg}$  DW and ranged as high as 184,000  $\mu\text{g}/\text{kg}$  DW (i.e., as sum of Aroclors; Table 33). Floodplain soil samples collected in reach CC02 (i.e., backwater area of Choccolocco Creek located near the confluence with Snow Creek) and CC03 (i.e., between Friendship Road and Highway 21, and the area west of Highway 21 located south of the Anniston Regional Airport) also had elevated levels of total PCBs, ranging as high as 16,900  $\mu\text{g}/\text{kg}$  DW and 19,900  $\mu\text{g}/\text{kg}$  DW, respectively. With the exception of reach CR02 (i.e., Coosa River floodplain), all of the reaches in the data gap sampling study area had one or more floodplain soils with total PCB concentrations that exceeded 2,000  $\mu\text{g}/\text{kg}$  DW (Tables 32 to 41).

Some of the soil samples collected in this study and in other studies (e.g., ENVIRON 2014a; 2014b) indicate that PCB contamination extends beyond the limits of the current 100-year floodplain. In some cases, the PCBs likely originated from activities conducted in the vicinity of the facility (e.g., landfilling of PCB-contaminated wastes). In other cases, the PCBs likely were deposited in upland soils during extreme high water events. Whatever process resulted in the

contamination of upland soils, it is apparent that the current scope of the data gap sampling study area does not fully define the spatial extent of contamination by PCBs originating from the facility. Therefore, further sampling in upland habitats may be required to fully delineate the spatial scope of the area with PCB contamination.

The spatial patterns of contamination by PCDD/PCDF congeners in floodplain soils within OU-4 generally tracked those exhibited by PCB Aroclors and PCB homologs. The highest concentrations of 2,3,7,8-TCDF and other congeners were observed in reaches CC01 and CC03 (Tables 32 to 41); these reaches also had the highest concentrations of total PCBs. The concentrations of PCDDs/PCDFs were generally lower in floodplain soil samples collected from the other reaches in the data gap sampling study area, with concentrations generally proportionate with the concentrations of total PCBs. These data suggest a common source for these two groups of contaminants.

In general, the concentrations of metals were relatively low in soils from un-sampled and under-sampled areas within the data gap sampling study area (Tables 32 to 43). However, elevated levels of certain metals (i.e., cadmium, copper, lead, and zinc) were observed in floodplain soils obtained from certain reaches. More specifically, cadmium concentrations as high as 10.3 mg/kg DW were found in AOI-1 (Reach SC01, which is located near the Solutia, Inc. facility; Table 32; Figure 38). Similarly, the measured concentrations of copper (to 672 mg/kg DW), lead (to 820 mg/kg DW), and zinc (to 2,720 mg/kg DW) in soil samples were elevated in Reach SC01 (Table 32). Although metals concentrations in floodplain soils are generally lower throughout most of the remainder of the data gap sampling study area, elevated concentrations of cadmium, copper, lead, and/or zinc were also observed in reach CC01 (Table 33).



## **4.0 Summary and Conclusions**

The 2013 sediment and floodplain soil data gap sampling program was designed to address the following objectives:

- Determine the concentrations of PCBs in un-sampled and under-sampled areas within the Site;
- Determine if other COPCs (i.e., in addition to PCBs) occur at concentrations sufficient to injure surface water, geologic, and biological resources in the data gap sampling study area;
- Confirm that the data collected by the Potentially Responsible Party provide a reliable basis for evaluating injury to surface water, geologic, and biological resources in the data gap sampling study area; and,
- Determine whether additional sampling, beyond the 2013 field sampling program, is required to determine the nature and extent of contamination of sediments and/or floodplain soils within the Site.

The 2013 sediment and floodplain-soil sampling program for the Site was conducted between November 4 and December 9, 2013. During the sampling program, a total of 61 sediment and 80 soil samples were collected from un-sampled or under-sampled aquatic and floodplain habitats located within the data gap sampling study area. All of the sediment and soil samples were analyzed to provide supplemental information on the nature and extent of contamination within the data gap sampling study area. More specifically, the concentrations of total metals, PCB Aroclors, and TOC, as well as the grain size distribution, were determined in each sediment and soil sample that was collected from the data gap sampling study area. The concentrations of mercury, PCB congeners, and PCDDs/PCDFs were determined in a subset of the samples. All of the data collected were evaluated and considered to be usable for assessing sediment and soil quality conditions within the data gap sampling study area.

The results of the 2013 sediment and soil data gap sampling program provide information that is directly relevant to the NRDAR of the Site. Importantly, the sediment chemistry and soil chemistry data that were collected in this investigation provide important information for assessing the nature and extent of contamination at the Site, particularly in un-sampled and under-sampled aquatic and riparian habitats within the data gap sampling study area. These results also confirm that aquatic and riparian habitats have been contaminated by PCBs, PCDDs/PCDFs, and metals. As the concentrations of numerous contaminants in sediment samples and/or soil samples from the data gap sampling study area exceed the levels that are associated with adverse effects to benthic invertebrates, soil invertebrates, and/or other ecological receptors, it is appropriate to consider PCBs, PCDDs/PCDFs, and certain metals (e.g., cadmium, copper, lead, mercury, and zinc) in the evaluation of injuries to natural resources. The results of this study also indicate that the spatial extent of contamination by PCBs extends beyond the 100-year floodplain polygons for Snow Creek and Choccolocco Creek, indicating the scope of the study area should be expanded to fully define the spatial extent of contamination (i.e., to determine how far from the river the PCB contamination extends). In some areas (e.g., Reaches CC01, CC02, CC07), the data collected in this investigation indicate that the concentrations of PCBs in floodplain soils are higher than those that have been documented in previous studies conducted to support the remedial investigation and previous investigations conducted for other purposes. Collectively, the results of this study indicate that PCBs have come to be located in areas beyond the current boundaries of OU-1/2 and OU-4. Therefore, additional sampling may be warranted to fully assess the nature, magnitude, and spatial extent of contamination, particularly in floodplain and upland soils. In the absence of such supplemental data, injury to natural resources will likely be understated.

## **5.0 References**

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