Please click this link for Volume 2 of 2 of the document.

MONSANTO

Monsanto Company
800 North Lindbergh Boulevard
Mail Stop LS1036
St. Louis, Missouri 63167

February 27, 2015

Mr. Dennis Matlock
On-Scene Coordinator
U.S. Environmental Protection Agency
Removal Enforcement and Oil Section (3HS32)
401 Methodist Building
Wheeling, WV 26003

Dear Mr. Matlock:

Re: Submission of Engineering Evaluation/Cost Analysis (EE/CA) Report
Administrative Order by Consent for Removal Response Action
EPA Docket No. CERC-03-2004-0171DC
Kanawha River Site, West Virginia

As requested, please find enclosed four (4) copies of the Engineering Evaluation/Cost Analysis (EE/CA) Report. These copies of the EE/CA Report are being submitted in accordance with the Administrative Order by Consent for Removal Response Action for the Kanawha River Site (EPA Docket NO. CERC-03-2004-0171DC).

Complete copies of the EE/CA report are being transmitted directly to the Mr. Bill Huggins (Techlaw) and Mr. Charles Armstead (WV DEP).

Should you have any questions, or wish to discuss any items, please do not hesitate to contact me at (314) 694-4111.

Sincerely,

Joseph G. Gabriel
Environmental Remediation Manager,
Project Coordinator for the Respondents

cc: Randy Sturgeon, U.S. EPA, Region 3
Bill Huggins, Techlaw, Inc.
Charles Armstead, WV DEP
Jeff Daniel, CRA

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St. Louis, Missouri 63167

I certify that the information contained in or accompanying this Engineering Evaluation/Cost Analysis (EE/CA) Report for the Kanawha River Project is true, accurate and complete.

I am aware that there are significant penalties for submitting false information, including potential criminal penalties, such as fines and imprisonment, for knowingly submitting false information.

Signature: [signature]

Name: Joseph G. Gabriel

Title: Environmental Remediation Manager,
Project Coordinator for the Respondents

ENGINEERING EVALUATION/COST ANALYSIS (EE/CA) REPORT

KANAWHA RIVER
NITRO, WEST VIRGINIA

FEBRUARY 27, 2015
REF. NO. 031884 (51)
This report is printed on recycled paper.

ENGINEERING EVALUATION/COST ANALYSIS (EE/CA) REPORT

KANAWHA RIVER
NITRO, WEST VIRGINIA

TEXT, FIGURES, TABLES – VOLUME 1 OF 2

FEBRUARY 27, 2015
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LIST OF ACRONYMS AND TERMS

2,3,7,8-TCDD	2,3,7,8-Tetrachlrodibenzo-p-dioxin
2,4,5-T	2,4,5-Trichlorophenoxyacetic acid
7Q10	seven consecutive day drought flow with a ten year return frequency
ACF	American Car and Foundry Industries, Inc.
ACLF	Armour Creek Landfill
ADCP	Acoustic Doppler Current Profiler
AES	Automatic Equipment Sales
Ah	Aryl hydrocarbon
Allied Chemical	Allied Chemical Corporation
amsl	above mean sea level
Anchor QEA	Anchor QEA, L.L.C.
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
ARCADIS	ARCADIS Geraghty & Miller, Inc.
ATSDR	Agency for Toxic Substances and Disease Registry
Axys	Axys Analytical Services Ltd.
BBL	Blasland, Bouck, & Lee
BCF	bioconcentration factor (unitless)
Be-7	Beryllium-7
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BHC	alpha-Benzenhexachloride
Blue Coast	Blue Coast Scientific Inc.
BMPs	Best Management Practices
BSAF	Biota Sediment Accumulation Factor
C_{AV}	COC concentration in aquatic and terrestrial vegetation [(mg COC/kg (wet weight)]
$C_{sed/s}$	COC concentration in sediment or soil (mg COC/kg sediment or soil)
CA	California
CA	Corrective Action
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act

LIST OF ACRONYMS AND TERMS

CIC	Charleston Industrial Corporation
Coastal	Coastal Tank Lines, Inc.
COC	Contaminant of Concern
COPC	Chemical of Potential Concern
CRA	Conestoga-Rovers & Associates, Inc.
Cs-137	Cesium-137
CSFs	Cancer Slope Factors
CSM	Conceptual Site Model
CSTAG	Contaminated Sediments Technical Advisory Group
CST	Cooperative Sewage Treatment Plant
CT	Central Tendency
CWA	Clean Water Act
DA_{event}	absorbed dose per event
DDT	dichlorodiphenyltrichloroethane
DEHP	bis (2-ethyl hexyl) phthalate
DGPS	Differential Global Positioning System
dioxins/furans	dioxin and dibenzofuran congeners
DNOP	di-n-octyl phthalate
DO	dissolved oxygen
DOC	Dissolved Organic Carbon
DoD	Department of Defense
DuPont	E.I. duPont de Nemours & Company, Incorporated
EE/CA	Engineering Evaluation/Cost Analysis
EEC	estimated exposure concentration
EFDC	Environmental Fluid Dynamics Code
EFH	Exposure Factors Handbook
EMS	Environmental Modeling Systems, Inc.
EOC	Extent of Contamination
EPCs	exposure point concentrations
ERA	Ecological Risk Assessment
ERFI	Expanded Remedial Facility Investigation
ERM Group	The Environmental Resource Management Group
ESQ	ecological screening quotient
ESV	ecological screening value
Exponent	Exponent, Incorporated
Falls	Kanawha Falls

LIST OF ACRONYMS AND TERMS

FDA	Food and Drug Administration
FESWMS	Finite Element Surface Water Modeling System
Fike	Fike Chemicals, Inc.
Fike/Artel	Fike/Artel Superfund Site
Flexsys	Flexsys America, L.P.
FMC	FMC Corporation
FOIA	Freedom of Information Act
FRGs	Final Remediation Goals
FSP	Field Sampling Plan
FST2DH	Depth Averaged Flow and Sediment Transport
GI	gastrointestinal
GIS	Geographic Information System
GLCC	Great Lakes Chemical Corporation
Golder	Golder Associates, Inc.
HASP	Health and Safety Plan
HEC-2	Hydrologic Engineering Center – River Hydraulic Package 2 Software
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
IC	Institutional Controls
J	estimated value
K_{oc}	organic carbon partitioning coefficient
K_{ow}	octanol-water partitioning coefficient
Kanawha Dredging	Kanawha Dredging and Mineral Company
LC_{50}	concentration at which 50 percent mortality occurs
LMS	linearized multistage
LOAELs	lowest observed adverse effects levels
LOECs	lowest observed effects concentrations
Midwest	Midwest Steel Corporation
MF	modifying factor
MLEs	maximum likelihood estimates
MNR	Monitored Natural Recovery
Monsanto Company	the corporation presently known as Monsanto Company
MS/MSD	Matrix Spike / Matrix Spike Duplicate

LIST OF ACRONYMS AND TERMS

NCP	National Contingency Plan
ND	not detected
NIC	Nitro Industrial Corporation
NOAELs	no observed adverse effects levels
NOECs	no observed effects concentrations
Normandeau	Normandeau Associates, Inc.
NPDES	National Pollutant Discharge Elimination System
NRC	natural recovery core
Old Monsanto	Pharmacia Corporation, formerly known as Monsanto Company and Monsanto Chemical Company
OMMP	Operation, Maintenance, and Monitoring Plan
ORNL	Oakridge National Laboratory
ORSANCO	Ohio River Valley Water Sanitation Commission
OSC	On-Scene Coordinator
OxyChem	Occidental Chemical Corporation
Pb-210	Lead-210
PCB	Polychlorinated Biphenyls
PCDD	Polychlorinated Dibenzo-*p*-dioxins
PCDF	Polychlorinated Dibenzofurans
Phase I EOC Results Report	Phase I EOC Sampling Results and Updated Phase II EOC Sampling Work Plan
PRGs	Preliminary Remediation Goals
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RA	Removal Action
RAGs	Remedial Action Goals
RAGS	Risk Assessment Guidance for Superfund
RAOs	Removal Action Objectives
RCRA	Resource Conservation and Recovery Act
Report	Engineering Evaluation/Cost Analysis Report
RfDs	Reference Dose
Rhône-Poulenc	Rhône-Poulenc AG Company
RI/FS	Remedial Investigation/Feasibility Study
River	Kanawha River
RM	River Mile

LIST OF ACRONYMS AND TERMS

RME	Reasonable Maximum Exposure
SAB	Science Advisory Board
SEI	Sea Engineering, Inc.
Site	Consists of the normal pool of an approximate 14-mile portion of the Kanawha River from the Coal River downstream to the Winfield Locks and Dam (between RM 31.1 and RM 45.5)
SLERA	Screening Level Ecological Risk Assessment
Solutia	Solutia Inc.
SOW	Scope of Work
SVOC	Semi-volatile Organic Compounds
SWAC	Surface Weighted Average Concentration
SWMS	Surface Water Modeling System
TCL/TAL	Target Compound List/ Target Analyte List
TEQ	toxicity equivalency quotient
TestAmerica	TestAmerica Inc.
TMDL	Total Maximum Daily Loading
TOC	Total Organic Carbon
TRV	toxicity reference value
TS	Total Solids
TSS	Total Suspended Solids
U	the analyte was analyzed for but was not detected above the reporting limit
UF	uncertainty factor
U.S. ACE	United States Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency
U.S. FHWA	United States Federal Highways Administration
U.S. FWS	United States Fish and Wildlife Service
UCC	Union Carbide Corporation
UCL	upper confidence level
USGS	United States Geological Survey
VOC	volatile organic compound
Voyager Coal	Voyager Coal Company
Work Plan	Engineering Evaluation/Cost Analysis Work Plan
WV	West Virginia
WV DEP	West Virginia Department of Environmental Protection

LIST OF ACRONYMS AND TERMS

WV DHHR	West Virginia Department of Health and Human Resources
WV DNR	West Virginia Department of Natural Resources
WV DWR	West Virginia Division of Water Resources
WV WQS	West Virginia Water Quality Standards
WWI	World War I

UNITS OF MEASUREMENT

%	percent
°F	degrees Fahrenheit
<	less than
>	greater than
cfs	cubic feet per second
cm	centimeters
cm/s	centimeters per second
cm/yr	centimeter per year
cy	cubic yards
cy/day	cubic yards per day
ft	feet or foot
ft amsl	feet above mean sea level
ft bgs	feet below ground surface
in	inches
kg	kilogram
kg/ m^3	kilograms per cubic meters
L	liter
m	meters
m^3	cubic meters
m^3/day	cubic meters per day
m^3/s	cubic meters per second
mg/kg	milligrams per kilogram
mg/kg-day	milligrams (of chemical eaten and/or absorbed) per kilogram (of body weight) per day
mm	millimeter
ng/kg	nanograms per kilogram
pci/g	picocuries per gram
pg/L	picogram per liter
pg/g	picogram per gram
ppb	parts per billion
µg/day	micrograms per day
µg/kg	microgram per kilogram

1.0 EXECUTIVE SUMMARY

This Engineering Evaluation and Cost Analysis (EE/CA) Report (Report) is being submitted by Monsanto Company for the Kanawha River (River) Site (Site) located in Nitro, West Virginia (WV).

Project Background and Objectives

In March 2004, U.S. EPA and Monsanto Company entered into an Administrative Order on Consent (AOC) to conduct an EE/CA to study dioxin-contaminated sediment throughout 14-miles of the Site. As described in more detail in the AOC, the purpose of this EE/CA is to evaluate Removal Action (RA) alternatives that will be protective of the health and welfare of the public and the environment, and to provide sufficient information for U.S. EPA to determine the necessity, feasibility and efficacy of non–time critical removal actions (40 CFR 300.415[b][4][i]).

The objectives of the EE/CA were to characterize the nature and extent of 2,3,7,8-TCDD in the Kanawha River Site. The EE/CA identifies and evaluates potential Removal Action Alternatives with respect to protectiveness of public health, welfare and the environment. Consistent with U.S. EPA guidance, this EE/CA also includes the evaluation of RA Alternatives with respect to effectiveness, implementability, and cost (Capital Cost and Operation, Maintenance and Monitoring). This evaluation formed the basis for selection of a preferred Removal Action alternative.

Extent of Contamination (EOC) Study

The EE/CA Work Plan included a phased EOC study work plan to identify historical and/or potential ongoing 2,3,7,8-TCDD source areas to the Site and to identify and fill data gaps to characterize the extent of 2,3,7,8-TCDD contamination at the Site. As presented in the Work Plan, data compilation activities were completed prior to the investigative activities, which were organized into Phase I and Phase II investigations.

Phase I EOC Activities

The Phase I EOC investigation was completed in 2005 and included the following activities:

- Bathymetric and geophysical surveys
- Surface water sampling and analysis (including velocity profiling)

- Fish tissue sampling and analysis
- Surface sediment sampling to support the geophysical survey, and mapping of soft sediment deposits
- Surface sediment sampling to support the derivation of a Site-specific biota-sediment accumulation factor (BSAF) for 2,3,7,8-TCDD

Phase II EOC Activities

The Phase II EOC investigation was completed during the period of November 2007 through July 2009 and included the following activities:

- Surface and subsurface sediment sampling to further define the EOC at the Site
- Collection and analysis of age-dated sediment cores to support natural recovery evaluations
- Collection of sediment cores for Sedflume testing
- Collection of additional fish tissue samples for evaluation of recovery trends for the River

Hydrodynamic and Sediment Transport Modeling

Hydrodynamic and sediment transport modeling was completed to evaluate sediment stability, transport, and recovery within the Site, with particular focus on areas of elevated 2,3,7,8-TCDD concentrations. The results of the modeling were used to develop a detailed understanding of hydrodynamics within the River to evaluate sediment stability over a range of storm and non-storm flow conditions. This information was used to evaluate sediment transport, deposition, and stability, to determine sediment natural recovery rates, and to develop preliminary designs for RA alternatives such as capping.

Human Health Risk Assessment

The Human Health Risk Assessment (HHRA) estimated cancer and non-cancer health impacts from exposure to chemicals of potential concern. The HHRA used U.S. EPA-approved or WV-approved methods, algorithms, and input values as reflected in U.S. EPA or WV guidance. The HHRA evaluated potential human health impacts associated with exposure to 2,3,7,8-TCDD identified in fish tissue and surface water at the Site. The potential receptors and exposure pathways evaluated at the Site considering the current and potential future use of the Site included: recreational angler (child and adult) exposed to impacted fish tissue, and recreational swimmer (youth and adult) exposed to impacted surface water.

Based on the information presented in the HHRA, the following conclusions are made:

- The calculated Reasonable Maximum Exposure (RME) cancer risk and non-cancer Hazard Index (HI) for the current/future recreational angler (child and adult) exceeded the target range of 1.00×10^{-4} to 1.00×10^{-6} for cancer risk and exceeded 1.0 for HI.
- The calculated Central Tendency (CT) cancer risk and non-cancer HI for the current/future recreational angler (child and adult) were below 1.00×10^{-5} for cancer risk and 1.0 for HI.
- The calculated cancer risk and non-cancer HI for the current/future recreational swimmer (youth and adult) were below 1.00×10^{-5} for cancer risk and 1.0 for HI for both RME and CT exposure scenarios.

Ecological Risk Assessment

An ecological risk assessment (ERA) was also conducted for the Site. The ERA evaluated the potential risks to ecological receptors. The ERA was specifically intended to evaluate the protectiveness, in regard to ecological receptors, of any potential removal action. The ERA concluded that current ecological risks were likely acceptable, or at worst, slight. While there was some uncertainty for certain species, this would likely be addressed by any successful Removal Action that addresses human health risk.

Remedial Action Objectives (RAOs)

Based on the Conceptual Site Model and risk evaluation, two RAOs were developed for the Site:

- **RAO 1** is to reduce the contribution of sediments to Kanawha River fish tissue 2,3,7,8-TCDD concentrations. The short-term performance objective is to reduce the average surface concentration of 2,3,7,8-TCDD in Site sediments to a level that will facilitate a reduction in 2,3,7,8-TCDD concentrations in fish tissue. The long-term performance objective is to reduce fish tissue 2,3,7,8-TCDD concentrations, recognizing that watershed source controls separate and apart from a sediment response action will likely be required to effectively reduce fish tissue concentrations to levels below the most stringent U.S. EPA risk criteria.

- **RAO 2** is to reduce the contribution of sediments to Kanawha River surface water 2,3,7,8-TCDD concentrations. Similar to RAO 1, the short-term performance objective is to reduce the average surface concentration of 2,3,7,8-TCDD in Site sediments to a level that will facilitate surface water recovery.

These RAOs were utilized to guide the development and evaluation of Removal Action Alternatives for the Site.

Removal Action (RA) Alternatives

A range of Removal Action alternatives were assembled from the Removal Action technologies/processes that are typical for sediment sites and were outlined in the AOC. The RA alternatives were evaluated consistent with U.S. EPA guidance based on:

- Effectiveness
- Implementability
- Cost

The following RA Alternatives were selected for evaluation based on the RA technologies screened:

- Alternative 1 - No Action
- Alternative 2 - Institutional Controls and MNR
- Alternative 3 - Institutional Controls, In Situ Treatment, and MNR
- Alternative 4 - Institutional Controls, MNR, and Limited Armored Capping
- Alternative 5A - Institutional Controls, MNR, Limited Dredging, and Near-Shore CDF
- Alternative 5B - Institutional Controls, MNR, Limited Dredging, and Off-Site Disposal

Based on the evaluation presented in Section 8.0 for the Removal Action Alternatives, Alternative 4 – Institutional Controls, Monitored Natural Recovery, and Limited Capping has been identified as the preferred RA.

Alternative 4 assumes that any 2,3,7,8-TCDD sources from the former Flexsys Facility have been controlled. Alternative 4 enhances the ongoing natural recovery trend through the implementation of source controls for the former Flexsys Facility and the placement of an armored cap over the areas of sediment with elevated 2,3,7,8-TCDD concentrations where modeling showed potential instability. Placement of the armored cap also provides an immediate and permanent reduction in the surface-weighted average concentration of 2,3,7,8-TCDD, accelerating the natural recovery trend as compared to Alternatives 2 and 3. Implementation of Alternative 4 would not result in the short-term increase in fish tissue 2,3,7,8-TCDD concentrations as a result of sediment resuspension that would occur under the dredging Alternatives 5A and 5B. Thus, Alternative 4 would have a faster anticipated recovery trend than the dredging alternatives. In addition, Alternatives 5A and 5B would be expected to leave significant dredge residuals with surface 2,3,7,8-TCDD concentrations exceeding those currently at the Site, requiring capping of some or all of the dredged areas.

No implementability issues are associated with Alternative 4. Capping materials are readily available and cap placement would not be limited by site conditions. As the majority of capping would be completed outside the navigation channel, cap thickness will not impact navigation. Dredging (Alternatives 5A and 5B) would be expected to be incomplete as rock outcrops along the banks would impede complete sediment removal. Incomplete removal and the dredge residuals resulting from normal dredging activities would be expected to result in significant portions of the areas to be dredged requiring capping.

The higher capital and overall (Net Present Worth) costs for Alternative 4 as compared to Alternatives 2 and 3 appear to be justified given the increased protectiveness and superior recovery trend offered by the addition of limited capping. Alternatives 5A and 5B have significantly higher capital and overall costs than Alternative 4, while resulting in lower short-term protectiveness and equivalent or lower long-term protectiveness. While Alternatives 5A and 5B do provide some contaminant mass removal, no additional protectiveness results from this removal.

In summary, Alternative 4 has been identified as the preferred RA because it is the alternative best suited to furthering the RAOs for the Site (including both short-term and long-term performance objectives) in a cost-effective manner with proven sediment treatment technologies.

2.0 INTRODUCTION

This Engineering Evaluation and Cost Analysis (EE/CA) Report (Report) is being submitted by Monsanto Company for the Kanawha River (River) Site (Site) located in Nitro, West Virginia (WV). Monsanto Company retained a consultant team including Conestoga-Rovers & Associates, Inc. (CRA), Anchor QEA, L.L.C. (Anchor QEA), and Exponent, Inc. (Exponent) to assist with this project.

This Report has been prepared consistent with the requirements of the EE/CA Work Plan (Work Plan) (CRA, 2004, and as amended August 2004), which was partially approved by the United States Environmental Protection Agency (U.S. EPA) on September 9, 2004 for the portion of the Work Plan relating to the Phase 1 Extent of Contamination (EOC) study. Monsanto Company later received U.S. EPA approval for the Final Phase II EOC Sampling Scope of Work (SOW) on October 29, 2007. Additional fish tissue sampling was discussed with U.S. EPA in a November 12, 2008 conference call, with the scope of work transmitted to U.S. EPA via email on November 20, 2008 (email from Randy Cooper (Monsanto Company[1]) to Dennis Matlock (U.S. EPA). A draft Report was submitted in October 2009. The draft Report was thereafter updated based on comments received from U.S. EPA, West Virginia Department of Environmental Protection (WV DEP), and U.S. Army Corps of Engineers (U.S. ACE).

2.1 BACKGROUND

The River, the Pocatalico River and Armour Creek have been placed on the State of West Virginia's 303(d) list of water quality impaired bodies for dioxin. The applicable WV water quality standards (WV WQS) specify the maximum allowable concentration of 2,3,7,8-TCDD to be 0.014 picograms per liter (pg/L) in the River and 0.013 pg/L in the Pocatalico River and Armour Creek

1 The name "Monsanto Company" has been used for many years, but it has been used by two distinct corporations. In 1933, "Monsanto Chemical Company" was incorporated in Delaware, in 1967 it changed its name to "Monsanto Company," and on March 31, 2000 it changed its name again to Pharmacia Corporation. Pharmacia Corporation was later acquired by Pfizer, Inc. On February 9, 2000, "Monsanto Ag Company" was incorporated, and on March 31, 2000 it changed its name to Monsanto Company. Today, Pharmacia Corporation is a wholly owned subsidiary of Pfizer, Inc., and Monsanto Company is a publically traded corporation. Today's Monsanto Company has never had manufacturing operations in the Nitro, WV area. Pursuant to certain contractual obligations Monsanto Company has with Pharmacia Corporation, Monsanto Company has engaged Conestoga-Rovers & Associates to compile this EE/CA Report. For clarity, this document uses the term "Old Monsanto" to refer to Pharmacia Corporation while it was operating under the name "Monsanto Company" and/or "Monsanto Chemical Company."

(http://www.dep.wv.gov/WWE/Programs/wqs/Documents/Rules/WVDEP_47CSR2_WQS_FinalRule percent206_27_2011.pdf).

At a facility approximately 1.5 miles north of Nitro, WV on the east bank of the River, Old Monsanto produced the pesticide 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) was a byproduct of the 2,4,5-T production process. Operation of this facility was transferred to Flexsys America LP (Flexsys), a joint venture between Old Monsanto and Akzo Nobel, in 1995. In 1997, Old Monsanto transferred its interest in the facility, including the real estate, to Solutia Inc. (Solutia). Activities began during the second quarter of 2004 to decontaminate, dismantle, and remove all surface structures. Demolition was completed in December 2005. This report refers to this facility as the Former Flexsys Facility.

In March 2004, U.S. EPA and Monsanto Company and Pharmacia Corporation entered into an Administrative Order on Consent (AOC) to conduct an EE/CA to study dioxin-contaminated sediment throughout 14 miles of the Site (defined in Section 3.1). The general Site location is depicted on Figure 2.1. Figures 2.2 through 2.6 identify the Site boundaries and Study Areas established for the Site. As described in more detail in the AOC, the purpose of this EE/CA is to evaluate Removal Action (RA) alternatives that will be protective of the health and welfare of the public and the environment, and to provide sufficient information for U.S. EPA to determine the necessity, feasibility and efficacy of non–time critical removal actions (40 CFR 300.415[b][4][i]). The Kanawha River Site was included as one of the sites listed on the U.S. EPA Contaminated Sediments Technical Advisory Group (CSTAG) for CSTAG review and input. The CSTAG conducted a Site visit and held a meeting with the project team on April 21 and 22, 2004. CSTAG provided recommendations on May 14, 2004 regarding implementation of the EE/CA. U.S. EPA's On-Scene Coordinator for the Site provided responses to these comments on October 8, 2004. Copies of the CSTAG recommendations and OSC responses are included in Appendix A.

The EE/CA Work Plan included a phased EOC study work plan to identify historical and/or potential ongoing 2,3,7,8-TCDD source areas to the Site and to identify and fill data gaps to characterize the extent of 2,3,7,8-TCDD contamination at the Site. As presented in the Work Plan, the investigative activities were organized into Phase I and Phase II efforts. The Phase I EOC investigation was completed in 2005. Results of the investigation were submitted to U.S. EPA on December 9, 2005 in the report entitled Interim Report, Phase I EOC Sampling Results and Updated Phase II EOC Sampling Work Plan. On March 6, 2006, Monsanto Company submitted updated sampling location maps to U.S. EPA for the Phase II EOC investigation, incorporating information obtained during the Phase I study along with U.S. EPA's comments. On January 19, 2007, Monsanto Company submitted new sampling location maps for the Phase II EOC investigation to incorporate U.S. EPA's comments provided on November 29, 2006 in response to Monsanto Company's March 2006 submission. The Final Phase II EOC Sampling SOW was submitted to U.S. EPA on October 12, 2007 and Monsanto Company received U.S. EPA approval on October 29, 2007. The Phase II EOC investigation was completed in July 2009.

Data and other historical information obtained from U.S. EPA, WV Department of Environmental Protection (WV DEP), and U.S. Army Corps of Engineers (U.S. ACE) are used in this Report to provide a summary of the Site history and conditions. Investigations completed prior to the submission of the EE/CA Work Plan, dated April 2004, were used to provide a preliminary screening of Site data collected from the EOC investigations, as the historical data were used to define the nature of environmental conditions at the Site prior to conducting the EOC study. Data from historical investigations also provided a basis from which data gaps were identified, and were used to assess the need for, and scope of, RA alternatives for the Site.

2.2 EXTENT OF CONTAMINATION STUDY OBJECTIVES

Consistent with the AOC requirements, the general objectives of the EOC investigations are summarized as follows:

- Collect, organize, and evaluate available historic data to determine conditions in the River and identify potential historic and ongoing 2,3,7,8-TCDD sources
- Develop a preliminary Conceptual Site Model (CSM) to provide a framework for understanding the River hydraulics, sedimentation patterns, and fate and transport of 2,3,7,8-TCDD at the Site
- Identify data gaps, scope of additional investigative activities to fill identified data gaps and further define Site conditions, implement the additional investigative activities, and incorporate the collected information into the Site database and update/revise the CSM
- Collect additional sediment quality data to further define the spatial and vertical distribution of samples with 2,3,7,8-TCDD exceeding concentrations of 0.5, 1.0, and 2.0 parts-per-billion; micrograms per kilogram (ppb; µg/kg) of 2,3,7,8-TCDD
- Utilize the framework of the CSM to predict how source controls or sediment removal actions will affect 2,3,7,8-TCDD distributions in the River

- Perform data collection and analysis to support the EE/CA evaluation of a range of potentially effective RA alternatives, including no action, monitored natural recovery (MNR), in-situ containment, and dredging/off-Site disposal approaches

2.3 EE/CA OBJECTIVES

The overall objectives of the EE/CA are to characterize the nature and extent of 2,3,7,8-TCDD at the Site that has been released from the Former Flexsys Facility in Nitro, WV and identify and evaluate potentially applicable methods and technologies for controlling or eliminating areas exceeding specified criteria/risk levels. Following screening of potentially applicable cleanup methods and technologies, RA alternatives were assembled and evaluated in terms of effectiveness to meet the Removal Action Objectives (RAOs), implementability and relative cost. This evaluation formed the basis for selection of a preferred RA alternative.

A range of RA alternatives were assembled from the RA technologies/processes, which are discussed in Section 7.0. The RA alternatives were evaluated for effectiveness in accomplishing the following:

- Address the suspected 2,3,7,8-TCDD source(s)
- Mitigate migration of 2,3,7,8-TCDD
- Minimize exposure to contaminated materials at the Site such as soils and sediments
- Reduce fish tissue concentrations of 2,3,7,8-TCDD

3.0 REVIEW OF EXISTING INFORMATION

3.1 SITE DESCRIPTION

As set forth in the AOC, the Site consists of the normal pool of an approximate 14-mile portion of the River from the Coal River downstream to the Winfield Locks and Dam. The Site is located near Nitro, WV, approximately 12 miles northwest of Charleston. The Site is located in both Kanawha and Putnam Counties.

For convenience, the Site has been divided into four Study Areas as follows:

- Study Area 1 is defined as the Site upstream of the Former Flexsys Facility from the Coal River (between River Mile (RM) 46 and RM 42)
- Study Area 2 includes the Site adjacent to the Former Flexsys Facility from RM 42 to Interstate 64
- Study Area 3 includes the portion of the Site downstream of the Interstate 64 bridge to the John E. Amos Power Plant (RM 39)
- Study Area 4 includes the portion of the Site farther downstream of the Interstate 64 bridge between RM 39 and the Winfield Lock and Dam (RM 31)

The locations of the Study Areas are presented on the Site Plan (Figure 2.2). Tributaries to the River in the Study Area are discussed in Section 3.1.2.

The climate of Kanawha and Putnam Counties is mild. The combined average annual precipitation is 41.43 inches for the period from 1895 through 2011 for the state station for Winfield Locks, WV (469683). The same station identifies the average high and low temperature ranges between 24 degrees Fahrenheit (°F) and 43°F in January; and between 63°F and 85°F in July (US HCN, 2012).

Land use within the Nitro area consists of mixed residential, commercial, and industrial uses. There are several residential areas located along State Route 62, and U.S. Route 35, which follow on either side of the River.

3.1.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

The geology of West Virginia is composed of the following physiographic provinces: the Appalachian Plateau Province, the Valley and Ridge Province, and the Blue Ridge Province. The majority of the state is located within the dissected, westward tilting

Appalachian Plateau Province (WV GES, 1997). The extreme eastern part of WV contains the oldest rocks, the very late Precambrian, Catoctin Formation. Moving westward, the younger, Paleozoic rocks are exposed. There is no significant Mesozoic or Cenozoic rock in West Virginia; however Quaternary alluvium overlies most formations (Lessing, 1996).

The Site lies within the Kanawha Section of the Appalachian Plateau Province. The maturely dissected Kanawha Section is characterized by a mature plateau of fine texture within moderate to strong relief. Floodplain deposits are generally silts, sands, and gravels and range in thickness from approximately 40 to 60 feet (ft). The near-surface River channel deposits are generally sand and gravel strata of up to 8 ft in thickness (U.S. ACE, 1986).

The alluvial deposits of the Kanawha River Valley contain the uppermost aquifer at the Site. The aquifer is unconfined, and depth to groundwater typically varies from 15 to 20 ft below ground surface (ft bgs) on adjacent sites. Although considerable soil variability occurs in the alluvial deposits, the groundwater within the alluvial deposits is generally interconnected and represents a single aquifer. Groundwater in alluvial deposits within the Study Area flows generally toward the River (Potesta, 2001), and the aquifer surface is located at a depth of approximately 19 ft bgs (NUS Corporation, 1985) in the vicinity of the Former Flexsys Facility.

3.1.2 KANAWHA RIVER BATHYMETRY AND HYDROLOGY

The River is one of the primary navigable waterways of West Virginia. It is formed by the confluence of the New and Gauley Rivers at Gauley Bridge, WV and flows in a generally northwesterly direction for approximately 97 miles to the Ohio River at Point Pleasant, WV. In the following discussion, locations along the River are delineated by River Mile. By convention, the mouth is designated as RM 0, and other River Mile locations are distances from the mouth. Thus, RM 42 is 42 miles from the confluence with the Ohio River.

The total drainage area contributing to the Site is approximately 12,300 square miles, and includes areas of southern WV, southwestern Virginia, and a small portion of northwestern North Carolina (WV DNR, 1987). The watershed contains economically significant deposits of coal, natural gas, timber, and salt (Weston, 2001). The River was first used as a navigation route in the early 1800s. By 1840, most large obstacles had been cleared, which allowed flatboats to transport coal, salt, and timber. From 1875 to 1898, a series of 10 locks was completed, making the River the nation's first to have a complete navigation system. This made the River a major transportation route, and attracted a wide range of industries to the Kanawha Valley. Upon completion of these improvements in 1898, the number of coal mines using the River had increased from 3 to 70, and the amount of material shipped had increased from 165,000 tons to more than one million tons (Wells, 1998). However, by the late 1920s this system had become obsolete, and by the early 1930s additional dams were constructed to accommodate raised water depths in the Ohio River (U.S. EPA Region III START, 2003), including the Marmet, London, and Winfield Locks and Dam (Wells, 1998).

The Site defined by the AOC is located between RM 31.1 (Winfield Locks and Dam) and RM 45.5 (confluence of the Coal River). The "Winfield Pool" controlled by the Winfield Dam generally refers to that portion of the River between the Winfield Dam (RM 31.1) and the Marmet Dam (RM 67.7), and includes the entire Site.

Tributaries: In addition to being formed by the confluence of the New and Gauley Rivers, principal tributaries to the Kanawha River include the Elk River at Charleston, WV (RM 57.8), the Coal River at St. Albans, WV (RM 45.5), and the Pocatalico River at Poca, WV (RM 39.0).

The Elk River is formed by the confluence of two short streams, Big Spring Fork, and Old Field Fork near Slatyfork, WV in Pocahontas County. The Elk River generally flows westward across several counties, entering the Kanawha River at Charleston, WV (RM 57.8). Principal tributaries to the Elk River include Birch River, Holly River, Blue Creek, Buffalo Creek, Big Sandy Creek, and Little Sandy Creek. The Elk River is located outside of the Site Study Area.

The Coal River is formed by the confluence of the Big and Little Coal Rivers near Alum Creek, WV, and generally flows northward through Western Kanawha County past Tornado, WV to the Kanawha River at St. Albans, WV (RM 45.5). The principal tributaries of the Coal River are Clear Fork, Marsh Fork, and the Little Coal River.

The approximately 75 mile Pocatalico River rises near Looneyville, WV and flows generally southwestwardly through southern Roane County, northern Kanawha, and southeastern Putnam Counties, past Sissonville, WV to the Kanawha River at Poca, WV (RM 39.0). The Pocatalico watershed spans 359 square miles of primarily forested land (Limno-Tech, Inc., 2000). Principal tributaries from mouth to source include Heizer Creek, Frog Creek, Pocatalico Creek, Big Lick Run, and Johnson Creek. Manila Creek is a tributary to Heizer Creek.

Non-principal tributaries and un-named backwaters to the main stem located within the Study Area were included in the EE/CA based on available information. This includes but is not limited to: Gallatin Branch, Scary Creek, Little Scary Creek, Steer Gut Branch, Armour Creek (also referred to as Blake Creek on 2012 US ACE Navigational Charts), Sulphur Creek, Linbarger Creek, Poca Run, Bills Creek, Farley Creek, Second Creek, Guano Creek, and Little Guano Creek (US ACE, March 2012).

Kanawha River Bathymetry: Present-day physical, hydrologic, and sediment transport characteristics of the River are controlled by the operation of flood control and navigation dams, constructed throughout the basin over the last 100 years. Within the immediate vicinity of Nitro, water surface elevations are regulated by operation of the Winfield Dam and associated locks (RM 31.1), constructed in 1935 by U.S. ACE. Bathymetric characteristics of the River were surveyed by U.S. ACE in 1999 (500 ft survey transects), and have also been inputted into a Hydrologic Engineering Center-river hydraulics package (HEC-2) model used by U.S. ACE Huntington District to help manage reservoir hydraulics in the River. Based on the 1999 survey, the width of the River in the Nitro Study Area ranges from approximately 760 to 820 ft (231 to 249 meters (m)), and the average water depth is 28.6 ft (8.73 m). The normal pool elevation for the Winfield Pool is 566.0 ft above mean sea level (amsl). Based on a November 2011 meeting with representatives of the Huntington District of the USACE, Kent Browning (USACE), advised Monsanto Company that the width of the navigation channel is established based on USACE guidance documents and is centered on the sailing line identified on USACE navigation charts rather than being a federally authorized channel. The navigation channel is approximately 490 ft wide and 12 ft deep in the vicinity of the former Flexsys Facility based on USACE Guidance (USACE, 1980).

The River channel's thalweg elevation (the deepest point of the flowing channel in a given cross-section) rises from about 530 ft amsl near RM 33.8 to 540 ft amsl near RM 42.9, corresponding to an average River bed gradient of roughly 0.0002. Large, longitudinal bedforms (bars and scour holes) with 2 to 6 ft of relief are present in the channel. However, features that are smaller than hundreds of feet in length cannot be resolved at the resolution of the U.S. ACE survey presented on the navigational charts. Golder Associates, Inc. (Golder), as a subcontractor to CRA, performed a detailed bathymetric study as part of the Phase I EOC activities. A summary of the bathymetric/geophysical survey is presented in Section 4.2.1 and a copy of Golder's report is included in Appendix B.

River Hydrology: As discussed above, the combined average annual precipitation in Kanawha and Putnam Counties is 41.43 in (USHCN, 2012), and Charleston (the location of the nearest River flow gauging station to the Site) receives an average of 42.5 inches of precipitation per year. Precipitation is relatively uniformly distributed throughout the year, with each month receiving between 2.9 and 5.0 inches, on average (SAGE, 2009). However, due to seasonal changes in watershed evapotranspiration, the mean monthly discharge of the River at Charleston (approximately 12 miles upstream of Nitro) ranges from a seasonal high of 30,100 cubic ft per second (cfs) in March to a seasonal low of 5,630 cfs (155 m^3/s) in September, based on United States Geological Survey (USGS) records collected over the period from 1939 to 2011 (USGS, 2012). The mean annual discharge ranges from 14,000 to 18,000 cfs. Based on present-day bathymetry, the average current velocity in the Study Area is approximately 43 centimeters per second (cm/s) (LTI, 2000), though significant temporal and spatial variations in velocity occur within the Study Area.

For the purpose of developing allowable wastewater discharge limitations for water quality protection under the National Pollutant Discharge Elimination System (NPDES), the critical 7-day, 10-year low flow condition (7Q10) for the River has been set at 1,960 cfs (55.5 m^3/s) at the Charleston gage, per WV WQS [WV 46-1-7.2.d.19.2].

3.2 LAND USE AND SITE HISTORY

3.2.1 KANAWHA RIVER

As discussed in Section 3.1.2, the River is one of the primary navigable waterways of West Virginia. The bed of the River to the historical low-water mark is owned by the State of WV. Flow control and navigation through the River is regulated by WV in conjunction with the US Coast Guard and U.S. ACE. Water quality conditions within the River are also regulated by the State of WV. Based on historical detections of 2,3,7,8-TCDD in water and fish samples collected from the Study Area at concentrations exceeding state criterion levels, the River and its Pocatalico River and Armour Creek tributaries, were placed on the State of WV's 1998 303(d) list of water quality impaired water bodies for 2,3,7,8-TCDD.

The Nitro Industrial Area, consisting primarily of chemical production facilities, is located along the right descending bank of the River. These industries use the River as a transportation medium, and as a process and non-contact water source (U.S. EPA, Region III START, 2003).

3.2.2 KANAWHA COUNTY

Kanawha County, located in the south-central part of WV, was formed in 1788 from parts of Greenbrier and Montgomery Counties. The county consists of approximately 901 square miles, and has a total population of 193,063 (U.S. Census Bureau, 2013).

The terrain of Kanawha County is broken and hilly, and is underlain by vast resources of minerals such as salt, brine, coal, oil, and gas. The salt industry was the first major industry in the county from 1808 to 1870. Technology and equipment designed for the salt wells was eventually adapted to drill deeper for gas and oil. Large-scale coal production began after the development of rail and River transport in the 1870s. One of the major employers in the county is the chemical industry, which is centered in South Charleston. South Charleston has a population of approximately 13,471 (U.S. Census Bureau, 2013), and is one of the major chemical centers in the world. Other Kanawha County industries include glass and glassware, mine machinery, wholesale/retail sales, banking, and state government (North, 1998). Charleston, the capital of WV, is located on the River at the mouth of the Elk River. It has a population of approximately 50,821 (U.S. Census Bureau, 2013).

3.2.3 PUTNAM COUNTY

Putnam County, located in southwestern WV, was formed in 1848 from parts of Cabell, Kanawha, and Mason Counties (North, 1998). The county consists of approximately 346 square miles, and has a total population of 55,486 (U.S. Census Bureau, 2013).

The terrain of Putnam County consists of the River valley and ranges of high hills. There were no major towns in Putnam County until development of the coal industry in the 1880's. Prior to this, agriculture was the only significant source of income, and population growth was minimal. Coal production began to decline after 1940; however, new employment opportunities were created with the growing chemical industry. Putnam is currently one of the few counties in WV that has seen a steady population growth since 1930.

Nitro is the county's largest city with a population of approximately 7,150 (U.S. Census Bureau, 2013). A large coal-burning power plant, the John E. Amos facility, is located on the River near Nitro (North, 1998).

3.2.4 CITY OF NITRO, WEST VIRGINIA

Shortly after entering World War I (WWI), the United States faced a severe shortage of gunpowder. On October 6, 1917, the United States Congress passed the Deficiency Appropriation Act, which provided for the construction of three explosives plants, with a combined capability of producing one and a half million pounds of propellant per day. Explosives Plant "C", commonly referred to as Nitro, was designed to produce 600,000 pounds per day of propellant (U.S. ACE, 2001).

The United States Ordnance Department negotiated a contract with the DuPont Company (DuPont) to acquire the farmland on which to construct Explosives Plant "C". The contract required that DuPont sell the land to the United States government, or any party that the government named, at cost of acquisition plus a fee of four percent. The Thompson-Starrett Company was contracted to construct the plant, and the Hercules Powder Company was contracted to operate the facility.

Explosives Plant "C" was constructed on the north bank of the River, approximately 12 miles west of Charleston, WV (Johnston, 1977). The facility design consisted of a completely self-contained explosives plant, and an entire town for employees, which was capable of housing 24,000 people. Ground was broken on December 23, 1917, and the plant and town were built and operating within 11 months (U.S. ACE, 2001). However, the plant only operated at full scale for a single week due to the cease-fire on November 11, 1918 (Johnston, 1977).

Explosives Plant "C" produced nitrocellulose, also known as "gun cotton", in a variety of sizes. The nitrocellulose was used for loading both large and small shells (Johnston, 1977). Production required three basic steps: the nitrocellulose process, the colloiding reaction, and the drying operation. The facility was also designed to manufacture sulfuric and nitric acid, which were two of the required materials (U.S. EPA, Region III START, 2003). The Explosives Plant "C" facility was divided into four main areas that included:

Area A: The Industrial Plant

The Industrial Plant area was subdivided into several departments that included the following departments.

The Cotton Purification Department

This department washed, bleached, and dried raw cotton linters and hull fibers to supply cellulose for the process (U.S. EPA, Region III START, 2003).

The Nitrating Department

The Nitrating Department was used from September 1918 to November 1918. Purified cellulose was digested in mixed acid, which consisted of one part nitric acid and two and a half parts sulfuric acid. The resulting nitrocellulose was then purified by boiling in water.

Inputs to the Nitrating Department were mixed acids, and cellulose. Outputs included nitrocellulose, spent acid, and wastewater. Nitrocellulose was sent to the colloiding department by railcar; spent acids were filtered to remove solids and then piped to the spent acid department. Wastewater was directed to the industrial sewer that discharged directly into the River (U.S. ACE, 2001).

The Colloiding Department

The Colloiding Department was used from September 1918 to December 1918. Nitrocellulose delivered to this department was refined, but still contained water. Alcohol was used to dehydrate the nitrocellulose, and then was converted into a colloidal matrix using ether. Diphenylamine was added next as a stabilizer and then benzene as a water repellant. The colloid was then forced by hydraulic pressure through dies to produce propellant grains.

Inputs to the Colloiding Department included nitrocellulose, alcohol, diphenylamine, benzene, and sulfuric acid. Ether was manufactured in this department by reacting alcohol with sulfuric acid. Outputs included propellant grain and the waste stream, which was directed to the industrial sewer that discharged directly into the River (U.S. ACE, 2001).

The Spent Acid Department

This department contained recovery units used to reclaim acids, caustic, and solvents (U.S. EPA, Region III START, 2003).

The Drying Department

This department was in operation from approximately October 1918 to January 1919. Solvent was removed from propellant grains either by evaporation or by forcing the solvent out of the grain with water, depending on the geometry of the grain. The finished product was then packed in zinc-lined metal boxes.

Inputs to this department were propellant grains from the colloiding department. Outputs included the packed finished product, which was shipped to the magazine area, and wastewater, which was directed to the industrial sewer that discharged directly into the River (U.S. ACE, 2001).

The Industrial Plant area is currently the Nitro Industrial Park, and is occupied by various chemical facilities, warehouses and other businesses. Some of the original buildings remain; however the nitrating, colloiding, and drying department buildings have been torn down (U.S. ACE, 2001).

Area B: Magazine Area

The Magazine Area consisted of 16 magazines that were used for shipping and storing boxed gunpowder.

After WWI, the magazines were removed, and the area was turned into a golf course. The area is currently the Rock Branch Industrial Park, and is comprised of industrial buildings and warehouses (U.S. ACE, 2001).

Area C: Proving Ground

The Proving Ground Area was used to test the finished product. Batches of propellant were subjected to a ballistic test to determine if the propellant could propel a projectile at the proper muzzle velocity from an artillery piece. Projectiles were fired into large sand-filled, reinforced concrete structures, known as the firing butts.

A housing subdivision is located in the Proving Ground Area. The firing butts still remain and are located in a resident's backyard. Foundations, which may be from the original buildings, also remain (U.S. ACE, 2001).

Area D: Housing Area

The Housing Area is now part of the City of Nitro, WV. Some of the buildings may date back to the original construction. However, most of the buildings have been replaced (U.S. ACE, 2001).

Utilities

Natural gas was the only utility that was originally available in the area. Other utilities such as power, water, steam, and sewers had to be designed and constructed. Electrical power was initially obtained from the Virginia Power Company by extending existing lines in Charleston to Nitro. Water was supplied by 53 drilled wells, located on the property. In April 1918, a temporary water filtering plant was built for domestic water use. Industrial water was pumped from the River. A permanent water system was completed on November 5, 1918. The system was designed so that the intake for domestic use was located on the River above Lock Seven, upstream from the plant. Sanitary and industrial sewage wastes were discharged downstream of the plant, below the locks. Twin boiler houses were constructed to provide steam for industrial uses, with a capacity of over one and a half million pounds of steam per hour. However, the boiler houses were not completed by the end of the war, and were consequently dismantled and sold.

WWI Era Sewer System

The sewer system for Explosives Plant "C" was designed and installed in 1918. The original installation consisted of approximately 49 miles of underground piping, with pipe diameters ranging in size from 4 to 84 inches, and with some sections placed as much as 22 ft bgs. Both sanitary and industrial outlets ran directly into the River. The original design called for treatment stations, but they were never built. The main sanitary sewer trunk line ran down the Blakes Creek and Armour Creek valleys to take advantage of existing grades. The system was designed so that the outfall discharged to the River at the mouth of Armour Creek. However, construction stopped when the war ended and the entire City of Nitro effluent was discharged through this outfall to Armour Creek (Johnston, 1977).

Following closure, the plant and town were sold to the Charleston Industrial Corporation (CIC), who marketed the property. The chemical industry continued to grow in the early 1920s, and new industries that moved into the area made use of the explosives plant equipment, utilities, living quarters, and nearby raw materials. At the time, the Nitro area was served by four railroads (Chesapeake & Ohio, Baltimore &

Ohio, Virginian, and the New York Central), and barge traffic on the River (Johnston, 1977).

In 1932, the town was incorporated as Nitro, and the name of the holding company was changed to the Nitro Industrial Corporation (NIC).

3.3 SUMMARY OF SITE INVESTIGATIONS

This section provides a summary of environmental investigations completed at the Site prior to initiation of the EOC investigations. This information was used to develop the scope of the EOC study and to develop the Conceptual Site Model (CSM). The summary includes the Kanawha River, tributaries to the River (as discussed in Section 3.1.2) as well as non-River investigations, including upstream sources and other potential upland sources.

Table 3.1 provides a chronological summary of previous investigations and documents relating to the River that CRA and Anchor QEA reviewed. A more detailed summary of each investigation, listed in chronological order, by location, is provided in Appendix C. Letters and memoranda have also been reviewed and have been listed according to the date of the correspondence.

3.3.1.1 KANAWHA RIVER

A number of investigations have been completed by U.S. EPA, U.S. Fish and Wildlife Service (U.S. FWS), various consultants, and various State agencies at the River since 1970. These studies included:

- Between 1970 and 1976, approximately 180 fish tissue samples representing selected collection sites of interest were collected by U.S. FWS and analyzed for selected toxic substances. U.S. FWS, at the request of U.S. EPA, sampled fish samples to assess the risks of exposure of priority pollutants to human health and the environment. The data were summarized in a report entitled Sampling and Analysis of Fish Tissues for Toxic Substances, EPA/FWS IAG-DY-01001, Final Report, U.S. Fish and Wildlife Service, 1980.
- As part of the National Dioxin Study, U.S. EPA collected fish and sediment samples at the River in Nitro, and at the Gauley Bridge between 1984 and 1986. The study plan, data, and associated analyses were summarized in the following reports: Work/Quality Assurance Project Plan, An Evaluation of Dioxin Contamination in

Fish Tissue and Sediments in the Kanawha and Mud Rivers, WV, WV DNR, Draft – March 10, 1986; Memorandum – 2,3,7,8-Tetrachlorodibenzodioxin (2,3,7,8-TCDD) Contamination of Fish in the River, Nitro, WV, Center for Disease Control, 1985; Draft - Assessment of Lifetime Cancer Risk from Consuming Fish Contaminated with 2,3,7,8-Tetrachlorodibenzo-p-dioxin from the River, WV, U.S. EPA, 1986; A Study of Dioxin Contamination in Sediments in the Kanawha River Basin, EPS-QA87-004, Final Project Report, EPA Region III, 1988; Letter from WV DNR to U.S. EPA Region III, U.S. Army Corps of Engineers dioxin data from Kanawha and Ohio River fish samples; and Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Sediments in the Kanawha River, WV and Proposal for Further Sediment Sampling, U.S. EPA, 1986 Dioxin Contamination in 1986 Fish Tissue Samples from the Kanawha River, Armour Creek, and the Pocatalico River, WV, 1986.

- Between 1999 and 2002, U.S. EPA collected additional samples from the Site. The study plan, data, and associated analyses were summarized in the following reports: Trip Report, Kanawha Valley-Dioxin Site, Nitro, Putnam County, WV, Weston, 1999; Dioxin Contamination of the Ohio and Kanawha Rivers, WV Citizen Research Group, 1999; Updated Kanawha River Fish Consumption Advisory, WV Bureau for Public Health, 2000; Trip Report, Kanawha River Valley Site (Nitro Storm Sewer/Outfall Investigation), Weston, 2000; Trip Report, Kanawha River Valley Site, Kanawha and Putnam Counties, WV, Weston, 2001; Trip Report, Kanawha River Valley Hi-Vol. Water Sampling, Nitro, Kanawha and Putnam Counties, WV, Ecology and Environment, Inc., 2000.
- Site investigation in 2001 at Mile point 41 to 42.5 and Mile Point 42.5 to 46 to characterize potential sources, nature of contamination, relative hazards posed by sources, and impacts to targets; Kanawha River Mile Point 41 to 42.5 and Mile Point 42.5 to 46.5 Site Inspection Report, Kanawha and Putnam Counties, WV, Region III, START, 2003.
- High and low flow sampling along the Kanawha River at the Former Flexsys Facility in 2001; and Sediment sampling immediately adjacent to the riverbed at the Former Flexsys Facility in 2002 passive vapor diffusion along the Kanawha River in 2002.

Summaries of these investigations are included in Appendix C. Available data from these investigations related to surface water quality, fish tissue concentrations, sediment concentrations, or other relevant information were incorporated into the Project database to support analysis of historic conditions and temporal trends.

The most recent investigation completed at the River prior to initiation of the EOC studies was completed by U.S. EPA in 2002 and included sediment sampling and passive vapor diffusion. The purpose of the 2002 investigation was to determine the volatilization of volatile organic compound (VOC) constituents in the hyporheic zones along the River.

3.3.1.2 ARMOUR CREEK

Armour Creek Landfill (ACLF) is located north of the City of Nitro along State Route 25. It is comprised of approximately 45 acres of land. Armour Creek is located to the north of the landfill (Weston, 1999).

Sediment sampling for 2,3,7,8-TCDD was conducted in Armour Creek in 1986 as part of U.S. EPA sampling of the Kanawha River and its tributaries to determine the areal extent of 2,3,7,8-TCDD, if contamination was continuing, and to locate "hot spots" or any present sources. The U.S. EPA determined that there were two 2,3,7,8-TCDD hot spots, the Pocatalico River near Poca, and at the mouth of Armour Creek. U.S. EPA hypothesized that 2,3,7,8-TCDD was or is being released from landfills near the two 2,3,7,8-TCDD hot spots, and this contamination has spread throughout the lower River; and that 2,3,7,8-TCDD was or is being released into the River from unknown sources, and has accumulated in the backwaters of Armour Creek and the Pocatalico River.

In 1987 U.S. EPA conducted an additional sampling event. To test the first hypotheses, sampling stations were located near the landfills next to Armour Creek and the Pocatalico River. To test the second hypothesis, sampling stations were located in Bills Creek and Lingbarger Creek. U.S. EPA concluded that data support the second hypothesis, which states that contamination is from unknown sources and is being deposited in slow-flowing backwaters of tributaries along the River. It was also concluded that low-level dioxin contamination is widespread in the lower River backwater areas below Nitro. The highest concentrations of dioxin were found in sediments collected from the mouths of backwater River streams (US EPA, 1988a).

The sediments in Armour Creek were sampled in November 1998 in response to public concern that ACLF was contributing to dioxin contamination in Armour Creek (Pam Hayes, WVDEP Office of Environmental Remediation). Dioxin was detected in the sediment. Soil sampling completed in the Armour Creek watershed identified elevated levels of dioxin, however, the ACLF was not identified as a source of 2,3,7,8-TCDD.

High-volume surface water sampling for dioxin was conducted by U.S. EPA and U.S. Geological Survey in June 2000. Sampling occurred in a total of 10 locations in the Kanawha River, its tributaries, and one outfall. Samples collected from Armour Creek on June 15, 2000 reported 2,3,7,8-TCDD concentrations of 59.9 fg/L in the column and

279 fg/L in the filters, and a total TEQ of 73 fg/L and 499 fg/L (rounded), respectively (U.S. EPA, Eleven Principals Memo, 2004).

In 2000, in response to public comments, WV DEP placed conditions on ACLF's Solid Waste/ NPDES Water Pollution Control Permit, effective June 2, 2000, to control potential releases of 2,3,7,8-TCDD, or other dioxin congeners. The ACLF was capped by May 2000 by Solutia pursuant to WV Solid Waste Industrial Landfill regulations (WV DEP, 2000). The Solid Waste/NPDES Water Pollution Control Permit continued the routine monitoring and maintenance of the closed ACLF.

A stormwater sample was collected at the outlet of the ACLF (Outlet 009) and an additional background sample was collected at a location outside the limits of ACLF. 2,3,7,8-TCDD was not detected in the runoff sample collected from Outlet 009 at the ACLF, and an estimated concentration of 6.1 pg/L of 2,3,7,8-TCDD was detected in the background sample (Potesta, 2001).

3.3.1.3 MANILA CREEK/ POCATALICO RIVER

Manila Creek drains into Heizer Creek, which in turn drains into the Pocatalico River, which joins with the River. An inspection was conducted by WV DWR on September 14, 1962 at Manila Creek and Pocatalico River. Following the inspection, the City of Nitro, Ohio Apex, Old Monsanto, and Cadle Sanitary Service (waste material hauler) were ordered to develop waste disposal procedures (WV DWR, 1962).

After notification from Old Monsanto that organic, herbicide, fungicide, and miscellaneous inorganic waste had been disposed of at a site in Amherst, Putnam County, WV from 1956 to 1957, WV DEP conducted a site inspection on May 13, 1980. Results of the site inspection led to a follow-on sampling effort. 2,4,5-T was detected at 3.3 ppb (3.3 μg/L) in the adjacent tributary but not in the off-site water samples (WV DEP, 1982).

Investigations at the Manila Creek site continued throughout the 1980s and 1990s and included the following:

- Site inspection at the Manila Creek dumpsite area on June 29, 1981 where grab samples were collected from a tributary that runs from Washington Hollow into Manila Creek (Casdroph, 1981).
- A preliminary benthic survey was conducted in Manila Creek on December 14, 1982 by WV Department of Natural Resources (WV DNR), which concluded that mine

drainage releases from the watershed overshadowed biological impacts that may be attributable to the disposal site (WV DNR, 1982).

- A dioxin screening at Manila Creek was conducted on September 18, 1984 as part of the U.S. EPA Region III, Tier II, Dioxin Study.
- Test borings were conducted at the Manila Creek Site in 1986, and peizometers were installed to determine water levels and groundwater flow directions. Groundwater was present in the coal deposits at the site. Waste material was present immediately overlying clay and/or fly ash layers (ERM-Midwest, 1986).
- A remedial investigation of subsurface conditions at the Manila Creek site was conducted in 1986 to determine the lateral and vertical extent of fill placed at the site and the location of saturated areas contributing to seeps, so that remedial alternatives could be developed. Approximately 2,400 to 2,900 cubic yards (cy) of waste was present at the site, in addition to a total of 5,000 to 7,000 cy of fly ash fill (REMCOR, 1986). Constituents detected included a number of volatile organic compounds, semi-volatile organic compounds, polychlorinated biphenyls, pesticides and TCDD (ASTDR 2010).
- In 1987, a sheet pile wall was installed around the Manila Creek site to re-direct ground water flow. A high-density polyethylene cap with overlying clay fill and topsoil was placed on the site. Following this, the cap was vegetated and a chain-link security fence was installed around the site.

The sediments in Manila Creek and Pocatalico River were sampled in November 1998 (Pam Hayes-WVDEP Office of Environmental Remediation). A subsequent round of sampling was conducted in September 1999. The soil samples ranged from 0 to 385 picograms per gram (pg/g) 2,3,7,8-TCDD. Groundwater sampling detected dioxin concentrations ranging from 197 to 1,470 pg/L in samples collected from monitoring wells installed within the waste layer of the landfill. Samples of Manila Creek sediments contained up to 38 pg/g 2,3,7,8-TCDD.

3.3.1.4 <u>HEIZER CREEK AND HEIZER CREEK LANDFILL</u>

Heizer Creek Landfill is located approximately 1 mile northeast of Poca, off Heizer Creek Road. The landfill is approximately 1 acre in size, and is bounded to the south by Heizer Creek Road, and to the north, east, and west by trail roads. The City of Nitro used this landfill from the late 1950s until the early 1960s. Old Monsanto reportedly used the landfill for approximately one year to dispose of plant trash.

A site inspection of Heizer Creek was performed on September 15, 1983. The inspection included the collection of aqueous and solid samples and the observation of 8 drums in various stages of decay, and a black tar-like substance. 2,4,5-trichlorophenol was detected at concentrations up to approximately 21 milligrams per kilogram (mg/kg) and one sample had a detected tetrachlorobenzene concentration of 35 percent. Both chemicals are used in the manufacture of trichlorophenoxyacetic acid (2,4,5-T); however, 2,4,5-T was not reported in any of the samples collected from the Heizer Creek Site (NUS Corporation, 1985).

A soil sampling investigation at the landfill performed in September 1984 detected 2,3,7,8-TCDD. Old Monsanto conducted soil sampling at the landfill in October 1985 to develop RA alternatives based on the findings. Soil 2,3,7,8-TCDD concentrations ranged from not detected to 3.79 ppb (3.79 μg/kg), which were below recommended levels for landfills; no further action was identified at that time as the most appropriate alternative for the Heizer Creek Landfill site (Wilson, 1986).

In 1998, U.S. EPA conducted a second Preliminary Assessment and collected one composite soil sample from on site and one sediment sample from a downgradient surface runoff stream. The soil sample exhibited a 2,3,7,8-TCDD TEQ concentration of 21.54 ppb (21.54 μg/kg) and the sediment sample exhibited a TEQ of 0.021 ppb (0.021 μg/kg) (ARCADIS, 2000).

Old Monsanto retained ARCADIS Geraghty & Miller, Inc. (ARCADIS) to prepare an EE/CA to further address the presence of 2,3,7,8-TCDD at the Heizer Creek Landfill site, pursuant to the AOC between Old Monsanto and U.S. EPA issued on September 30, 1999. The September 2000 EE/CA presented results of a field investigation conducted in May 2000 that included soil, surface water, and sediment sampling. The EE/CA concluded that there was a potential for 2,3,7,8-TCDD to migrate from the Heizer Creek Landfill site through erosion and surface water runoff, but at concentrations below those that would pose a potential threat to human health. Implementation of a full vegetative cover with consolidation was determined to mitigate human and ecological exposure, and potential releases to surface water and sediment from the Heizer Creek Landfill site.

In September and October 2001, ARCADIS collected groundwater samples for analysis for 2,3,7,8-TCDD, at the request of U.S. EPA, to further characterize the nature, concentration, and extent of 2,3,7,8-TCDD contamination in residential wells, so that recommendations based on a full groundwater evaluation could be reported. Since 2,3,7,8-TCDD was not detected in any of the samples, the additional investigation verified that groundwater did not to pose a threat to the Pocatalico River or nearby residential groundwater wells (ARCADIS, 2001).

Based on the EE/CA report, a remedial alternative was selected to address the dioxin impact at the Heizer Creek Landfill site, which consisted of the placement of a vegetative cover over the former waste disposal area. Construction of the vegetative cover was performed in 2008, and consisted of the following key activities:

- Removal of trees and other vegetation
- Re-grading of site to a slope of not greater than 3:1
- Consolidation of waste material near the toe of the slope
- Construction of a retaining structure at the toe of the slope
- Placement of clean cap material with a seeded topsoil layer
- Installation of storm water management controls
- Implementation of long-term monitoring and maintenance program

Slope failures were identified in portions of the cover system in 2009. Repair of these areas was completed in 2010, and the site is being monitored to confirm the effectiveness of the repairs.

3.3.2 UPLAND INVESTIGATION

In addition to the investigations conducted within the River and its tributaries, investigations have been completed for facilities upstream, within, and downstream of Nitro. The summary of investigations was used to assist in determining potential sources of 2,3,7,8-TCDD and/or other Contaminants of Concern (COC) to the River.

2,3,7,8-TCDD is a common by-product from burning (including incineration and backyard residential burning), from the production of chlorinated organic compounds, and from the bleaching step of the papermaking process. Historical industrial activities in the River's watershed appear to have resulted in the release of 2,3,7,8-TCDD to the River. Releases of 2,3,7,8-TCDD to the River in the Study Area likely was associated with the production of the herbicide 2,4,5-T and may have also been associated with the production of industrial solvents or other industrial processes.

A number of upstream facilities were identified which, based on historic data and/or CRA's evaluation of processes used by the facilities, may have contributed 2,3,7,8-TCDD to the River. These facilities are discussed in Appendix C.2. Other downstream sources, such as the former American Car and Foundry (ACF) Industries site near Winfield Dam, likely also released 2,3,7,8-TCDD to the River. Depending on the ultimate cleanup level for the River selected by U.S. EPA, ongoing discharges from upland facilities, if not adequately controlled, may represent potential ongoing sources of potential concern (see Figures 3.1 and 3.2; see discussion in Sections 6.4 and 7.1.3).

A number of potential dioxin sources were identified within the Study Area, including the following sites which were confirmed to have 2,3,7,8-TCDD present on the property:

Former Flexsys Facility

Fike/Artel Superfund Site (Fike/Artel)

Nitro Municipal Landfill

Former ACF Industries

Dioxin was identified at the Great Lakes Chemical Site; however, this property is not believed to be a significant dioxin source based on the known history of manufacturing at the property.

Discussions of each potential source upstream and within the Site are presented in Appendices C.2 and C.3, respectively. These potential sources are summarized in the following sub-sections.

3.3.2.1 FORMER FLEXSYS FACILITY

This facility is located on the east bank of the River, approximately one-half mile north of the City of Nitro in Putnam County, West Virginia, in a heavily industrialized region. The Former Flexsys Facility encompasses approximately 116 acres. Production areas, warehouse buildings, parking, or open storage had covered about 60 percent of the site. The Former Flexsys Facility is bordered to the east and northeast by commercial properties on State Route 25, to the south by an industrial property, to the west and northwest by the River, and Interstate Highway 64 divides the site (U.S. EPA, 2008a).

The property occupied by the Former Flexsys Facility was used to produce a number of chemicals throughout its operation including the pesticide 2,4,5-T. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) was a byproduct of the 2,4,5-T production process. Operation of the Nitro Facility was transferred to Flexsys America LP (Flexsys) in 1995. Flexsys manufactured rubber and rubber additives for tire companies. Hazardous wastes generated include waste paint and solvents from daily operations, Sufasan and Santovar residues, lab wastes such as Acetonitrile, and seal oil contaminated with sulfuric acid (Kennedy, 1997). In 1997, Old Monsanto transferred its interest in the Facility to Solutia. The Former Flexsys Facility was demolished in June 2005.

The Former Flexsys Facility has undergone a number of investigations and remedial activities. The Former Flexsys Facility is currently being closed under the Resource Conservation and Recovery Act (RCRA) Corrective Action (CA) Program. Significant source control activities have been completed and are planned to be completed as part of the RCRA Closure. These activities are discussed in additional detail in Section 7.1.3.

The Former Flexsys Facility is believed to be the primary source of historic 2,3,7,8-TCDD loading to the River in Nitro.

3.3.2.2 FIKE-ARTEL SUPERFUND SITE

The Fike/Artel Superfund Site is located on Viscose Road (Plant Road) in Nitro, WV, 1.1 miles south-southwest of the intersection of Interstate 64 and State Route 25. The site consists of an 11.9 acre former chemical manufacturing facility and a 0.9 acre former wastewater treatment plant known as the Cooperative Sewage Treatment Plant (CST) (ICF, 1998).

The former Fike/Artel facility is located in the Nitro Industrial Complex, approximately 2,200 feet east of the River. The Fike Facility was a small volume chemical manufacturing plant that specialized in the development of new chemicals, custom chemical processing, and specialty chemicals. The former CST is located approximately 500 feet west of the facility. Dana Container, Inc., a tank repair and cleaning facility, separates the former Fike Facility from the former CST (ICF, 1998).

CST was formed as a joint venture between Fike Chemicals, Inc. (Fike) and Coastal Tank Lines, Inc. (Coastal) to treat industrial wastewater.

In 1977, sampling was conducted at the Fike/Artel site to determine compliance with NPDES Permit limitations, among other objectives. However, U.S. EPA concluded that additional investigations were required to characterize hazardous substances that may have been discharged to the River from the CST (U.S. EPA Region III, 1978).

Samples of soil and water were collected from a drainage area adjacent to the Fike facility on March 29, 1983, with reported dibenzofuran concentrations in soil ranging up to 123,600 ppb (123,600 μg/kg). The U.S. Center for Disease Control identified potential environmental and public health risks associated with off-site migration of hazardous substances from this facility (U.S. EPA Region III, 1983).

U.S. EPA initiated a Removal Action at the Fike/Artel facility in June 1988. The RA included the removal of hazardous materials from numerous tanks, drums, and reactor vessels. Following completion of the RA activities, the Fike/Artel site was divided into seven Operable Units, which were all addressed by 1993. Supplemental disposal of dioxin-containing sludge occurred in 1995. The Fike/Artel site was capped with an asphalt cover system in 2003, and is currently used as a truck parking area.

A separate groundwater remedy is currently underway at the Fike/Artel site. Groundwater contamination has been detected almost a mile away from the site property boundary, and is discharging toward the River. A biosparging system has been in operation since 2007. Additional groundwater treatment system components are under design. Dioxins are not a COC for the groundwater remedy.

Although no complete pathway currently exists for 2,3,7,8-TCDD migration from the Fike/Artel facility to the river, it is considered to have been a potential historic source due to presence of 2,3,7,8-TCDD on the property, and historic pathways such as historic sewer use.

3.3.2.3 NITRO SANITATION LANDFILL

The Administrative Record for the Nitro Sanitation Landfill (EPA ID: WVD980513642) was reviewed in order to determine if this landfill was a potential historical source area (U.S. EPA, 2012). A Consent Agreement and Order dated October 15, 1987 states that the Nitro Sanitation Landfill consists of approximately 5 acres and is located on Main Street in the City of Nitro, Kanawha County (U.S. EPA, 1987b). It was owned by the City of Nitro and received waste chemicals and drums from FMC Corporation between 1965 and 1974 (U.S. EPA, 1987b). An estimated 4,700 tons of chemical wastes including phenols, carbon filter cake containing heptanes, and organic phosphates were accepted (Weston, 1990a). Fred C. Hart Associates, Inc. reports additional documentation that FMC Corporation deposited arsenic trichloride and other wastes at the landfill (Fred C. Hart Associates, Inc., 1980). The City of Nitro used the landfill for municipal disposal until 1974 when the area was covered with topsoil and converted into a playground. The playground was closed in 1986 and the area was fenced to prevent access (Weston, 1990a).

The Nitro Sanitation Landfill has been referred to by numerous aliases as documented in the Administrative Record. These include the following:

- The Nitro Municipal Landfill (Weston, 1990a)
- The Nitro Landfill
- Smith Street Landfill (Weston, 1990a)

It should be noted that another landfill, also referred to as the Nitro Municipal Landfill is discussed in Section 3.3.2.4.

Sampling in April 1986 by the West Virginia Department of Natural Resources found phenol levels as high as 12,000 mg/kg (U.S. EPA, 1987b). Fred C. Hart Associates, Inc. conducted an investigation in February 1980 and concluded that no evidence of industrial waste products present in leachate (Fred C. Hart Associates, Inc., 1980). In a 1981 Weston investigation, sampling revealed the presence of phenols as high as 12.0 ppb (12.0 μg/kg) in an outfall along the Kanawha River. Weston also found exposed drums containing carbon filter cake and Kronitex residue (Weston, 1990a). In 1986 Weston and U.S. EPA conducted additional sampling of four seeps, seep sludge and two sediment samples (Weston, 1990). Exposed drums were found at the surface in 1986. Significant levels of phenol, 2,4-dimethylphenol and 4-methylphenol were reported (Weston, 1990b). Partially exposed drums and several seeps were observed in 1987. The drums were removed and the site was recovered with clean dirt in response to a CERCLA Section 106 Consent Order to the City of Nitro dated October 15, 1987 (Weston, 1990a). The City of Nitro conducted air and water sampling in September/October 1987, including a storm sewer entering the Kanawha River. Target compounds were not detected in any of the samples and seeps were not observed during the sampling event (Weston, 1990a). OSC Gerald Heston and Pam Hayes of the WV DNR visited the site in January 1990 and reported that no areas of contamination were observed (Weston, 1990a). Additional Weston sampling in March 1990 concluded that phenolic compound materials were present below the surface or have migrated into soils and water below and adjacent to the landfill (Weston, 1990b).

In an August 1990 letter, the ATSDR concluded that "the levels of contaminants found in surface soils during the most recent assessment do not pose a significant threat the human public health. However, if private wells are in use in the area, a potential health threat exists through ingestion of site-related contaminants." The ATSDR recommended that the landfill meet Federal, State, and local closure requirements; capping or covering of the surface be considered; and future users be made aware of previous existence of the landfill to prevent disruption to the protective actions taken (ATSDR, 1990).

3.3.2.4 NITRO MUNICIPAL LANDFILL

The Administrative Record for the Nitro Municipal Landfill (EPA ID: WVD980538722) was reviewed in order to determine if this landfill was a potential historical source area. An Administrative Order By Consent dated April 20, 1990 states that the Nitro Municipal Landfill is located between Kelly Creek and Bailey Creek on WV Route 38 approximately 3 miles north the intersection of WV Routes 38 and 31 and west of the Pocatalico River in Putnam County, WV. The property consists of approximately 187.5 acres. Approximately 2.58 acres of the strip bench at the upper end of a U-shaped ravine was used for a waste disposal area (U.S. EPA, 1990). The Order states that Old Monsanto deposited general plant solid wastes from its Nitro Facility in the Nitro Municipal Landfill in the late 1950's, which were then burned. U.S. EPA and Old Monsanto conducted investigations that determined 2,3,7,8-TCDD was present in soil at the landfill at levels up to 17.8 ppb (17.8 μg/kg) (U.S. EPA, 1990). The Order states that "*Monsanto Company conducted the technical equivalents of a CERCLA Remedial Investigation (R.I.) and a Feasibility Study at the Nitro Municipal Landfill Site. EPA approved the R.I. on February 24, 1989. The studies recommended that Monsanto remove all drums and drum debris from the Site and cover all areas where dioxin contamination was found. The investigation and study do not constitute an "RI/FS" as described in Section 104(a)(1) of CERCLA and therefore do not require the determinations described in that Section.*" (U.S. EPA, 1990).

This landfill has also been referenced by several aliases, which include:

- Poca Landfill (U.S. EPA, 1996; U.S. EPA, 1990 and U.S. EPA, 2012)
- Poca Strip Mine Pit (U.S. EPA, 2012)

The Nitro Municipal Landfill has been referred to by a number of names including Poca Strip Mine Landfill. The Landfill is a surface mine bench located one-quarter mile off Poca River Road, on an un-named tributary to the Pocatalico River. The Nitro Municipal Landfill site is approximately 3 miles east of Poca, WV, and received municipal and hazardous wastes in the late 1950s and early 1960s (WV DWR, 1984). During 1962 to 1963, the landfill was known as the Nitro City Dump, and was used by the City of Nitro, FMC, Ohio Apex, and Old Monsanto (Weston, 1999).

A Hazardous Waste Survey indicates that Old Monsanto used the landfill site in 1959 and 1960 to dispose of both open drummed and contained hazardous wastes (WV DWR, 1984). This report also states that open burning occurred at the landfill site. Other documentation obtained by the WV Division of Water Resources (WV DWR) reports incidents of foam and scum on the Pocatalico River, and fish kills in the early 1960's (WV DWR, 1984).

The Poca Landfill, also known as the Poca Strip Mine was used as the Nitro Municipal Landfill for several years in the late 1950's and early 1960's, accepting trash, refuse and chemical wastes from local companies. The only companies to acknowledge prior use of the site are FMC Corporation and Old Monsanto. Limited sampling in 1985 indicated the presence of hazardous substances (FMC Corporation, 1987).

A February 1986 Consent Agreement and Order in the matter of the Poca Landfill (Respondent – Monsanto Company) states that "sampling conducted by EPA and Monsanto on September 7, 1984, indicated the presence of TCDD at the site" (U.S. EPA, 1986). This document also refers to the site as the "Poca Strip Mine Area".

An April 10, 1987 Consent Agreement and Order in the matter of the Poca Landfill (Respondent – FMC) states that FMC disposed of waste at the site and that sampling conducted by EPA and others on May 9, 1985 indicated the presence of hazardous substances (U.S. EPA 1987a).

A number of investigations were completed at the Nitro Municipal Landfill site throughout the 1980s. On December 16, 1980, soil samples were collected from the bank of the River to help determine if hazardous substances were migrating from the landfill. Two pipes were observed near the north end of the landfill that appeared to convey landfill leachate. Various drums and scrap metal belonging to Midwest Steel Corporation (Midwest) were observed in the landfill, and refuse was present at the edge of the River bank (Stone, 1980).

Four monitoring wells were installed at the landfill site between June 16 and 23, 1982. Dioxins were not detected in any of the groundwater samples (Ecology and Environment, Inc., 1982).

Existing data for the Nitro Municipal Landfill site were reviewed by U.S. EPA in 1983. Based on this review, NUS Corporation (1983) recommended that a security fence be installed around the perimeter of the landfill, buried drums be removed and disposed appropriately, and a water and soil sampling program be performed to further characterize the landfill site (NUS Corporation, 1983).

A February 1988 Consent Agreement and Order (Respondent – Old Monsanto) states that Old Monsanto deposited wastes at the site for a period in the late 1950's. Wastes were then burned. The Order states that sampling by both EPA and Old Monsanto revealed the presence of TCDD. Three remedial investigations were conducted at the Poca Landfill; 1) NUS Corporation operating under EPA Contract No. 68-01-6699; 2) Old Monsanto to supplement and verify the NUS Corporation data; and 3) FMC Corporation in April 1987 in response to EPA Docket No. III-87-13-DC. All three investigations focused on 2,3,7,8-TCDD as an indicated chemical (U.S. EPA, 1988c).

Remedial investigations of the landfill focused on 2,3,7,8-TCDD. NUS Corporation, under U.S. EPA Contract No. 68-01-6699, conducted the first investigation, and FMC conducted an additional investigation in April 1987 in response to U.S. EPA Docket No. III-87-12-DC (ERM-Midwest, 1988).

Old Monsanto conducted a remedial investigation of the Nitro Municipal Landfill under a consent agreement in March 1986. Landfill capping and other remediation actions were completed in the late 1980s (Weston, 1999). Closure activities effectively controlled any future releases to the River Approximately 80 percent of the landfill volume has been removed and disposed in a secure off-site facility.

3.3.2.5 FORMER ACF INDUSTRIES

ACF was located in Putnam County, approximately 20 miles northwest of Charleston, WV near the communities of Red House, Eleanor, and Buffalo, WV. The ACF site consisted of a 21.81 acre tract of land adjacent to the right descending bank of the River. The ACF site is located immediately upstream of the Winfield Locks and Dam and is bordered by Highway 62 to the north and the west.

The ACF site was originally agricultural land that was part of the Noffsinger farm, as documented by aerial photographs taken in 1950. ACF constructed and operated a railcar service and repair facility at the ACF site from 1952 until closure in March 1996. Shop facilities required for cleaning and repairing railcars, a paint shop, and a wastewater treatment system were all located on-site. The wastewater treatment system consisted of a series of lagoons adjacent to the River.

The ACF site remained idle until U.S. ACE filed a Declaration of Taking for the 21.81-acre tract in order to construct an upstream approach for the new lock and gate bay at the Winfield Locks and Dam. Concurrently, WV DNR conducted a Complaint Investigation in December 1988, and a Compliance Evaluation Inspection on February 14, 1989 to determine the status and condition of on-site drums of waste material. An environmental site investigation was conducted in May 1989 to determine the extent of soil contamination at the ACF site, and on October 27, 1989, WV DNR issued an Administrative Order that required ACF to remediate the identified contaminated areas.

ACF removed approximately 9,151 cy of contaminated soil from the site in 1990. Seeps along the completed excavation sidewalls contained elevated concentrations of several hazardous substances, suggesting that residual soil contamination likely remains in adjacent soils. U.S. ACE took possession of the site on May 1, 1990 (U.S. ACE, 1992). 2,3,7,8-TCDD was identified in impacted soil at the property.

3.3.2.5 GREAT LAKES CHEMICAL SITE

The Great Lakes Chemical Corporation (GLCC) site, formerly FMC Corporation (FMC), was located in the Kanawha Valley in Nitro, WV. The Former Flexsys Facility is adjacent to the north of the GLCC site and the River is located directly west of the GLCC site.

The former FMC plant manufactured phosphorus-based organic and inorganic chemical intermediates for commercial use. FMC operated from 1987 until 1999 when GLCC purchased the plant and continued chemical manufacturing operations. The plant discontinued operations and closed in 2001 (U.S. EPA, 2008b).

In May 2005, Blasland, Bouck, & Lee (BBL) collected surface soil samples along the northern and eastern perimeter of the GLCC site. Samples were submitted for analysis of PCBs, pesticides, dioxins, chloride, percent solids, phosphate, and total phosphorus. Concentrations of 2,3,7,8-TCDD were measured in soil at concentrations between 0.0025 B μg/kg to 0.59 J μg/kg. The highest concentration, 0.59 J μg/kg, was observed near the northeast corner of the GLCC site, approximately 830 ft from the River (BBL, 2007).

In May/June 2006, BBL collected surface soil samples in the area of the former lab and warehouse buildings located approximately 700 ft east of the samples collected in 2005. Samples were submitted for analysis of PCBs, pesticides, dioxins, chloride, percent solids, phosphate, and total phosphorus. Concentrations of 2,3,7,8-TCDD were observed to range from 0.0034 J μg/kg to 3.3 J μg/kg. The two highest concentrations, 1.7 μg/kg and 3.3 μg/kg, were located outside the lab and warehouse buildings approximately 40 ft and 80 ft east of the northern property boundary, respectively (BBL, 2007).

3.4 EXTENT OF CONTAMINATION (BASED ON PRE-EOC STUDY DATA)

3.4.1 REVIEW OF EXISTING DATA VALIDITY

Data developed by U.S. EPA and WV DEP/DNR were subject to full validation with the exception of historic fish sampling data for which validation information was not available. The validated data were therefore determined to be useable and was incorporated into the database of historic Site characterization information. Where sample coordinates were available, they were utilized as location information in the database. Where location data were not available, the mapped locations of sample points were digitized and tied to the site coordinate system to provide approximate location information.

3.4.2 SURFACE WATER 2,3,7,8-TCDD DATA

Surface water 2,3,7,8-TCDD data (collected prior to the EOC study) are summarized in Table 3.2.

WV WQS in effect at the time of the investigations were written to apply at all times when flows are equal to or greater than the minimum mean seven consecutive day drought flow with a ten year return frequency (7Q10) (WV 46-1-7.2.b), with the exception of the River, where the minimum flow is 1,960 cfs at the Charleston gauge (WV 46-1.7.2.d.19.2). U.S. EPA guidance suggests that the average flow condition represented by the harmonic mean flow is the appropriate design condition for contaminants that are regulated as potential carcinogens such as dioxins. However, WV WQS (WV 46-1-8-2.b) defer a specific decision on critical flows for carcinogens.

Key findings of prior surface water investigations can be summarized as follows:

- Surface water samples collected in May 1999 and June 2000 at locations well upstream of Nitro contained between 0.007 to 0.009 pg/L total 2,3,7,8-TCDD (dissolved plus particulate), or approximately one-half to two-thirds of the State water quality criterion of 0.014 pg/L ($1.4x10^{-8}$ ppb).
- Surface water samples collected between June 1998 and June 2000 within the Nitro area and at downstream locations (RM 29.7 to 42.2) contained total 2,3,7,8-TCDD concentrations ranging from 0.109 to 0.375 pg/L (1.09 x 10-7 to 3.75 x 10-7 ppb), or approximately 8 to 27 times the State water quality criterion with 6 of the 10 samples exceeding the criteria in the dissolved phase sample.

- On average, 2,3,7,8-TCDD associated with suspended particulate material accounts for about 90 percent of the total 2,3,7,8-TCDD concentration, whereas dissolved 2,3,7,8-TCDD only accounts for about 10 percent of the total concentration.

3.4.3 SEDIMENT 2,3,7,8-TCDD DATA

This section summarizes information available prior to implementation of the EOC Study regarding the nature and extent of sediment 2,3,7,8-TCDD concentrations within the Study Area, based largely on the results of a recent U.S. EPA sampling investigation (U.S. EPA, 2001). The EOC screening criteria was used to evaluate the pre-EOC data to ensure consistency between evaluations of all of the data (EOC, and pre-EOC) and to allow direct comparison between the data.

Spatial Distribution of 2,3,7,8-TCDD: The spatial distribution of 2,3,7,8-TCDD concentrations is identified on Figure 3.3. Figure 3.4 presents 2,3,7,8-TCDD analytical results from all depths, plotted by RM, and separated into left and right River bank samples. Elevated 2,3,7,8-TCDD concentrations were not identified within the navigation channel. This is consistent with U.S. ACE bathymetric information and dredge records, which indicate the navigational channel is self-scouring, with velocities too high to allow deposition of fine-grained sediments.

Review of the data available prior to implementation of EOC sampling reveals that elevated 2,3,7,8-TCDD concentrations have been detected in buried subsurface sediment intervals. All sediment 2,3,7,8-TCDD concentrations greater than 5 µg/kg (5 ppb) have been detected in subsurface intervals. In contrast, all surface sediment samples collected from the top 15 cm of the sediment column, which typically represents the biologically active zone where the majority of benthic organisms live (Boudreau, 1997; DiToro et al., 2001), have all contained less than 0.5 µg/kg (0.5 ppb) of 2,3,7,8-TCDD, the highest being 0.495 µg/kg (0.495 ppb) at RM 42.5. The sediment core data reveal a general pattern of increasing 2,3,7,8-TCDD concentrations with greater depth within the sediments, and the highest levels are present in relatively deeply buried sediments (Figure 3.5). These patterns are consistent with a historical release of 2,3,7,8-TCDD to the River, and subsequent natural recovery of surface sediment quality resulting from sediment deposition, burial, and/or biodegradation processes (microbial degradation).

One sediment coring location exhibited an exception to the general recovery trend—Core SD-3 was collected at RM 33.9, relatively far downstream in the Winfield Pool. Core SD-3 reveals an increasing concentration trend in surface sediments (Figure 3.6).

Order of Magnitude Reduction in Sediment Concentrations: As discussed above, based on the sediment core profiles (excluding Core SD-3), there is evidence of improvement in the quality of surface sediments over time between RM 42.5 and 36.0. Based on the sedimentary record, there appears to have been an order of magnitude or larger reduction over time in surface sediment 2,3,7,8-TCDD concentrations at the Site—evidenced by frequent detections of 1 to 5.2 µg/kg (5.2 ppb) 2,3,7,8-TCDD in subsurface sediments, compared with surface sediments that all contain less than 0.5 µg/kg (0.5 ppb) 2,3,7,8-TCDD. This can be explained by deposited sediment with lower concentrations of 2,3,7,8-TCDD mixing with existing sediments, and the reduction over time of source contributions to the River. Lower concentrations of 2,3,7,8-TCDD in sediment means less 2,3,7,8-TCDD reentering the water column due to resuspension, implying the loss due to sedimentation outweighs the gain due to resuspension, thereby decreasing the total concentration in the water column (Bansidhar et al., 2001).

Point Source and Tributary Sediments: The plot of sediment 2,3,7,8-TCDD concentration versus River Mile for the right bank of the River is presented on Figure 3.4, and for comparison, outfall and tributary sediments are also plotted at their point of discharge to the River.

U.S. EPA (2002a) conducted an outfall sampling program in August 2001. Sediments were collected from River sediment adjacent to the outfall pipes. Sample results were all below 0.5 µg/kg, except for two outfalls on the Former Flexsys Facility. Pipeline sediments from the Former Flexsys Facility Outfall 006 contained 2.9 µg/kg 2,3,7,8-TCDD, and pipeline sediments from the Former Flexsys Facility Outfall 008 contained 1.0 µg/kg 2,3,7,8-TCDD. Relative to a possible sediment benchmark of 0.5 µg/kg 2,3,7,8-TCDD, these outfalls are a potential concern for historic sediment loading but have since been closed as part of the RCRA CA (see Section 6.4 for further details).

Sediment samples from Armour Creek contained low to moderate 2,3,7,8-TCDD concentrations—all samples were less than 0.5 µg/kg (0.5 ppb) 2,3,7,8-TCDD. Sediment samples from Pocatalico River contained low 2,3,7,8-TCDD concentrations—all samples were below 0.02 µg/kg (0.02 ppb) 2,3,7,8-TCDD (U.S. EPA, 2001). Remedial measures and/or source controls have likely helped to reduce the 2,3,7,8-TCDD concentrations in the tributary sediment load. Presently, neither Armour Creek nor the Pocatalico River appears to pose a risk for sediment recontamination.

Key findings of prior sediment investigations can be summarized as follows:

- The highest sediment 2,3,7,8-TCDD concentrations have historically been detected on the right bank (looking downstream) near RM 42.5 (Nitro) and near RM 38.2 (roughly one mile downstream of the Pocatalico River), reaching peak concentrations of approximately 5.0 µg/kg in subsurface sediment
- The right bank (looking downstream) contains consistently higher concentrations of 2,3,7,8-TCDD than the left bank of the River
- The overall pattern of sediment 2,3,7,8-TCDD concentrations in the River, particularly at locations downstream of RM 42.5 appears patchy and discontinuous
- Surficial sediment concentrations and sediment core profiles indicate that surficial sediment concentrations are approximately 1 order of magnitude lower in concentration than sediments deposited historically

3.4.4 FISH TISSUE 2,3,7,8-TCDD DATA

2,3,7,8-TCDD has been measured in fish tissues by several agencies at numerous locations throughout the River, Armour Creek, and Pocatalico River since the early 1970s and prior to the EOC study. The most commonly sampled species included channel catfish and various types of bass (largemouth, smallmouth, white, striped, spotted, and hybrid).

One benchmark that has been used to evaluate fish tissue data is the former West Virginia criterion of 6.4 nanograms per kilogram (ng/kg) (0.0064 ppb) for 2,3,7,8-TCDD in edible fish tissue. Although this criterion has since been removed from WV regulations, it was considered in the development of the River TMDL (U.S. EPA, 2000b). Current West Virginia fish tissue advisory levels are based on consumption frequency (meals per year), method of preparation (skin on or skin off) and age group (adult or child). Current tissue advisory levels for 2,3,7,8-TCDD range from 0.46 to 37.54 ng/kg (0.004 to 0.038 ppb) (WV DHHR, 2007).

WV Fish Consumption Advisory Levels (WV DHHR, 2007), based on carcinogenic effects for 2,3,7,8-TCDD are:

Advisory Level	*Skin Off Filet*		*Skin On Filet*	
	Min. ***(ng/kg)***	***Max.*** ***(ng/kg)***	***Min.*** ***(ng/kg)***	***Max.*** ***(ng/kg)***
No restriction (255 meals/year)	--	<0.46	--	<0.64
1 meal per week	0.46	1.98	0.64	2.78
2 meals per month	>1.98	4.3	>2.78	6.02
1 meal per month	>4.3	8.6	>6.02	12.03
6 meals per year	>8.6	17.19	>12.03	24.07
Do not eat	>17.19	--	>24.07	--

Advisory levels for non-carcinogenic effects are slightly less restrictive, ranging from 0.72 to 37.54 ng/kg:

Advisory Level	*Skin Off Filet*		*Skin On Filet*	
	Min. ***(ng/kg)***	***Max.*** ***(ng/kg)***	***Min.*** ***(ng/kg)***	***Max.*** ***(ng/kg)***
No restriction (255 meals/year)	--	<0.72	--	<1.00
1 meal per week	0.72	3.09	1.00	4.33
2 meals per month	>3.09	6.70	>4.33	9.39
1 meal per month	>6.70	13.41	>9.39	18.77
6 meals per year	>13.41	26.82	>18.77	37.54
Do not eat	>26.82	--	>37.54	--

Lipid Content: As shown on Figure 3.7, the tissue 2,3,7,8-TCDD concentrations of pre-EOC investigations fish tissue data show a good linear correlation with lipid content, consistent with the expectation that this hydrophobic organic contaminant tends to concentrate in the fatty parts of the fish. The arithmetic average lipid concentration in fish tissue samples from the River and tributaries prior to the EOC study is about 3 percent based on the data presented on Figure 3.7.

Spatial Distribution of Fish Tissue 2,3,7,8-TCDD Concentrations: Tissue 2,3,7,8-TCDD concentrations versus RM are presented on Figure 3.8; these concentrations are normalized using the equation below to the regional average lipid content of 3 percent to reduce variability in the data and to better elucidate underlying trends in the database.

$$\mathit{Lipid\ Normalized\ TCDD\ Concentration} = \frac{3\ \mathit{percent\ Lipid}}{\mathit{percent\ Lipid\ in\ Sample}} \times \mathit{TCDD\ Concentration\ in\ Sample}$$

Tissue concentrations from pre-EOC sampling all exceed the current WV no restriction levels for fish consumption. Approximately half of historic bottom feeder tissue samples from 1992 or earlier exceeded the "do not eat" advisory level. The remainder of the historic bottom feeder data falls within the advisory range. For sport fish, one sample from a 1984 sampling event exceeded the "do not eat" advisory level, with the remainder of samples falling within the advisory range.

Temporal Distribution of Fish Tissue 2,3,7,8-TCDD Concentrations: Fish tissue 2,3,7,8-TCDD concentrations versus time are presented on Figure 3.9. Although there is a significant amount of spatial and sample variability in tissue concentrations at any given time, the data indicate a generally decreasing trend in concentration over time.

Based on the best-fit regression line, there has been roughly an order of magnitude reduction in tissue 2,3,7,8-TCDD concentrations over the last 30 years. This reduction is commensurate with the order of magnitude reduction in sediment concentrations that are observed between subsurface core samples and present-day surface sediments. In the 1970s, exceedances of the Food and Drug Administration (FDA) Advisory Level were common. In the 1990's, exceedances of the FDA Advisory Level were rare. More recently, the mean value of the tissue concentrations in the River appears to be approaching the former State criterion of 6.4 ng/kg (as evidenced by the trend of the regression line on Figure 3.9).

The observed reduction in fish tissue 2,3,7,8-TCDD concentrations over time provides further indication of natural recovery processes within the River system.

4.0 EE/CA COMPLETED INVESTIGATION AND ANALYTICAL DATA

The information necessary to fill the data gaps identified in the Work Plan was collected through the completion of 9 investigative tasks. Tasks 1 through 3 were data compilation tasks; these tasks were initiated prior to the development of the Work Plan. Tasks 4 through 9 were sampling and analytical tasks. These tasks were implemented in two phases, such that the results of the Phase I EOC investigation were used to optimize and focus the scope of the Phase II EOC investigation. The Phase I EOC investigation included Tasks 4 through 6, and the Phase II EOC investigation included Tasks 7 through 9. Field activities, sample handling, and analysis were completed in accordance with the procedures identified in the Work Plan, including the Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP), as well as the Final Phase I EOC Sampling SOW, Final Phase II EOC Sampling SOW, and Supplemental Phase II EOC Sampling SOW.

Due to the specialized nature of some of the investigative activities, specialty subcontractors were employed to complete a number of activities. Project Team personnel directly supervised all activities completed by subcontractors. A CRA, Exponent, or Anchor QEA representative was on-Site during the implementation of all Phase I and II EOC activities. Appendix D presents field notes associated with the field activities completed for the Site. A photographic log is presented in Appendix E.

4.1 DATA COMPILATION ACTIVITIES

4.1.1 TASK 1 - REVIEW OF EXISTING INFORMATION

A comprehensive review of U.S. EPA, WV DEP, U.S. ACE, and other agency files was completed for the purposes of the Work Plan to obtain available relevant information on the River, its tributaries, and potential historic and ongoing sources of 2,3,7,8-TCDD. The review also included the review of Pharmacia Corporation, Monsanto Company, and Solutia files relevant to the Site. The information obtained and reviewed as part of the file review is summarized in the discussion of Site conditions presented in Section 3.0 of this Report.

4.1.2 TASK 2 – AERIAL PHOTOGRAPHY AND BASE MAPPING

Aerial photography was completed for the Site (from upstream of the Coal River to downstream of the Winfield Dam) in April 2003. Ground truthing surveys were completed for the area photographed to allow accurate topographic base mapping to be developed for the area photographed. Base mapping was developed in the vicinity of Nitro, WV.

4.1.3 TASK 3 – HISTORICAL DATABASE DEVELOPMENT/GIS

All analytical data obtained as part of Task 1 were entered into a database for the Site. The data entered were reviewed for Quality Assurance/Quality Control (QA/QC) purposes and flagged with regard to the level of data validation and usability. A geographic information system (GIS) was created using the database and aerial photography and base mapping developed as part of Task 2. The available sample locations have been added to the GIS database. Validated location information could not be obtained for approximately 50 percent of the historic data points entered into the database.

A copy of the current GIS database for the Site is included on the enclosed compact disk, in Appendix F.

4.2 PHASE I EOC ACTIVITIES

The Phase I EOC investigation sampling and analysis program included:

- Bathymetric and geophysical surveys
- Surface water sampling and analysis (including velocity profiling)
- Fish tissue sampling and analysis
- Surface sediment sampling to support the geophysical survey, and mapping of soft sediment deposits
- Surface sediment sampling to support the derivation of a Site-specific biota-sediment accumulation factor (BSAF) for 2,3,7,8-TCDD

A summary of the Phase I EOC field activities is provided in Table 4.1. The Phase I EOC sampling activities were completed in two mobilizations: October 4, 2004 through November 2, 2004; and April 11, 2005 through April 18, 2005. Velocity profiling, bathymetric/geophysical surveying, low flow surface sampling activities, fish tissue sampling, and sediment sampling to support the BSAF determination were completed during the first mobilization. High flow surface water sampling was completed during the second mobilization.

The Phase I investigation tasks and results were presented in detail in the Phase I EOC Results Report (CRA, 2005 and CRA, 2008), and included herein.

4.2.1 TASK 4 – BATHYMETRIC AND GEOPHYSICAL SURVEY

A bathymetric and geophysical survey of the Site was completed to develop an understanding of sediment characteristics and depositional patterns to support Site evaluation and to facilitate design of subsequent sampling activities. Golder completed the bathymetric and geophysical survey as a subcontractor to CRA, in accordance with the Work Plan. A copy of the Golder Report is included in Appendix B.

In general, the survey provided the following information:

- Water depth in the main channel varies from approximately 25 to 45 ft. Bathymetric depressions and probable scour holes are observed at the mouths of the Pocatalico and Coal Rivers.
- The side slopes of the River are steep, typically 2:1 to 3:1 (horizontal:vertical), descending to channel depth within 50 to 200 ft of the shoreline. The deepest part of the channel (i.e., thalweg) tends to migrate toward the outside of meander bends, locally forming steeper banks in those areas.
- Bedrock outcrops appear to be exposed or covered by a thin sediment veneer on many of the side-slope areas, especially the lower portions of the side slopes.
- Coarse-grained deposits up to six feet thick and intervening hardpan surfaces were mapped in the center channel. Follow-on grab sampling indicated channel sediments are comprised of fine- to coarse-grained sand and gravel.
- Finer grained sediments appeared to be mainly restricted to shallower, near shore benches and bays, especially near tributary mouths.
- Coal was identified in a number of the sediment grab samples. This was anticipated based on the use of the River for coal transportation and historic coal recovery dredging activities.

The bathymetric contours and geophysical features are summarized on Figures 4.1 and 4.2.

4.2.2 TASK 5 – SURFACE WATER SAMPLING AND ANALYSIS

High volume surface water sampling for 2,3,7,8-TCDD was performed at 5 sampling stations along the River, as follows:

- RM 68 – upstream of Marmet Dam (representing regional background surface water concentrations, coincident with the principal fish sampling location upstream of the Site, i.e., upstream of Study Area 1)
- RM 46 – upstream Study Area boundary (representing area background surface water conditions)
- RM 42 – immediately downstream of the Former Flexsys Facility in Nitro (coincident with the downstream fish sampling location)
- RM 33 – downstream Study Area boundary (in the vicinity of Little Guano Creek), upstream of Winfield Dam
- RM 31 – on the upstream side of Winfield Dam

Sample locations were selected based on previous sampling programs conducted by the Ohio River Valley Sanitation Commission (ORSANCO), USGS, and U.S. EPA.

Sampling methods, as described below, are based on methods developed by USGS and identified in the document entitled Kanawha River Fish Tissue, Surface Water, and Sediment Sampling Rationale, Draft Engineering Evaluation/Cost Analysis (EE/CA) Work Plan Addendum dated August 24, 2004 and approved by USEPA in a letter dated September 8, 2004. All surface water samples were collected using appropriate channel cross-section flow-weighted compositing methods based on a modification of the procedures developed by the USGS, as described in the Phase I EOC Sampling Results and Updated Phase II EOC Sampling Work Plan (Phase I EOC Results Report) as follows:

1. Initial flow measurements (Acoustic Doppler Current Profiler (ADCP) velocity profiles) were completed at each sampling station/transect to characterize flow conditions. These data were used for subsequent EE/CA hydrodynamic modeling.
2. Due to the greater potential for cross-channel variability, the River transect at RM 42 was divided into 8 equal flow sections, and sampled accordingly.
3. Using the high volume apparatus, sampling of the River was performed at the midpoint of each of the flow sections at 0.2 and 0.8 times the total depth of the water column at each location. The inlet for the high volume sampler was

deployed for equal time periods at 8 different station locations, typically requiring moving the inlet once every 3 hours (16 station locations and nominal 1.5-hour intervals at RM 42). Grab samples of the water were also collected twice a day during high volume surface water sampling and were analyzed for Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) concentrations.

Velocity profiling was completed on cross-sections at RM 31, 33, 42, 46, and 68 in order to divide the River at each cross section into quadrants of equal flow to determine the high-volume surface water sampling stations. Velocity profiling was completed by Blue Coast Scientific, Inc. (Blue Coast) under the supervision of CRA. An ADCP was utilized for the survey. As noted in Table 4.1, a replacement ADCP unit was sent to the Site due to a leak identified in the unit first delivered to the Site. All velocity profile information was recorded utilizing the second ADCP unit. A copy of the report provided by Blue Coast was included as part of the Phase I EOC Results Report and is included in Appendix B.

Current velocity and direction flow measurements were performed every 2 seconds along each transect. This equated to measurements on approximate 2 m (approximately 6.5 ft) intervals horizontally. At each horizontal interval, discrete measurements were collected for each vertical interval. The vertical intervals utilized were approximately 25 centimeters (10-inches). Location data were recorded by a Differential Global Positioning System (DGPS).

The location of each transect was also tied to physical features to ensure the same locations would be utilized for surface water sampling during high flow and low flow events. A summary of the flow measurements taken at the center of each section of equal flow is presented in Table 4.2.

Two surface water sampling events (corresponding to seasonal low and high flow River conditions) were completed. The seasonal low flow condition surface water sampling occurred during October/November 2004, while the seasonal high flow event occurred during April 2005. Seasonal discharge conditions from the Charleston gage (USGS 03198000) and prior high volume 2,3,7,8-TCDD sampling events conducted by U.S. EPA and Monsanto Company are presented on Figure 4.3.

The high volume sampling method was implemented in the field to obtain flow-weighted composite samples. The high water volume was required to achieve the target low detection limits specified in the EE/CA Work Plan. Large volumes of River water were pumped through a dual-media filter (approximately 1,000 liters (L) pumped at approximately 2 L per minute). The water was first passed through a glass-fiber filter to capture particulate 2,3,7,8-TCDD bound to suspended sediments, followed by an XAD resin column, which extracted dissolved 2,3,7,8-TCDD. The two filters are analyzed separately to provide particulate, dissolved, and total 2,3,7,8-TCDD concentrations.

One deviation from the specified sampling protocol was made due to weather. On October 13, 2004, sampling at RM 42 was suspended due to lightning, after 7 of the 8 specified equal flow sections had been sampled. As sufficient sample volume had been filtered to achieve the desired detection limits, it was requested that sampling be considered complete for that location. This request was verbally approved by U.S. EPA, and confirmed in an October 18, 2004 e-mail from Mr. Jeff Daniel of CRA to U.S. EPA. The remaining section, which was not sampled, was adjacent to the western River bank (i.e., opposite bank from the Former Flexsys Facility). A high flow event (70,300 cubic feet per second) occurred on September 30, 2004. Although flows returned to normal level by early October 2004, the high flow event may have impacted the representativeness of the October 2004 sampling event as an indication of low flow conditions.

Particulate and dissolved fractions of the surface water samples were submitted for analysis of 2,3,7,8-TCDD congeners, as well as Total Suspended Solids (TSS), DOC, and TOC to Axys Analytical Services Ltd. (Axys) of Sidney, British Columbia. Axys also provided the high volume sampling equipment and a field technician to assist in collecting the samples. Grab samples were collected 3 times for each transect and tested for dissolved oxygen (DO), redox, and conductivity utilizing a water quality meter.

The surface water sampling locations and results for 2,3,7,8-TCDD (dissolved and particulate), TOC, DOC, and TSS are presented on Figure 4.4 and are summarized in Table 4.3. Table 4.3 also presents the flow data from the Charleston gage for each day of sampling. Analytical data reports for surface water samples are presented in Appendix G and the database of all analyses is included as Appendix F. Surface water sample results are further discussed in Section 4.4.1.

4.2.3 TASK 6 – FISH TISSUE SAMPLING AND ANALYSIS

Phase I EOC fish tissue sampling activities took place in October 2004 alongside the surface water sampling activities. The fish tissue sampling and analysis plan described in the Work Plan was modified in August 2004 prior to conducting the sampling activities. The modifications to the target fish species identified in the Work Plan were as follows:

- Adult channel catfish collected well upstream (approximately RM 75 to 95) and on-Site/downstream (approximately RM 33 to 45) to be representative of bottom fish species.
- Adult bass (largemouth bass, smallmouth bass, and spotted bass) collected at upstream (RM 68), on-Site (RM 42), and downstream (RM 33) locations to represent sport fish species.
- Forage fish. These were not originally included in the Work Plan but in the modifications these fish were identified as a BSAF target species well suited for monitoring spatial trends due to its limited home range and lack of historical contaminant burden. The intent was to sample white suckers and red horse suckers less than 150 millimeters (mm) (6 in) in total length. However, because these species could not be found at the Site during the time of sampling, the forage fish was changed to gizzard shad, after consultation with U.S. EPA and U.S. ACE.

Fish tissue samples were to be originally collected at the upstream boundary of the Site (RM 46.0), one in the vicinity of Nitro (RM 42.0), and the third downstream of Pocatalico River (RM 36.0). Modifications to the sample locations resulted in the following 5 sample locations:

- RM 75 to 95: This location was added to ensure that the home ranges of channel catfish sampled were beyond potential influence from the Former Flexsys Facility
- RM 68: This location was selected to be immediately upstream of the Marmet Dam to represent the regional background conditions unaffected by the releases from the Former Flexsys Facility
- RM 42: This location was selected to be in the vicinity of Nitro downstream of the Former Flexsys Facility
- RM 33 to 45: This location was not originally included in the modified Work Plan; however, sufficient numbers of channel catfish were obtained at this location to provide a sample to represent conditions downstream of the Former Flexsys Facility
- RM 33: This location was selected to be in the vicinity of Little Guano Creek and upstream of the Winfield Dam

The locations of the sampling stations at RM 68, RM 42, and RM 33 are consistent with areas sampled in previous investigations.

Fish samples were obtained by electro-fishing conducted by Normandeau Associates, Inc. (Normandeau) under the supervision of CRA. Trotlines were also utilized; however, electro-fishing was found to provide the best results in obtaining target species. Recovered fish were prepared by CRA's biologist in accordance with the Work Plan procedures.

At each fish sampling location, 5 composite samples of fish were prepared by CRA's biologist in accordance with the modified EE/CA Work Plan procedures. Forage fish were sent to the lab whole, with 15 fish per composite sample. Sport (bass) and bottom feeding (channel catfish) fish tissues were filleted in the field. Fillets from a minimum of 4 to 5 similarly-sized fish were composited into samples for chemical analysis. Channel catfish were filleted with skin off, and bass and the forage fish were filleted with skin on, consistent with U.S. EPA guidance and general local practices (WV DHHR, 2002). Five duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples were collected at RM 33 for forage fish (gizzard shad); however, only 2 duplicate samples were submitted for analysis to comply with the requirement of 1 duplicate sample for every 20 samples.

Fish tissue samples were collected from the following sampling locations:

- Channel catfish from two areas - RM 33 to 34 and RM 75 to 95. Sufficient numbers of channel catfish were obtained to provide the requisite samples for RM 33 to 45. Four replicate samples were obtained from RM 75 to 95.
- Bass from three areas – RM 33, 42, and 68. Sufficient numbers of fish were obtained at all locations.
- Forage fish (gizzard shad) from three areas - RM 33, 42, and 68. Sufficient numbers of fish were obtained at RM 33 and RM 42. At RM 68, replicate sample #4 consisted of 6 larger gizzard shad. A sufficient number of fish could not be obtained to collect a 5^{th} replicate sample.

Samples were stored on dry ice and shipped to Axys for analysis. The tissue was homogenized and analyzed for lipid content and 2,3,7,8 dioxin/furan congeners at Axys. A summary of the fish tissue samples is presented on Table 4.4. Fish sample locations and results are presented on Figure 4.5 and in Table 4.5a and are further discussed in Section 4.4.2. Complete analytical results are presented in Appendix G and fish tissue sample preparation field forms are included in Appendix H.

Additional fish tissue sampling was proposed as part of the Phase II EOC SOW to provide additional data to evaluate the continuing recovery trends for the River. Phase II EOC fish tissue sampling took place in two mobilizations; December 12, 2008 through December 22, 2008 and January 12, 2009 through January 20, 2009. These sampling events are further discussed in Section 4.4.2.

Additional Surficial Sediment Sampling

Per the original EE/CA Work Plan, sediment sampling activities were to be included in the Phase II EOC activities. However, Anchor QEA modified the Phase I EOC sampling activities in August 2004 to include surface sediment sampling locations. The modifications included the collection of surface sediment samples for BSAF determinations and sediment mapping. The Phase I EOC surface sediment sampling was completed for two purposes, as follows:

- To provide physical properties data (grain size, TOC, percent solids, and field geologic descriptions) to support the interpretation of geophysical survey data
- To provide 2,3,7,8-TCDD data for surface sediment in the area of forage fish sample collection. This data was utilized to support the development of a BSAF for the Site

Surface sediment sampling activities took place in October 2004 and surface sediment samples (0 to 6 cm) for sediment mapping were proposed at 28 locations; however, samples were only collected at 20 locations, between RM 32 and RM 44, to provide physical properties data to support the interpretation of geophysical survey data. Sample locations are presented on Figure 4.6a and Figure 4.6b. Samples were not collected at 8 locations (GT-005, GT-010, GT-13, GT-14, GT-17, GT-20, GT-26, and GT-27) after three failed successive attempts. Samples collected were submitted for analysis of TOC, total solids (TS), and grain size. Sample results are summarized in Table 4.6a and a summary of the Phase I EOC investigation surface sediment sampling field measurements (i.e., water depth, sample depth) and field descriptions is presented in Table 4.8a. Grain size data for the 20 samples is presented in Table 4.9a. These sample results are further discussed in Section 4.4.3.

Surface sediment samples (0 to 6 cm) for the BSAF calculations were collected from the following 3 locations:

- RM 68 – Immediately upstream of the Marmet Dam to represent regional background conditions unaffected by releases from the Former Flexsys Facility
- RM 42 – In the vicinity of Nitro, adjacent to the Former Flexsys Facility
- RM 33 – Downstream of the Former Flexsys Facility and upstream of Winfield Dam, in the vicinity of Little Guano Creek

At each station, two composite samples, with a minimum of 5 grab samples per composite, of relatively fine-grained sediment deposits were collected in the vicinity of the fish sampling locations for spatial monitoring/BSAF species. At total of 6 composite surface sediment samples were collected (KD-200 to KD-205), each comprised of 5 grab samples (KD-001 to KD-030). These samples were collected to characterize contemporaneous sediment exposure data and to assess short-term sediment 2,3,7,8-TCDD exposures to fish for the purpose of BSAF calculations. All sediment samples were submitted for analysis of 2,3,7,8-TCDD, TOC, TS, and grain size. Once the composite samples were made, the remaining samples were archived.

During the collection of the surface sediment samples, oily material was observed at sample locations KD-010 and KD-118. Samples from these two locations were submitted for additional chemical analysis of expanded Target Compound List/Target Analyte List (TCL/TAL) parameters (dioxins and furans, metals, PCBs, pesticides, SVOCs, and VOCs) and oil/grease. The results of these analyses are summarized on Table 4.7 and complete laboratory reports are presented in Appendix G. These results are further discussed in Section 4.4.3.

4.3 PHASE II EOC ACTIVITIES

The Phase II EOC sampling and analysis program included the following major activities:

- Surface (SSD-01 to SSD-29 and COR-01 to COR-43) and subsurface (COR-01 to COR-43) sediment sampling to further define the EOC at the Site
- Collection and analysis of age-dated sediment cores (NRC-01 to NRC-08) to support natural recovery evaluations
- Collection of sediment cores for Sedflume testing
- Collection of additional fish tissue samples for evaluation of recovery trends for the River

Phase II EOC sampling activities were completed in four mobilizations: November 26, 2007 through December 17, 2007; February 19, 2008 through February 25, 2008; December 8, 2008 through January 9, 2009, and July 27, 2009 through July 30, 2009. During the first mobilization, high flow conditions in the River caused by heavy rainfall, made core retrieval and surface and subsurface sediment sampling difficult at several locations, particularly at locations mid-channel of the River. Although sampling conditions were difficult in a number of center-channel locations due to increased flows, the only locations which were not sampled were those near the locks and dam which U.S. ACE instructed the sampling team not to collect. This was due to safety considerations and as instructed by the U.S. ACE Lock Master. The area immediately upstream of the Winfield Locks and Dam is designated as a Restricted Area due to a strong undertow created by the flow of water through the gated section of the dam. The sampling vessel was in radio contact with the Winfield Lock and Dam during all sampling activities, and was instructed to maintain a distance determined to be safe by the U.S. ACE Lock Master from the Restricted Area. The U.S. ACE and Winfield Lock and Dam were notified in advance of sampling activities through Notice to Navigation Permits.

According to the USGS data (USGS, 2007) for West Virginia at Charleston, the River flow rate reached 38,100 cfs on December 15, 2007 compared to 6,150 cfs on December 8, 2007. The average total flow rate for the month of December over the past 10 years is recorded as approximately 14,000 cfs (USGS, 2007). The sampling activities completed during each mobilization are described in more detail in the following sections. A summary of the Phase II EOC Field Activities is provided in Table 4.1.

4.3.1 TASK 7 – SURFACE AND SUBSURFACE SEDIMENT SAMPLING

The Phase II EOC investigation included collection of both surface (0 to 6 inches) and subsurface (to a maximum depth of 10 ft) sediment samples to provide further definition of the spatial and vertical extent of 2,3,7,8-TCDD contamination. The surface sediment samples are representative of sediments that are exposed to the water column, primarily via resuspension, and that are available for exposure to fish and other aquatic life. The subsurface sediment samples provide a record of 2,3,7,8-TCDD accumulation patterns over time.

All sediment samples, both surface and subsurface, were completed in accordance with the procedures presented in the EE/CA Work Plan and analyzed for 2,3,7,8-TCDD, TOC, TS, and grain size (volume permitting). Samples from several locations (listed below) were analyzed for additional parameters to determine the presence of other significant chemicals of concern in the River. These parameters included:

- Dioxin and furan congeners (polychlorinated dibenzo-*p*-dioxins/ polychlorinated dibenzofurans [PCDD/PCDF])
- Priority Pollutant Metals

- Semi-volatile Organic Compounds (SVOCs)
- Polychlorinated biphenyls (PCBs)
- Chlorinated Pesticides

Samples proposed for additional analyses were selected following sample collection based on sample volume and location, and were proposed to, and approved by, U.S. EPA prior to analysis. To the extent possible, sample locations were selected to provide good spatial coverage of the Study Areas. Samples analyzed for additional parameters included:

- Surficial sediment samples from the following locations in Study Area 4 (Downstream Area): COR-03, COR-07, COR-13, and COR-20
- Surficial sediment samples from the following locations in Study Area 3 (Downstream Area): SSD-18, SSD-20, and SSD-20 (duplicate)
- Surficial sediment samples from the following locations in Study Area 2 (Adjacent Area): SSD-25
- Surficial sediment samples from the following locations in Study Area 1 (Area upstream of the Former Flexsys Facility): SSD-27
- Sediment core samples from locations COR-08 (2-4 ft) and COR-22 (2-4.1 ft) from Study Area 4
- Sediment core samples from locations COR-28 (0-2 ft) from Study Area 3
- Sediment core samples from locations COR-33 (0-1.75 ft), COR-36 (2-4 ft), COR-36 (4-6 ft), COR-39 (0-1.4 ft), and COR-39 (1.4-2.8 ft) from Study Area 2

Surface and subsurface sediment samples were submitted to TestAmerica, Inc. (TestAmerica) in North Canton, Ohio, for analysis and/or archiving in accordance with the QAPP. All analytical data reports are presented in Appendix G.

4.3.1.1 SURFACE SEDIMENT SAMPLING

Surface sediment sample locations were collected during the first and second mobilizations of the Phase II EOC sampling activities. A total of 72 surface sediment samples were proposed in the EE/CA Work Plan; however, one sample location (SSD-08) was not accessible as the location was too shallow for the sampling vessel to reach and the closest offset location was another predetermined sample location. Therefore a total of 71 surface sediment samples (SSD-01 to SSD-29 and COR-01 to

COR-43) were collected from the top four inches of sediment (COR-01, COR-15, SSD-06, and SSD-20 were collected from the top six inches) and submitted to TestAmerica for analysis of 2,3,7,8-TCDD, TOC, TS, and grain size. Surface sediment sample locations and 2,3,7,8-TCDD results are presented on Figures 4.6a and 4.6b. Surface sediment samples were collected from the following Study Area locations:

- Study Area 1 (upstream of Former Flexsys Facility) – 5 samples (SSD-26 to SSD-29 and COR-43)
- Study Area 2 (vicinity of Former Flexsys Facility) – 13 samples (SSD-23 to SSD-25 and COR-33 to COR-42)
- Study Area 3 (downstream of Former Flexsys Facility) – 17 samples (SSD-15 to SSD-22 and COR-24 to COR-32)
- Study Area 4 (downstream of Former Flexsys Facility) – 36 samples (SSD-01 to SSD-13 and COR-01 to COR-23)

The surface sediment sampling analytical and expanded analytical results are summarized in Tables 4.6a and 4.10a, respectively, and on Figures 4.7 through 4.10. The grain size data results are summarized in Table 4.9 and the sample results are discussed in Section 4.4.3.

4.3.1.2 SUBSURFACE SEDIMENT SAMPLING

Sediment core samples were collected and analyzed to delineate the depth of contamination and provide information regarding sediment deposit thickness. Coring and subsurface sampling activities were completed in three mobilizations: November 26, 2007 through December 17, 2007; February 19, 2008 through February 25, 2008; and December 8, 2008 through January 9, 2009.

A total of 24 of the 43 proposed sediment cores were successfully advanced using an electrically powered vibracore during the first mobilization. Core retrieval at locations COR-01 and COR-02, located in close proximity to the Winfield Lock and Dam, were not attempted at the request of U.S. ACE due to safety considerations. Locations COR-05, COR-06, COR-13 to COR-17, and COR-31 were not successfully sampled due to high flow conditions, which made positioning of the sampling vessel and sediment penetration difficult. Sampling was not performed at the location designated for COR-10. Refusal was encountered at 7 core locations: COR-24, COR-26, COR-27, COR-29, COR-31, COR-32, COR-34, and COR-37. The cores that were successfully retrieved were processed for analysis at TestAmerica for 2,3,7,8-TCDD, TOC, TS, and grain size.

Core locations that were not attempted during the first mobilization due to River conditions were attempted during the subsequent mobilization in February 2008. The locations attempted during the second mobilization included COR-01, COR-02, COR-05, COR-06, COR-13, COR-14, COR-15, COR-16, and COR-17. During the second mobilization, core advancement and retrieval were successful at two locations COR-15 and COR-16, and were submitted for analysis, both are River-bank locations. A shallow 8 inch recovery was successful at COR-05 which was profiled; however it was not submitted for analysis. Core retrieval in mid channel locations was not possible due to the coarse granular nature of the gravel present at these locations.

Based on preliminary analysis of surface and subsurface data collected during the first two mobilizations of the Phase II EOC activities, along with evaluations of the Phase I EOC sediment sampling data and historically available data, U.S. EPA determined that additional sampling would be beneficial in determining the extent of several areas of comparatively higher concentration in order to support EE/CA activities. Specifically, areas of elevated 2,3,7,8-TCDD concentrations had been detected along the east bank of Study Area 2 near the Former Flexsys Facility, along the west bank, upstream of I-64, and downstream of the power plant in Study Area 4, and further delineation of sediment concentrations in these areas would better inform the EE/CA. Accordingly, a total of 9 additional subsurface cores were retrieved in December 2008. The locations were selected and approved by U.S. EPA as follows:

- COR-42 was re-sampled as limited retrieval was achieved during the first mobilization
- COR-40 was re-sampled
- COR-36 was re-sampled
- COR-36A is located upstream of COR-36 on the west River bank in Study Area 2 across from the Former Flexsys Facility
- COR-36B and COR-36C are located downstream of COR-36 on the west River bank in Study Area 2 across from the Former Flexsys Facility
- COR-32A and COR-32B are on the west River bank in Study Area 3 downstream and opposite of the Former Flexsys Facility
- COR-28A is located between KRSD-15 and COR-28 on the east River bank of Study Area 3 downstream of the Former Flexsys Facility

Cores from all of the 9 sediment coring locations were successfully collected and sampled. All samples were split with U.S. EPA and submitted to Test America for analysis of 2,3,7,8-TCDD, TOC, TS, and grain size. Core sample locations and 2,3,7,8-TCDD results for all Phase II mobilizations are presented on Figures 4.6a and 4.6b.

Consistent with the Work Plan, all cores from all sampling events were sub-sectioned into 2 ft intervals; the top three intervals (top 6 ft) were submitted for chemical analysis and the remaining intervals were put on hold for analysis and analyzed if 2,3,7,8-TCDD was detected in the top 6 feet. Prior to being processed for analysis, cores were photographed and visually classified (the photolog presented in Appendix E includes sediment core photographs).

At most of the core locations, core penetration was limited to four feet or less. All samples from locations that had four feet of recovery or less were submitted to TestAmerica for analysis. The top three intervals from COR-03, COR-04, COR-21, and COR-36 from the first two mobilizations, and COR-40 from the third mobilization, were submitted for analysis and the remaining intervals were archived for potential future analysis (COR-40 only had three intervals). At location COR-35 from the first two mobilizations and COR-32B and COR-36 from the third mobilization, all intervals were submitted for analysis.

A summary of subsurface sediment sampling activities is presented in Table 4.1 and the analytical results and expanded analytical results are summarized in Tables 4.6b and 4.10b, respectively. Sample results are also presented on Figures 4.6a and 4.6b and 4.7 through 4.10. Sediment coring field measurements and field descriptions are summarized in Table 4.8b. The grain size data results are summarized in Table 4.9 and the sample results are discussed in Section 4.4.4. Corehole logs for all completed cores are presented in Appendix I.

4.3.2 BLACK CARBON CORE SAMPLING

The prevalence of coal in sediment could potentially affect 2,3,7,8-TCDD bioavailability due to different adsorption characteristics; therefore eight select samples (BC-COR-10A, BC-COR-10B, BC-COR-13A, BC-COR-13B, BC-COR-37A, BC-COR-37B, BC-SSD-26A, and BC-SSD-26B) were collected for statistical (e.g., correlation) analyses in February 2008 to determine if coal particles in the River are preferred sites for 2,3,7,8-TCDD adsorption. River sediments may affect chemical availability and the relationship between sediment and fish tissue concentrations. Since the adsorption properties of black carbon (including coal) vary depending on the surface area of individual particles, bioaccumulation controls are expected to vary depending on the grain size of coal within the sediments. Four samples with observable portions of coal material were selected for targeted analysis. These were collected in samples associated with core locations COR-10, COR-13, COR-37, and SSD-26. In each case, a sample with observable coal material was submitted along with a companion sample from an adjacent location with lower amounts of observable coal, for a total of 8 samples.

The 8 samples included 2 surface sediment samples (BC-SSD-26A and BC-SSD-26B) that visually contained the greatest density of coal particles and 6 core samples (BC-COR-10A, BC-COR-10B, BC-COR-13A, BC-COR-13B, BC-COR-37A, and BC-COR-37B). These samples were submitted for analysis of black carbon content, 2,3,7,8-TCDD, TOC, and TS. Sampling locations where black carbon analysis was completed are presented on Figure 4.11. The samples were screened to segregate materials into three different size categories: 1) greater than 300 micron material (coarse sands and gravel); 2) between 75 and 300 microns (fine and medium sands); and 3) less than 75 microns (silts and clays). This resulted in a total of 24 samples that were submitted for analysis.

A summary of the results for the 24 samples that were analyzed for black carbon content, 2,3,7,8-TCDD, TOC, and TS is presented in Table 4.11. Samples results are discussed in Section 4.4.4. The statistical analyses of this data are presented in Appendix J.

4.3.3 ADDITIONAL FISH TISSUE SAMPLING

Fish tissue sampling was proposed as an addition to the Phase II EOC SOW to provide additional data to evaluate the continuing 2,3,7,8-TCDD recovery trends for the River. The additional Phase II EOC fish tissue sampling took place in December 2008/January 2009. The same scope from the Phase I EOC fish tissue sampling event was proposed during the sampling events. At each station, 4 composite fish samples (minimum 5 fish per composite) were collected. During the December 2008/January 2009 mobilization, target fish species were collected from sampling locations consistent with areas sampled during the Phase I EOC fish tissue sampling task.

The target species for this sample event were the same as those sampled in 2004: a forage fish (gizzard shad), bottom feeder (channel catfish), and sport fish (bass) that could be targeted by human anglers. However, the target fish species and fish sizes were not available at all locations. Thus, for example, small gizzard shad less than 150 mm were targeted, but small gizzard shad were unavailable during December 2008/January 2009. Consequently, the shad collected were considerably larger than desired; average lengths were about 240 mm, 250 mm, and 320 mm at RM 33, RM 42, and RM 68, respectively.

Similarly, insufficient channel catfish of a suitable size were available at both the upstream (RM 75-95) and downstream (RM 33-45) sampling locations due to colder than average River temperatures. Another popular common sport fish, sauger (*Stizostedion canadense),* was added to complete the samples. Consequently, some composites at these locations were channel catfish only, some were sauger only, and some were combinations of both species.

Ultimately, sufficient fish tissue was collected for all samples except one upstream (RM75-95) bottom feeder (channel catfish) sample. In addition, forage fish (gizzard shad) collected were typically 2-3 times larger than the fish collected during the 2004 sampling event.

All fish tissue samples were sent to Axys for analysis for lipid content and 2,3,7,8-TCDD congeners. Samples were sent whole and filleted and homogenized by Axys using the same procedures used in 2004. Gizzard shad were processed as whole fish, with 10 fish in each composite sample. Bass, sauger, and channel catfish were filleted at the Axys, and composites were formed from 5 fish. These species were processed similar to being processed by local anglers. That is, bass and sauger were processed as skin-on fillets, and channel catfish were processed as skin-off fillets. Generally, there were five composite samples per sample location. However, due to scarcity of both channel catfish and sauger at RM 75-95, only two complete composite samples (5 sauger per composite) and one incomplete composite sample (2 channel catfish) were sent to the lab. Due to scarcity of gizzard shad at RM 68, three of the five composite samples were composed of only 5 fish per composite. At RM 33-45, an insufficient number of channel catfish were available; therefore sauger was added to complete the samples. Two samples comprised of both channel catfish and sauger, one sample of sauger only, and two samples of only channel catfish were sent to Axys for analysis. The modifications to the SOW were discussed with U.S. EPA's field oversight personnel prior to modification of the field activities.

A summary of the fish tissue samples collected is presented in Table 4.4. The Phase II EOC fish tissue sample results for 2,3,7,8-TCDD are presented in Table 4.5b and on Figure 4.5. Results are further discussed in Section 4.4.2. Complete analytical reports are presented in Appendix G and fish tissue sample preparation field forms are included in Appendix H.

4.3.4 TASK 8 – NATURAL RECOVERY EVALUATION

Natural recovery analysis was performed at selected sediment sampling locations in an attempt to evaluate the rate at which sediment deposition occurs in the River and to evaluate the stability of sediment. This information would assist in predicting the anticipated rate 2,3,7,8-TCDD concentrations would be expected to recover in the River following implementation of effective upland source controls and/or focused in-water Removal Actions, as appropriate. Natural recovery core (NRC) sampling activities were completed during two mobilizations in December 2007 and February 2008. A summary of the NRC sampling activities is presented in Table 4.1.

Eight radioisotope cores were proposed in the Work Plan; however, only 6 cores were successfully collected. NRC sampling locations are presented on Figure 4.12. At one location (NRC-05), a sample was collocated with an existing U.S. EPA core, based on an existing 2,3,7,8-TCDD profile. At two NRC locations (NRC-03 and NRC-04), samples were to be collected along the left River bank in the vicinity of COR-09 and SSD-09, respectively. The remaining 5 NRCs were to be collected with sediment cores as described under Task 7, as follows:

- NRC-01 collocated with COR-02
- NRC-02 collocated with COR-04
- NRC-06 collocated with COR-31
- NRC-07 collocated with COR-36
- NRC-08 collocated with COR-40

During the December 2007 mobilization, five NRC locations (NRC-02, NRC-03, NRC-05, NRC-07, and NRC-08) were successfully advanced using a vibracore, to a maximum of 6 ft below the mudline. A core sample was not collected at NRC-01 due to its close proximity to the Winfield Dam. NRC-04 had low recovery; likely due to relatively coarse sediment grain size resulting from high velocity conditions in this area of the River. Retrieval attempts at location NRC-06 resulted in refusal after five attempts. Although NRC-05 and NRC-08 were successfully advanced, inadequate information was obtained to provide input parameters for the natural recovery analysis, consequently requiring a second attempt to obtain the necessary data. During the February 2008 mobilization, locations NRC-01, NRC-04, NRC-05, and NRC-08 were re-attempted. NRC-01 had low recovery (6 inches) while NRC-04, NRC-05, and NRC-08 were successfully advanced. NRC logs are presented in Appendix I.

Consistent with the procedures identified in the Work Plan, once retrieved, the cores were sectioned into intervals and processed for chemical analysis of Beryllium-7 (Be-7), Cesium-137 (Cs-137), and TS. The top 50 cm of the cores were finely sub-sectioned into 2.5 cm intervals and 10 samples from each core were submitted for radioisotope analysis (Be-7 and Cs-137) to age date the cores. From 50 cm to 185 cm, the cores were sub-sectioned into 5 cm intervals and archived, and the remaining core was discarded. This allowed conversion of the sediment 2,3,7,8-TCDD depth profile to a time series of 2,3,7,8-TCDD accumulation. If the age dating profile required further definition, 5 to 10 additional subsamples were available (from the archived intervals) to be submitted for radioisotope analysis. A total of 7 NRC samples were sent to TestAmerica, but only 5 samples were submitted for analysis of Be-7, Cs-137, and TS (NRC-02, NRC-04, NRC-05 (February 2008 sample), and NRC-08 (December 2007 sample and February 2008 sample). Samples from NRC-03 and NRC-07 were put on hold and archived.

As stated in the Work Plan, if subsamples of cores exhibited a relatively continuous sequence of fine-grained deposits, with no evidence of interruption, they were to be submitted for analysis of Lead-210 (Pb-210), in addition to Be-7 and Cs-137. Pb-210 is more sensitive to non-uniform sedimentation rates, and breaks in the depositional record caused by erosion and/or dredging, which may invalidate the age determination. No cores exhibited a continuous sequence of fine-grained deposits; therefore no samples were submitted for analysis of Pb-210.

All NRC samples were submitted to TestAmerica, for analysis or archiving, in accordance with the QAPP. NRC sample results are summarized in Table 4.12 and results are discussed in Section 4.4.4.2. Analytical data reports are presented in Appendix G.

4.3.5 TASK 9 – SEDIMENT STABILITY EVALUATION

Inverted flume testing (Sedflume testing) was proposed in the Work Plan as necessary to support determination of critical shear velocities for the River sediments and to determine the conditions under which sediments are likely to erode. In most locations, sediment characteristics were representative of silts/sands for which critical shear velocities can be determined by direct calculation. To support the additional 3-dimensional sediment transport modeling described in Section 4.4.7, Sedflume testing was performed to better characterize erosional characteristics of clay size sediment deposits. Monsanto Company proposed 20 locations for the collection of sediment cores for the purpose of Sedflume testing, and U.S. EPA verbally approved the locations in July 2009. The proposed locations were as follows:

- Study Area 1 – KRSD-28, KRSD-25, and KRSD-24
- Study Area 2 – COR-42, COR-40, COR-39, KRSD-20, COR-36, and COR-35
- Study Area 3 – COR-32B, COR-30, KRSD-14, COR-25, and KRSD-48
- Study Area 4 – KRSD-10, COR-20, KRSD-05, KRSD-04, COR-07, and KRSD-01

Sea Engineering, Inc. (SEI) was selected to complete core collection and Sedflume testing. SEI used specialized sediment core equipment to obtain cores up to 60 cm in length, to allow for analysis at their laboratory in Santa Cruz, California (CA). Sediment core recovery was conducted from July 27 to July 30, 2009, and was successful, based on visual inspection for core length and quality, at all locations except for locations COR-32B and COR-25, due to no recovery after 5 attempts. The lack of recovery at these locations was attributable to the presence of sand overlying dense clay at COR-32B and very loose sand overlying gravel at COR-25. A summary of sediment coring activities for the July 2009 mobilization is presented in Table 4.1. Sediment coring field measurements (i.e., water depth, sample depth) and field descriptions are summarized in Table 4.8b. The retrieved cores were shipped to the SEI laboratory in Santa Cruz, CA in custom padded upright shipping containers to preserve the core structure. The erosion rates of the sediment as a function of shear stress and depth were measured at the SEI lab. The analysis also determined the critical shear stress of the sediment as a function of depth, as well as particle size and bulk density measurements. A copy of CRA's and SEI's field notes for the Sedflume mobilization is presented in Appendix D and photographs are presented in the photolog in Appendix E. The SEI report documenting testing and results is included in Appendix K. The results of the Sedflume analysis are summarized in Table 4.14 and results are discussed in Section 4.4.6. These data were utilized as an input to modeling activities described in Section 4.4.7.

4.4 PHASE I/II EOC SAMPLING RESULTS

The results of Phase I and II EOC sampling events are presented in the following sections. These results are further described in Section 5.0 as they relate to the updated CSM, recovery rates, and exposure assessment.

4.4.1 SURFACE WATER SAMPLING RESULTS

As discussed above, low and high volume surface water sampling was completed at cross-sections of the River at RM 31, 33, 42, 46, and 68 in October /November 2004 and April 2005. Samples were obtained by dividing the River into 4 sections of equal flow and sampling at 2 points within each section, providing an 8-point composite sample. At RM 42 the River was divided into 8 sections of equal flow and sampled at 2 locations in each section, resulting in a 16-point composite, consistent with the Work Plan. The surface water sampling locations and results for dissolved and particulate 2,3,7,8-TCDD (composite sample), and discrete samples for TOC, DOC, and TSS are presented on Figure 4.4 and in Table 4.3.

Surface water sample results were generally consistent between the upstream locations (RM 68 and RM 46). The samples collected at RM 68 had concentrations of 0.00112 J pg/L for dissolved 2,3,7,8-TCDD during the low flow sampling event and not detected at or above the associated value of 0.00188 pg/L (less than (<) 0.00188 pg/L) during the high flow sampling event. The particulate low flow sample concentration was <0.000753 pg/L and qualified as being below the reporting limit (U) pg/L and 0.00635 J pg/L for the high flow concentration. The DOC concentration was 2 mg/L for both the low flow and high flow sampling events. The TOC concentration was observed to be higher during the low flow sampling event with a concentration of 2 mg/L and ranged from <0.08 mg/L to 1 mg/L for the high flow event. The same observation was made for TSS concentrations with results ranging from 5 mg/L to 8 mg/L for low flow and 4 mg/L to 9 mg/L for high flow. Note that variations in DOC, TOC, and TSS concentrations can all influence partitioning of 2,3,7,8-TCDD within the water column (e.g., between dissolved and particulate phases).

The water samples collected at RM 46 had dissolved 2,3,7,8-TCDD concentrations of 0.000874 J (estimated value) pg/L during the low flow sampling event and <0.00221 pg/L during the high flow sampling event. The particulate low flow sample concentration was <0.00127 U pg/L and 0.00853 J pg/L for the high flow concentration. The DOC and TOC concentrations were 2 mg/L for low flow and ranged from 1 mg/L to 2 mg/L for high flow. The TSS concentrations ranged from <2.8 mg/L to 5 J mg/L for low flow and <2.8 mg/L to 13 mg/L for high flow. The 2,3,7,8-TCDD results for RM 68 and RM 46 were lower than the downstream results for RM 42, RM 33, and RM 31 during both sampling events.

In both historic and Phase I EOC sampling events, sample results increased slightly in the Nitro area (RM 42) where duplicate samples were collected at RM 42 and results for dissolved 2,3,7,8-TCDD ranged from 0.00705 J pg/L to 0.00709 J pg/L for low flow and ranged between 0.00964 J pg/L to 0.00966 J pg/L for high flow. The particulate concentrations were 0.005 J pg/L for low flow and ranged from 0.00796 J pg/L to 0.11864 pg/L for high flow. A duplicate particulate sample could not be collected during the low flow sampling event based on the equipment configuration. A pronounced difference was observed between the duplicate samples collected from RM 42 during the April 2005 (high flow) sampling event. In the particulate phase samples, more than an order of magnitude difference was observed between the two samples with the higher result being 0.11864 pg/L. While the average of these results is representative of the River conditions at the time of sampling and was utilized in evaluating the data in this EE/CA, uncertainties associated with the sample split are nevertheless apparent. No problems with the sample analysis were identified during data validation. It is possible that the separation of flow though the particulate filters was biased, or that by chance, a different fraction of suspended sediment entered one filter. The DOC concentrations were 2 mg/L for low flow and ranged from 1 mg/L to 2 mg/L for high flow. The TOC concentrations were 2 mg/L for low flow and 1 mg/L for high flow. The TSS concentration was lower during the low flow sampling events with concentrations ranging from 5 J mg/L to 8 J mg/L and ranging from 6 mg/L to 14 mg/L during the high flow sampling event.

An increase in 2,3,7,8-TCDD concentrations was observed in areas downstream of Nitro. This increase was observed in both dissolved and particulate fractions of the samples. An increase of approximately one order of magnitude in concentrations in low flow and high flow conditions was observed in the areas downstream of Nitro (RM 33 and RM 31) as compared to areas upstream of Nitro in both the high flow and low flow sampling events. The samples collected at RM 33 had concentrations of 0.0109 pg/L for dissolved 2,3,7,8-TCDD during the low flow sampling event and 0.0103 pg/L during the high flow sampling event. The particulate low flow sample concentration was 0.0156 pg/L and 0.0336 pg/L for the high flow concentration. The DOC concentrations were 2 mg/L for low flow and ranged from <0.08 mg/L to 1 mg/L for high flow. The TOC concentrations ranged from 1 mg/L to 2 mg/L for both low flow and high flow. TSS concentrations ranged from 7 J mg/L to 9 J mg/L during the low flow sampling event and ranged from 10 mg/L to 19 mg/L during the high flow sampling event.

The samples collected at RM 31 had dissolved concentrations of 0.00596 J pg/L for the low flow sampling event and 0.014 pg/L for the high flow sampling event. The particulate low flow sample concentration was 0.0463 pg/L and 0.0489 pg/L for the high flow concentration. The DOC and TOC concentrations ranged from 2 mg/L to 3 mg/L for low flow and ranged from 1 mg/L to 2 mg/L for high flow. The TSS concentrations ranged from 6 mg/L to 11 mg/L during the low flow sampling event and ranged from 7 mg/L to 12 mg/L during the high flow sampling event.

TOC and DOC concentrations were very consistent across all samples ranging from <0.08 mg/L to 3 mg/L. TOC and DOC results were generally higher at all stations during low flow events. TSS concentrations ranged from <2.8 mg/L to 19 mg/L with high flow results generally above 10 mg/L and low-flow results generally ranging from less than the detection limit to 9 mg/L. TSS results were generally higher at all stations during high flow events, as was anticipated.

In comparison to the WV Water Quality Criteria (0.014 pg/L), only the high flow sample collected at River Mile 31 was equal to the criteria for the dissolved phase. The 11 other samples were below criteria for the dissolved phase samples. Six of the 10 historic samples (from the 1998 and 2000 sampling events) exceeded the criteria based on dissolved phase concentrations.

Data obtained from both low-flow and high-flow sampling events exhibited lower concentrations than historic sample results. Over the period from 1998 to 2005, surface water column concentrations declined by approximately 26 percent per year at stations downstream of Nitro. As discussed in the EE/CA Work Plan, the observed decline is likely due in large part to coal recovery dredging that was implemented during the timeframe of previous sampling events. Coal recovery dredging directly resuspended and mobilized sediments containing elevated 2,3,7,8-TCDD concentrations, increasing releases to the water column. A summary of dredging activities in the River are presented in Section 4.5.3. Figure 4.13 presents the temporal trends in 2,3,7,8-TCDD surface water sampling results. Figure 4.14 presents the spatial trends in surface water data. Ongoing source control activities at the Former Flexsys Facility and natural recovery processes in the River are also likely to have contributed to the observed reductions in surface water column concentrations over time.

4.4.2 <u>FISH TISSUE SAMPLE RESULTS</u>

A summary of the fish tissue samples collected from the Phase I and Phase II EOC sampling events is presented on Table 4.4. The fish tissue 2,3,7,8-TCDD results are presented in Tables 4.5a and 4.5b and on Figure 4.5.

As discussed previously, the historical fish tissue data available for the Site identified a recovery trend in fish tissue in both sport fish and bottom feeders, consistent with the surface water and sediment data. Additional fish tissue sampling was completed as part of the Phase I and Phase II EOC sampling to further document this trend.

Gizzard shad, bass, and channel catfish samples were all collected during both the 2004 and 2008/2009 sampling events. Most of the available historical data are for bass and channel catfish with only one historical sample for gizzard shad. Sampling completed in 2004 was collocated with surface sediment samples collected at RM 68, RM 42, and RM 33 to support the determination of a Site-specific BSAF for 2,3,7,8-TCDD.

The samples collected from RM 33 included bass and gizzard shad tissue samples. During the 2004 bass tissue sampling event, 5 composite samples were collected with 5 fish per composite with 2,3,7,8-TCDD results (not lipid normalized) ranging from 1.37 pg/g to 4.46 pg/g. During the 2008 bass tissue sampling event, 5 composite samples were collected with 5 fish per composite with results (not lipid normalized) ranging from 1.22 pg/g to 2.14 pg/g for 2,3,7,8-TCDD. The bass samples collected in 2008 were comparable in length and weight to the samples collected in 2004. During the 2004 gizzard shad tissue sampling event, 5 composite samples were collected with 15 fish per composite (3 fish per sample) with 2,3,7,8-TCDD results (not lipid normalized) ranging from 3.35 pg/g to 7.53 pg/g. Duplicate and MS/MSD samples were submitted for gizzard shad at RM 33; however, only 2 of the 5 duplicate samples were analyzed. The remaining 3 samples were archived. During the 2008 gizzard shad tissue sampling event, 5 composite samples were collected with 10 fish per composite (2 fish per sample) with 2,3,7,8-TCDD results (not lipid normalized) ranging from 7.07 pg/g to 16.1 pg/g. Only 10 fish were collected per composite instead of 15 due to difficulty collecting the required number of gizzard shad. This can be attributed to lower fish populations observed during the winter months. The gizzard shad samples collected in 2008 were greater in weight and length than the samples collected in 2004. This increased size and weight of fish is indicative of older fish with a longer period of exposure to River conditions which would be reflected in a higher body burden of 2,3,7,8-TCDD than younger fish caught in the 2004 sampling event.

The samples collected between RM 33 and RM 45 were comprised of channel catfish during the 2004 sampling event and a combination of channel catfish and sauger during the 2008/2009 sampling event due to the scarcity of channel catfish during the winter months. A total of 5 channel catfish samples were collected in 2004 with 5 fish per composite and results (not lipid normalized) ranging from 1.33 pg/g to 19.5 pg/g for 2,3,7,8-TCDD. During the 2008/2009 sampling event, two composite samples comprised of only channel catfish were collected with 5 fish per composite with 2,3,7,8-TCDD results (not lipid normalized) of 2.09 pg/g and 8.58 pg/g. One composite sample of sauger only was collected with 5 fish per composite with a 2,3,7,8-TCDD concentration (not lipid normalized) of 0.975 J pg/g. Two composite samples comprised of both channel catfish and sauger with 5 fish per composite were collected with 2,3,7,8-TCDD results (not lipid normalized) of 2.53 pg/g and 36.2 pg/g. The sauger samples collected in 2008 were of comparable size to the channel catfish samples collected in 2004; however, the channel catfish samples collected in 2008/2009 were generally greater in weight and length than the 2004 samples. This increased size and weight of fish is indicative of older fish with a longer period of exposure to River conditions which would be reflected in a higher body burden of 2,3,7,8-TCDD than younger fish caught in the 2004 sampling event.

The samples collected from RM 42 included bass and gizzard shad tissue samples. During the 2004 bass tissue sampling event, 5 composite samples were collected with 5 fish per composite with 2,3,7,8-TCDD results ranging from 1.79 pg/g to 4.02 pg/g. In 2008/2009, 5 composite bass samples were collected with 5 fish per composite with 2,3,7,8-TCDD concentrations (not lipid normalized) ranging from 1.71 pg/g to 12.6 pg/g. The bass samples collected in 2008 were comparable in length and weight to the samples collected in 2004. During the 2004 gizzard shad tissue sampling event, 5 composite samples were collected with 15 fish per composite (3 fish per sample) with 2,3,7,8-TCDD results (not lipid normalized) ranging from 0.877 J pg/g to 6.70 pg/g. During the 2008/2009 sampling event, 5 composite samples were collected with 10 fish per composite (2 fish per sample) with 2,3,7,8-TCDD results (not lipid normalized) ranging from 4.22 pg/g to 9.05 pg/g. The gizzard shad samples collected in 2008/2009 were greater in weight and length than the samples collected in 2004. Fewer gizzard shad were collected per composite in 2008/2009 due to difficulty collecting the required number of fish for the composite sample. This could be attributed to lower fish populations observed during the winter months.

The samples collected from RM 68 included bass and gizzard shad tissue samples. During the 2004 bass tissue sampling event, 5 composite samples were collected with 5 fish per composite with 2,3,7,8-TCDD results (not lipid normalized) ranging from <1.08 U pg/g to 0.469 J pg/g. In 2008, 5 composite bass samples were collected with 5 fish per composite with all 2,3,7,8-TCDD sample concentrations (not lipid normalized) of ND. The bass samples collected in 2008 were comparable in length and weight to the samples collected in 2004. In October 2004, four composite gizzard shad samples were collected with 15 fish per composite for 3 of the composite samples and 6 large gizzard shad for the remaining composite sample. A fifth composite sample could not be collected as a sufficient number of fish could not be obtained. The 2,3,7,8-TCDD concentrations (not lipid normalized) ranged from 0.222 J pg/g to 2.10 pg/g. In November 2004, two additional gizzard shad composite samples were collected with 15 fish per composite with 2,3,7,8-TCDD results (not lipid normalized) of 0.936 J pg/g and 0.307 J pg/g. During the 2008 sampling event, 5 composite samples were collected with only 5 fish per composite due to scarcity of gizzard shad collected with 2,3,7,8-TCDD results (not lipid normalized) ranging from <1.22 U pg/g to 0.387 J pg/g.

The gizzard shad samples collected in 2008 were greater in weight and length than the samples collected in 2004.

The samples collected upstream from the Study Area between RM 75 and RM 95 were comprised of channel catfish. A total of 5 channel catfish samples were collected in 2004 with 5 fish per composite with 2,3,7,8-TCDD results (not lipid normalized) ranging from 0.251 J pg/g to 0.736 J pg/g. During the 2008/2009 sampling event, only two sauger composite samples were collected with 5 fish per composite with 2,3,7,8-TCDD concentrations (not lipid normalized) below detection limits. The sauger samples collected in 2008/2009 were generally shorter in length and lighter in weight compared to the channel catfish samples collected in 2004.

Fish tissue 2,3,7,8-TCDD concentrations were generally consistent between the 2004 and 2008/2009 sampling events for both sport fish and bottom feeders; however, in both species groups, the maximum detected concentration was higher than recorded for the November 2004 sampling event. Sport fish data from the most recent event exhibited more scatter than the November 2004 event. This may be due to the more diverse species collected as part of the sampling due to limited capture of bass during the 2008/2009 sampling event.

Figures 4.15 through 4.18 present the temporal trends in fish tissue data for bottom feeders and sport fish on both a wet weight and lipid normalized basis for 2,3,7,8-TCDD concentrations. These Figures illustrate a recovery in both bottom feeder and sport fish species over the 25-year data history by the declining trend of 2,3,7,8-TCDD concentrations over time.

Sediment 2,3,7,8-TCDD and TOC, and fish tissue 2,3,7,8-TCDD and lipid content results used in the BSAF determination are presented on Figure 4.19 and the calculated BSAF is presented in Table 4.13. Lipid normalized values were used in the development of BSAF values for gizzard shad but these values did not improve the precision of the historical time series. Therefore, at the request of U.S. EPA, historical time series were presented using a wet weight basis. The calculated BSAF using the 2004 data ranged from 0.11 to 0.13 within the Study Areas. A BSAF could not be determined for upstream areas (RM 68) as 2,3,7,8-TCDD was not detected in any of the sediment samples collected. Gizzard shad collected during the 2008/2009 sampling event were significantly (2 to 3 times) larger in length and weight than the gizzard shad collected in the 2004 sampling event. The 2,3,7,8-TCDD concentrations in these samples were correspondingly higher on a wet weight basis. However, lipid normalized values exhibited lower concentrations than the 2004 data. BSAF calculations utilizing the 2008/2009 gizzard shad data resulted in BSAFs between 0.11 and 0.12 which are consistent with values calculated using the 2004 gizzard shad data. The BSAF is based upon the assumption that sediment, surface water, and fish tissue concentrations are in equilibrium. Therefore the relationships between contributions from surface water and sediment to fish tissue concentrations can be approximated by developing a relationship between sediment concentrations and fish tissue concentrations. The use of the BSAF does not imply that contaminant loading to fish tissue is solely, or even primarily due to contaminants in sediment.

4.4.3 SURFACE SEDIMENT SAMPLE RESULTS

Surface sediment sampling was completed throughout the Study Areas to supplement existing data collected by U.S. EPA and determine current conditions. Pre-EOC Study sampling data identified a number of locations with surface sediment 2,3,7,8-TCDD concentrations in excess of the EE/CA screening levels (0.5, 1.0, and 2.0 ppb). Phase I EOC surface sediment sampling activities took place in October 2004 and Phase II EOC surface sediment sampling activities took place in November/December 2007.

4.4.3.1 PHASE I EOC SURFACE SAMPLE RESULTS

Surface sediment sample results from the Phase I EOC activities were collected to provide physical properties data to support the interpretation of the geophysical survey data and to provide 2,3,7,8-TCDD data for surface sediment in the Study Area for BSAF calculations. Surface sediment sample locations and 2,3,7,8-TCDD results are presented on Figures 4.6a and 4.6b. Sample results for 2,3,7,8-TCDD, TOC, TS, and grain size data are summarized in Tables 4.6a and 4.9a, respectively.

A total of 20 samples were collected for analysis of TOC, TS, and grain size to provide the physical properties data. Samples were collected from the following locations:

- RM 33 – 2 samples
- RM 34 to 42 – 14 samples
- RM 42 to 44 – 4 samples

The grain size data results indicated highly multimodal sediments in the River, with sand values ranging from 9 percent to 95.6 percent, silt values ranging from 1 percent to 68.1 percent, and fines (clay and sand) values ranging from 2.4 percent to 89.7 percent from RM 32 to RM 44. Surface sediment TOC concentrations in this area of the River averaged approximately 0.125 percent (dry weight basis), but also exhibited similar variability. Excluding samples with high coal concentrations, the average surface sediment TOC concentration in this area of the River is approximately 0.073 percent.

These results generally confirm that the finer grained sediment deposits are located in side channel areas of the River (with correspondingly higher TOC levels), and are the preferential repositories for the sediment 2,3,7,8-TCDD inventory. The coarser grained sediments located within the center of the channel generally contain lower levels of TOC and lower 2,3,7,8-TCDD concentrations.

A total of 6 composite surface sediment samples were collected for analysis of 2,3,7,8-TCDD. The two samples collected upstream from RM 68 had 2,3,7,8-TCDD concentrations of <0.36 pg/g and <0.31 pg/g. The samples collected at the Site from RM 42 contained 2,3,7,8-TCDD concentrations of 24 pg/g to 71 pg/g. The downstream samples from RM 33 had 2,3,7,8-TCDD concentrations ranging from 15 pg/g to 280 pg/g.

The two surface sediment samples where oily material was observed at RM 33 (KD-010) and RM 36 (KD-118) showed results of 196,000 J µg/kg and <53,400 U µg/kg for oil and grease, respectively.

4.4.3.2 PHASE II EOC SURFACE SEDIMENT SAMPLE RESULTS

Discrete (i.e., non-composited) surface sediment samples were collected from a total of 71 locations during the Phase II EOC sampling activities to characterize the extent of 2,3,7,8-TCDD in Site sediments. Surface sediment samples were collected from the top four inches of sediment (COR-01, COR-15, SSD-06, and SSD-20 were from the top six inches) and submitted for analysis of 2,3,7,8-TCDD, TOC, TS, and grain size. Sample locations and 2,3,7,8-TCDD results are presented on Figures 4.6a and 4.6b.

In Study Area 1, five surface samples were collected along the right bank (SSD-26 to SSD-29 and COR-43). All 2,3,7,8-TCDD concentrations from the surface sediment samples in Study Area 1 were non-detect except for a sample collected from SSD-26, which had a 2,3,7,8-TCDD concentration of 0.0029 µg/kg.

Thirteen surface samples were collected from Study Area 2 (adjacent to the Former Flexsys Facility). Six samples were collected on the right bank, one from the center of the channel, and six on the left bank. The samples collected from the right bank starting from downstream of Study Area 1 included the following sample locations and corresponding 2,3,7,8-TCDD results: COR-41 (<0.0006 µg/kg), COR-40 (0.059 µg/kg), COR-39 (3.4J µg/kg), COR-38 (0.25 µg/kg), COR-35 (0.055 µg/kg), and COR-34 (0.021 µg/kg). The sample collected from location COR-37 at the center of the channel had a 2,3,7,8-TCDD concentration of 0.0031 µg/kg. The samples collected from the left bank included the following sample locations and corresponding 2,3,7,8-TCDD results: COR-42 (<0.0017 U µg/kg), SSD-25 (<0.00098 µg/kg), SSD-24 (<0.0017 U µg/kg), SSD-23 (0.074 µg/kg), COR-36 (0.0056 µg/kg), and COR-33(0.015 µg/kg).

Seventeen surface sediment samples were collected from Study Area 3; nine along the right bank, two along the left bank, five along the center of the channel, and one from Rock Branch Creek. The samples collected from the right bank included the following sample locations and corresponding 2,3,7,8-TCDD results: SSD-22 (0.015 µg/kg), SSD-21 (0.01 µg/kg), COR-30 (0.013 µg/kg), COR-28 (0.0088 µg/kg), SSD-19 (0.0018 µg/kg), COR-25 (0.0011 µg/kg), SSD-18 (0.052 µg/kg), SSD-17 (0.035 µg/kg), and SSD-15 (0.012 µg/kg). The samples collected from the center of the channel included the following sample locations and corresponding 2,3,7,8-TCDD results: COR-32 (0.012 µg/kg), COR-31 (0.0039 µg/kg), COR-29 (0.0013 µg/kg), COR-27 (0.013 µg/kg), and COR-26 (0.0026 µg/kg). The samples collected from the left bank included the following sample locations and corresponding 2,3,7,8-TCDD results: SSD-16 (0.0055 µg/kg) and COR-24 (0.0043 µg/kg). The sample collected from the mouth of Armour Creek (SSD-20) had a 2,3,7,8-TCDD concentration of 0.017 µg/kg and was also collected as a MS/MSD sample. The highest surficial sediment 2,3,7,8-TCDD concentration observed was 0.052 µg/kg from sample location SSD-18, located approximately 5,000 ft upstream from the Study Area 3 and Study Area 4 limit on the right bank.

Thirty-six surface samples were collected from Study Area 4. Eighteen samples were collected from the right bank, nine from the center of the channel, six from the left bank, and three samples from inlets to the River. The samples collected from the right bank starting from downstream of Study Area 3 included the following sample locations and corresponding 2,3,7,8-TCDD results: SSD-14 (0.023 µg/kg), COR-23 (0.066 µg/kg), COR-22 (0.056 µg/kg), COR-21 (0.023 µg/kg), COR-20 (0.009 µg/kg), COR-19 (0.012 µg/kg), SSD-13 (0.038 µg/kg), SSD-12 (0.015 µg/kg), COR-18 (<0.00072 U µg/kg), COR-16 (<0.00052 U µg/kg), COR-14 (0.012 µg/kg), COR-11 (0.01 µg/kg), COR-09 (0.014 µg/kg), SSD-06 (0.038 µg/kg), COR-07 (0.048 µg/kg), SSD-04 (0.0041 µg/kg), SSD-03 (0.0046 µg/kg), and SSD-02 (0.0065 µg/kg). The samples collected from the center of the channel included the following sample locations and corresponding 2,3,7,8-TCDD results: COR-17 (<0.0028 U µg/kg), COR-13 (0.01 µg/kg), COR-10 (<0.0038 U µg/kg), SSD-07 (0.017 µg/kg), COR-06 (0.0031 µg/kg), COR-05 (0.02 µg/kg), COR-02 (0.048 µg/kg), COR-01 (0.014 µg/kg), and SSD-01 (0.0026 µg/kg). The samples collected from the left bank included the following sample locations and corresponding 2,3,7,8-TCDD results: SSD-10 (0.0038 µg/kg), COR-15 (<0.0069 U µg/kg), COR-12 (0.023 µg/kg), COR-08 (0.0041 µg/kg), COR-04 (0.0073 µg/kg), and COR-03 (0.01 µg/kg). The samples collected from the River inlets included the following sample locations and corresponding 2,3,7,8-TCDD results: SSD-11 (0.0052 µg/kg), SSD-09 (<0.025 U µg/kg), and SSD-05 (0.024 µg/kg). The highest surficial 2,3,7,8-TCDD concentration observed was 0.066 µg/kg at sample location COR-23, which is located approximately 500 ft downstream from the Study Area 3 and Study Area 4 limit on the right bank.

Samples from Study Area 1 were observed to have the lowest 2,3,7,8-TCDD concentrations, while samples from Study Area 2 contained the highest concentrations. Samples from Study Areas 3 and 4, downstream of the Former Flexsys Facility, were observed to have lower 2,3,7,8-TCDD concentrations than those from Study Area 2, which is adjacent to the Former Flexsys Facility. Samples collected as part of the Phase II EOC sampling event identified only one location, COR-39, with a 2,3,7,8-TCDD concentration of 3.4J µg/kg, which exhibited a surface sediment concentration above the minimum screening level of 0.5 ppb for 2,3,7,8-TCDD. Figures 4.20 and 4.21 present the profiles of sediment data from the Phase II EOC surface sediment sampling along the right bank and left bank of the River (looking downstream), respectively. The surface sediment sampling analytical and expanded analytical results are summarized in Tables 4.6a and 4.10a, respectively. The grain size data are summarized in Table 4.9a and the analytical data reports are presented in Appendix G.

4.4.4 SEDIMENT CORE SAMPLE RESULTS

A total of 43 sediment core samples were collected during the Phase II EOC sampling activities to further define the vertical extent (depth) of dioxin concentrations for the screening levels of 0.5, 1.0, and 2.0 µg/kg and to further characterize historical trends and accumulation patterns of dioxin in the sedimentary record, and to the extent possible, correlate trends in the sedimentary record with trends from the fish tissue samples results. Sediment core samples were collected from the upper ten feet of sediment (when possible) and were submitted for analysis of 2,3,7,8-TCDD, TOC, TS, and grain size. Additional analysis was completed on samples collected from locations COR-08 (2-4 ft) and COR-22 (2-4.1 ft) from Study Area 4, COR-28 (0-2 ft) from Study Area 3, and COR-33 (0-1.75 ft), COR-36 (2-4 ft), COR-39 (0-1.4 ft and 1.4-2.8 ft) from Study Area 2. The results of these additional analyses are discussed in Section 4.4.5. Sample locations and 2,3,7,8-TCDD results are presented on Figures 4.6a and 4.6b. Samples results are also presented by sample depth on Figures 4.7 to 4.10. It should be noted that at each of the core locations, a surficial sediment sample was collected from the upper 6 inches of sediment, as discussed in the Section 4.4.3. The surficial samples discussed in Section 4.4.3 are representative of conditions in the bioactive zone. Sediment samples collected from the first interval in the sediment cores (presented in this section) are not considered surficial samples.

In Study Area 1, only one core from location COR-43 was retrieved from the right bank, and 2,3,7,8-TCDD was not detected in the sample collected from the entire 22 inches of the core length.

Fourteen cores were collected from Study Area 2 (adjacent to the Former Flexsys Facility). Five cores were collected from the right bank and six from the left bank. The samples collected from the right bank starting from downstream of Study Area 1 included the following locations: COR-41, COR-40, COR-39, COR-38, and COR-35. At location COR-41, the core was advanced in 2007 to a depth of 3.5 ft (recovery up to 2.1 ft) with samples (and corresponding 2,3,7,8-TCDD concentrations) collected at 0-1 ft (<0.0016 U µg/kg) and 1-2 ft (<0.00049 µg/kg). The location COR-40, adjacent to the Former Flexsys Facility, was sampled in 2007 and again in 2008. In 2007, the core was advanced to a depth of 3.3 ft with 100 percent recovery and with samples (and corresponding 2,3,7,8-TCDD results) collected from 0-2 ft (0.01 µg/kg) and 2-3.3 ft (0.0081 µg/kg). In 2008, the core was advanced to a depth of 5.5 ft with 100 percent recovery and with samples collected at 0-2 ft (0.049 µg/kg 2,3,7,8-TCDD), 2-4 ft (<0.00074 U µg/kg 2,3,7,8-TCDD), and 2-5.5 ft (<0.003 µg/kg 2,3,7,8-TCDD). The location at COR-39, adjacent to the Former Flexsys Facility, was sampled in 2007 and was advanced to a depth of 3.7 ft (recovery up to 2.8 ft) with samples (and corresponding 2,3,7,8-TCDD results) collected from the 0-1.4 ft interval (22 J µg/kg), and 1.4-2.8 ft (33 J µg/kg). It was noted that a strong hydrocarbon odor was encountered throughout the entire core. At location COR-38, adjacent to the Former Flexsys Facility, only 2.7 ft of sediment was penetrated (recovery up to 2 ft) with only one sample collected from 0-2 ft with a 2,3,7,8-TCDD concentration of 0.0087 µg/kg. At location COR-35, the core was advanced in 2007 to a depth of 5 ft (recovery up to 4.5 ft) with samples (and corresponding 2,3,7,8-TCDD results) collected at 0-2 ft which was also a field duplicate sample (0.0036 µg/kg and 0.003 µg/kg), 2-4 ft (<0.00034 µg/kg), and 2-4.5 ft (<0.00038 µg/kg).

The samples collected from the left bank of Study Area 2 included the following locations: COR-42, COR-36A, COR-36, COR-36B, COR-36C, and COR-33. At location COR-42, the core was sampled in 2007 and resampled in 2008. In 2007, the core was advanced to a depth of 2.4 ft with 100 percent recovery and one sample was collected at 0-2.4 ft which resulted in <0.00026 µg/kg for 2,3,7,8-TCDD. In 2008, the core was advanced to a depth of 1.5 ft with 100 percent recovery and one sample collected at 0-1.5 ft which was also a field duplicate sample with 2,3,7,8-TCDD results of <0.0011 U µg/kg and 0.0018 µg/kg, respectively. At location COR-36A, the core was only advanced in 2008 to a depth of 0.8 ft with 100 percent recovery and one sample collected from 0-0.8 ft with a 2,3,7,8-TCDD result of <0.00065 µg/kg. The longest core was advanced at location COR-36 to a depth of 10 ft (recovery up to 9.1 ft) in 2007 and a depth of 9.2 ft with 100 percent recovery in 2008. In 2007, samples (and corresponding 2,3,7,8-TCDD results) were collected from 0-2 ft (0.027 µg/kg), 2-4 ft (3.3 J µg/kg), and 4-6 ft (18 J µg/kg) and a petroleum odor was observed at 3 ft. In 2008, samples (and corresponding 2,3,7,8-TCDD results) were collected from 0-2 ft (0.15 µg/kg), 2-4 ft with a field duplicate (2.3 J µg/kg and 1.6 J µg/kg, respectively), 4-6 ft (25 J µg/kg), 6-8 ft (3.8 J µg/kg), and 8-9.2 ft (0.21 µg/kg). At COR-36B, only one sample was collected in 2008 from 0-1 ft (0.025 µg/kg) as the core was only advanced to 1.2 ft below the top of sediment, with 100 percent recovery. The location COR-36C was advanced in 2008 to 3.5 ft (recovery up to 3.3 ft) with a sample (and corresponding 2,3,7,8-TCDD result) collected at 0-2 ft (0.46 J µg/kg) and 2-3.3 ft (0.16 µg/kg). The last coring location in Study Area 2 was COR-33, which was advanced in 2007 to a depth of 2.7 ft (recovery up to 1.8 ft) with one sample collected at 0-1.8 ft and had a 2,3,7,8-TCDD concentration of 0.19 µg/kg.

The highest 2,3,7,8-TCDD concentration was observed in Study Area 2 at subsurface sediment sample location COR-39, adjacent to the Former Flexsys Facility, on the right bank. At COR-39, the sample collected from the 1.4 to 2.8 ft below top of sediment interval had a 2,3,7,8-TCDD concentration of 33 J µg/kg. Approximately 1,500 ft downstream on the opposite bank, COR-36 had the second highest 2,3,7,8-TCDD concentration of 25 J µg/kg in the 4-6 ft below top of sediment interval.

Six cores were collected from Study Area 3, downstream of the Former Flexsys Facility. Four cores were collected from the right bank and two from the left bank. The samples collected from the right bank starting from downstream of Study Area 2 were collected from the following locations: COR-30, COR-28A, COR-28, and COR-25. At location COR-30, the core was advanced in 2007 to a depth of 2.9 ft (recovery up to 2.5 ft) with samples (and corresponding 2,3,7,8-TCDD results) collected at 0-2 ft (<0.00036 µg/kg) and 2-2.5 ft (0.0021 µg/kg). A trace of coal was observed in this core at 0.2 ft below the top of sediment. The location COR-28A was only advanced in 2008 to a depth of 0.5 ft with 100 percent recovery and one sample was collected at 0-0.5 ft with a 2,3,7,8-TCDD result of <0.0004 µg/kg. COR-28 was advanced in 2007 to a depth of 2.3 ft (recovery up to 2.0 ft) with one sample collected at 0-2 ft (<0.0004 µg/kg 2,3,7,8-TCDD) and a metallic odor was detected in the core from 0.9-1.1 ft below the top of sediment. The last core location in Study Area 3 along the right bank was COR-25 which was advanced to a depth of 1.2 ft with 100 percent recovery and one sample collected from 0-1.2 ft (<0.00045 µg/kg 2,3,7,8-TCDD). The sample locations along the left bank of Study Area 3 included: COR-32A and COR-32B. At location COR-32A, the core was advanced in 2008 to a depth of 1.5 ft with 100 percent recovery and one sample collected from 0-1.5 ft (<0.00055 µg/kg 2,3,7,8-TCDD). COR-32B was advanced to a depth of 9 ft (recovery up to 7.8 ft) in 2008 with samples (and corresponding 2,3,7,8-TCDD concentrations) collected at 0-2 ft (<0.00025 µg/kg), 2-4 ft (<0.00042 µg/kg), 4-6 ft (<0.00036 µg/kg), and 6-7.8 ft (<0.00039 µg/kg).

Only one sample from Study Area 3 had a detectable 2,3,7,8-TCDD concentration: location COR-30 at the 2-2.5 ft below top of sediment interval with a concentration of 0.0021 µg/kg. All other samples collected in Study Area 3 were non-detect for 2,3,7,8-TCDD.

Fourteen cores were collected from Study Area 4. Nine cores were successfully collected from locations along the right bank of the River (two additional locations were attempted but not successfully advanced) and five of the core locations were collected along the left bank of the River. Core collection was attempted at six locations in the center of the channel; however, none were successfully advanced.

The samples collected along the right bank, starting from downstream of Study Area 3, were collected from the following locations: COR-23, COR-22, COR-21, COR-20, COR-18, COR-11, COR-09, and COR-07. At location COR-23, the core was advanced in 2007 to a depth of 3.0 ft (recovery up to 2.3 ft) with one sample (and corresponding 2,3,7,8-TCDD concentration) collected at 0-2.3 ft (<0.00052 µg/kg). Fine grained coal was observed throughout this core. The location COR-22 was advanced in 2007 to a depth of 7.9 ft (recovery up to 4.1 ft) with samples (and corresponding 2,3,7,8-TCDD concentrations) collected at 0-2 ft (3 J µg/kg), and 2-4.1 ft (1.1 J µg/kg). Black staining and a hydrocarbon odor were observed at 1.5 ft. COR-21 was advanced in 2007 to a depth of 10 ft (recovery up to 6.5 ft) with samples (and corresponding 2,3,7,8-TCDD concentrations) collected at 0-2 ft with a field duplicate (2.7 J µg/kg and 2.3 J µg/kg), 2-4 ft (0.088 µg/kg), and 4-6.5 ft (0.0018 µg/kg). Coal was observed at 2.17 ft, 3.4 ft, and 5.3 ft and a hydrocarbon odor was detected at 1.5 ft. At the location of COR-20, the core was advanced in 2007 to a depth of 2.6 ft with 100 percent recovery and samples (and corresponding 2,3,7,8-TCDD results) collected at 0-2 ft (0.014 µg/kg) and 2-2.6 ft (0.052 µg/kg). At location COR-18, the core was advanced in 2007 to a depth of 10 ft but recovery of the core was unsuccessful; however, a sample was collected from 0-2 ft with a corresponding 2,3,7,8-TCDD result of <0.00047 µg/kg. COR-11 was advanced in 2007 to a depth of 2.5 ft (recovery up to 2.0 ft) with one sample collected at 0-2 ft, with a 2,3,7,8-TCDD concentration of 0.015 µg/kg, and a diesel odor was detected at the surface of the core. At location COR-09, the core was advanced in 2007 to a depth of 3.3 ft (recovery up to 2.8 ft) with samples collected at 0-2 ft (0.0086 μg/kg 2,3,7,8-TCDD) and 2-2.8 ft (<0.00055 μg/kg 2,3,7,8-TCDD). Finally along the right bank, COR-07 was advanced in 2007 to a depth of 3 ft with 100 percent recovery and samples collected at 0-2 ft (<0.00031 μg/kg 2,3,7,8-TCDD) and 2-3 ft (<0.00027 2,3,7.8-TCDD μg/kg). Bits of coal were observed at 1.3 ft below the top of sediment at COR-07.

The samples collected from the left bank starting from downstream of Study Area 3 were collected from the following locations: COR-15, COR-12, COR-08, COR-04, and COR-03. At location COR-15, the core was advanced in 2008 to a depth of 2.8 ft (recovery up to 1.6 ft) with three samples collected from the 0-1.6 ft interval, which resulted in 2,3,7,8-TCDD concentrations of 0.013 μg/kg, 0.0042 μg/kg, and 0.0049 μg/kg. The core at location COR-12 was advanced in 2007 to a depth of 2.5 ft (recovery up to 2.0 ft) with one sample collected at 0-1.8 ft and 2,3,7,8-TCDD was detected with a concentration of 0.15 μg/kg. At location COR-08, the core was advanced in 2007 to a depth of 4.0 ft with 100 percent recovery with samples (and corresponding 2,3,7,8-TCDD concentrations) collected at 0-2 ft (0.0093 μg/kg) and 2-4 ft (1.4 J μg/kg). At location COR-04, the core was advanced in 2007 to a depth of 10 ft (recovery up to 8.2 ft) with samples (and corresponding 2,3,7,8-TCDD concentrations) collected at 0-2 ft (0.013 μg/kg), 2-4 ft (0.0098 μg/kg), and 4-6 ft (0.0086 μg/kg). Finally, at COR-03, the core was advanced in 2007 to a depth of 10 ft (recovery up to 8.9 ft) with samples (and corresponding 2,3,7,8-TCDD results) collected at 0-2 ft (0.0083 μg/kg), 2-4 ft (0.011 μg/kg), and 4-6.8 ft (0.019 μg/kg).

The highest 2,3,7,8-TCDD concentration in Study Area 4 was detected at location COR-22, along the right bank, approximately 2,000 feet downstream of the Study Area 3 limit. The sample collected from the 0-2 ft interval of this core had a 2,3,7,8-TCDD concentration of 3.0 μg/kg. The second highest concentration was detected at COR-21 in the 0-2 ft interval, which was also analyzed as a field duplicate and had 2,3,7,8-TCDD concentrations of 2.7 μg/kg and 2.3 μg/kg, respectively. At both COR-22 and COR-21, the 2,3,7,8-TCDD concentrations decreased with sediment depth.

Sediment core sampling identified trends in sediment 2,3,7,8-TCDD concentrations with sample depth. A number of core samples collected by U.S. EPA had identified a pattern of "cleaner" sediments at the surface underlain with sediments of increasing 2,3,7,8-concentration with increasing depth. At a number of core locations, the 2,3,7,8-TCDD concentration decreased as sample depth increased beyond the detected peak concentration. This pattern is typically associated with historic sources being controlled and the Site undergoing a natural recovery process.

Sediment core sampling completed as part of the Phase II EOC activities identified similar patterns in 8 of 18 sediment cores with multiple sample intervals adjacent to and downstream of Nitro (COR-03, COR-08, COR-20, COR-30, COR-32B, COR, COR-36 in 2007 and 2008, and COR-39). Sediment core profiles for the Phase II EOC cores are presented on Figures 4.22 through 4.25. At three core locations (COR-36, COR-39, and COR-03), the concentration profile identifies an increasing 2,3,7,8-TCDD concentration with depth. This profile is indicative of recovery of the River sediments, with lower concentration sediments being deposited on top of sediments historically deposited which had higher 2,3,7,8-TCDD concentrations. This profile was not observed at all locations. This could be due to disturbance of the sediment column by coal recovery dredging, more recent releases, or can be an indication of an unstable sediment deposit. Further evaluation of the stability of the sediment deposits was completed as part of the modeling and is discussed in Section 4.4.7.

4.4.4.1 BLACK CARBON SAMPLE RESULTS

The results from the black carbon sample analysis are summarized in Table 4.11 and sample locations are presented on Figure 4.11. The 8 samples were submitted for analysis of black carbon content, 2,3,7,8-TCDD, TOC, and TS. Samples were collected to determine if coal present in the River is a preferred site for 2,3,7,8-TCDD adsorption.

The black carbon content was calculated using the Lloyd Kahn method. The TOC values were determined using both the Lloyd Kahn method and SW-846 Method 9060 (modified).

The results for 4 samples (BC-COR-10A, BC-COR-10B, BC-COR-13A, and BC-COR-13B) in the coarsest coal fraction with the highest concentrations of 2,3,7,8-TCDD (0.042 µg/kg, 0.049 µg/kg, 0.13 µg/kg, and 0.074 µg/kg, respectively) were not calculated due to insufficient sample volume. Results were analyzed to determine if a correlation was present between 2,3,7,8-TCDD concentration and black carbon content. The samples with the highest black carbon content (BC-SSD-26B (A) and (B)) resulted in non-detect values for 2,3,7,8-TCDD. Of the samples with non-detect values for black carbon, there was one sample with a moderately low 2,3,7,8-TCDD concentration of 0.078 µg/kg and the remaining samples indicated very low 2,3,7,8-TCDD values, which ranged from non-detect to 0.046 µg/kg. Based on these data, there is no identified correlation between black carbon content and 2,3,7,8-TCDD concentrations.

4.4.4.2 NATURAL RECOVERY CORE RESULTS

The results from the NRC sample analysis are presented in Table 4.12 and NRC sample locations are presented on Figure 4.12. Eight samples were collected; however, only four samples were submitted for analysis of Be-7, Cs-137, and TS. The remaining four samples (NRC-01, NRC-03, NRC-06, and NRC-07) were archived. In depositional environments, radioisotope data can provide information on sediment deposition rates and mixing rates. Due to the short half-life of Be-7 (53.3 days) the presence of Be-7 concentrations in the upper sediment layers can be used to characterize recent deposition and/or bioturbation rates.

No cores were collected from Study Area 1, upstream of the Former Flexsys Facility.

From Study Area 2, adjacent to the Former Flexsys Facility, one core (NRC-08) was advanced and sampled during both the 2007 and the 2008 mobilizations. In 2007, the core was advanced to 4.5 ft (recovery up to 3.9 ft) with samples collected at 0 ft, 0.08 ft, 0.16 ft, 0.24 ft, 0.67 ft, 1.16 ft, 1.66 ft, 2.33 ft, 3 ft, and 3.66 ft. All samples were non-detect for Be-7 and Cs-137 and ranged from 36.6 percent to 64.2 percent TS. Coal was observed from 0.75-1.16 ft below the top of sediment at location NRC-08 during core advancement. In 2008, the core was advanced to 7.4 ft with 100 percent recovery with samples collected every inch from 0 to 3 inches and then every foot from 1 to 6 ft. All samples were non-detect for Be-7 and Cs-137 except for three samples for Cs-137 collected at 0 ft (0.122 J +/-0.0601 picoCuries per gram (pci/g)), 0.16 ft (0.0787 J +/-0.0436 pci/g), and 0.24 ft (0.0835 J +/-0.0422 pci/g). Values for TS ranged from 8.8 percent to 40.1 percent.

No cores were collected from Study Area 3, immediately downstream of the Former Flexsys Facility.

From Study Area 4, downstream of the Former Flexsys Facility, two cores (NRC-05 and NRC-04) were advanced and sampled in 2008 and one core (NRC-02) was advanced and sampled in 2007. At NRC-05, just downstream of the Study Area 3 limit, the core was advanced to 9.0 ft (recovery up to 5.0 ft) with samples collected at 1 inch intervals at 0 ft, 0.08 ft, 0.16, 0.25 ft, 0.75 ft, and 1.58 ft and 2 inch intervals at 2.33 ft, 3.16 ft, 4 ft, and 4.83 ft. All samples were non-detect for Be-7 and Cs-137 except for two samples for Cs-137 collected at 0.08 ft (0.11 J +/-0.0405 pci/g), and 0.16 ft (0.0823 J +/-0.0436 pci/g). Values for TS ranged from 9.2 percent to 38.9 percent. Coal was observed at 1.2 ft and 2.3 ft and a subtle hydrocarbon odor was detected at 1.6 ft. At NRC-04, the core was advanced to 3.5 ft with 100 percent recovery and samples collected at 1 inch intervals at 0 ft, 0.08 ft, 0.16, 0.25 ft, 0.83 ft, and 1.33 ft and 2 inch intervals at 1.83 ft, 2.33 ft, 2.83 ft, and 3.33 ft. All samples were non-detect for Be-7 and Cs-137 except for one sample for Cs-137 collected at 0.08 ft (0.136 J +/-0.0552 pci/g). Values for TS ranged from 5.3 percent to 29 percent. A strong diesel odor was detected at 0.8 ft and a trace of coal was observed at the surface of the core. Lastly, in 2007, NRC-02 was advanced to 8 ft (recovery up to 7.7 ft) and samples were collected at 0 ft, 0.08 ft, 0.16, and 0.25 ft and then at 1 foot intervals from 1 ft to 6 ft. All samples were non-detect for Be-7. Non-detect values for Cs-137 occurred at two samples collected at 0 ft and 0.16 ft below the top of sediment. The remaining samples for Cs-137 had values of 0.0702 J +/-0.0341 pci/g (0.08 ft), 0.0485 J +/-0.0204 pci/g (0.25 ft), 0.0471 J +/-0.0279 (1 ft), 0.074 +/-0.0283 pci/g (2 ft), 0.121 J +/-0.0418 pci/g (3 ft), 0.151 J +/-0.0468 (4 ft), 0.103 +/-0.0425 pci/g (5 ft), and 0.128 J +/-0.0401 pci/g (6 ft). Values for TS ranged from 53.6 percent to 74.9 percent.

Very low levels of radioisotopes were detected in the natural recovery core samples, consistent with the low levels of sediment fines and TOC that are characteristic of the River. The laboratory extended count times up to 3 fold to reduce detection limits; however, in most samples, detectable levels of radioisotopes were not present. As a result, the natural recovery cores did not provide radioisotope data to reliably determine sediment age patterns.

4.4.5 SAMPLE ANALYSIS FOR ADDITIONAL PARAMETERS

The results from the expanded analysis for surface and subsurface sediment samples are summarized in Tables 4.10a and 4.10b, respectively. For comparison purposes, the Mid-Atlantic Biological Technical Assistance Group (BTAG) Freshwater Screening Benchmark Levels are included on Tables 10a and 10b. Sample locations are presented on Figures 4.7 to 4.10. The eight surface samples and eight subsurface samples were submitted for analysis of dioxin and furan congeners, priority pollutant metals, SVOCs, PCBs, and chlorinated pesticides. Samples were collected to determine whether other significant COCs are present in the River.

Of the eight surface sediment samples (excluding the field duplicate at SSD-20) and eight field subsurface sediment samples, several constituents other than 2,3,7,8-TCDD were detected at levels nominally exceeding screening levels utilized in other jurisdictions[2]. These screening criteria are very conservative and exceedance of the

2 Sediment screening criteria for other jurisdictions (Ontario Ministry of the Environment) are utilized as West Virginia and U.S. EPA Region III do not have promulgated sediment quality criteria or screening criteria in place.

criteria does not necessarily indicate unacceptable risks. Exceedances of the screening criteria may warrant additional assessment to determine if unacceptable risks are associated with those parameters; however that assessment is beyond the scope of this EE/CA. Many of these results exceeded carbon-normalized screening levels as a result of the relatively low concentrations of TOC characteristic of the River, as well as elevated detection limits due to the presence of other interfering chemicals detected in the samples.

Aside from the cases where a screening level was exceeded only as the result of an elevated detection limit, the constituents that appeared to exceed the carbon-normalized screening level most notably included bis (2-ethyl hexyl) phthalate (DEHP) and di-n-octyl phthalate (DNOP). DEHP was present at elevated concentrations at all eight of the subsurface sediment sample locations. The highest DEHP detections were at COR-39 in sample intervals 0-1.4 ft and 1.4-2.8 ft, in the range of 1,500 to 1,700 mg/kg, respectively, and at location COR-36 across the River at about one-fifth of the levels detected at COR-39. DNOP was present in only two of the eight samples; both were in COR-39 samples in the range of 24 to 36 mg/kg. These constituents were detected at only very low concentrations in the surface sediment samples, at levels that do not exceed the carbon-normalized screening level.

PCBs were not detected in any of the eight surface sediment samples. Total PCBs exceeded the carbon-normalized screening level and the dry weight basis screening level in subsurface sediment samples collected from COR-39 at 0-1.4 ft and 1.4-2.8 ft. The detection of Aroclor 1248 in these samples and Aroclor 1260 in the sample collected from the 1.4 to 2.8 ft interval were elevated above screening criteria.

Several constituents were present at concentrations exceeding the Ontario Lowest Effect Level for unadjusted results, including several polycyclic aromatic hydrocarbons (acenapthylene, benzo(a) pyrene, benzo (g,h,i) perylene, fluorene, fluoranthene, phenanthrene, pyrene), methyl phenols (2-, 4-, 2,4- dimethyl) and certain pesticides such as 4,4'-DDD, 4,4'-DDE, endrin, alpha-Benzenehexachloride (BHC), delta-BHC and methoxychlor, chlordane). In a number of these cases, the exceedance of the screening level was marginal and also limited to one location. It should be noted that none of these parameters exceeded the corresponding carbon normalized screening levels.

Of the metals detected, the following metals exceeded the Ontario Lowest Effect Levels in six of the eight surface sample locations (COR-03, COR-20, SSD-18, SSD-20, and SSD-27): copper, mercury, nickel, silver, and, zinc. Of the subsurface samples, the screening levels were exceeded for the following metals: arsenic, cadmium, copper, lead, mercury, nickel, silver, and zinc. It was observed that surface sediments had lower metal concentrations than subsurface samples.

The sixteen field samples submitted for additional analyses were also analyzed for the full suite of PCDD/PCDF. Very low concentrations of several congeners were detected in most of these samples. A toxicity equivalent quotient (TEQ) was calculated for each sample, with results for each congener equated to the toxicity of an equivalent concentration of 2,3,7,8-TCDD. The ratio of the 2,3,7,8-TCDD results to the total TEQ for the samples ranged from 75 to 99 percent. It should be noted that the three results with ratios in the 75 percent range were surface sediment samples with very low total PCDD/PCDF results (in the range of 0.01-0.02 μg/kg TEQ). All of the remaining ratios, where calculable (three samples had no calculable TEQ), were in the 92 to 99 percent range for 2,3,7,8-TCDD as a proportion of the TEQ.

4.4.6 SEDFLUME ANALYSIS RESULTS

A total of 18 sediment cores were obtained from the River and submitted to the SEI laboratory in CA to characterize the stability of the sediment within the River. Sediment bulk density, particle size distribution, critical shear stress, and erosion rates as a function of shear stress and depth were determined for each of the sediment cores. The critical shear stress determined by two interpolation techniques (power law and linear) identified the minimum shear stress at which a very small measurable rate of erosion will occur, and this rate of erosion is defined as 10^{-4} cm/s (McNeil et al., 1996; Roberts et al., 1998). Erosion rates were measured at different shear stresses for each depth interval for all sediment cores. A detailed description of the experimental procedures that were conducted to measure these data is presented in the Sedflume Analysis Report in Appendix K.

A summary of the mean results from the Sedflume analysis are presented in Table 4.14. Complete data are presented in Appendix K. Deeper subsurface sediment required greater shear stress to erode than surface sediment, due to the greater bulk density of subsurface (versus surface) sediment. Appendix K presents Figures showing the erosion rates for each sediment core with respect to sediment depth and applied shear stress during the Sedflume analysis. These data were used in follow-on sediment stability and transport modeling evaluations, discussed in the section below.

4.4.7 HYDROLOGIC AND SEDIMENT TRANSPORT MODELING

Hydrodynamic and sediment transport modeling was completed to evaluate sediment stability, transport, and recovery within the Site and with particular focus on areas of elevated 2,3,7,8-TCDD concentration. The primary objectives of the modeling were to:

- Develop a detailed understanding of hydrodynamics within the River to evaluate sediment stability over a range of storm and non-storm flow conditions. This aids in the evaluation of sediment transport and stability evaluations, and the resulting analyses can also be used to develop preliminary designs for RA alternatives such as capping.
- Assess the stability of sediment deposits with elevated subsurface 2,3,7,8-TCDD concentrations.
- Assess sediment deposition rates based on River transport characteristics, and use this information to assess sediment natural recovery rates.

Modeling was completed utilizing the Environmental Fluid Dynamics Code (EFDC). EFDC is a three-dimensional model that solves the vertically hydrostatic, free surface, and turbulence averaged equations of motion for a variable density fluid. Developed by Hamrick (1992) at the Virginia Institute of Marine Science, EFDC is a public domain model supported by U.S. EPA. The model includes hydrodynamic, sediment, water quality and toxic modeling capabilities and has been extensively applied to rivers, lakes, estuaries, wetlands, bays and coastal areas.

EFDC can simulate the transport of multiple sizes of sediment, including both cohesive (i.e., clay) and non-cohesive (i.e., sand and gravel) material which both exist at the Site. Both bed-load (resuspended sediment) and suspended-load (sediment suspended in the water column as it enters the Site) can be modeled by the software. Multiple bed-load transport equations for non-cohesive sediment are included in the source code (such as bed-load formulations due to van Rijn, 1984a or Engelund and Hansen, 1967). The model can also simulate settling, deposition, and resuspension (entrainment) of sediments. Various settling velocity formulations for cohesive sediment are included. EFDC simulates multiple layers of bed material as well as the effect of consolidating sediment. The model includes consideration for armoring (coarsening) of the bed surface as well as a probability-based exposure and hiding relationship to account for the heterogeneity of the bed surface. Both are important components of transport of multiple grain sizes.

The EFDC model has been applied at over 80 sites (Craig, 2005). Applications of the model include simulation of wetting and drying processes of hydrodynamics and sediment transport, thermal discharge studies, tidal intrusion, and water quality modeling. The model is widely used by universities and government agencies and has been applied at several U.S. Superfund sites. The model was set up for the Kanawha River and its floodplains just downstream of the confluence of the Coal and Kanawha Rivers and Winfield Dam. A rectangular grid was developed for the main channel and floodplain. The grid was defined by 11,629 cells with dimensions of 98.4 ft (30 m by 30 m).

In addition to the EFDC model, the Surface Water Modeling System (SWMS), developed by Aquaveo and distributed by Environmental Modeling Systems Inc. (EMS) was utilized to confirm the hydrodynamic model behavior predicted by EFDC. The U.S. Federal Highways Administration's (U.S. FHWA) Finite Element Surface Water Modeling System (FESWMS) is integrated into SWMS and was used for the modeling. FESWMS is a hydrodynamic model that supports both super and sub-critical flow analyses, including area wetting and drying. It uses the depth-averaged Flow and Sediment Transport model (FST2DH), a two-dimensional finite element surface water model that can compute the direction of flow and water surface elevation in a horizontal plane. FESWMS is a proven hydrodynamic model which was employed to verify the appropriate setup of the EFDC model.

Similar to the EFDC model, the SMS model was set up for the Kanawha River and its floodplain between the confluence of the Coal and Kanawha Rivers and Winfield Dam. A curvilinear, mostly orthogonal grid was developed for the floodplain. The grid was defined by 54,787 nodes connected into 19,579 quadrilateral and triangular elements. The bathymetric surface required for the modeling was created in ArcView from a Digital Elevation Map (USGS) and a hydrographic and geophysical survey conducted by Golder in 2005 as part of the Phase I EOC study.

Calibration of the models was completed using all available data compiled as part of the implementation of the EOC study for the Site, including River configuration, sediment bathymetry, sediment thickness, grain size information, erosion characteristics of sediment determined based on the Sedflume testing, stage discharge record information (1931 to present), and operational information for the Winfield Dam.

Both models identified that minimal flooding beyond the top of bank of the main River channel is associated with the 100-year storm event. Where flooding occurs, it is associated with backwater effects in tributaries. The EDFC model calculated maximum flow velocities of up to 5.4 ft/s in the main channel and 3.85 ft/s in the overbank under the 100-year flood scenario near the Flexsys Facility (RM 42.38). The SMS model calculated maximum flow velocities of up to 6.2 ft/s in the main channel and 4.6 ft/s in the overbank under the 100-year flood scenario near the Flexsys Facility (RM 42.38). Center channel and near bank velocities in the SMS and EFDC models are comparable. Figures 4.28 through 4.31 present the SMS calculated shear stress mapping for Study Areas 1 through 4 for the 100-year flood event. These data are overlain on surface sediment 2,3,7,8-TCDD concentration data and areas with elevated shear stresses and elevated 2,3,7,8-TCDD concentrations identified. In particular, the COR-39 location was determined to be erodible under larger storm events. As discussed above, subsurface sediment (1.4 to 2.8 ft below mudline) at COR-39, adjacent to the Former Flexsys Facility, contained the highest 2,3,7,8-TCDD concentration detected at the Site of 33 J µg/kg.

Based on the Sedflume sediment stability testing (Appendix K of the EE/CA), the area in the vicinity of COR-39 is subject to erosion under conditions less than the 100-year storm events. By contrast, other areas of the Site with elevated 2,3,7,8-TCDD concentrations are not as subject to erosion under conditions less than the 100-year storm event.

Based on the source control activities either recently completed or underway at the Former Flexsys Facility, further control of ongoing loading of 2,3,7,8-TCDD to the River in the Nitro area is possible. Using the EFDC model, natural recovery processes for the Study Area were evaluated to estimate sediment recovery rates following implementation of various RA Alternatives. The RA Alternatives and evaluation of recovery of the Site under each Alternative are discussed in Sections 7.0 and 8.0, respectively.

4.4.8 SURFACE-WEIGHTED AVERAGE CONCENTRATION

Surface-Weighted Average Concentrations (SWACs) are a representation of the average sediment concentration within a given area of interest. Potential risks to human health from consuming fish caught from the Site area results from integrated bioaccumulation exposures of fish to bioavailable sediment contaminants throughout the characteristic foraging range for target fish species. Therefore, assessments of potential bioaccumulation exposures to sediments in the Site area, along with potential reductions in fish tissue concentrations resulting from sediment remediation (see Section 6.3.2), are appropriately based on SWACs calculated over a reasonably conservative home range for target fish species.

Several important recreational fish have been used as target species for bioaccumulation monitoring in various parts of the Kanawha River, including channel catfish (*Ictalurus punctatus*) and largemouth bass (*Micropterus salmoides*). Both species feed on a range of aquatic insects, benthic organisms, planktonic organisms and other fish. Channel catfish typically reside in the deeper parts of moderate to large rivers, but they may move inshore to feed at night. Though largely sedentary, channel catfish can migrate relatively large distances (10 to 40 miles). Largemouth bass typically reside in the upper levels of the warm water of larger slow rivers. Though this species is highly territorial during spawning in the spring, and summer territories are relatively small, individuals may move up to 3 to 5 miles over the course of the entire year. Thus, largemouth bass have an overall smaller home range than channel catfish. Other sport fish (e.g., other bass species) have a similar home range as largemouth bass.

As recreational fish forage throughout a range that encompasses much of the Site, the corresponding SWAC should be calculated over the reasonable minimum area of fish exposure representative of its home range. Based on the home range behavior summarized above, the SWAC was calculated for this EE/CA over a rolling 3-mile reach of the River encompassing Study Areas 1 through 4.

The 1/2-mile sections of River used to make up each of the rolling 3-mile reaches are presented on Figure 4.26.

For the Site, SWACs were calculated for rolling 3-mile sections of the Study Area, moving in 1/2–mile increments. Where the 3-mile reach being evaluated includes a tributary or tributaries to the river, the backwater areas at the tributary mouths were included in the SWAC calculation, including all relevant data from the backwater areas. The SWAC calculation methodology is presented in detail in Appendix Q and summarized below:

- For each 1/2 mile segment of the River, all 2,3,7,8-TCDD sediment data were tabulated and reviewed. Where the 3-mile reach being evaluated included a tributary or tributaries to the river, relevant data from the backwater areas at the tributary mouths were included
- All data for samples which included at least some portion of sediment in the bioactive zone (upper 10 cm) were used in the SWAC calculations. Data for samples collected below the bioactive depth were excluded. Data tables for each 1/2-mile segment are provided in Appendix Q.
- Where core samples and surficial sediment samples were co-located, the surficial sediment sample was selected. As part of the data review, two locations (COR-11

and KRSD-03) were identified where the 0-2' interval sample from the core exhibited higher concentrations than the corresponding surfiucial sample. As discussed in Section 9.1, these areas will be subject to additional sampling during pre-design and the SWAC for these areas re-evaluated.

- The maximum concentration of split samples or duplicate samples was selected to be conservative.
- Non-detected results were assigned a value of 1/2 the detection limit for the sample, and duplicate and split sample results were averaged.
- 2,3,7,8-TCDD concentration contour maps were developed from the data retained as outlined above, and the average sediment concentration and sediment surface area for each 1/2-mile segment calculated utilizing Environmental Visualization Software (EVS) as described in Appendix Q.
- Within each 3-mile reach, the SWAC was calculated as the area-weighted average concentration of the six included 1/2-mile segments.

Figure 4.27 presents the calculated 2,3,7,8-TCDD SWAC for each of the rolling 3-mile reaches. The highest existing 2,3,7,8-TCDD SWAC for surface sediments within a 3-mile reach is approximately 0.022 μg/kg (dry wt basis) from RM 39 - 42.

4.5 UPDATED CONCEPTUAL SITE MODEL

This section describes the various aspects of the CSM which frames the understanding of 2,3,7,8-TCDD sources, fate and transport processes, environmental receptors, and exposure mechanisms which were evaluated as part of the EE/CA. Specifically, this section discusses the following based on available historic information:

- Physical and Chemical Properties of 2,3,7,8-TCDD
- Sediment Transport Processes
- Dredging Activities in the Site
- Groundwater and Local Surface Water 2,3,7,8-TCDD Loading
- Potential Exposure Pathways

The CSM is based on historic information and data obtained during implementation of the EOC Investigation completed for the Site.

4.5.1 PHYSICAL AND CHEMICAL PROPERTIES

In its pure form, 2,3,7,8-TCDD is a colorless, odorless crystalline solid with a molecular weight of 321.97. It is insoluble in water, with measured solubility of 2×10^{-7} g/L at 25°C (US Department of Health and Human Services, 2011). Other physical and chemical properties of 2,3,7,8-TCDD are discussed below.

Chemical Partitioning: 2,3,7,8-TCDD is extremely hydrophobic, as evidenced by relatively high values of the octanol-water (log K_{ow}) and organic carbon (log K_{oc}) partitioning coefficients. As a result, 2,3,7,8-TCDD partitions strongly to soil, sediment, and other particulate matter, and is not readily dissolved in either surface water or groundwater, unless it is subject to co-solution by other organic fluids. High volume 2,3,7,8-TCDD groundwater sampling completed in areas of the Former Flexsys Facility with elevated organic fluids have not exhibited elevated 2,3,7,8-TCDD concentrations. Because of these environmental characteristics, 2,3,7,8-TCDD is not expected to leach significantly from soils or sediments into pore waters. Therefore, the dominant transport processes are through its adherence to particulates. The preference of 2,3,7,8-TCDD for particulate-phase transport is evidenced by the results of the high-volume water samples from the River, in which an average of 90 percent or more of the total 2,3,7,8-TCDD concentration in the water column was associated with suspended sediments (U.S. EPA, 2000b). Because of its hydrophobicity, 2,3,7,8-TCDD bioaccumulates in the tissues of fish and other aquatic organisms; however, 2,3,7,8-TCDD does not tend to biomagnify significantly (U.S. EPA, 1993a).

Environmental Degradation and Persistence: 2,3,7,8-TCDD degradation rates have been determined using biodegradation rate experiments as well as field studies of chemical persistence under controlled applications. Degradation half-lives range from one to several years for soil and sediment (SRC, 2003). These published rates are not inconsequential in terms of sedimentary and natural recovery processes, which are also measured on time scales of years and decades.

Degradation of 2,3,7,8-TCDD via volatilization and photolysis in the River is assumed to be negligible (e.g., see LTI, 2000). These processes are hindered by the chemical's affinity to bind with suspended sediments.

4.5.2 SEDIMENT TRANSPORT PROCESSES

Because 2,3,7,8-TCDD is hydrophobic and sediment-bound, its fate and transport is closely linked to the fate and transport of soil and sediments. Potentially important sediment transport processes in the River include the following:

- Sediment Loading
- Sedimentation
- Resuspension
- Sediment Dispersion (Bioturbation and Propwash)

Sediment Loading: Several rivers and creeks are tributary to the River in the area of investigation between the Winfield Dam and the Nitro area. These include the Coal River (RM 45.5-Left, which denotes the upstream boundary of the Site), Scary Creek (RM 42.8-Left), Armour Creek (RM 40.8-Right), the Pocatalico River (RM 39.1-Right) and its subdrainages Heizer Creek and Manila Creek, and Bill's Creek (RM 38.2-Left), among others.

LTI (2000) found no significant increase in TSS concentrations in the River between St. Albans (RM 46.1) and the Winfield Dam (RM 31.1) under a range of flow conditions. As a result, tributary contributions of suspended sediments to this reach of the River are probably small compared to the ambient sediment load carried in the main stem of the River. This is supported by comparing the flow in the Pocatalico River, a major tributary to the Site, with the flow in the River, although the only USGS gauging station on the Pocatalico River is about 10 miles upstream of the confluence in the town of Sissonville, WV. The flow in the Pocatalico at Sissonville is typically 1 to 4 percent of the flow in the River.

Sedimentation: Sedimentation rates in the main channel of the River are relatively low, based in part on U.S. ACE observations that the navigational channel is effectively self-scouring due to velocities in the navigation channel generating shear stresses sufficient to remove accumulated sediments on an ongoing basis. Therefore, the navigational channel does not require maintenance dredging. Fine-grained sediments have been observed to accumulate in the nearshore areas along both banks and in the mouths of the tributaries where scour velocities are lower due to River geometry. This understanding of general Site conditions was confirmed by the bathymetric survey completed as part of the EOC study. Geophysical surveys, and subsequent sample collection and analysis confirmed that the majority of the River bottom is exposed bedrock. Limited center channel deposits exist which consist of coarse sand and gravel.

Fine-grained deposits are limited to tributary mouths and near-shore areas along both banks of the River.

A bathymetric survey of the River was conducted in 1999 by U.S. ACE, as described in Section 3.1.2. A bathymetric survey was completed as part of the Phase I EOC investigation in 2004 by Golder. The only known bathymetric survey conducted prior to that time dates to 1930, and precedes the construction of the Winfield Dam in 1935. Comparing the sediment bed elevations in the River between the two surveys provides general information on sedimentation rates. On average, from 2 to 11 ft of sediment has accumulated in the Winfield Pool between the 1930 and the 2004 bathymetric survey completed as part of the Phase I EOC investigations. This corresponds to time-averaged sedimentation rates ranging from 1 to 4 centimeters per year (cm/yr). However, it is uncertain how well these time-averaged rates represent modern sedimentation rates because watershed characteristics, sedimentary processes, and waterway dynamics may have changed over the last 70 years. Sedimentation rates are further evaluated by Site sediment transport modeling (Section 4.4.7).

Resuspension: Considering the volume of shipping traffic in the River, and the fact that the channel has never been dredged, relatively high rates of resuspension could be expected within the navigation channel, where coarse (sand and gravel) substrates predominate. However these materials do not act as a repository for 2,3,7,8-TCDD due to their coarse-grained nature and low TOC content. Fine-grained deposits along both banks of the River exhibit lower resuspension rates due to lower shear stresses being generated by lower velocities of flow in these areas. The variation in flow velocities is a function of River geometry. Resuspension in these nearshore areas is highly dependent on local channel geometry, which can impact shear stresses, sediment characteristics, and velocities.

Sediment Dispersion (Bioturbation and Propwash): Similarly, no quantitative information is available regarding surface sediment mixing/bioturbation rates. Sediment core profile data suggest that surface and subsurface sediments within the finer-grained sedimentary deposits of the River in many areas have maintained their integrity over time (i.e., indicative of little vertical mixing of deeper sediments to the surface). Observations of habitat made during fish tissue sampling indicate that habitat quality is generally poor, with a limited bioactive zone. As a result, relatively little bioturbation would be anticipated in Site sediments.

4.5.3 SUMMARY OF KANAWHA RIVER DREDGING ACTIVITY

Historical dredging activities in the Site were determined by reviewing dredging permits on file at the Huntington District of the U.S. ACE and are summarized in the Work Plan (CRA, 2004).

According to the U.S. ACE, the federal navigation channel in the Winfield Pool is virtually self-scouring and therefore requires no maintenance dredging throughout most of the pool. Some localized dredging is required in the vicinity of the Winfield Locks to maintain the up-River and down-River approach lanes to the locks. Otherwise, private parties have performed dredging activities in and upstream of the Study Area for the purposes of building or improving waterfront structures, clearing water intake lines, or reclaiming spilled coal.

Construction Dredging: Dredging permits were issued to various parties for one-time waterfront construction projects involving maintenance and/or improvements to docks, bulkheads, marinas, and clearing water intake lines. Construction dredging permits have been issued to FMC, Old Monsanto, Allied Chemical, Union Carbide Company (UCC), Union Boiler, Midwest, and Rhône-Poulenc AG Company (Rhône-Poulenc). These projects were authorized to remove between 30 and 5,000 cy of dredged material. A summary of Kanawha River dredging permits is presented in Table 4.15.

Reclamation Dredging: By far the most significant dredging activities in the Winfield Pool (in terms of total dredged sediment volumes) have been performed by the Kanawha Dredging and Mineral Company (Kanawha Dredging) and the Voyager Coal Company (Voyager Coal). These companies held permits in several reaches of the River during the 1980's and 1990's for the purpose of reclaiming spilled coal and sand from various locations within the Riverbed. Kanawha Dredging was incorporated in July 1975 and terminated in December 1992; Voyager Coal was incorporated in May 1990 and terminated in June 2002. Voyager Coal generally succeeded Kanawha Dredging as the active permittee for U.S. ACE dredging permits.

Dredged sediments were processed to remove spilled coal from the sediment bed (estimated at 38 to 85 percent of the dredged material), and the processed materials were redeposited in the River near their original location. The companies processed between 2,000 and 8,000 cy of sediments per day, year round, weather permitting, using a typical dredge cut of 12 ft. Permit conditions limited such reclamation dredging activities to bands of the River located more than 150 ft beyond the federal channel, but also more than 130 ft from the shoreline. Dredging was originally performed using a 3 cy clamshell bucket; however, the clamshell was replaced with a 10-inch hydraulic dredge in September 1988.

The majority of the permitted dredging areas for coal reclamation were on the left bank of the River (looking downstream). However, one of the permitted areas was on the right bank of the River downstream of Pocatalico River, between RM 36.97 and RM 38.81.

Water Quality Certification of Reclamation Dredging: As early as 1987, the WV DNR recognized that "*The proposed dredge site* [RM 40.45 to 41.70] *lies within a reach of the Kanawha River where joint WVDNR/U.S. EPA sampling has documented dioxin contamination in sediments and fish*." (WV DNR, 1987). WV DNR nevertheless granted conditional certification of the dredging activity based on the assumption that reclamation dredging would involve processing relatively coarse-grained channel sediments, whereas the majority of the 2,3,7,8-TCDD contamination was assumed to be associated with finer grained bank sediments. However, the file review did not produce data on which WV DNR based their assumption regarding the location of 2,3,7,8-TCDD in sediment.

In subsequent years, the WV DNR/WV DEP occasionally denied Section 401 Water Quality Certification for certain reclamation dredging applications on the grounds that "*…the hydraulic dredging and redepositing of 85 percent of dredged material will impact both the river's water quality and its aquatic resources by increasing turbidity and resuspending other pollutants*." (WV DNR, 1991) and "*…potential adverse affects are recognized for fish spawning sites, degraded aquatic habitat, excessive sedimentation, and resuspended pollutants*." (WV DEP, 1997). In some cases, the denials were successfully appealed by the applicant, and Section 401 Water Quality Certification was eventually obtained for reclamation dredging.

The last known dredging occurred at the Site in 1999.

In 2008, a permit application was submitted to resume coal recovery dredging in 3 areas of the River. One area was within the Site boundaries (RM 43.15 to RM 45.25). The following language has been excerpted from an October 24, 2008 letter from S. Mandirola (WV DEP) to G. Mullins (U.S. ACE – Huntington District) providing WV DEP comments on the permit application.

The applicant has proposed to renew authorization to continue dredging coal from the Kanawha River at three distinct reaches:

> *Site #1 is located between RM 43.15 and 45.25 near St. Albans. The proposed dredging activities will occur at five separate sites starting a minimum distance of 130 feet from the shorelines. It is expected that 1,209,000 cubic yards of material could be removed during the life of the permit. Of that amount, approximately 1,088,000 cubic yards of the material would be returned to the river.*

The applicant proposes to use a cutter head suction dredge and the unsuitable material will be immediately re-deposited into the river via three flume pipes into the dredge cut. There are concerns with coal dredging in the Kanawha River. These concerns include re-suspension of contaminated sediments, the potential negative impacts of increased turbidity on aquatic life, impacts to near shore habitats and impacts to the other recreational users of the river.

Despite concerns raised (as noted above) by the WV DEP, the permit has been issued by U.S. ACE. However, it does not appear, based on information provided by residents on the River, that dredging has commenced under the permit.

4.5.4 2,3,7,8-TCDD LOADING ANALYSIS

4.5.4.1 2,3,7,8-TCDD LOAD FROM RECLAMATION DREDGING

Resuspension of impacted sediment from reclamation dredging in the River has not been considered in previous TMDL assessments of contributions to water column concentrations. However, reclamation dredging moved relatively large volumes of sediments (thousands of cy per day) at significant depths (up to 12 ft cuts). One of the permitted reaches included potentially contaminated sediments on the right bank of the River downstream from the mouth of the Pocatalico River. Based on calculations presented in the EE/CA Work Plan and summarized below, which assume a typical release of 2 percent of the mass of 2,3,7,8-TCDD dredged, reclamation dredging likely represented the primary source of 2,3,7,8-TCDD loading to the River during the period of active dredging. Higher short-term loading rates would have been realized when the more contaminated reach was being actively worked, because the contractor rotated his dredge between several active permit sites at any given time.

The preliminary analysis was based on the following parameters and assumed values:

- **Dredge Production Rate** [P] = 5,000 cy/day = 3,820 cubic meters per day (m^3/day)
- **Fraction of Working Time** [F] = 10 percent
- **Average Sediment 2,3,7,8-TCDD Concentration** [C] **=** based on surface weighted average concentration (SWAC[3]) values for each Study Area
- **Sediment Dry Bulk Density** [p] = 1,120 kilograms per cubic meters (kg/m^3)
- **Contaminant Loss During Dredging** [L] = 2 percent (typical range: 1 percent to 10 percent)

According to the following equation:

Dredging 2,3,7,8-TCDD Flux = P x F x C x p x L ~10,000 µg/day

Daily dredge production rates were as specified in U.S. ACE permits (see Table 4.15). The fraction of the dredge working time is assumed to be 10 percent, because: the dredge did not work on weekends or during bad weather, only one dredge was operating four different permits in the River, and only one of those permits appears to have been in an area with subsurface 2,3,7,8-TCDD concentrations approaching or exceeding 0.5 µg/kg (0.5 ppb). The sediment 2,3,7,8-TCDD concentration represents the average of sediment samples in the vicinity of the permitted reach on the right bank of the River (U.S. EPA, 2001), assuming roughly 25 percent of the dredge cut consisted of contaminated sediments. Dry bulk density was calculated from total solids concentrations reported by U.S. EPA (2001).

Primary sources of uncertainty regarding this calculation include the lack of information regarding actual dredging durations, locations, and volumes; and the sparseness of data to describe the distribution of 2,3,7,8-TCDD concentrations in the permitted reach, both spatially and vertically within the dredge prism, at the time of dredging. Nevertheless, this preliminary calculation indicates the potential load could have been substantial in relation to other loading sources in recent years.

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3 The SWAC is a statistically generated area-weighted average, which is useful in evaluating sediment sites as changes in tissue concentrations in receptor species can often be generally related to changes in average sediment concentrations. This is discussed in detail in Section 6.3.2.

4.5.4.2 2,3,7,8-TCDD LOAD FROM GROUNDWATER SEEPAGE

The groundwater flux estimate completed as part of the TMDL in 2000 was on the order of 7 µg/day of 2,3,7,8-TCDD. The basis of this estimate was presented in a simplified manner utilizing very limited data for the Nitro Area, and the very conservative assumption that the entire observed increase in water column concentrations between RM 45.5 and RM 41.3 was due entirely to groundwater flux. This analysis was identified within the TMDL to contain a high degree of uncertainty.

Since the completion of the TMDL study, dismantling of the Former Flexsys Facility, and implementation of the EOC for the River, Solutia has completed additional groundwater sampling to determine the actual 2,3,7,8-TCDD TEQ loading to the River via the groundwater pathway from the Former Flexsys Facility. This work was completed as part of the ongoing RCRA closure process and reviewed as part of the EE/CA completion. This analysis was completed utilizing much more accurate and current Site-specific data. High volume groundwater sampling from wells sited specifically to support this analysis was completed to provide groundwater concentration data. Gradients measured at the Former Flexsys Facility, and hydraulic conductivity data from testing of Former Flexsys Facility soils were employed to generate water volume estimates reflective of Former Flexsys Facility conditions. To be conservative, no attenuation of 2,3,7,8-TCDD concentrations between monitoring wells and the River was assumed. The calculated loading to the River from groundwater was approximately 0.0083 µg/day 2,3,7,8-TCDD TEQ (less than 0.1-percent of the loading calculated in the TMDL). A copy of the analysis is presented in Appendix M. This analysis was developed as part of the RCRA CA for the Former Flexsys Facility and has been submitted to WV DEP and U.S. EPA.

4.5.4.3 2,3,7,8-TCDD LOAD FROM POINT SOURCES (OUTFALLS)

Source investigation results indicate that residual 2,3,7,8-TCDD contamination in the outfalls draining the area in and around the Former Flexsys Facility could have historically added a significant 2,3,7,8-TCDD load to the River. These outfalls have since been closed and no longer represent a pathway for ongoing releases. Based on the evaluation completed as part of the RCRA CA for the Former Flexsys Facility, a maximum loading under current conditions of 2.445 µg/day 2,3,7,8-TCDD TEQ from surface water was calculated (the calculations are presented in Appendix M). The proposed construction of a clean permeable cover system, abandonment and replacement of the sewer system, and consolidation/capping of designated areas of impacted material will further reduce loading from surface water.

A copy of the 2,3,7,8-TCDD TEQ analysis completed for the Former Flexsys Facility is presented in Appendix M. This analysis was developed as part of the RCRA CA for the Former Flexsys Facility and has been submitted to WV DEP and U.S. EPA.

Additional point sources to the River which could contribute low levels of 2,3,7,8-TCDD to the River exist in the Nitro area (Nitro Wastewater Treatment Plant), and upstream in the South Charleston/Institute area from various industrial facilities. Monitoring data to quantify potential contributions are not currently available; however, based on CRA's evaluation, a number of processes in use at upstream facilities would be anticipated to produce low levels of 2,3,7,8-TCDD which may have contributed to historic loading and/or contribute to ongoing loading.

4.5.4.4 2,3,7,8-TCDD LOAD FROM SOIL RUNOFF

2,3,7,8-TCDD loading to the River from direct overland flow of water to the River (i.e., not through point source discharges) may have been a significant historic source of 2,3,7,8-TCDD to the River. Potential 2,3,7,8-TCDD sources associated with soil runoff to the River or its tributaries include:

- Historic and ongoing soil erosion from upstream industrial facilities
- Landfills adjacent to the river and its tributaries
- Former Flexsys Facility, including nearshore soils adjacent to the bank
- ACF Facility

To the extent that any of these properties were historic sources to the River, the site closure activities like those previously completed at the ACLF, Heizer Creek Landfill, Former Flexsys Facility, and ACF Facility have likely provided controls of soil runoff from these facilities.

Historic loading from overland flow at the Former Flexsys Facility may have included both overland flow from the upland portions of the facility directly to the River (i.e., not through sewers), as well as erosion of bank soils into the River. The extent of potential historic loading or ongoing loading from the bank is uncertain. However, based on elevated soil concentrations of 2,3,7,8-TCDD detected in this general area, runoff from bank soils had the potential to represent a significant ongoing source to the River. The RCRA CA undertaken by Solutia would be expected to effectively control this potential source.

4.5.5 POTENTIAL EXPOSURE PATHWAYS

Potential exposure pathways for 2,3,7,8-TCDD to human and ecological receptors include:

Human receptors:

- Direct contact with water or sediment
- Ingestion of water or sediment
- Fish consumption

Ecological receptors:

- Direct contact with sediment
- Ingestion of sediment or water
- Consumption of prey species (bio-uptake)

Numerous pathways for bio-uptake of ecological receptors may exist and a general depiction of ecological exposure pathways is shown on Figure 4.32. Exposure point concentrations to sediment and the water column are highly variable and are impacted within the Site area by many factors, including:

- Water column loading (dissolved and suspended solids) from sources upstream of the Study Area
- Increases and/or decreases in surface sediment concentrations due to erosion and re-deposition of sediment along the banks of the River
- Variability in re-suspension/settling rates due to variations in flow velocities in the River
- Coal recovery dredging increasing water column and surface sediment concentrations by discharging formerly buried contaminated sediment to the water column in large quantities
- Habitat quality
- Water temperature impacting ecological receptor behavior patterns

The relevance of exposure pathways to human and ecological receptors is discussed in detail in Section 5.0.

4.5.6 SUMMARY OF CSM

Based on the evaluation of Site conditions and available investigative data, the following factors contribute to 2,3,7,8-TCDD releases to and within the River system:

- Upstream (i.e., upstream of the Former Flexsys Facility) contributions from upland point sources, non-point sources, and re-suspension of impacted sediment contribute to base loading of 2,3,7,8-TCDD entering the Site from upstream. Based on sampling completed as part of the EE/CA, upstream loading (0.00853 pg/L) represents approximately 66 percent of the WV surface water criterion of 0.013 pg/L.
- Historic loading to the River from various current and former facilities (point sources, groundwater, and surface water runoff) in the Nitro area contributed to historic loading of 2,3,7,8-TCDD to sediments. Some ongoing loading from sources may be continuing; however, changes in facility operations and implementation of source controls have significantly reduced contributions.
- Sediment re-suspension/deposition throughout the Site contribute to exchange of 2,3,7,8-TCDD in the water column. This is primarily controlled by River flow and velocity; however, propwash may cause re-suspension of sediments in the navigational channel and wave action may cause resuspension of shallow sediments in near-shore areas.
- Coal recovery dredging likely caused significant re-suspension of impacted sediment until late 1999. This activity likely delayed or temporarily reversed natural recovery of the system.
- The stability of 2,3,7,8-TCDD in the environment, its affinity for organic material, and its potential to bioaccumulate results in potential uptake throughout the food chain, and to human receptors through fish consumption.

5.0 STREAMLINED RISK EVALUATION

5.1 HUMAN HEALTH RISK ASSESSMENT

A Human Health Risk Assessment (HHRA) estimates cancer and non-cancer health impacts from exposure to chemicals of potential concern. Estimates are typically developed for each potential receptor by exposure pathway. Since this EE/CA is being submitted to U.S. EPA as required by the AOC for the Site, the HHRA uses U.S. EPA-approved or WV-approved methods, algorithms, and input values used as reflected in U.S. EPA or WV guidance. Monsanto Company does not acknowledge or admit that such methods, algorithms or input values are based on sound science or that they would be appropriate outside the EE/CA context.

5.1.1 INTRODUCTION

This HHRA was conducted in accordance with the following U.S. EPA and WV DEP guidance:

- U.S. EPA Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part) A, EPA/540/1-89/002, December 1989
- U.S. EPA Exposure Factors Handbook, EPA/600/P-95/002Fa, August 1997
- U.S. EPA Example Exposure Scenarios, National Center for Environmental Assessment, April 2004a
- U.S. EPA RAGS Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004b
- WV DEP West Virginia Voluntary Remediation and Redevelopment Act Guidance Version 2.1, 1997

5.1.1.1 SPECIFIC GOALS OF THE HHRA

The specific goals of the HHRA were to:

- Estimate and evaluate potential cancer and non-cancer health impacts to pertinent human receptors and identify what areas of the Site may require Removal Action
- Provide a basis for determining which media and exposure pathways are contributing to the identified potential health impacts at the Site

- Provide a basis for determining which exposure pathways, and receptors would need to be addressed so that public health is adequately protected in the future
- Provide a basis for comparing potential health impacts of various remedial alternatives

5.1.1.2 ORGANIZATION OF THE HHRA

The HHRA is presented in the following sections:

Section 5.1.2 Problem Formulation
Section 5.1.3 Exposure Assessment
Section 5.1.4 Toxicity Assessment
Section 5.1.5 Risk Characterization
Section 5.1.6 Uncertainty Analysis
Section 5.1.7 Summary and Conclusions

5.1.2 PROBLEM FORMULATION

The problem formulation is discussed below in the following sections:

Section 5.1.2.1 Selection of Chemicals of Potential Concern
Section 5.1.2.2 Characterization of the Exposure Setting
Section 5.1.2.3 HHRA Conceptual Site Model

5.1.2.1 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

In March 2004, U.S. EPA, Monsanto Company, and Pharmacia Corporation entered into an AOC with U.S. EPA to conduct an EE/CA to study dioxin-contaminated sediment in the River. The intent of the EE/CA is to characterize the nature and extent of 2,3,7,8-TCDD in the Site. The purpose of the EE/CA was to provide a basis to evaluate remedial alternatives with respect to protection of public health, welfare, and the environment. Since this HHRA is a part of this effort, 2,3,7,8-TCDD is selected as the only contaminant of potential concern (COPC) for the HHRA.

As part of the EE/CA, fish tissue and surface water samples were collected and analyzed for 2,3,7,8-TCDD. Table 5.1 presents a summary of 2,3,7,8-TCDD detections in fish tissue and Table 5.2 presents a summary of 2,3,7,8-TCDD detections in surface water. Tables 5.3 and 5.4 present a summary of the occurrence and distribution of 2,3,7,8-TCDD in fish tissue and surface water, respectively.

5.1.2.2 CHARACTERIZATION OF EXPOSURE SETTING

As part of the HHRA process, potentially exposed populations and potential exposure pathways are determined through an evaluation of the physical setting of the Site. The consideration of factors specific to the Site is important in (a) the development of realistic current and future exposure scenarios, (b) the determination of complete and incomplete exposure pathways, and (c) the quantification of potential health impacts. 2,3,7,8-TCDD has been detected in surface water, fish tissue, and sediments in the Study Area.

5.1.2.2.1 IDENTIFICATION OF POTENTIAL EXPOSURE PATHWAYS

An exposure pathway describes a mechanism by which humans may come into contact with Site-related COPCs. An exposure pathway is complete (i.e., it could result in a receptor contacting a COPC) if the following four elements are present:

1. A source or a release from a source (e.g., COPCs released to surface water or sediment due to historical releases)
2. A probable environmental migration route of a Site-related COPC (e.g., leaching or partitioning from one medium to another)
3. An exposure point where a receptor may come in contact with a Site-related COPC (e.g., surface water)
4. A route by which a Site-related COPC may enter a potential receptor's body (e.g., ingestion or dermal contact)

If any of these four elements are not present, the exposure pathway is considered incomplete and does not contribute to the total exposure from the Site.

5.1.2.2.2 POTENTIAL MIGRATION ROUTES

Many complex factors control the partitioning of a COPC in the environment; thus, measured concentrations in the River only represent Site conditions at a discrete point in time. An understanding of the general fate and transport characteristics of the COPCs are important when predicting future exposure, linking sources with currently contaminated media, and identifying potentially complete pathways to Site media. Therefore, the fate and transport analysis conducted at this stage of the exposure assessment is not intended to provide a quantitative evaluation of media-specific COPC concentrations; it is meant to identify media that are likely to receive Site-related COPCs.

The following sections provide a fate and transport evaluation to determine the relative significance of the release sources and mechanisms. The concentration and distribution of COPCs in the environment are subject to change due to several mechanisms, such as transportation by convection (wind or water) and physical (volatilization or sedimentation), chemical (photolysis or hydrolysis), and/or biological (degradation by microorganisms) alterations. In addition, hydrophilic and hydrophobic qualities will influence the bioavailability of a given COPC once released to the environment.

2,3,7,8-TCDD is a high molecular weight crystalline solid that is insoluble in water, with measured solubility in the range of 0.008 to 0.2 µg/L (8,000 to 200,000 pg/L) (SRC, 2003). 2,3,7,8-TCDD is extremely hydrophobic, with reported $\log K_{ow}$ and $\log K_{oc}$ partitioning coefficients as high as 6.8 and 7.4 (U.S. EPA, 2006), respectively. As a result, 2,3,7,8-TCDD partitions strongly to soil, sediment, and other particulate matter and is not readily dissolved in either surface water or groundwater. Because of these environmental characteristics, 2,3,7,8-TCDD is not expected to leach significantly from soils into groundwater or from sediments into pore waters. The preference of 2,3,7,8-TCDD for particulate-phase transport is evidenced by the results of the high-volume water samples from the River, in which an average of 90 percent or more of the total 2,3,7,8-TCDD concentration in the water column was associated with suspended sediments (U.S. EPA, 2000b).

In surface water, 2,3,7,8-TCDD is primarily subject to slow rates of volatilization and photodegradation. In addition, biodegradation of 2,3,7,8-TCDD also occurs, albeit slowly. However, degradation of 2,3,7,8-TCDD via volatilization and photolysis in the River are assumed to be negligible (LTI, 2000). All of these processes are further slowed by the very strong tendency of 2,3,7,8-TCDD to sorb strongly to particulate matter. Consequently, burial in sediments may be the most important fate process for 2,3,7,8-TCDD in the River.

5.1.2.2.3 POTENTIAL EXPOSURE POINTS

After contaminated or potentially contaminated media have been identified, the exposure points are determined by identifying whether a potentially exposed population can contact these media. 2,3,7,8-TCDD has been identified in fish tissue and surface water. As such, exposure to 2,3,7,8-TCDD in these media has been evaluated further in the HHRA.

5.1.2.2.4 POTENTIAL EXPOSURE ROUTES

In general, humans can be exposed to impacted environmental media, through specific routes of exposure. Since 2,3,7,8-TCDD was detected in fish tissue and surface water, potential exposure routes include ingestion of impacted fish, and direct contact (ingestion, dermal contact) with impacted surface water.

5.1.2.2.5 RECEPTOR CHARACTERISTICS

As noted previously, consideration of factors specific to the Site is important in identifying current and future exposure scenarios. With respect to impacted fish, exposure through ingestion of fish caught by recreational anglers is regarded as the applicable exposure scenario because consumption rates would be higher for recreational anglers than for the general population. Moreover, there were no subsistence fishing populations evident in the vicinity of the Site. The Study Area is near a metropolitan area, i.e., Nitro, WV, and no resident Native American populations or reservations were apparent. U.S. EPA (1997a) indicates that subsistence fishing populations that have been studied have been restricted to Native American populations in the West, in Alaska, and in Florida. With respect to contact with impacted surface water, recreational swimming is regarded as the applicable exposure scenario. The exposure scenarios and receptors are described below.

Current/Future Recreational Angler Exposure to Fish Tissue

Under current and future conditions a recreational angler may be exposed to 2,3,7,8-TCDD, which originated from River surface water or sediment, and subsequently has bioaccumulated in fish tissue. As noted previously, recreational anglers were selected as the target population because fish consumption rates for this group would be higher than general population intakes. In this regard, anglers would be exposed to 2,3,7,8-TCDD through the consumption of fish caught on a recreational basis.

Current/Future Recreational Swimmer Exposure to Surface Water

The recreational swimmer is assumed to be a youth (less than 18 years) or adult (greater than 18 years), who potentially would occasionally swim in the River during the summer. The recreational swimmer could be exposed to 2,3,7,8-TCDD through incidental ingestion and dermal contact of surface water during the time spent swimming. Although included as an exposure scenario in the HHRA, exposure to sediments due to recreational swimming is not considered to be a significant risk scenario for the site as the side slopes to the River are quite steep, typically 2:1 or 3:1 side slopes descending to channel depth within 50-200 feet of the shoreline.

5.1.2.3 HHRA CONCEPTUAL SITE MODEL

As noted previously, potential receptors and pathways by which individuals may come in contact with 2,3,7,8-TCDD must be determined in order to evaluate the significance of potential 2,3,7,8-TCDD exposure. The combination of factors (chemical source, media of concern, release mechanisms, and potential receptors) that could produce a complete exposure pathway and lead to human uptake of chemicals is described in the CSM.

The HHRA CSM is summarized in Table 5.5. The CSM assumes the following potential human receptors may be exposed to 2,3,7,8-TCDD impacts in the River:

- Current/Future Recreational Angler
- Current/Future Recreational Swimmer

5.1.3 EXPOSURE ASSESSMENT

Exposure is defined as the contact of a receptor (i.e., person) with a chemical or physical agent. The exposure assessment is the estimation of the magnitude, frequency, and duration of exposure. An exposure assessment provides a systematic analysis of the potential exposure mechanisms by which a receptor may be exposed to a chemical or physical agent at or originating from a study area.

Typically, exposure assessment includes both a qualitative assessment, in which potential receptors and exposure pathways are identified, and a quantitative assessment, in which exposure estimates for pertinent receptors and pathways are developed. Identification of potential receptors and pathways are often integral to the development of a CSM, which was described in Section 5.2.2.3. Determination of quantitative estimates of exposure is described in the following sections.

To quantify exposure, potential exposure scenarios were developed using the following U.S. EPA and WV DEP guidance:

(i) U.S. EPA RAGS, Volume I, Human Health Evaluation Manual (Part) A, EPA/540/1-89/002, December 1989

(ii) U.S. EPA Exposure Factors Handbook, EPA/600/P-95/002Fa, August 1997

(iii) U.S. EPA Example Exposure Scenarios, National Center for Environmental Assessment, April 2004a

(iv) U.S. EPA RAGS Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004b

(v) WV DEP West Virginia Voluntary Remediation and Redevelopment Act Guidance Version 2.1, 1997

Exposure factors were obtained for Central Tendency (CT) and Reasonable Maximum Exposure (RME) exposure scenarios. The CT scenario is based on average or mean exposure factors and approximates the most probable exposure conditions. The RME scenario is based on conservative assumptions that generally utilize the 90th to 95th percentile values and represents an upper bound on potential exposure estimates.

The CT and RME EPC values for the various exposure scenarios were determined based on available analytical data using U.S. EPA's ProUCL 4.00.04 (U.S. EPA, 2009b). The arithmetic mean, maximum, and 95 percent UCL of the mean concentrations of 2,3,7,8-TCDD in fish tissue, and surface water are summarized in Tables 5.6 and 5.7, respectively.

Quantification of exposure is discussed further below in terms of estimation of intake (Section 5.1.3.1) and exposure factors (Section 5.1.3.2).

5.1.3.1 SPECIFIC INTAKE EQUATIONS

The following sections provide intake equations for potential ingestion of impacted fish tissue, and ingestion and dermal contact with impacted surface water. In the HHRA, exposure estimates reflect chemical concentration, contact rate, exposure time, and body weight in a term called "intake" or "dose."

5.1.3.1.1 FISH TISSUE INGESTION EQUATION

The equation for calculating chemical intake from the ingestion of fish tissue according to U.S. EPA (1989) is:

$$CDI = \frac{Cfish \times IR \times Ff \times CF \times EF \times ED}{BW \times AT}$$

Where:

CDI	=	chronic daily intake (mg/kg body weight-day)
Cfish	=	chemical concentration in fish (mg/kg)
IR	=	ingestion rate of fresh water fish - (g/day)
F_f	=	fraction of ingested fish from impacted waterbody
CF	=	conversion factor (kg/g)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time - cancer (averaging period, days)

5.1.3.1.2 SURFACE WATER INGESTION INTAKE EQUATION

The equation for calculating potential chemical intake via ingestion of surface water by the recreational swimmer (child and adult) according to U.S. EPA (1989) is as follows:

$$CDI = \frac{CW \times IR \times ET \times EV \times EF \times ED}{BW \times AT}$$

Where:

CDI	=	chronic daily intake (mg/kg body weight-day)
CW	=	chemical concentration in surface water (mg/L)
IR	=	ingestion rate of surface water (L/hour)
ET	=	exposure time per event (hour/event)
EV	=	event frequency (event/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time - cancer (averaging period, days)

The concentrations of 2,3,7,8-TCDD adsorbed to suspended sediments was generally (70 percent of results) higher than the dissolved phase concentrations. As such, the concentration of 2,3,7,8-TCDD adsorbed to suspended sediments was used to estimate potential chemical intake via ingestion in this HHRA.

5.1.3.1.3 SURFACE WATER DERMAL CONTACT INTAKE EQUATION

The equation for calculating potential chemical intake via dermal contact with surface water by the recreational swimmer (child and adult) according to U.S. EPA (2004a) is as follows:

$$CDI = \frac{\mathrm{DA_{event}} \times \mathrm{SA} \times \mathrm{EF} \times \mathrm{EV} \times \mathrm{ED}}{\mathrm{BW} \times \mathrm{AT}}$$

Where:

CDI	=	chronic daily intake (mg/kg body weight-day)
DAevent	=	absorbed dose per event (mg/cm2-event)
SA	=	skin surface area available for contact (cm^2)
EV	=	event frequency (events/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time - cancer (averaging period, days)

To calculate the absorbed dose per event (DA_{event}) as a result of dermal contact with surface water, U.S. EPA (2004a) recommends the following:

$$If\ t_{event} \le t^*, then\ DA_{event} = 2 \times FA \times K_p \times C \times \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}},$$

$$If t_{event} > t^*, then\ DA_{event} = FA \times K_p \times C \times \left[\frac{t_{event}}{1+B} + 2 \times \tau_{event} \times \left(\frac{1+3 \times B + 3 \times B^2}{(1+B)^2} \right) \right]$$

Where:

CW	=	chemical concentration in surface water (e.g., mg/cm^3 water)
CF	=	conversion factor (L/cm3)
FA	=	fraction absorbed water (dimensionless)
ET	=	exposure time per event (hour/event)
PC	=	permeability constant (cm/hour)
Kp	=	dermal permeability coefficient of compound in water (cm/hr)
tevent	=	event duration (hr/event)
τevent	=	lag time per event (hr/event)
t*	=	time to reach steady state (hr) = 2.4 x τevent
B	=	dimensionless ratio of permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless)

Surface water concentrations used to estimate potential chemical intake via dermal contact according to U.S. EPA (2004a) are dissolved phase concentrations. However for this HHRA, concentrations absorbed to suspended sediments were used to be consistent with the surface water ingestion pathway and in order to provide a conservative assessment.

5.1.3.2 EXPOSURE FACTORS

In order to develop quantitative exposure estimates, exposure factors that describe potential intake or contact rates, exposure frequency, and exposure duration are needed. These factors are specified for each exposure scenario (recreational fishing or recreational swimming), receptor (child, youth, or adult), and exposure condition (RME or CT). Exposure factors were obtained from U.S. EPA and WV DEP sources. They are presented in Table 5.8 for the recreational angler scenario, and in Table 5.9 for the recreational swimmer scenario.

5.1.4 TOXICITY ASSESSMENT

The toxicity assessment evaluates the available evidence regarding the potential for a COPC to potentially cause adverse effects in exposed individuals. Numerical toxicity criteria are developed from this effort using a two-step approach: hazard identification and dose-response assessment. Hazard identification determines the potential adverse effects associated with exposure to a COPC. Two broad categories of health effects are defined: cancer and non-cancer toxicity. Following hazard identification, numerical toxicity values are determined or selected from the available toxicity data in the dose-response assessment often using mathematical modeling.

Toxicity criteria used in HHRAs are generally those developed by regulatory authorities. In the selection of toxicity values, preference has been given to the most recently developed values because these would incorporate the most recent toxicological information and would provide the best basis upon which to assess potential health impacts. Consistent with U.S. EPA (2009c), toxicity values for 2,3,7,8-TCDD were obtained from the Agency for Toxic Substances and Disease Registry (ATSDR, 1998) and Cal EPA Toxicity Criteria Database (CalEPA, 2008). Monsanto Company does not acknowledge or admit that such values are based on sound science or that they would be appropriate outside the EE/CA context.

5.1.4.1 NON-CARCINOGENIC HAZARDS

5.1.4.1.1 TOXICITY INFORMATION FOR NON-CARCINOGENIC EFFECTS

For substances that cause non-carcinogenic chronic effects, toxicity criteria are usually expressed as acceptable chronic intake levels or Reference Dose (RfDs) (in units of mg/(kg-day)) below which, no adverse effects are expected. Thus, there is a level or threshold of exposure to a chemical below which no toxic effects are anticipated.

Chronic RfDs are used in HHRA as to evaluate the potential for non-carcinogenic health effects. A chronic RfD is defined as an estimate (with an uncertainty spanning an order of magnitude or greater) of a daily exposure level for the human population, including sensitive sub-populations, which poses no appreciable risk of deleterious effects over a lifetime of exposure.

RfDs are most often derived from laboratory animal studies. Test results in the most sensitive species are selected, and from this "critical study," the highest dose/concentration level administered that did not cause observable adverse effects is selected. This dose level is the no observed adverse effects levels (NOAEL). The NOAEL is then divided by uncertainty (safety) and modifying factors to derive a chronic RfD. In general, an uncertainty factor (UF) of 10 is used to account for interspecies variation due to extrapolation of animal study results to humans, and another factor of 10 to account for sensitive human populations. Additional factors of 10 are used if the critical study included only a lowest observed adverse effects level (LOAEL) instead of a NOAEL, and if the duration of the critical study was less than a lifetime exposure. A modifying factor (MF) of 10 or less can also be included if the database is judged as less deficient. The combination of MF and UFs can produce an overall uncertainty factor as high as 100,000.

2,3,7,8-TCDD RfDs for oral and dermal routes of exposure are presented in Table 5.10. The oral RfD was derived from a developmental toxicity study in rhesus monkey, in which behavioral effects were noted in offspring. Because there is no RfD available for dermal exposure, the oral RfD was extrapolated to the dermal route according to U.S. EPA (2004a).

5.1.4.2 CARCINOGENIC RISKS

5.1.4.2.1 TOXICITY INFORMATION FOR CARCINOGENIC EFFECTS

Cancer Slope Factors (CSFs) are quantitative risk estimates of theoretical carcinogenic potency. Slope factors relate the lifetime probability of excess cancers to the lifetime average exposure dose/concentration of a substance. CSFs are estimated using mathematical extrapolation models, most commonly the linearized multistage (LMS) model, and are presented as risk per mg/(kg-day) (i.e., mg carcinogen per kg body weight per day) for oral and dermal CSFs. These models assume low dose-response linearity and thus may not be appropriate for some suspected carcinogens, in particular those such as dioxin that are not geno-toxic. As well, the body's natural repair processes and defense mechanisms may decrease cancer risk at low exposure levels. Thus, the risks at lower exposure levels are likely overestimated using a linear model. When adequate human epidemiological data are available, maximum likelihood estimates (MLEs) of model parameters are used to generate a CSF. When only animal data are available, the CSF is typically the upper 95 percent confidence limit on the MLE. In other words, the true risk to humans, while not identifiable, is not likely to exceed the upper-bound estimate. This is a conservative estimate, and in some cases a linear slope of zero may be as appropriate for the data (i.e., no carcinogenic risk).

Known or suspect human carcinogens have been evaluated and identified by the Carcinogen Assessment Group using the U.S. EPA Weight-of-Evidence approach for carcinogenicity classification (HEAST, 1997). The U.S. EPA classification is based on an evaluation of the likelihood that the agent is a human carcinogen. The evidence is characterized separately for human and animal studies as follows:

Group A - Known Human Carcinogen (sufficient evidence of carcinogenicity in humans)

Group B - Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)

Group C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data)

Group D - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)

Group E - Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in animal studies)

2,3,7,8-TCDD is classified utilizing the U.S. EPA system as a group B2 chemical. The oral and dermal CSFs used in the HHRA are presented in Table 5.11.

For 2,3,7,8-TCDD, the oral CSF was derived by California EPA (OEHHA, 2009) based on the LMS model using Global79. The Agency used male mouse liver tumor data from NTP (1982). However, in its response to U.S. EPA's Dioxin Reassessment (U.S. EPA, 2000c), the U.S. EPA Science Advisory Board (SAB) was divided on whether a linear dose-model was appropriate because dioxin is considered primarily a cancer promoter rather than an initiator (U.S. EPA, 2001). As such, there was no consensus regarding the appropriateness of using a linear approach for 2,3,7,8-TCDD. However, to be consistent with methods used by the U.S. EPA for a HHRA under Superfund, this HHRA used the oral CSF derived by CalEPA, which were derived based on the LMS model. Monsanto Company does not acknowledge or admit that a linear CSF for dioxin is based on sound science or would be appropriate outside the EE/CA context; considerable scientific evidence establishes that a linear cancer slope factor for dioxin and similar substances is not appropriate as applied to small concentrations.

5.1.4.3 POTENTIAL RISK FROM CARCINOGENS

A CSF multiplied by the lifetime average daily intake provides a theoretical estimate of the increased probability of cancer during the lifetime of the exposed individual. This increased cancer risk is expressed, for example, as 1×10^{-6} or 1.0E-06 (one in one million increased cancer risk). This is an upper limit estimate of risk, based on very conservative toxicity and exposure factors, and, as noted, an assumed linear cancer-slope factor.

5.1.4.4 DERMAL TOXICITY

Assessment of potential health impacts associated with dermal exposure is based on absorbed dose, i.e., the amount of COPC that is absorbed through the skin. However, oral toxicity values (RfDs and CSFs) typically used to evaluate dermal exposures are based on administered dose. Thus, to characterize risk for the dermal exposure pathway, adjustment of oral toxicity factors is needed to yield an absorbed dose rather than administered dose. This adjustment accounts for the absorption efficiency in the "critical study" which forms the basis of the RfD or CSF. For example, in the case where oral absorption in the critical study is essentially complete (i.e., 100 percent), the absorbed dose is equivalent to the administered dose, and therefore no toxicity adjustment with respect to absorption from the gastrointestinal (GI) tract is necessary (U.S. EPA, 2004b). When GI absorption of a chemical in the critical study is poor (i.e., 1 percent), the absorbed dose is much smaller than the administered dose, and therefore toxicity factors based on the administered dose must be adjusted.

Because of the intrinsic variability in the analysis of absorption studies, the U.S. EPA recommended a threshold of 50 percent GI absorption to ascertain the need to adjust administered doses, i.e., GI absorption of <50 percent would require adjustment. This cutoff level obviates the need to make comparatively small adjustments in the toxicity value that would otherwise impart on the process a level of accuracy that is not supported by the scientific literature (U.S. EPA, 2004b). Oral to dermal adjustment factors consistent with Exhibit 4-1 of U.S. EPA (2004a) were applied in the HHRA and are presented in Tables 5.10 and 5.11.

5.1.5 RISK CHARACTERIZATION

The objective of this risk characterization is to integrate information developed in the exposure and toxicity assessments. The methods used in this risk characterization were based on U.S. EPA and WV DEP guidance (U.S. EPA, 1989, 1997a, 2004a, 2005; WVDEP, 1997).

5.1.5.1 HAZARD QUOTIENT ESTIMATES

The potential for non-cancer health effects from exposure to a COPC is evaluated by comparing a calculated intake over a specified time period to a RfD for a similar time period. This ratio, termed a hazard quotient (HQ), is calculated according to the following general equation:

$$HQ = \frac{CDI}{RfD}$$

where:

HQ = The Hazard Quotient (unitless) is the ratio of the chronic daily intake of a chemical to a reference dose. A hazard quotient equal to or below 1.0 is considered protective of human health.

CDI = The Chronic Daily Intake is the chemical dose or concentration calculated by applying the exposure scenario factors and expressed as mg/(kg-day). The intake represents the average daily chemical dose or concentration over the expected period of exposure.

RfD = The Reference Dose is a daily dose believed not to cause an adverse effect from even a lifetime exposure [mg/(kg-day)].

If more than one COPC is included in an assessment, a hazard index (HI) is calculated, which is the sum of HQs for individual COPCs for a specific exposure scenario. An HI equal to, or below 1.0, is considered protective of human health over a lifetime and indicates that the exposure scenarios are not of concern. A HI above 1.0 does not indicate that adverse health effects are imminent or likely to occur, but only that the margin of safety is reduced. The total hazard index for each exposure pathway is presented in the summary Tables shown in Section 5.1.5.3, and the HQs are presented in the Tables referenced within the summary tables.

5.1.5.2 CANCER RISK ESTIMATES

Exposure scenarios may involve potential exposure to more than one carcinogen. To represent the potential carcinogenic effects posed by exposure to multiple carcinogens, it is assumed, in the absence of information on synergistic or antagonistic effects, that these risks are additive. Cancer risks are calculated utilizing the following general equation:

$$\text{Cancer Risk} = \text{LADD} \times (\text{CSF})$$

where:

Cancer Risk	=	Estimated upper bound on additional risk of cancer over a lifetime in an individual exposed to the carcinogen for a specified exposure period (unitless).
LADD	=	The Lifetime Average Daily Dose of the chemical calculated using exposure scenario factors and expressed in mg/(kg-day) for oral and dermal exposure. The intake represents the total lifetime chemical dose or concentration averaged over an individual's expected lifetime of 70 years.
CSF	=	The Cancer Slope Factor models the potential carcinogenic response and is expressed as $[mg/(kg\text{-}day)]^{-1}$.

The potential cumulative risks resulting from exposure to the COPCs are compared to the target cumulative risk level, which typically is in the range of 1.0×10^{-6} to 1.0×10^{-4} or 1 in 1,000,000 to 1 in 10,000.

Risks are often added to address potential combined child and adult exposures. The cumulative carcinogenic risks for combined child or youth and adult exposures are presented in the summary Tables presented in Section 5.1.5.3 and the calculation of the risk assessments for the recreational angler and swimmer for both the RME and CT scenarios are presented in Tables 5.12, 5.13, 5.14, and 5.15, respectively. The individual risk estimates are presented in the referenced Tables within the summary tables.

5.1.5.3 RISK QUANTIFICATION SUMMARY

The non-cancer hazard index calculations and calculated lifetime cancer risks for the Site are summarized below.

Current/Future Recreational Angler

Medium	*Receptor*	*Route*	*Exposure*	*Carcinogenic Risk*	*Non-Carcinogenic Hazard Index*	*Table Reference*
Fish Tissue - All Fish	Recreational Angler (Child)	Ingestion	RME	2.7E-05	2.4E+00	5.12
			CT	2.4E-06	2.2E-01	5.13
	Recreational Angler (Adult)	Ingestion	RME	1.2E-04	2.6E+00	5.12
			CT	3.3E-06	1.9E-01	5.13
	Recreational Angler (Combined)	Ingestion	RME	1.4E-04	2.6E+00	5.12
			CT	5.7E-06	2.2E-01	5.13

The cumulative RME cancer risk and non-cancer HI for the recreational angler (child and adult) were 1.4×10^{-4} and 2.6, respectively. For the CT evaluation, cumulative cancer risk and non-cancer HI for the recreational angler (child and adult) were 5.7×10^{-6} and 0.22, respectively.

Current/Future Recreational Swimmer

Medium	*Receptor*	*Route*	*Exposure*	*Carcinogenic Risk*	*Non-Carcinogenic Hazard Index*	*Reference Table*
Surface Water	Recreational Swimmer (Youth)	Ingestion & Dermal	RME	3.4E-07	3.1E-02	5.14
			CT	6.3E-09	5.7E-04	5.15
	Recreational Swimmer (adult)	Ingestion & Dermal	RME	1.2E-06	2.6E-02	5.14
			CT	8.0E-09	4.8E-04	5.15
	Recreational Swimmer (Combined)	Ingestion & Dermal	RME	1.5E-06	3.1E-02	5.14
			CT	1.4E-08	5.7E-04	5.15

The cumulative RME cancer risk and non-cancer HI for the recreational swimmer (youth and adult) were 1.5×10^{-6} and 0.031, respectively. For the CT evaluation, cumulative cancer risk and non-cancer HI for the recreational swimmer (youth and adult) were 1.4×10^{-8} and 0.00057, respectively.

A summary of exceedances of potential target levels for cancer risk and hazard index of 1.00 x 10^{-4} and 1.0 respectively is provided in Section 5.1.5.4. An uncertainty analysis is presented in Section 5.1.6.

5.1.5.4 SUMMARY OF EXCEEDANCES

A summary of the exceedances of target cancer risk and hazard index levels for all exposure media, pathways, and human receptors is presented below:

Medium	*Receptor*	*Route*	*Exposure*	*Carcinogenic Risk*	*Non-Carcinogenic Hazard Index*	*Table Reference*
Fish Tissue - All Fish	Recreational Angler (Child)	Ingestion	RME	NA	2.4E+00	5.12
	Recreational Angler (Adult)	Ingestion	RME	1.2E-04	2.6E+00	5.12
	Recreational Angler (Combined)	Ingestion	RME	1.4E-04	2.6E+00	5.12

Note:
NA = Not Applicable as cancer risk is within risk range of 1E-06 to 1E-04

5.1.6 UNCERTAINTY ANALYSIS

The purpose of this section is to provide a summary and discussion regarding the uncertainties associated with the HHRA evaluation. The various uncertainties are discussed below.

5.1.6.1 EXPOSURE SCENARIO FACTORS

This section evaluates the uncertainty associated with the primary exposure scenario factors such as frequency of exposure. Because on occasion the assumptions used in the scenarios are not objectively determined but rather are subjective estimates based on judgment, conservatism, experience, and U.S. EPA Superfund guidance. In these cases, the tendency is to select overly conservative values to guard against under-estimating exposure. This leads to a general over-estimation of exposure. This is regarded as the case for the RME exposure frequency for recreational swimming. A frequency of 100 days/year was recommended by U.S. EPA Region III (U.S. EPA, 2009d). This was based on assuming someone might swim daily in the River. However, the River is navigable with barges, commercial shipping, etc. and as such, routine swimming in the River is unlikely.

With respect to the fraction of ingested fish that comes from the impacted waterbody, a value of 1 was used for RME risk estimates. This value assumes that 100 percent of ingested fish over the exposure duration of some 30 years come only from the impacted waterway. This assumption significantly overestimates potential risks associated with fish consumption because fish ingestion rates presented in U.S. EPA's Exposure Factors Handbook (EFH) (U.S. EPA, 1997b) reflect intakes from all sources including recreationally caught fish, store bought fish, restaurant meals, etc. In this regard, EFH Table 10-49 presents the number of study respondents who reported monthly consumption of seafood that was purchased or caught by someone they knew. Only approximately 6 percent reported consuming mostly caught fish (fraction unreported) compared to approximately 94 percent who reported consuming mostly store purchased fish. Moreover, recreationally caught fish that are consumed are unlikely to come from only one source especially in areas where more than one fishable waterbody exists. For these reasons, a fraction of 1 would overestimate potential long-term fish ingestion characteristics even for RME risk estimates.

Long-term exposure point concentrations are inherently uncertain because COPC concentrations are assumed to remain constant over time. This assumption could have a major effect on the exposure point concentrations of organics. The concentrations of organics will decrease over time due to degradation, sedimentation, and remediation processes. The assumptions that the measured concentrations are equivalent during sampling and exposure over the duration of exposure will overestimate the intake and resulting risk.

5.1.6.2 <u>DOSE RESPONSE</u>

One of the major uncertainties in estimating Site-specific risk is the use of published toxicity information. Factors introducing uncertainty associated with toxicity criteria are as follows:

i) Applicability of animal toxicity data - chemicals may be assumed to be human carcinogens based on animal studies even when there is limited or no available evidence that the chemical is a human carcinogen.

ii) Use of maximum tolerated dose - CSFs are derived from animal studies using dose levels that are known to elicit toxicity and may overwhelm metabolic pathways, thereby inducing a response that does not occur at lower doses.

iii) Dose-response modeling - CSFs are developed in a conservative manner often using default mathematical models based on low-dose linearity that are likely to overestimate potency.

iv) Uncertainty factors - RfDs are also established with conservative uncertainty factors, the combination of which, likely overestimates the adjustments needed to extrapolate results to exposed populations.

5.1.6.3 THEORETICAL NATURE OF RISK ESTIMATES

A HHRA assigns a numerical value to the excess probability (above background cancer rates) of a case of cancer developing in a population exposed to a specified amount of chemical that is a known or suspect carcinogen. This numerical value is presented as an upper limit excess cancer risk such as 1.00×10^{-6}, or one additional cancer case in a population of one million people exposed to the chemical at a specific chemical concentration for an upper bound duration of time, for example, some 30 years. Thirty years represents the 90^{th} percentile duration that individuals remain at one residence. Thus, most people (90 percent of the population) would be exposed for a shorter duration than assumed in the HHRA and therefore, true risks would be lower than those calculated, and may quite reasonably approach zero.

5.1.6.4 WEST VIRGINIA FISH ADVISORIES

An evaluation of potential health effects from consumption of fish according to the advisory rates presented in WV Department of Health and Human Resources (WV DHHR, 2007) is provided in Appendix N. Fish advisory methodology including that used by WV DHHR was developed to provide simplified and uniform advice to local populations regarding recommended rates of consumption of locally caught fish. The methodology is based on a standardized meal size of approximately 8 oz or 227 g. Using different consumption frequencies, e.g., 1 meal/week, allowable fish tissue concentrations are calculated that are protective of human health. Analytical fish tissue test results are then compared to these allowable concentrations to determine maximum recommended rates of consumption.

However, it should be noted that fish advisory intake rates were developed to provide a simplified and understandable basis to communicate with the public. These ingestion rates do not reflect those determined from actual study of anglers, and therefore the applicability of any risk estimates based on these intakes is unknown. In short, it is unknown whether the advisory intakes reflect local consumption patterns, and therefore the utility of resultant risk estimates is unclear.

Details of risk estimates based on fish advisory intake rates are presented in Appendix N. Based on the fish tissue sampling completed as part of the EOC, consumption of bass and sauger at a frequency of one meal per week would be acceptable. Catfish consumption at a rate of one meal per month would be acceptable. This evaluation is not intended to indicate any change in fish consumption advisories should be made. Any reduction of fish consumption advisories would be made by the State of West Virginia based upon their evaluation of all relevant data.

5.1.7 SUMMARY AND CONCLUSIONS

Based on the information presented in the HHRA, the following conclusions are made:

i) The HHRA evaluated potential human health impacts associated with exposure to 2,3,7,8-TCDD identified in fish tissue and surface water collected at the Site.

ii) The potential receptors and exposure pathways evaluated at the Site considering the current and potential future use of the Site included: recreational angler (child and adult) exposed to impacted fish tissue, and recreational swimmer (youth and adult) exposed to impacted surface water.

iii) The calculated RME cancer risk and non-cancer HI for the current/future recreational angler (child and adult) were outside the target range of 1.00×10^{-4} to 1.00×10^{-6} for cancer risk and exceeded 1.0 for hazard index.

iv) The calculated CT cancer risk and non-cancer HI for the current/future recreational angler (child and adult) were below 1.00×10^{-5} for cancer risk and 1.0 for hazard index.

v) The calculated cancer risk and non-cancer HI for the current/future recreational swimmer (youth and adult) were below 1.00×10^{-5} for cancer risk and 1.0 for hazard index for both RME and CT exposure scenarios.

5.2 ECOLOGICAL RISK ASSESSMENT

This section presents an ecological risk assessment (ERA), which evaluates the potential risks to ecological receptors. Figure 5.1 presents the limits of the Site for which the ERA was conducted. As recommended by U.S. EPA, the ERA focuses on 2,3,7,8-TCDD alone, which greatly simplifies the calculations, analyses, and conclusions. It should be noted, however, that 2,3,7,8-TCDD at this and other sites generally occurs in a mixture with other dioxin and dibenzofuran congeners (dioxins/furans). Together 2,3,7,8-TCDD and the other 2,3,7,8-TCDD substituted dioxins and furans pose additive toxicity that is generically known as dioxin-like toxicity. The total dioxin-like toxicity from all the dioxin/furan congeners is summed and expressed in terms of TEQ relative to 2,3,7,8-TCDD. Nonetheless, focusing on 2,3,7,8-TCDD will not meaningfully affect the results of the ERA because 2,3,7,8-TCDD at this Site is, by far, the dominant source of dioxin-like toxicity due to dioxins and furans, and the other dioxin-like chemicals occurring at the Site present risks to potential ecological receptors similar to risks posed by 2,3,7,8-TCDD. In fish, 2,3,7,8-TCDD alone contributes an average of about 97 percent of the total dioxin/furan TEQ. Therefore for the Kanawha River, 2,3,7,8-TCDD is assumed to be representative of total TEQ and the current risks and potential risk-reduction for various remedial strategies will be based on this assumption; however, the effects of other dioxin-like chemicals is qualitatively addressed below.

This ERA relies on data collected from 2004 to 2009 as part of the EOC Studies. Sediment, surface water, and fish tissue data were collected as part of the requirements of the Phase I EOC sampling, completed on April 18, 2005. Phase I EOC sampling was executed according to the Work Plan (CRA, 2004). The scope of Phase I EOC sampling and analysis was approved by U.S. EPA in September 2004. Results of the Phase I EOC investigation were presented in the report entitled Interim Report, Phase I EOC Sampling Results and Updated Phase II EOC Sampling Work Plan (CRA, 2005). Additional sediment samples were collected in 2007 and 2008 during the Phase II EOC sampling activities. Additional fish tissue samples were collected again during December 2008/January 2009. Surface and subsurface sediment, surface water, and fish tissue sampling locations are presented on Figures 5.2, 5.3, and 5.4, respectively.

All samples in all media were analyzed for 2,3,7,8-TCDD. Fish tissue and a limited subset of sediment samples were also analyzed for a wider list of constituents.

5.2.1 OVERVIEW OF THE ECOLOGICAL RISK ASSESSMENT PROCESS

In general, this ERA follows U.S. EPA guidance, primarily U.S. EPA 1997. This ERA also follows other appropriate guidance, including:

- Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, U.S. EPA/530-D-99-001A, August 1999 (U.S. EPA, 1999a)
- Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual, Interim Final, U.S. EPA/540/1-89/001, March 1989

- Framework for Conducting Ecological Risk Assessment, U.S. EPA/630/R-92/001, February 1992
- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment, U.S. EPA/540/R-97/006, June 1997 (U.S. EPA, 1997a)
- U.S. EPA Region I Supplemental Risk Assessment Guidance for the Superfund Program, Draft Final, U.S. EPA 901/5-89-001, June 1989
- U.S. EPA Region I Risk Updates No. 4, November 1996
- EcoUpdate Intermittent Bulletins

As described in U.S. EPA guidance (1997a), the ERA process can involve up to eight steps, described as follows:

Step 1 - Screening-level problem formulation and ecological effects evaluation: This first step consists of a basic description of a site and its habitats and known hazards and their likely modes of ecotoxicity. This information is then analyzed to determine whether there are complete or potentially complete exposure pathways from known sources. This information is combined into a preliminary Ecological Exposure Model.

Step 2 - Screening-level exposure estimate and risk calculation: The second step of the ecological risk screening includes the exposure estimate and risk calculation. Risk is estimated based on maximum exposure concentrations compared to ecotoxicity screening values from Step 1 and screening quotients of COPCs are presented. A screening quotient less than 1 indicates the COPC alone is unlikely to cause adverse ecological effects.

The ERA can produce only three outcomes: 1) Information is adequate to determine that ecological risks are negligible; 2) Information is inadequate to make a decision; or 3) Information indicates a potential adverse ecological effect exists. The risk assessment process is continued if either of the latter two conclusions is reached.

Step 3 - Baseline ecological risk assessment (BERA) problem formulation: The results of the screening assessment, in coordination with site-specific data, are used to assess the scope and goals of the BERA. The following should be completed at the end of this step:

- Refine preliminary COPCs
- Further characterize ecological effects

- Review and refine information on contaminant transport and fate, exposure pathways, and ecosystems potentially at risk
- Select assessment endpoints
- Develop Ecological Exposure Model with testable hypotheses
- Analyze uncertainties associated with the risk assessment

Step 4 - Study design and data quality objective process: The conceptual model is completed during this step of the BERA, and measurement endpoints are developed based on the model. The Ecological Exposure Model is used to determine the study design and the data quality objectives. The products of this step include a work plan and sampling and analysis plan, detailing the data analysis methods, exposure parameters, data reduction and interpretation methods, and statistical analyses.

Step 5 - Field verification of sampling design: The sampling design, testable hypotheses, exposure pathway models, and measurement endpoints are examined to ensure they are appropriate and that they can be implemented.

Step 6 - Site investigation and analysis phase: This step includes all of the field sampling and surveys that are part of the BERA. The data collected during this phase are evaluated on existing and potential exposure and ecological effects outlined in Steps 1 to 5.

Step 7 - Risk characterization: This step consists of risk estimation and risk description. Data on exposure and effects are used to characterize risk based on assessment endpoints. The product of this step is the identification of a threshold for effects on the assessment endpoint(s) as concentrations ranging from levels found to pose no ecological risk to levels likely to produce adverse ecological effects.

Step 8 - Risk management: This phase involves balancing risk reductions associated with remediation of the Site with the potential effects of the remediation itself.

5.2.2 STRUCTURE OF THE ERA

Generally, Steps 1 and 2 comprise the Screening Level Ecological Risk Assessment (SLERA), while Steps 3 through 8 are the BERA. As per the U.S. EPA's directive (Matlock, 2004), the following analysis will be limited to Steps 1 and 2. However, the format of the following analysis will deviate, when appropriate, from the usual SLERA practice because the intent of this ERA differs from a typical SLERA. For example, SLERAs are usually intended as the beginning of the risk assessment process, and are typically intended to focus subsequent risk assessment analyses on most important stressors (i.e., COPC selection) and most critical exposure pathways. Given their preliminary nature, SLERAs are typically very conservative. As such, they are really capable only of dismissing the potential for risk. SLERAs have very limited capacity to assess either the likelihood or magnitude of ecological risks.

In contrast, this ERA for the River is not intended to identify COPCs or help identify what further risk assessment activities are necessary. Rather, this ERA is intended to evaluate potential efficacy, with respect to protection of ecological resources, "of potential response actions and the associated cleanup goals" for 2,3,7,8-TCDD (Matlock, 2004). To that end, the following ERA will include elements of Steps 3 through 8 that are normally parts of a BERA.

5.2.3 SUMMARY OF SAMPLING DATA USED IN THE ERA

Data used in the ERA were collected on two phases: Phase I EOC sampling conducted from 2004 to 2005 and Phase II EOC sampling conducted from 2007 to 2009.

5.2.3.1 PHASE I EOC SAMPLING

The Phase I EOC sampling and analysis program, conducted as part of the Work Plan, included the following major activities:

- Bathymetric and Geophysical Surveys
- Surface Water Sampling and Analysis (including velocity profiling)
- Fish Tissue Sampling and Analysis
- Surface sediment sampling to support the geophysical survey, and mapping of soft sediment deposits
- Surface sediment sampling to support the derivation of a site-specific BSAF for 2,3,7,8-TCDD

Phase I EOC sampling activities were completed in 2 mobilizations: October 4, 2004 through November 2, 2004 and April 11, 2005 through April 18, 2005. Low flow surface water sampling, fish tissue sampling, bathymetry/geophysics, and sediment sampling activities were completed during the first mobilization. High flow surface water sampling was completed during the second mobilization.

The surface water, fish tissue, and sediment sampling locations identified in the Work Plan for Phase I EOC sampling were discussed in Section 4.2 and results are summarized on Figures 4.4, 4.5, 4.6a, and 4.6b, respectively. Rationales for the collection of these samples are as follows:

River Mile	*Location*	*Medium*	*Rationale for collection*
RM 75-95	Upstream of Site	catfish and sauger	Sufficiently upstream to ensure that the home ranges of the channel catfish sampled here are upstream of influence of the Former Flexsys Facility
RM 68	Upstream of Site	bass, forage fish, sediment, water	Immediately upstream of the Marmet Dam to be representative of regional background conditions unaffected by releases from the Former Flexsys Facility and urban Charleston area
RM 45	Upstream of Former Flexsys Facility (Study Area 1)	water	Upstream of the Former Flexsys Facility but downstream of urban Charleston area
RM 42	Adjacent to Former Flexsys Facility (Study Area 2)	bass, forage fish, sediment, water	In the vicinity of Nitro (adjacent and immediately downstream of the Former Flexsys Facility in Nitro)
RM 33	Downstream of Former Flexsys Facility (Study Areas 3 and 4)	bass, forage fish, sediment, water	In the vicinity of Little Guano Creek, upstream of Winfield Dam
RM 33-45	Entire reach of Site	catfish and sauger	Upstream of Winfield Dam and in the vicinity of Nitro, to ensure that the home range of the catfish sampled are within the impacted area.

5.2.4 STEP 1: SCREENING-LEVEL PROBLEM FORMULATION AND ECOLOGICAL EFFECTS EVALUATION

The Site is a 14-mile reach of the River in the southwest portion of WV. The River flows north to the Ohio River. The Site is bounded at the southern upstream end by the confluence of the River and the Coal River at RM 46. The downstream, northern end of the Site is the Winfield Dam at RM 33. The Site location and Site plan are presented on Figures 2.1 and 2.2, respectively.

For the purpose of conducting the EE/CA, the Site was divided into four Study Areas:

- **Study Area 1** - Defined as the upstream portion of the Site. In terms of surface water and sediment samples, Study Area 1 is the portion of the Site upstream of the Former Flexsys Facility, between RM 45 and RM 42.5. However, because some fish may migrate long distances, upstream samples of fish were taken well upstream of this area at RM 68. For the purposes of the risk assessment, all upstream samples, including the fish samples from far upstream (i.e., RM 68), are considered representative of Study Area 1.
- **Study Area 2** - An approximately 1 mile stretch of River adjacent to and immediately downstream of the Former Flexsys Facility. It runs from about RM 42.5 downstream (i.e., north) to Interstate 64 at RM 41.3.
- **Study Areas 3 and 4** - Study Area 3 is the near downstream area. It includes an approximate three mile stretch of River from Interstate 64 to the John E. Amos Power Plant (RM 38.4). Study Area 4 is considered the far downstream area. Study Area 4 is the length of the River from RM 38.4 to the Winfield Lock and Dam (RM 31). Because some fish may migrate across these artificial boundaries, catfish were sampled from a number of locations in Study Areas 3 and 4 and composited as one sample. Consequently, the risk assessment treats Study Areas 3 and 4 as one area.

  Tributaries to the River including the Pocatalico River and non-principal tributaries and un-named backwaters to the main stem located within the Study Area were included in the EE/CA risk evaluations and surface-weighted average concentration (SWAC) calculations.

5.2.4.1 ENVIRONMENTAL SETTING

The upstream 5 mile portion of the River, from RM 90.6 to the Kanawha Falls (Falls) at RM 95, is not a navigational channel. Here, the River is a more natural, free flowing river. The Falls, at RM 95, is a natural rock dam that has been augmented by manmade dams. The Falls are located below the River's confluence with the Gauley River and the New River. There is a deep pool at the base of the Falls that consists of mostly boulder substrate. There are several islands in this upstream reach. The substrate here also has greater amounts of cobble and boulders when compared to the downstream stations. In general, the physical aquatic habitat here is relatively good.

In contrast, the physical habitat value of the lower 90.6 miles is constrained by the modifications to flow and physical habitat associated with the commercial shipping.

The locks and dams have created long navigational pools that, especially during drier periods, are more lentic (i.e., pond-like or lake-like) than riverine. In addition to the ponding and slowing of current, the downstream portion of the River (adjacent to the locks) has been dredged periodically by the U.S. ACE to promote navigation. Dredging of the channel has minimized longitudinal variability in depth and eliminated typical riverine microhabitats such as pools, riffles, and runs. The depth of the channel is fairly constant, ranging from 10 to 18 feet, to approximately 20 to 24 feet during high water.

Cross-channel heterogeneity has also been greatly reduced. Additional dredging has been performed periodically along the shorelines adjacent to industrial facilities to provide for barge docking. To minimize erosion due to boat wake, large portions of the banks are covered with riprap. Consequently, the Riverbanks are steep and descend quickly to the barge channel depth. There is little to no shallow water habitat along the River's edge, and no significant areas of emergent wetlands and submerged aquatic plant beds. There is some limited habitat features, such as downed trees and other woody debris along the sides. However, these habitat features are limited and temporary.

In summary, the River functions primarily as a shipping channel, this limits its physical habitat quality. The lower River has minimal diversity of aquatic habitat types and little physical structure, both factors that promote productivity and diversity of fish and other aquatic species in natural rivers. Substrate in the pools is mostly sand, with some gravel and silt. Average discharge of the River at Charleston is approximately 15,000 cfs. As with any river, flow velocity varies with discharge, but variability of flow in the River is greatly attenuated by the lock and dam system.

Another potential impact on aquatic biota is barge traffic, which is relatively heavy on the River. Barge traffic can resuspend bottom sediments in the navigation channel, and the resulting turbidity and deposition can impact biota in the water column and sediments.

All of these factors greatly constrain the biological potential of the River. Small fish (minnows and darters) and Asiatic clam shells (*Corbicula*) were observed along the River banks during sampling events. The fish species captured during fish-tissue sampling are an assortment of warm water species associated with large rivers and lakes and ponds, as summarized on Table 5.16. Common species found were carp and other minnows, catfishes, black basses (e.g., smallmouth and spotted bass), and gizzard shad.

5.2.4.2 RARE, THREATENED, AND ENDANGERED SPECIES

State or federally listed rare, threatened, or endangered species can be of particular concern in an ecological risk assessment due to their population status and sensitivity. Letters requesting information on threatened or endangered species or critical habitats were sent in January 2009 to the WV DNR and the WV Wildlife Resources Section. A response from the WV DNR was received on January 23, 2009. A copy the response letter is included in Appendix O. The letter states that several rare species occur along the Site; however, none of these species are considered threatened or endangered in West Virginia. Moreover, none of these species is likely to face significant exposure to 2,3,7,8-TCDD. The southern redbelly dace is a benthic herbivorous fish that lives in small headwater and upland creeks. Consequently, it likely does not occur in the River. The meadow jumping mouse is primarily a terrestrial species. Similarly, the six plant species that are listed may be found in the area or on the banks of the Site. However, they are terrestrial plants and, thus, would not likely be exposed to 2,3,7,8-TCDD in the River.

The WV DNR Wildlife Resources Section, Wildlife Diversity Unit was contacted in November 2012 in order to determine if there was any new information on rare, threatened, or endangered species in the area. The WV DNR responded via email November 29, 2012 stating that no new information on rare, threatened, and endangered species is available for this area. A copy of the WV DNR email stating that the January 2009 letter remains accurate is presented in Appendix O.

A letter requesting information on rare, threatened, or endangered species was also sent to the US FWS WV Field Office in November 2012. The US FWS responded in February 2013 providing a list of Aquatic Habitats Supporting Federally Listed Endangered and Threatened Species and Proposed Species in West Virginia dated August 2012. The following Endangered and Threatened Fish Species were identified as potentially being present in the Kanawha River in Kanawha and Putnam Counties: fanshell, pink mucket, pearlymussel, sheepnose, spectaclecase, and tubercled-blossum pearlymussel. A copy of this document is presented in Attachment O. The US FWS Field Office suggested that implementation of Best Management Practices and an erosion and sedimentation control plan may mitigate the need for surveys prior to work causing bank disturbance.

5.2.4.3 CONTAMINANT FATE AND TRANSPORT

Because of its high hydrophobicity, 2,3,7,8-TCDD bioaccumulates in the tissues of fish and other aquatic organisms. Notably, however, 2,3,7,8-TCDD and the other dioxins and furans do not biomagnify in food chains (EPA 1993a, Wan 2005), unlike other very hydrophobic chlorinated compounds, such as PCBs and dichlorodiphenyltrichloroethane (DDT). Biomagnification is the process in which lipid-normalized concentrations increase as the chemical moves up the food chain.

2,3,7,8-TCDD and the other dioxin/furans are persistent in aquatic systems. In sediment, half-lives for 2,3,7,8-TCDD are estimated to be from about 1.5 to 5 years (Mackay et al., 1992), probably mostly desorption and losses from overlying water. In surface water, 2,3,7,8-TCDD is primarily subject to slow rates of volatilization and photodegradation. Biodegradation also occurs, albeit slowly. All of these processes are slowed by the very strong tendency of 2,3,7,8-TCDD and other dioxin/furans to sorb strongly to particulate matter. Therefore, degradation of 2,3,7,8-TCDD via volatilization and photolysis in the River is assumed to be negligible (e.g., see LTI, 2000). Consequently, as with many other aquatic systems, burial in sediments may be the most important fate process for 2,3,7,8-TCDD and the other dioxin/furans in the River.

5.2.5 IDENTIFICATION OF EXPOSURE PATHWAYS/ PRELIMINARY CONCEPTUAL SITE MODEL

The distribution of 2,3,7,8-TCDD in aquatic systems is a function of its very low solubility in water, and its tendency to partition to sediments, organic carbon, and lipids of biota. Therefore, 2,3,7,8-TCDD is preferentially concentrated in sediment and biological tissue. Concentrations in the water column are generally extremely low, and most of the 2,3,7,8-TCDD mass in surface water is not dissolved but is adsorbed to suspended sediments and dissolved organic carbon. Because of its affinity for lipids, and its low rate of degradation, 2,3,7,8-TCDD has the potential to bioaccumulate in food chains, but it generally does not biomagnify (U.S. EPA 1993a, U.S. EPA 1995). Nonetheless, with bioaccumulation alone, 2,3,7,8-TCDD levels in lipid-rich fish can accumulate to levels that potentially pose risk to the fish themselves and to their predators.

Thus, the primary exposure pathways in aquatic sediments are those from 2,3,7,8-TCDD in sediments to aquatic and semi-aquatic ecological receptors. The sediments are also the primary source of 2,3,7,8-TCDD exposure via the food chain (e.g., from sediment to crayfish to raccoon). However, biota are not generally exposed to 2,3,7,8-TCDD or other contaminants in sediments deeper than approximately 10-15 cm (4-6 inches). Complete exposure pathways from 2,3,7,8-TCDD in deep sediments to biota were, therefore, considered incomplete.

Although 2,3,7,8-TCDD concentrations dissolved in surface water are relatively minor, direct and indirect exposure pathways from 2,3,7,8-TCDD in water to ecological receptors also exist. Thus, fish and other aquatic life are exposed to 2,3,7,8-TCDD in the water, and the predators of the aquatic life are secondarily exposed to the 2,3,7,8-TCDD bioaccumulated from the water column.

The Ecological Exposure Model also considers the mode of ecotoxicity. As described previously, vertebrates are sensitive to dioxin-toxicity at certain concentration levels. Fish and other semi-aquatic vertebrates are also exposed, directly and through the food chain, to 2,3,7,8-TCDD in surface sediments and surface water. Therefore, effects of 2,3,7,8-TCDD on fish, birds, and mammals should be analyzed in the ERA.

In contrast, the ERA will not consider 2,3,7,8-TCDD effects on benthic invertebrates, water column invertebrates, or aquatic plants. As discussed previously (in Section 5.2.4.1), these taxa lack the Ah receptor and are generally insensitive to dioxin-like toxicity. Therefore, despite its tendency to accumulate in sediments, 2,3,7,8-TCDD does not generally pose risk to benthic invertebrates (U.S. EPA 1993a, Loonen et al. 1996, Barber et al. 1998). Similarly, water column invertebrates and aquatic plants are also insensitive to dioxins even though exposure pathways are complete.

5.2.6 <u>ASSESSMENT AND MEASUREMENT ENDPOINTS</u>

Assessment endpoints are the specific ecological values that should be protected from 2,3,7,8-TCDD. Assessment endpoints should be selected based on several factors: economic importance, importance to society, ecological importance, and sensitivity to contaminants (U.S. EPA, 1997a). Based on the Ecological Exposure Model, as presented on Figure 4.30, the following are appropriate assessment endpoints for 2,3,7,8-TCDD effects in the Study Area:

- Protection of the fish community from changes in structure and function due to 2,3,7,8-TCDD
- Maintenance of populations of herbivorous vertebrates foraging on aquatic plants in the River
- Maintenance of populations of omnivores feeding on benthic macroinvertebrates (e.g., crayfish) and aquatic plants at the Site

- Maintenance of populations of aerial insectivores, wildlife foraging on aquatic insects emerging from the Site
- Maintenance of populations of predators (fish eating wildlife) foraging similar to those found in similar habitats not exposed to 2,3,7,8-TCDD

Assessment endpoints are general goals that are difficult to assess quantitatively. Consequently, assessment endpoints are translated into measurement endpoints, which are quantifiable factors that respond to the stressor and describe or measure characteristics that are essential for the maintenance of the assessment endpoint. Measurement endpoints can range from biochemical responses to changes in community structure and function. Given the assessment endpoints chosen above, the following are appropriate measurement endpoints:

- 2,3,7,8-TCDD concentrations in the water column below those that cause ecologically significant reductions in reproduction or growth of native fish.
- 2,3,7,8-TCDD concentrations in River fish below those that cause ecologically significant reductions in their reproduction.
- 2,3,7,8-TCDD concentrations in River aquatic plants and algae below those that cause reductions in the reproduction of semi-aquatic herbivores. To estimate potential impacts, exposures and effects on muskrats (Ondatra zibethicus) and canvasbacks (Aythya valisenaria) will be assessed. The muskrat is a mammalian herbivore that is common in West Virginia and may be present at the Site. There is also adequate life history information for this species. The canvasback is representative of avian herbivores. Adequate life history information is available for this species, and this species may occur at the Site during winter roosting.
- 2,3,7,8-TCDD concentrations in adult aquatic insects below those that cause impacts on reproduction of aerial insectivores. To estimate this potential, exposure and potential effects of 2,3,7,8-TCDD will be estimated for little brown bat (Myotis lucifugus) and tree swallows (Tachycineta bicolor). The bat is an aerial insectivore, is likely present at the Site, and has adequate life history information to estimate its exposure. Similarly, the tree swallow may occur at the Site, has adequate life history information, and is often considered in ecological risks assessments of aquatic areas.
- 2,3,7,8-TCDD concentrations in aquatic benthos below those that cause impacts to the reproduction of their predators. Sentinel species for this measurement endpoint will be the raccoon (Procyon lotor) and the mallard duck (Anas platyrhynchos). These species are likely found at the Site, have well described exposure characteristics, and are commonly used to assess risks at aquatic sites. Both are

omnivores that eat a combination of animal and vegetable matter from both aquatic and adjacent terrestrial systems.

- 2,3,7,8-TCDD concentrations in River forage fish lower than those that cause reproductive failure in fish-eating wildlife. To assess risks to piscivorous mammals, mink (Mustela vison) will be used. Mink were chosen because they face relatively high exposure to bioaccumulating 2,3,7,8-TCDD and are known to be sensitive to dioxin-like toxicity. Great blue herons (Ardea herodias) are selected to represent the avian top carnivore. These birds are also exposed to bioaccumulated 2,3,7,8-TCDD. The great blue heron is also of societal importance, is present at the Site, and has ample natural history information to support its evaluation.

5.2.7 PREFERRED TOXICITY DATA

In the screening analysis, observed concentrations and estimated exposures will be compared to ecological screening values (ESV) and toxicity reference values (TRV), respectively. ESVs are concentrations that are associated with minimal chances of toxicity. Two types of ESVs are typically considered in ERAs, no observed effects concentrations (NOECs), and lowest observed effects concentrations (LOECs). In general, NOECs correspond to concentrations that cause no effects at all, while LOECs are the lowest concentrations at which effects are noticeable. TRVs are doses, which are usually expressed in terms of milligrams of chemical eaten and/or absorbed per kilogram of body weight per day (mg/kg-day). TRVs also generally come in pairs, NOAELs and LOAELs, which are functionally equivalent to NOECs and LOECs.

Consistent with their preliminary and, thus, very conservative nature, SLERA often base decisions on more conservative NOEC and NOAEL values (U.S. EPA, 1997a). However, the analysis presented here is more detailed than a typical SLERA. Moreover, comparisons to less conservative LOECs and LOAELS provide a better perspective on the likelihood and potential severity of ecological impacts. Thus, the following analyses will use both NOEC/NOAEL and LOEC/LOAEL values in assessing risks.

5.2.7.1 ESVS FOR SEDIMENTS

No reliable ESVs exist for screening 2,3,7,8-TCDD risks in sediment to either macrobenthos or fish. This does not represent a significant uncertainty because 2,3,7,8-TCDD and the other 2,3,7,8-substituted dioxins and furans are not very toxic to invertebrates. Potential risks of 2,3,7,8-TCDD to fish can be assessed with water column and body burden ESVs, which are described below.

5.2.7.2 ESVS FOR 2,3,7,8-TCDD IN THE WATER COLUMN

2,3,7,8-TCDD concentrations in the water column were compared to a conservative water quality ESV, originally from Mehrle et al. (1988). This bioassay considered potential effects, via water borne exposure, to juvenile rainbow trout. Based on review of available toxicity information, this bioassay yields the most sensitive response and lowest LOEC (U.S. EPA 1999b, Environment Canada 2001, Grimwood et al. 1999). Moreover, as described in the next section, salmonids tend to be extremely sensitive to dioxin toxicity. Based on this study, Grimwood and Dodds (1995) proposed that the toxicity threshold for fish should occur between 11 and 38 pg/L dioxin TEQ. The lower value, 11 pg/L, will be used as a NOEC to screen water quality data for direct risks to fish, and the higher value will be used as a LOEC. Because laboratory waters are generally low in suspended sediments, these ESVs are really applicable to dissolved 2,3,7,8-TCDD concentrations as opposed to the total 2,3,7,8-TCDD concentrations measured in the turbid River. Nonetheless, to be conservative, these ESVs will be compared to total as well as dissolved 2,3,7,8-TCDD concentrations measured in the River water.

5.2.7.3 ESVS FOR 2,3,7,8-TCDD IN FISH TISSUE

In addition to assessing impacts on fish by considering water column concentrations, considerable analyses have also evaluated potential risks to fish posed by their body burdens of 2,3,7,8-TCDD. Compared to water column concentrations, body burdens are potentially better indicators of risk. Body-burdens reflect all modes of exposure (e.g., water, food, and sediments) and the Site-specific bioavailability of those. In addition, the potential impacts of dioxins and furans on fish health, using the body-burden methodology, have been investigated for a large number of species.

For dioxin/furan effects on fish, the most sensitive ecological endpoint is mortality during development between the fertilized egg to feeding fry stages. Measured concentration at which 50 percent mortality occurs (LC_{50}) for 2,3,7,8-TCDD, expressed as concentration in fish egg, are available for a large number of fish species. These include lake trout, brook trout, rainbow trout, coho salmon, northern pike, zebra fish, bullhead, channel catfish, fathead minnow, mendaka, mosquitofish, guppy, bluegill, largemouth bass, and yellow perch (U.S. EPA, 1993a; Elonen et al., 1998). The LC_{50} values, as egg concentrations of 2,3,7,8-TCDD, range from about 90 ng/kg for lake trout, 140 ng/kg to 200 ng/kg for brook trout, and about 400 ng/kg for rainbow trout. For less sensitive non-salmonids species, LC_{50} values in eggs range from 539 ng/kg for fathead minnow, about 650 ng/kg for channel catfish, and up to 2,610 ng/kg for zebrafish (Elonen et al., 1998). These same analyses have also produced LOEC and NOEC values, also based on 2,3,7,8-TCDD concentrations in fish eggs, as summarized in Table 5.17.

In general, the available data indicate that cold-water fish tend to be more sensitive than warm water, salmonids tend to be more sensitive to dioxin effects than other taxa (U.S. EPA, 1993a; Elonen et al., 1998), and lake trout are more sensitive than other fish, salmonid species studied, as summarized in Table 5.17. However, the River in summer water is much too warm to support cold water fish in general and the highly sensitive salmonids species specifically. Thus, the fish fauna in the River are limited to warm water fish. Fish species collected when electrofishing included various sunfish species and black basses, carp and minnows, various suckers, pikes (e.g., muskie and chain pickerel), percids (walleye and sauger), and gizzard shad, as presented in Table 5.16.

Based on the available data on dioxin toxicity to fish, presented in Table 5.17, the most sensitive River fish are likely the catfishes, such as the bullheads and channel and flathead catfish. The available data on critical body burdens of dioxin also pertain to a number of other species found in the River. For example, the fathead minnow is a Cyprinid species, and thus, should be representative of dioxin sensitivity of other minnows and carp. The white sucker's sensitivity is indicative of the sucker family, and the sensitivity of the River pikes is likely similar to the insensitive northern pike. There are no data on sensitivity of the eggs and fry of the *Centrarchidae*, the family which contains sunfish species and black basses. However, LC_{50} values for single injection to juvenile bluegill and juvenile largemouth bass were 16,000 ng/kg and 11,000 ng/kg, respectively. By comparison, single injection LC_{50} values were 3,000 ng/kg and 5,000 ng/kg for carp and bullhead juveniles, respectively. These experiments suggest that the Centrarchids are considerably less sensitive to dioxin toxicity than the minnows and catfishes.

The crucial body burdens pertain to egg concentrations of 2,3,7,8-TCDD. By comparison, 2,3,7,8-TCDD analyses of River fish pertain to fillets, skinless fillets, and whole fish. However, uptake and deposition of 2,3,7,8-TCDD and other hydrophobic substances within fish tends to follow lipid levels in those tissues (Niimi 1983, Nichols et al., 1998). Thus, lipid normalized concentrations in eggs should be comparable to lipid normalized concentrations observed in whole gizzard shad and fillets of catfish, sauger, and bass. Consequently, the NOEC, LOEC, and LC_{50} values from Table 5.16 were all normalized to 1 percent lipid, and these ESVs were compared to tissue concentrations measured in River fish, also normalized to 1 percent lipid. Assuming that the catfishes are the most sensitive taxa in the River, the NOEC, LOEC, and LC_{50} values for critical body burdens of 2,3,7,8-TCDD at 1 percent lipid are 80 ng/kg, 104 ng/kg, and 134 ng/kg, respectively. These ESVs are applicable to the lipid-normalized concentrations observed in fillets and whole body measured in River fish.

5.2.7.4 TOXICITY REFERENCE VALUES (TRVS) FOR FOOD-CHAIN EXPOSURE TO SEMI-AQUATIC VERTEBRATES

Once exposure to 2,3,7,8-TCDD is estimated with the food chain models, which are described below, the estimated exposure is then compared to a TRV. As recommended by U.S. EPA (1997a), TRVs used in the ERA are generally NOAELs. These are doses of a chemical shown to have no ecological effects on an organism. However, LOAELs are often better indicators of actual impacts. Therefore, estimated exposures will also be compared to LOAELs to provide perspective on the potential and severity of potential ecological impacts.

Except for the mink, the TRV values for 2,3,7,8-TCDD were obtained from the Oak Ridge National Laboratory (ORNL) (Sample et al., 1996). This document is widely used as a source of ecological TRVs (e.g., see U.S EPA, 1999a). The avian TRV value for 2,3,7,8-TCDD is based on a study by Nosek et al. (1992). Ring-necked pheasants were injected weekly, intraperitoneally, for 10 weeks at three dose levels: 0.14, 0.014, and 0.0014 µg/kg-day. Egg production and hatchability were significantly reduced in birds receiving the highest dose (0.14 µg/kg/day), but not in the other two dose groups. Therefore, the NOAEL for 2,3,7,8-TCDD and birds was determined to be 0.014 µg/kg-day, and the LOAEL 0.14 µg/kg/day.

This TRV for mammals other than mink (presented in Sample et al., 1996) is based on a three generation rat study conducted by Murray et al. (1979). Male and female rats were fed a diet of lab chow that averaged about 22, 210, and 2,200 ng/kg, dry weight, 2,3,7,8-TCDD (U.S. EPA, 1995) to give long-term exposures of 0.001, 0.01, and 0.1 µg/kg-day. No effects on survival and reproduction were noted at the lowest dose, but impacts were noted on reproduction in the second and third generation at the second-highest dose, 0.01 µg/kg-day. Consequently, this study produces NOAEL and LOAEL doses of 1 ng/kg-day and 10 ng/kg-day, respectively. In terms of wet weight food concentrations, the NOAEL and LOAEL correspond to a diet with about 6 ng/kg and 60 ng/kg 2,3,7,8-TCDD (Sample et al., 1996).

Mink-specific TRVs for 2,3,7,8-TCDD were recently developed by Blankenship et al. (2008) based on a variety of feeding studies with dioxin-like compounds (e.g., dioxins, furans, and PCBs.) These feeding studies provide a range of NOAELs (1.9 ng/kg-day to 8.5 ng/kg-day) and LOAELs (7.6 to 36.3 ng/kg-day). The geometric means of each range, 3.9 ng/kg-day and 16.6 ng/kg-day, were used as mink-specific NOAEL and LOAEL values. These values correspond to wet weight diets which averages 26 ng/kg and 110 ng/kg 2,3,7,8-TCDD, respectively.

5.2.8 STEP 2: SCREENING-LEVEL EXPOSURE ESTIMATE AND RISK CALCULATION

In the second step of the ERA, COPCs and receptors with complete exposure pathways identified in Step 1 are screened in terms of their potential to cause ecological risk.

5.2.8.1 SCREENING OF RISKS

In analyses that follow, 2,3,7,8-TCDD is screened for potential ecological risk to assessment endpoints using the quotient method. Specifically, ecological screening quotients (ESQ) are estimated as:

$$ESQ = \frac{EEC}{ESV}$$

where EEC is the estimated exposure concentration and ESV is the ecological screening value, which is also a concentration. Depending on the intent of the screening analysis, the EEC can be based on the maximum concentration, the mean concentration, or some conservative estimator of the mean such as the 95 percent upper confidence level (UCL). The most conservative EEC, the maximum concentration, is used to select COPCs for further evaluations. EECs based on mean and 95 percent UCLs are generally preferable for assessing risks because ecological risk pertain to effects on populations of animals.

A variant of the above equation is used in sections below which estimate risks due to 1) bioaccumulated 2,3,7,8-TCDD and subsequent risks to the organisms themselves or 2) risks to predators of these organism via food chain exposure. In the first case, the ESQ is equal to the observed body burden of the chemical divided by a critical body burden below which effects are unlikely. Both are expressed in mg/kg fresh weight. In the second case, the estimated exposure to the predator, via the food chain, is divided by a TRV. Both estimated exposure and TRV are doses (mg/kg-day).

As with exposure concentrations, quotients based on body burdens can be based on maximum concentration, mean concentrations, or 95 percent UCLs. Similarly, food chain exposures can also be based on these different concentrations. Estimation of exposure via the food chain is described below.

5.2.8.2 SCREENING OF BIOACCUMULATED 2,3,7,8-TCDD WITH FOOD CHAIN MODELS

Aquatic biota bioaccumulate 2,3,7,8-TCDD from water and sediments; hence, the ERA must considers potential toxicity of 2,3,7,8-TCDD through bioaccumulation pathways. The large number of potential receptor species found in any ecosystem precludes an assessment of potential risks for each species. Therefore, potential risks were assessed for a number of species representing a range of feeding guilds with varying exposure and sensitivity to 2,3,7,8-TCDD. Potential risks were assessed for mammalian and avian herbivores, omnivores, piscivores, and aerial insectivores.

To be conservative, the potential food chain exposure to 2,3,7,8-TCDD was modeled using worst-case assumptions. That is, these receptors were assumed to eat only contaminated food from the Site for their entire lives. In addition, this ERA considers idealized consumers within an idealized food web. Thus, for example, largely herbivorous species, such as muskrats and canvasback, were assumed to be 100 percent herbivores. For omnivorous species it was assumed their diet consist of 50 percent plant matter and 50 percent animal material. Mostly carnivorous species, such as mink and heron, were assumed to consume only fish. Idealized food chains are preferable in early stages of the risk assessment because they are simpler, and they encompass a wider range of potential exposure scenarios, providing a more conservative assessment.

Specifically, the following dietary assumptions were made:

- Muskrats and canvasbacks were assumed to eat only aquatic plant matter.
- The diets of ducks and raccoons were assumed to consist of one-half plant matter and one-half aquatic invertebrates. The plant matter that raccoons consume was assumed to be from terrestrial plants rather than aquatic plants. For this reason the consumption rate for raccoons was reduced by 50 percent in the calculations, and that reduced consumption was assumed to be totally benthic invertebrates (e.g., crayfish). Ducks were assumed to consume aquatic plant matter, which was set

at 50 percent of the duck's consumption. The balance of ducks consumption was assumed to be aquatic benthos.

- The insectivorous birds and mammals were assumed to consume insects which during the larval stage of their life-cycle are benthic invertebrates, after which they migrate from sediment to ambient air and are subsequently consumed.
- The mink and great blue heron were assumed to eat only (100 percent) gizzard shad.

In addition, the following conservative (i.e., tending to exaggerate estimated risks) assumptions were applied in the ERA to estimate the daily COC dose levels for the measurement receptors evaluated based on U.S. EPA (1997, 1999) recommendations:

- COCs in food items, sediment, and water are assumed to be 100 percent bioavailable
- Each of the measurement receptors' most sensitive life stage is present in the assessment area being evaluated in the risk assessment
- Each individual species in a community or class-specific guild is equally exposed
- The measurement receptor spends 100 percent of its time in the contaminated area, such that their diet is 100 percent contaminated, even for receptors with home ranges larger than the habitat area being evaluated
- Impacts in individual organisms would cause impacts to their populations

The total exposure for each species was modeled using the following equation:

Total Dose = [food] * consumption rate * absorption efficiency + [sediment] * incidental sediment consumption rate * absorption efficiency +[water] * drinking rate * absorption efficiency + [air] * inhalation * absorption efficiency + [soil] * dermal absorption rate + [airborne dust] * dust inhalation * absorption efficiency

All bracketed terms (e.g., [water]) refer to the concentration of the chemical in that medium; other values are self-explanatory. Sediment concentrations were based on Surface sediment samples, 0 to 10 cm in depth. Based on the conservative methodology recommended by U.S. EPA (1997a), absorption efficiency was assumed to be 100 percent for all pathways. However, the last three terms (exposure via air, dermal absorption, and airborne dust) are generally insignificant and thus, were ignored in the calculations. Consequently, the equation collapses to:

Total Dose = [food] * consumption rate + [sediment] * incidental sediment consumption rate + drinking rate * [water]

Species-specific ingestion rates were taken from data supplied by U.S. EPA (1993b, 1999a) or other sources (e.g., Baron et al., 1999), when available. If specific ingestion rates were not available, rates were estimated from consumption-body mass (allometric) models as per U.S. EPA (1993b). Ingestion rates for each species are listed in Table 5.18.

5.2.8.3 ESTIMATION OF EXPOSURE POINT CONCENTRATIONS

The following describes the underlying data and methods of calculating for exposure point concentrations (EPCs) used in the risk assessment.

5.2.8.3.1 EXPOSURE POINT CONCENTRATIONS IN WATER

Data collected in 2004 and 2005 were used to determine exposure point concentrations in water. Surface water samples were collected at the same locations as fish samples (RM 33, 42, and 68), as well as two additional locations, RM 46 and RM 31. Two samples were collected at each location, dissolved 2,3,7,8-TCDD and particulate (adsorbed) 2,3,7,8-TCDD. To determine the exposure point concentration for associated fish samples, water samples collected from RM 31 and 33 were considered together and applied to fish collected in Study Areas 3 and 4. Water samples collected from RM 42 were used to estimate exposure point concentrations for Study Area 2. Water samples collected from RM 46 and RM 68 were combined and used to estimate exposure point concentrations for the upstream portion of the Site, i.e., Study Area 1. For each set of data, the mean was determined for the dissolved fraction and particulate (adsorbed) fraction. The two fractions were added together and averaged to determine the average total 2,3,7,8-TCDD concentration in each Study Area. Because only a limited number of samples were collected, no 95 percent UCL was calculated. The maximum total water concentration from each location was used instead. These values are summarized in Table 5.19.

5.2.8.3.2 EXPOSURE POINT CONCENTRATIONS IN SEDIMENTS

Surface sediment samples were collected in 2004 and 2007/2008. Only grab samples were considered in the risk analyses because they were taken from the biologically active zone, about the top 10 cm. In contrast, tops of core samples were not included in estimating exposure point concentrations because they went down well below the biologically active zone, down to 2 feet below the sediment surface. Sediment samples that were not collected in the main stem of the River were also excluded (i.e., SSD-11, SSD-18, and SSD-20). EPCs for sediments in Study Area 1 were based on all sediment samples collected upstream of RM 42.5. Sediment samples collected in Study Area 2 were used to estimate EPCs for biota foraging in that area. Sediment samples from Study Areas 3 and 4 were used to estimate EPCs for the downstream area. The mean and 95 percent UCL (using ProUCL version 4.00.02) 2,3,7,8-TCDD concentrations were calculated for each Study Area. These values are summarized in Table 5.19.

5.2.8.3.3 EXPOSURE POINT CONCENTRATIONS IN FISH TISSUE

Gizzard shad and bass were collected from RM 33 (Study Area 3 and 4), RM 42 (Study Area 2), and RM 68 (upstream of Study Area 1) in 2004 and 2008/2009. The average and 95 percent UCL 2,3,7,8-TCDD concentrations (using data from both years) were calculated for each species separately, for each associated RM/Study Area. Catfish and sauger were also collected, at RM 75-95 and RM 33-45. Catfish was collected in 2004 and in 2008/2009, while Sauger was only collected in 2008/2009. Some 2008 samples were composites of both species, while others were of only one species. Both species were considered together for the calculation of the average and 95 percent UCL 2,3,7,8-TCDD concentrations for each RM/Study Area. In addition, 2,3,7,8-TCDD concentrations of all species at the sampling locations were normalized to 1 percent lipid. A lipid normalized average and 95 percent UCL concentration was calculated for each species for each Study Area. These values are summarized in Table 5.19.

The lipid normalized concentrations of all fish species were used to assess impacts to the fish themselves. For the food chain analysis, the bass lipid normalized 2,3,7,8-TCDD concentration was used to estimate 2,3,7,8-TCDD concentrations in crayfish and other benthic prey (see section 5.2.8.3.5). The 2,3,7,8-TCDD concentrations in gizzard shad, not lipid normalized, were used in the risk assessment for great blue heron and mink. These predators were assumed to eat only whole gizzard shad.

5.2.8.3.4 CONCENTRATIONS OF 2,3,7,8-TCDD IN AQUATIC VEGETATION

Concentrations of COCs in aquatic vegetation tissue are due to root uptake from River sediments. The following equation was applied in calculating the COC concentrations in plant tissue due to root uptake:

$$C_{AV} = C_{sed/S} * BCF_{sed/S\text{-}AV} * 0.12$$

where:

C_{AV} = Concentration in aquatic and terrestrial vegetation (mg COC/kg wet weight)
$C_{sed/S}$ = COC concentration in sediment or soil (mg COC/kg sediment or soil)
$BCF_{sed/S\text{-}AV}$ = Sediment/soils-to aquatic vegetation bioconcentration factor (unitless)
0.12 = Dry weight to wet weight conversion factor

This equation and the BCF values were obtained from U.S. EPA (1999a). The concentrations of 2,3,7,8-TCDD in sediments are based on the EPCs for sediments described in the previous section.

5.2.8.3.5 CONCENTRATIONS OF 2,3,7,8-TCDD IN BENTHIC INVERTEBRATES AND EMERGED ADULT INSECTS

Typically, concentrations of chemicals in benthic invertebrates are estimated with BSAF values taken from other locations. However, use of non-Site specific BSAF values is problematic for estimating benthic invertebrate concentrations in the River for two reasons. First, BSAF values for 2,3,7,8-TCDD are very variable depending on local bioavailability. Values reported in U.S. EPA's BSAF database range over about two orders of magnitude, from about 0.02 to 5.0, and those listed in Environment Canada's technical document on dioxins and furans are similarly variable. There is also great uncertainty, at the Site, about which sediment concentration to use with the BSAF to estimate benthic invertebrates since sediment concentrations are so variable.

Consequently, concentrations of 2,3,7,8-TCDD in benthic invertebrates were estimated with aquatic food chain models and Site-specific fish tissue data. This estimation method has several advantages. First, local fish concentrations provide Site-specific information on dioxin bioavailability. The native fish body burdens also reflect the real patchiness of 2,3,7,8-TCDD across sample locations and across sediment depths. In addition, concentrations of 2,3,7,8-TCDD found in the catfish and bass are potentially good indicators of benthos concentrations. Food chain exposure is generally a fish's dominant exposure pathway to 2,3,7,8-TCDD, and the catfish and bass species are connected, to the benthos, by the food chain. That is, both the channel catfish and the bass may consume significant amounts of benthos. Consequently, 2,3,7,8-TCDD in the benthos is likely the dominant source of 2,3,7,8-TCDD to these fish. The methodology is conservative because fish tissue concentrations reflect past exposures as well as more recent exposures.

The situation is different for gizzard shad. Gizzard shad are filter-feeders that primarily consume phytoplankton and, to lesser extent, water column invertebrates. Consequently, their primary 2,3,7,8-TCDD exposure is via the water column, either directly across the gills or indirectly via the water column food chain. The gizzard shad's exposure contrasts with the primary 2,3,7,8-TCDD exposure for benthic invertebrates. The latter are primarily exposed to 2,3,7,8-TCDD in sediment, either via bioaccumulation of 2,3,7,8-TCDD in pore water or ingestion of 2,3,7,8-TCDD associated with sediment and detritus. Thus, gizzard shad could potentially have lower lipid normalized concentrations of 2,3,7,8-TCDD than the benthos or benthivorous fish.

Given this background, the estimation of 2,3,7,8-TCDD concentrations in aquatic food chains is reasonably straightforward because this chemical does not biomagnify (EPA 1993a, Environment Canada 2001, Wan et al. 2005). Therefore, the lipid-normalized concentrations in the predator fish species should be similar to lipid-normalized concentrations in their benthic prey. (Note that if 2,3,7,8-TCDD biomagnifies in the River, this will be a conservative assumption because lipid weighted concentrations in prey will be less than those in the predator fish.)

Therefore, 2,3,7,8-TCDD concentrations in benthos were estimated based on lipid normalized concentrations in bass, as presented in Table 5.19. Lipid normalized concentrations in bass, instead of catfish, were chosen to estimate benthos concentration because the bass are less migratory. Hence, bass sampled at upstream (Study Area 1), adjacent (Study Area 2), and downstream (Study Areas 3 and 4) locations can be used to estimate different benthic concentrations, and different exposure regimes, at these three locations.

Lipid concentrations in benthos are generally in the range of 1 percent to 3 percent (Morrison et al. 1999), and those for crayfish are determined to be 2.5 percent (Morrison et al. 1999). Crayfish lipid content was used to estimate 2,3,7,8-TCDD concentrations for all benthic species for several reasons. Crayfish are preferred prey of the basses, so the food chain modeling based on bass concentrations is most appropriate. In addition, crayfish are a preferred prey of one of the measurement receptors, the raccoon. Lastly, 2.5 percent lipid is a relatively conservative lipid value for most benthos.

Thus, 2,3,7,8-TCDD concentrations in aquatic benthos were set equal to 2.5 times the 2,3,7,8-TCDD concentrations observed in bass fillets, after the latter were normalized to 1 percent lipid.

5.2.8.4 RESULTS OF SCREENING

5.2.8.4.1 SCREENING OF WATER

Observed concentrations of 2,3,7,8-TCDD in the water column downstream of Nitro averaged about 0.010 pg/L dissolved. This concentration is about 1000 times lower than the NOEC value of 11 pg/L, as presented in Table 5.20. As discussed previously, the NOEC value is really more applicable to dissolved 2,3,7,8-TCDD concentrations. Nonetheless, to be conservative, observed concentrations of total 2,3,7,8-TCDD in water can be compared to this NOEC. The maximum concentration of total 2,3,7,8-TCDD in the water column, 0.073 pg/L (Study Area 2), is still more than 100 times lower than the NOEC. Consequently, risks to fish from water column exposure of 2,3,7,8-TCDD are well below levels that would cause risk to even the most sensitive salmonid fish species. Risks to warm water fish that are native to the River are expected to be even less. Consequently, risks to fish from water borne exposure can be dismissed with a high degree of certainty.

5.2.8.4.2 SCREENING OF FISH TISSUE CONCENTRATIONS TO CRITICAL BODY BURDENS

For fish collected from Study Areas 2, 3, and 4 in 2004 and winter 2008/2009, the gizzard shad, bass, and catfish and sauger samples averaged about 1.7 ng/kg, 7.2 ng/kg, and 6.1 ng/kg when normalized to 1 percent lipid, respectively. These values are well below the NOEC and LOEC body burdens for the most sensitive warm water species. Results for the screening or risk based on the body burden method for fish tissue are presented in Table 5.21. Observed values are also generally below the NOEC and LOEC values for highly sensitive salmonids. NOEC and LOEC values are presented on Figure 5.5 and in Table 5.17. Consequently, current body burdens in River fish pose no potential for risk to the fish's health or reproduction. (Concentrations of 2,3,7,8-TCDD in fish collected upstream of the Former Flexsys Facility , in Study Area 1, were lower than downstream. Risks are similarly lower.)

5.2.8.4.3 SCREENING OF RISKS VIA FOOD CHAIN EXPOSURE TO SEMI-AQUATIC VERTEBRATES

The results of screening of risks to semi-aquatic vertebrates feeding on River prey are presented in Tables 5.22 (for Study Areas 3 and 5) and 5.23 (for Study Area 2). Except for bats, estimated exposures to all species were negligible (e.g., below or only nominally above the NOAEL) at the downstream location (Study Areas 3 and 4). At this location, estimated exposure to bats was about half-way between the NOAEL and LOAEL. Ecological impacts at this intermediate level of exposure cannot be dismissed with certainty but are generally assumed to be negligible.

Exposures to all receptors are slightly higher at RM 42. In this case, only three species (the bat, the swallow, and the raccoon) are estimated to have exposures more than nominally above NOAEL values. Except for the bat, all of these exposures were well below the LOAELs, even when calculated with the 95 percent UCL values. Estimated exposure to the bat, based on 95 percent UCL values, was slightly below the LOAEL.

5.2.8.5 UNCERTAINTY ANALYSIS

Evaluation of risk to ecological receptors is typically associated with several areas of uncertainty. In the absence of data, assumptions must be made regarding actual exposure concentrations and actual responses of populations of biota to chemical constituents. To avoid incorrectly dismissing the potential of risk, exposure concentrations and other assumptions are generally conservatively biased. That is, the assumption will tend to identify risk. While these overt conservative biases increase certainty that risks can be dismissed when ESQ values are low, they add uncertainty to inferences about risks when ESQs are above 1.0. In the latter case, excessive ESQ values could be due to compounded conservatism rather than real likelihood of impacts.

Thus, for example, consider the effect of conservative assumptions for the vertebrate receptors that had estimated exposures greater than the NOAELs. In the analyses above, swallows and bats were conservatively assumed to eat only aquatic insects from the River and reside at the Site year round. However, swallows migrate south in late summer after breeding (U.S. EPA, 2002). Accounting for migration reduces their exposure to the River 2,3,7,8-TCDD by about half, and these more realistically estimated exposures to 2,3,7,8-TCDD are no longer significantly greater than NOAELs. Furthermore, both bats and swallows are opportunistic foragers; they will both consume a variety of insects of terrestrial and aquatic origin. Baron et al. (1999) assumed that closely related rough-winged swallows ate about only 40 percent aquatic prey. And while some accounts show that little brown bats do consume about 80 percent aquatic insects (e.g., see Belwood and Fenton 1976 and Sample et al. 1997). If the brown bats on the River consume only 50 percent aquatic insects, their estimated exposure is reduced to a value mid-way between the NOAEL and LOAEL, even when exposure is conservatively estimated with the 95 percent UCL at RM 42. The midpoint between the NOAEL and LOAEL is often considered a threshold exposure at which impacts are assumed to be *de minimis*.

Another significant area of uncertainty pertains to the relevance of the TRV for dioxins to specific species. The TRV for mammals other than mink was based on a multigenerational-study with rats. This assumes that bats are as sensitive to 2,3,7,8-TCDD toxicity as rats. In fact, the available, albeit limited toxicological data, suggests that bats are less sensitive than rats to dioxin-like toxicity (Reinhold et al. 1999). In addition, the rat TRV was applied to bats without modification. To account for the faster excretion of smaller animals, many authors suggest that TRVs should be scaled for differences in body weight between the lab animal and receptor species. Scaling for body weight would increase the TRV for the bat, and reduce the ESQ, by about 2.5 fold. As with the uncertainty about the proportion of aquatic insects in the diet, uncertainty about the TRV suggests that risks to bats are lower than suggested by ESQ values estimated by the ERA.

To avoid the question of body-scaling, an alternate methodology considers risk in terms of NOEC and LOEC food concentrations. The estimated benthic concentrations are much closer to the NOECs from the Murray et al. rat study, about 6 ng/kg, than this study's LOEC, 60 ng/kg. Focusing on food concentrations also suggests that risks to the bats, and to raccoons as well, are low.

In contrast to the usually conservative ERA assumptions, one assumption of this ERA was non-conservative. Specifically, the ERA focused on 2,3,7,8-TCDD alone, ignoring the other 2,3,7,8-substituted dioxin/furans and other dioxin-like compounds, notably PCBs. The first half of this assumption should not have a significant effect on the results. 2,3,7,8-TCDD alone made up, on average, 97 percent of the total dioxin/furan TEQ in fish samples (when less than detect concentrations of dioxins and furans were set equal to zero). Consequently, the risks of 2,3,7,8-TCDD alone are essentially equal to those total dioxin/furan TEQ.

Dismissing the impact of additional dioxin-like toxicity due to PCB is more difficult. PCBs were assayed in 9 surface sediment samples. Results are presented in Table 4.10a and analytical data reports are presented in Appendix G. No PCB Aroclor was detected in any of these sediments, at detection levels ranging from about 46 μg/kg to 100 μg/kg.

However, PCBs were detected in several subsurface sediment samples, generally at low concentrations. An exception was subsurface sample from location COR-39. Total PCB Aroclor concentrations in two subsurface sediments averaged approximately 47 mg/kg. Similarly, PCB concentration in food fish collected in the Winfield Pool were sometimes moderately high in larger catfish: 0.4 mg/kg in 17 inch fish and 0.95 mg/kg in 19.5 inch fish (WVDHHR, 2009b). On the other hand, the PCB concentrations were quite low, e.g., about 0.05 to less than 0.02 mg/kg, in smaller catfish and small to moderate sized smallmouth bass. The large scale differences among fish in their PCB concentrations are likely due to differences in their diets and potential food chain biomagnifications. The bass and smaller catfish are largely benthivorous, while larger channel catfish can be largely piscivorous. The latter allows more potential for food chain biomagnification of PCBs. (In contrast, 2,3,7,8-TCDD does not biomaginify, so its concentrations do not change dramatically from small to large catfish or from bass to large catfish.)

Consequently, the available PCB concentrations observed in sediments and fish indicate that potential contribution of dioxin-like PCBs to total TEQ will be most significant for larger fish at the top of the food chain. Contributions to total TEQ will be much less significant for smaller fish low on the food chain and even less significant for benthic invertebrates. Since the highest risks pertain to the benthos eaters, this qualitative assessment suggests ignoring the TEQ of PCBs will not significantly affect the risk conclusions.[4] Nonetheless, the uncertainty surrounding this conclusion should be recognized.

The use of conservative exposure concentrations, such as the 95 percent UCL or maximum concentrations, also tends to overestimate risks. These concentrations are considerably higher than the surface weighted average SWACs calculated for the Site. Utilizing the SWACs for 2,3,7,8-TCDD would reduce all ESQs to below 1.0, suggesting, on average, no risks to any species.

Another area of uncertainty pertains to sediment stability. For this ERA, the surface sediment concentrations were effectively assumed to be stable. This assumption is

4 Estimation of TEQ based on total PCB concentrations is fraught with uncertainty. However, the PCBs are overwhelmingly Aroclor 1248, which has a TEQ of about 1/60,000th total PCB concentration (Beliveau, 2003). That is, a total PCB concentration of 1 mg/kg would represent a TEQ of 15 ng/kg. PCB mixtures observed in Great Lakes fish have slightly higher TEQ per total PCB, about 25 ng TEQ per mg of PCBs (Bhavsar et al., 2007). Ignoring biomagnifications and conservatively assuming that benthic invertebrates had the same PCB concentration, < 0.05 mg/kg, as their predators (smallmouth bass, smaller catfish), would suggest a TEQ due to PCBs of about 1 ng/kg or less in benthic invertebrates. This additional TEQ from PCBs would, at most, about a 5 percent increase over the2,3,7,8-TCDD TEQ estimated at RM 42.

incumbent with the use of measured fish concentrations, which necessarily pertain to current and historical surface sediment concentrations and ignore other potential sources of 2,3,7,8-TCDD. However, 2,3,7,8-TCDD concentrations are, on average, higher in deeper sediments than those in surface sediments. Exposures to ecological receptors, and attendant risks, would increase if more contaminated deep sediments were exposed so as to increase surface sediment concentrations. Similarly, exposures and risks would decrease if exposed surface sediment is buried by cleaner sediment. Appendix P, Table P.2 presents averages for all sediment samples, including those in surface and deep sediment samples.

5.2.8.6 RISK CHARACTERIZATION OF CURRENT CONDITIONS

Toxic effects of 2,3,7,8-TCDD on fish reproduction can be dismissed with a high degree of confidence. Potential risks of 2,3,7,8-TCDD to fish were assessed in two different ways. First, observed water column concentrations were compared to a conservative water column ESVs based on salmon. Based on other evidence, salmon are likely more sensitive to 2,3,7,8-TCDD toxicity than the warm water fish species that occur in the River. Despite this conservatism, concentrations of 2,3,7,8-TCDD measured in the water column were 2 to 3 orders of magnitude below the conservative ESV. Risks to fish were also assessed by comparing observed 2,3,7,8-TCDD body burdens to those that have been shown to be potentially harmful to fish reproduction. Concentrations of 2,3,7,8-TCDD observed in fish, when lipid normalized, were generally 10 to 50 times lower than those observed to cause reproductive failure in most-sensitive warm water fish.

The risk assessment also considered indirect risks to semi-aquatic vertebrates exposed, via the food chain, of 2,3,7,8-TCDD bioaccumulated by aquatic biota. A range of semi-aquatic wildlife spanning various niches and trophic levels were considered. These included totally herbivorous species, such as canvasbacks and muskrats, aerial insectivores (e.g., swallows and bats), and fish-eating herons and mink. Concentrations of 2,3,7,8-TCDD in vegetation were estimated with BSAFs, recommended by U.S. EPA (1997a), and observed concentrations in surface sediments. Concentrations in benthic invertebrates were estimated based on observed concentrations in bass. To estimate exposure to piscivorous wildlife, the concentrations of 2,3,7,8-TCDD observed in gizzard shad were used.

Exposures of 2,3,7,8-TCDD to semi-aquatic wildlife in the ERA were estimated conservatively. For example, the semi-aquatic wildlife were conservatively assumed to obtain all of their aquatic food from the River. This assumption ignores foraging at other locations or on non-aquatic organisms. It also ignores seasonal migration for the birds. Using more realistic assumptions could reduce calculated exposures 50 percent or more. The bioavailability of 2,3,7,8-TCDD in water, food, and sediments was also, conservatively, assumed to be as high as that observed with 2,3,7,8-TCDD in food. In addition, exposures were estimated at the 95 percent UCL. Despite this level of conservatism, 2,3,7,8-TCDD exposures for most species at all locations were generally below NOAELs. Exposures to all species at all locations were also below the LOAEL, although just barely below the LOAEL for the bat at RM 42.

Thus, ecological risks from 2,3,7,8-TCDD can be dismissed with certainty for most semi-aquatic vertebrates, notably the largely herbivorous (e.g., muskrat and canvasback) and largely piscivorous wildlife (e.g., heron and mink). However, risks to predators of River benthos, especially bats and to lesser extent raccoons and swallows, are more uncertain. The weight of evidence suggests that significant ecological impacts to these species are somewhat unlikely. Moreover, these somewhat unlikely risks are limited to a small length of the River. However, the conclusion that risk to these species is acceptable is less certain than with the other semi-aquatic vertebrates and fish.

5.2.9 RELEVANCE OF ERA RESULTS TO REMEDIAL STRATEGY

This ERA was specifically intended to "evaluate the protectiveness, in regard to ecological receptors, of any potential response action and the associated cleanup goals" (Matlock, 2004). The ERA concluded that current ecological risks were likely to be non-existent, or at worst, slight. While there was some uncertainty for certain species, notably bats, this uncertainty would likely be addressed by any successful "response action," protective of human receptors.

6.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

6.1 REMOVAL ACTION OBJECTIVES

RAOs provide a general description of what can be reasonably accomplished by a response action, and also help focus the development of specific response action alternatives (U.S. EPA, 2005). RAOs are derived from the CSM (Section 4.5.6), and address significant exposure pathways and unacceptable human health and ecological risks identified in the risk evaluation (Section 5.0). As discussed in U.S. EPA (2005), RAOs should be achievable by sediment remediation at the Site, and should be differentiated from actions such as watershed source control that are outside the control of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) project. For example, complete biota recovery (i.e., a reduction in fish tissue concentration) may depend on the cleanup of sources that are regulated under other authorities. In the area of the Site, U.S. EPA and WV DEP are using other statutory authorities to control potential on-going 2,3,7,8-TCDD releases from the Former Flexsys Facility including but not limited to the River bank, along with other potential sources.

RAOs typically consist of 3 elements, and collectively reflect response objectives that are achievable for the Site:

1. General RA objectives
2. Performance objectives
3. Measurable metrics

General RA objectives are narrative statements that outline the EE/CA goals of reducing exposures to contaminated media. Specific performance objectives and measurable metrics need to be defined to evaluate whether the general response objective is being achieved, and will continue to be achieved. Both short-term and long-term conditions often need to be considered in the formulation of performance objectives, particularly at sediment sites. Measurable metrics verifying that removal actions achieve the intended objective (e.g., sediment cleanup levels) will be developed by U.S. EPA in the forthcoming Action Memorandum, building on the evaluations presented in this EE/CA.

Based on the CSM and risk evaluation, RAOs for the Site are as follows:

- **RAO 1** – The general objective of RAO 1 is to reduce the contribution of sediments to Kanawha River fish tissue 2,3,7,8-TCDD concentrations. The short-term performance objective is to reduce the 2,3,7,8-TCDD SWAC in each of the rolling 3-mile reaches of the Site, which do not already meet the short-term Preliminary Remediation Goals (PRGs), to a level that will facilitate a reduction in 2,3,7,8-TCDD concentrations in fish tissue. The SWAC is a statistically generated area-weighted average, which is useful in evaluating sediment sites as changes in tissue concentrations in receptor species can often be generally related to changes in average sediment concentrations. This is discussed in detail in Section 6.3.2. The long-term performance objective is to reduce fish tissue 2,3,7,8-TCDD concentrations, recognizing that watershed source controls separate and apart from a sediment response action will likely be required to effectively reduce fish tissue concentrations. In light of the data summarized in Sections 4.5.4.2 and 4.5.4.3, it is not anticipated that any additional measures would be required at the former Flexsys Facility. PRGs associated with the short- and long-term performance objectives are discussed in Section 6.3; final measurable metrics will be developed in consultation with U.S. EPA following completion of this EE/CA, as part of the ongoing Project activities.

- **RAO 2** - The general objective of RAO 2 is to reduce the contribution of sediments to Kanawha River surface water 2,3,7,8-TCDD concentrations. Similar to RAO 1, the short-term performance objective is to reduce the 2,3,7,8-TCDD SWAC for each of the 3-mile rolling reaches within the Site to a level that will facilitate surface water recovery. The 3-mile rolling reaches are further discussed in Section 6.3.2. Measurable surface water metrics will need to be consistent with how water quality criteria are applied in comparable circumstances by U.S. EPA and WV DEP (e.g., under Sections 303[d], 305[b] and 314 of the Clean Water Act [CWA]), including considerations of spatial/temporal representativeness and averaging, also recognizing that watershed source controls separate and apart from a sediment response action will likely be required to achieve surface water Applicable or Relevant and Appropriate Requirements (ARARs). In light of the data summarized in Sections 4.5.4.2 and 4.5.4.3, it is not anticipated that any additional measures would be required at the former Flexsys Facility. Again, PRGs are discussed in Section 6.3; final metrics will be developed in consultation with U.S. EPA following completion of this EE/CA, as part of the ongoing Project activities.

The potential effectiveness of each RA alternative is evaluated in Section 8.0 of this EE/CA relative to whether the RAOs listed above can be achieved and the time frame for providing protection of human health and the environment. Additional effectiveness, implementability and cost evaluations are also included in the Section 8.0 comparative evaluation.

6.2 APPLICABLE, RELEVANT, AND APPROPRIATE REQUIREMENTS

RA alternatives must comply with ARARs, including chemical-specific requirements (e.g., surface water quality standards), action-specific requirements (e.g., landfill disposal, limitations on filling in the River and raising the flood levels, prevention of harmful air emissions, etc.), and location-specific requirements (e.g., limitations on construction actions that can be performed in federal navigation channels, historic areas or floodplains), unless the ARARs are waived as infeasible. To support the evaluation of potential response action technologies and the assembly on alternatives, a listing of potential ARARs is provided in Table 6.1.

Response actions performed under CERCLA must comply with the substantive elements of applicable or relevant and appropriate environmental reviews and permitting requirements. Although a response action performed under formal CERCLA authorities would be exempt from the procedural requirements of federal, state and local environmental laws, the action must nevertheless comply with the substantive requirements of such laws.

6.2.1 CHEMICAL-SPECIFIC REQUIREMENTS

The CWA (33 USC Section 1251 et seq.) requires the establishment of guidelines and standards to control the direct or indirect discharge of pollutants to waters of the United States. Section 304 of the CWA (33 USC 1314) requires U.S. EPA to publish Water Quality Criteria, which are developed for the protection of human health and aquatic life. Federal water quality criteria are used by states, including West Virginia, to set water quality standards for surface water.

As discussed above, chemical-specific ARARs for this EE/CA include State of West Virginia water quality standards for 2,3,7,8-TCDD of 0.014 pg/L for non-public water supplies, including the Kanawha River, and 0.013 pg/L for public water supplies, including its tributary rivers and creeks [WV 46-1-7.2]. Compliance with this ARAR is discussed in U.S. EPA's Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act, including spatial and temporal representativeness, comparison to criteria that incorporate averaging, the numbers and spacing of potential nearby sources, flow and other physical conditions of the waterbody, and statistical thresholds for determining exceedances. The guidance also states that "human health criteria for carcinogens are presumed to have a duration of a year or more", meaning that surface water concentrations should be above these criteria over this duration for the criteria to be considered exceeded.

6.2.2 ACTION-SPECIFIC REQUIREMENTS

Discharges of pollutants into navigable waters are regulated under Sections 401 and 404 of the CWA (33 USC 1341 and 1344), 40 CFR Part 230 [Section 404(b)(1) guidelines], 33 CFR Parts 320 (general policies), 323 and 325 (permit requirements), and 328 (definition of waters of the United States). These requirements regulate the excavation of shoreline materials and the placement of fill material (including caps) below the ordinary high water elevation of waters of the United States. The 401/404 regulations are implemented by the U.S. ACE and U.S. EPA. Under the Section 404(b)(1) guidelines, 40 CFR 230.10(b), no discharge (i.e., excavation or cap) shall be allowed if it:

- Causes or contributes to violations of water quality standards, pursuant to Section 401 of the CWA, after consideration of local dilution and dispersion
- Violates any applicable toxic effluent standard or discharge prohibition under Section 307 of the CWA
- Jeopardizes the continued existence of any endangered or threatened species, or contributes to the destruction or modification of any critical habitat for such species
- Violates any requirement imposed by the Secretary of Commerce to protect sanctuary areas

The guidelines in 40 CFR 230.10(c) also provide that no discharge will be authorized that contributes to significant degradation of the waters of the United States. Where there is no practicable alternative to a discharge, 40 CFR 230.10(d) requires the use of appropriate mitigation measures to minimize potential adverse impacts of the discharge on the aquatic ecosystem. The term "practicable" is defined in 40 CFR 230.3(q) to mean "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." Examples of specific steps that may be taken to minimize adverse impacts are set forth in 40 CFR Part 230, Subpart H. As discussed above, Section 401 and Section 404 requirements of the CWA may be applicable to a shoreline removal action if sediment dredging and/or capping are implemented.

An additional substantive requirement is 33 CFR Part 322 of Section 10 of the Rivers and Harbors Act, which limits actions to excavate or fill, or in any manner alter or modify the course, location, condition, or capacity of the channel of any navigable water in the United States.

The width of the navigation channel is established based on the Engineering and Design - Layout and Design of Shallow Draft Waterways (USACE 1980) and is centered on the sailing line identified on USACE navigation charts rather than being a federally authorized channel. The navigation channel is approximately 490 ft wide and 12 ft deep in the vicinity of the former Flexsys Facility based on this guidance.

This requirement is applicable to the capping RA alternative.

Other action specific requirements are related to water discharges, waste management, and air emissions. Depending on the RA alternative that is to be implemented at the Site, the substantive provisions of Federal and State requirements are applicable for the appropriate discharge of Site stormwater and water from dewatering sediment. Under the CWA (40 CFR 401 and 40 CFR 122), wastewater and stormwater originating from a land disturbance (from industrial activity or construction) point source discharges to surface waters must follow these substantive requirements, though actions under CERCLA do not need to follow the specific procedural requirements. Similarly, under the State Water Pollution Control Act (WV 47 CSR 2), discharges containing pollutants from known point sources, including stormwater from construction sites, are regulated.

RCRA (40 CFR 260-268), State Solid Waste Management Act (WV 33 CSR 1), and State Hazardous Waste Management Act (WV 33 CSR 20) are applicable for the disposal of RCRA hazardous waste disposed off-Site or on-Site, dredged sediments in an on-Site confined disposal facility (CDF), and hazardous dredged sediments in an on-Site CDF, respectively.

There are also National standards (Clean Air Act) and State regulations (Air Pollution Control) for the prevention and control of particulate matter emissions that would be applicable for the on-Site construction and operation of sediment dewatering, treatment and disposal facilities. These standards/regulations are considered in the evaluation of related RA alternatives.

6.2.3 LOCATION-SPECIFIC REQUIREMENTS

Under the National Historic Preservation Act (36 CFR 800), when proponents seek a federal approval, the responsible federal agency must consult with the State Historic Preservation Officer and the federal Advisory Council on Historic Preservation to determine if the project would affect cultural or historic sites on or eligible for the National Register of Historic Places.

6.3 PRELIMINARY REMEDIATION GOALS

6.3.1 LONG-TERM PRGS

As discussed in the preamble to the National Contingency Plan (55 Fed. Reg. 8666, 8712-13; March 8, 1990), PRGs for this EE/CA represent the desired endpoint concentrations of 2,3,7,8-TCDD that will both comply with ARARs and provide for protection of human health and the environment under a reasonable future exposure scenario.

The range of risk-based PRGs in fish tissue fillets for the protection of human health under various cancer and non-cancer risk levels are summarized in the table below. For comparison, current fish tissue concentrations are also presented for the Site, based on all composite samples of sportfish and bottom feeders collected in 2004 and 2008/2009. Total risk in the table below includes recreational angler exposure as a child (for 6 years) and as an adult (for 24 years) plus recreational swimmer exposure during this 30-year period.

Scenario	*Reasonable Maximum Exposure Fish Tissue Concentration (ng/kg)*	*Central Tendency Fish Tissue Concentration (ng/kg)*
Fish Tissue Concentration[1]	7.25 (Calculated 95 percent UCL)	3.41 (Calculated Average)
Recreational Angler and Recreational Swimmer Total Risk 1 x 10^{-4}	5.09	60.2
Recreational Angler and Recreational Swimmer Total Risk 1 x 10^{-6}	0.05	0.60
Recreational Angler and Recreational Swimmer Hazard Quotient = 1	2.8	15.8
[1] Based on all fish tissue samples collected from the Site in 2004 and 2008/2009		

A 30 percent reduction in fish tissue concentrations (based on the 95 percent UCL) used in the RME scenario) would bring cancer risk levels into the 10^{-4} to 10^{-6} excess cancer risk range. This risk range is consistent with the desired endpoints outlined in the National Contingency Plan (C.F.R. § 300.430(e)(2)(i)(A)(2); preamble to in 55 Fed. Reg. 8666, 8713; March 8, 1990). An approximate 60 percent reduction in fish tissue concentrations would reduce the HQ to 1 under the RME scenario. Under the CT Scenarios, all cancer and non-cancer risks are currently within U.S. EPA accepted ranges under current conditions.

The surface water PRG based on the Kanawha River water quality standard for 2,3,7,8-TCDD of 0.014 pg/L [WV 46-1-7.2] is applicable to annual average concentrations throughout the water column of the River. This PRG would address RAO 2 discussed in Section 6.1. As discussed in Section 6.4, and consistent with the TMDL evaluation by LTI (2000), watershed source controls separate and apart from a sediment response action will be required to achieve this surface water PRG.

6.3.2 SHORT-TERM PRGS

As discussed in Section 4.4.8, SWACs represent the average sediment concentration which can potentially bioaccumulate in fish within a given area of interest. Surface sediment 2,3,7,8-TCDD concentrations are the appropriate metric for targeting response actions because these concentrations represent levels of potential exposure to benthic organisms (which in turn are consumed by fish; ecological receptors exposure pathways are presented on Figure 4.30) within the biologically active layer as well as 2,3,7,8-TCDD flux from sediments to the water column. More deeply buried sediment deposits are not expected to contribute to bioaccumulation based on the CSM.

The short-term performance objective is to reduce the 2,3,7,8-TCDD SWAC in each of the rolling 3-mile reaches of the Site, which do not already meet the short-term PRGs, to a level that will facilitate a reduction in 2,3,7,8-TCDD concentrations in fish tissue. Figure 4.27 identifies 3-mile reaches where elevated 2,3,7,8-TCDD SWACs can be correlated to locations of elevated surficial sediment concentrations as compared to other samples within the 3-mile reach.

The effectiveness of a short-term PRG of 0.01 μg/kg 2,3,7,8-TCDD in meeting the general response objective of RAO 1 (to reduce the contribution of sediments to Kanawha River fish tissue 2,3,7,8-TCDD concentrations) may be evaluated by predicting resultant fish tissue concentrations utilizing the Site-specific BSAF. Site-specific BSAFs and other data collected during the EE/CA can be used to develop preliminary estimates of anticipated fish tissue concentrations associated with reductions in SWAC values. Preliminary

BSAF calculations corresponding to a post-remedial SWAC of 0.01 μg/kg 2,3,7,8-TCDD were performed using the following average values:

- Post-Removal Action 2,3,7,8-TCDD SWAC = 0.01 μg/kg (dry wt basis; see above)
- Measured sediment TOC = 0.73 percent (dry wt basis)
- Measured BSAF = 0.083 (TOC/lipid basis; based on gizzard shad data)
- Measured mixed bass species fillet lipid = 1.1 percent (wet wt basis)

This evaluation utilizes a post-remedy SWAC of 0.01 μg/kg which represents the upper limit of the anticipated post-remedy SWAC. The actual post-remedy SWAC may be lower following the implementation of remedial activities.

The BSAF-derived estimate of average bass tissue fillet concentrations is 1.32 ng/kg, based on a SWAC of 0.01 μg/kg 2,3,7,8-TCDD. Fish tissue concentrations estimated by this method represent equilibrium concentrations which would be approached over a period of years following remedy implementation as the existing 2,3,7,8-TCDD body burden of the fish population declines following remedy implementation. This fish tissue concentration is below the protective concentrations identified in Section 6.3.1 for both cancer and non-cancer risk (based on the RME scenario and a risk of $1x10^{-4}$). These SWAC-BSAF calculations also provide further support for setting a short-term PRG of 0.01 μg/kg 2,3,7,8-TCDD based on the 2,3,7,8-TCDD SWAC for each rolling 3-mile reach as a means to achieve target reductions in 2,3,7,8-TCDD fish tissue concentrations. Sediment data collected in Study Area 1 also reveal that reductions in SWAC below approximately 0.01 μg/kg 2,3,7,8-TCDD are limited by upstream (i.e., upstream of Study Area 1) background conditions and thus are not practicable to achieve. A SWAC PRG of 0.01 μg/kg was therefore used in this EE/CA to develop appropriate Removal Action alternatives (Section 7.0).

In order to determine the extent of remediation necessary to achieve the short-term PRG, each rolling 3-mile reach exceeding the short-term PRG of 0.01 μg/kg 2,3,7,8-TCDD was evaluated. The area(s) within the 3-mile reach requiring remediation to reduce to the 2,3,7,8-TCDD SWAC to below the short-term PRG were determined by removing the highest concentration surface sample data from the data set and re-evaluating the SWAC until the calculated SWAC was below the short-term PRG. It was determined that areas adjacent to the former Flexsys Facility, the COR-39 area, the COR-21/22 area, and the RIV 8/9/10 area would require remediation to meet the short-term PRG. The predicted post-Removal Action SWACs achieved by addressing these areas are presented on Figure 6.2. The extent of remediation required to address these areas (e.g., through capping or dredging) was then estimated for the purpose of evaluating

Removal Action Alternatives. Further delineation of these prospective remediation areas would be completed as a pre-design activity for the selected Removal Action Alternative. The COR-11 and KRSD-03 areas have been identified as requiring further delineation to support SWAC determination for these areas.

6.4 OTHER WATERSHED SOURCES

In considering the 0.014 pg/L WV standard as an ARAR in order to develop appropriate PRGs for surface water and other media, upstream (i.e., upstream of the Site) loading and the potential contributions from other sources within the Site need to be considered. The TMDL study (LTI 2000) identified 2,3,7,8-TCDD inputs from upstream of the Former Flexsys Facility at a concentration of 0.009 pg/L based on sampling completed by ORSANCO in May 1999. This concentration represented 64 percent of the allowable surface water concentration in the TMDL. The upstream 2,3,7,8-TCDD concentration in the May 2005 sample collected at RM 46 (Upstream Limit of study Area 1), was measured at 0.00853 pg/L. This concentration represented 66 percent of the allowable WV surface water quality criterion. The upstream (i.e., upstream of the Former Flexsys Facility) contribution will limit future concentration reductions that can reasonably be achieved by sediment remediation alone because the surface water 2,3,7,8-TCDD concentrations upstream of the Site are a significant percentage of the allowable criteria. This needs to be considered in the development of appropriate cleanup levels for the Site.

At the Former Flexsys Facility a number of source control actions associated with remediation of contaminated soil, groundwater, and stormwater have recently been or are proposed to be implemented to control various potential sources in the watershed. It appears that measures previously implemented at the Former Flexsys Facility, including bank stabilization, installation of a new storm sewer system, and installation of clean cover in upland areas have reduced dioxin loading to the River. Further information is presented in Appendix M. A detailed discussion of the previously completed and planned remedial activities at the Former Flexsys Facility is included in Section 7.1.3.

A number of other potential sources within and upstream of the Former Flexsys Facility were identified as discussed in Section 3.3.

Monsanto Company reviewed available information for these facilities; however, sufficient information to assess loading on an individual site basis does not exist. Loading from upstream (i.e., upstream of Study Area 2) facilities is captured in upstream surface water sampling.

Ongoing sources within the Site area limit future concentration reductions that can reasonably be achieved by sediment remediation alone, and again needs to be considered in the development of appropriate cleanup levels for the Site. Source control considerations at the Former Flexsys Facility are discussed further in Section 7.1.3.

7.0 REMOVAL ACTION ALTERNATIVES

A range of RA technologies were evaluated and assembled to develop RA alternatives based on a review of available technologies and process options, and considering RAOs, ARARs, PRGs, and SWAC goals discussed in Section 6.0. The assembled alternatives are evaluated in Section 8.0 of this EE/CA with respect to effectiveness, implementability and cost.

The potential effectiveness of each RA alternative evaluated in this EE/CA was evaluated relative to the following:

1. Whether RAOs can be achieved and the time frame for providing protection of human health and the environment
2. Potential effects to human health and the environment during the construction and implementation phase, including short-term water quality impacts and contaminated dredging residuals resulting from implementation of the remedy
3. Reliability with respect to the chemical constituents and conditions in the Site area (U.S. EPA, 1988b)

Both the technical and administrative feasibility of implementing each process option were evaluated (U.S. EPA, October 1988). The technical implementability evaluation concentrated on the institutional aspects of implementability, including the ability to obtain necessary approvals, availability of any transportation, storage, and/or disposal services needed, and availability of necessary equipment and personnel. According to 40 CFR 300.400, "no federal, state, or local permits are required for on-site response actions conducted pursuant to CERCLA Sections 104, 106, 120, 121, or 122." The term "on-site" refers to the Study Areas, "and all suitable areas in very close proximity necessary for implementation of the response action."

Cost evaluations described in this EE/CA include all construction, operation, maintenance, and monitoring necessary for each alternative, and the necessity for additional pre-design and design information specific to that alternative, including present worth costs and analysis. Capital costs include both direct and indirect (overhead) costs associated with implementing an alternative, along with operation, maintenance, and monitoring costs as appropriate.

7.1 REMOVAL ACTION TECHNOLOGIES

Potentially applicable RA technologies and process options were identified for the Site. Each technology/process that was considered a potential component of a RA for the Site was evaluated to identify its potential applicability to the Site. This evaluation was completed at a screening level based upon published information, direct experience on other projects, and third party data/information.

The categories of technologies/processes evaluated for the Site were developed based on the technologies required to be evaluated by the AOC and a review of other potentially applicable technologies. The technologies/processes evaluated include:

- No Action
- Institutional Controls (ICs)
- Source Control
- Monitored Natural Recovery (MNR)
- In Situ Treatment
- Capping
- Dredging
- Treatment/Disposal

Identified technologies/processes within these categories were reviewed on the basis of the effectiveness, implementability, and cost of the technologies/processes relative to one another within each category.

7.1.1 NO ACTION

No Action was retained as a representative process option, as required by the National Contingency Plan (NCP). Although this alternative does not include any form of active remediation, it was retained and used as a baseline to evaluate other alternatives. As discussed previously, a number of RAs already have taken place in support of improving conditions in the River including the on-Site external source control activities discussed in Section 7.1.3.

7.1.2 INSTITUTIONAL CONTROLS

ICs are non-engineering measures, usually legal or physical means of limiting potential exposure to a site or a medium of concern. ICs prevent human exposure to the identified COCs. They can be used at any stage during the Site remedial process to help reduce exposure to contaminated sediments. Examples of ICs include fish consumption advisories, land access, resource use, and deed restrictions. Three ICs were evaluated for the Site: Fish Advisory, Waterway Use Restrictions (e.g., Prohibition on Dredging for Coal Recovery), and Controls on Property Use. As part of, or in addition to, the ICs for the River, warning signs may be posted to inform people of use restrictions in place for the River.

Fish Consumption Advisories and Fish Bans are ICs used to limit the public from consuming contaminated fish. Fish consumption advisories for 2,3,7,8-TCDD, mercury, and PCBs are currently in place for the Kanawha river. Advisories usually involve informing the public not to consume fish in a certain area or limiting the number of fish that should be consumed over a certain period of time. The implementation of a Fish Advisory IC requires efforts to ensure adherence to the advisory and to address public education and communication needs. The Fish Advisory IC can be effective in protecting human health as the risk to fish consumers can be reduced. However, a Fish Advisory IC may not be relied upon to protect all consumers as some consumers may not be reached by, or may not adhere to, the recommendations in the Advisory. Any Fish Advisory IC would be issued by the State of WV. Information developed for the Site may be considered by the State in any revisions to Fish Advisory ICs. Monsanto Company does not have any direct control over such ICs.

Waterway Use Restrictions are ICs that can be used to ensure the integrity of an in place RA alternative. The Prohibition on Dredging for Coal Recovery IC is effective in protecting human health and wildlife as it will prevent significant disturbance and resuspension of contaminated sediment that was formerly buried in the River. The effectiveness of the Property Use Restriction IC is dependent on the effectiveness of the source controls implemented by property owners/operators along the River. Monsanto Company does not have any direct control over such ICs. Implementation of the ICs will need to involve negotiations with U.S. ACE and property owners along the River. A Prohibition on Dredging for Coal Recovery IC will require U.S. ACE permit restrictions. The Controls on Property Use IC would require property easements and deed restrictions. The costs associated with all of the ICs will include the cost to develop and implement the ICs. The appropriateness of revising or discontinuing Fish Consumption or Prohibition on Dredging for Coal Recovery ICs would need to be reviewed following implementation of the selected RA, as monitoring data are obtained.

7.1.3 SOURCE CONTROL – FORMER FLEXSYS FACILITY

The Former Flexsys Facility is undergoing a RCRA Corrective Action (RCRA CA). The RCRA CA is being completed by Solutia and addresses a number of constituents identified at the facility, including 2,3,7,8-TCDD. A number of activities have occurred at the Former Flexsys Facility as part of the RCRA CA, which have altered the facility from its historic configuration and reduced potential ongoing releases of 2,3,7,8-TCDD from the facility.

7.1.3.1 RCRA CORRECTIVE ACTION ACTIVITIES

Activities completed as part of the RCRA Corrective Action for the Former Flexsys Facility include:

- Demolition of above ground structures with the exception of a small administrative and security building.
- Placement of a permeable cover system of clean material over most of the facility. A total of approximately 80 acres of permeable cover has been placed as shown on Figure 7.1.
- Physical closure of the existing storm sewer system, including sealing of all outfalls and drop inlets (approximately 135 inlets) and installation/monitoring of a new storm sewer system to drain areas where clean cover had been installed. Surface water is currently collected and discharged to the River via NPDES regulated Outfall 008.
- Installation of slurry walls in designated areas.
- Groundwater monitoring. A total of 22 wells (11 well pairs) installed under specific protocols developed to allow high-volume sampling of the wells for 2,3,7,8-TCDD have been monitored. Sampling events are completed on an ongoing basis. The results of these sampling events have been utilized to re-estimate groundwater loading to the River (discussed in Section 7.1.3.2).
- Bank stabilization along the frontage of the facility on the River (approximately 4,800 ft of bank) – completed in 2013. Bank stabilization activities extended from the top of bank down to below the water surface. The extent of the bank stabilization under the surface varies according to the slope of the river bottom in each area of the bank stabilization, ranging from approximately 5 to 15 feet into the River (laterally)

from the waterline. Bank stabilization along the frontage of the facility on the River included:

- Removal of vegetation
- Re-grading of the bank to a consistent and stable slope
- Placement of geotextile
- Placement of armor stone (rip rap) from the top of bank to below the waterline

Additional activities are planned to be completed by Solutia as part of the RCRA CA for the Former Flexsys Facility to address remaining exposure and contaminant migration pathways. Several of these activities will further limit the potential for dioxin migration from the facility. These proposed activities relevant to the River EE/CA include:

- Completion of placement of low permeability covers on the areas identified on Figure 7.1
- Implementation of long-term groundwater and point-source discharge monitoring

7.1.3.2 DIOXIN MIGRATION EVALUATION

As part of the CA process, Potesta on behalf of Solutia completed an Expanded Remedial Facility Investigation (ERFI) for the Former Flexsys Facility. U.S. EPA approved the draft report on April 25, 2008. In the ERFI report (and addendums to the report), the current dioxin loading to the River from groundwater and stormwater was evaluated. Documents outlining the loading calculations are included in Appendix L. The analysis of loading was completed on the basis of 2,3,7,8-TCDD TEQ loading rather than 2,3,7,8-TCDD. However, given the profile of individual TEQ constituents typical of 2,4,5-T manufacturing processes, these results are anticipated to reasonably represent 2,3,7,8-TCDD loading.

Monitoring of the NPDES discharge from the new stormwater system has provided documentation of relatively small 2,3,7,8-TCDD loadings from stormwater. Under current conditions approximately 2.445 µg/day of 2,3,7,8-TCDD is being discharged from the Former Flexsys Facility through storm water outfalls.

Sampling of the network of 22 groundwater monitoring well pairs and analysis of the samples was conducted in two rounds in the second and third quarter of 2008. The monitoring results indicate that the 2,3,7,8-TCDD flux in ground water from the Former Flexsys Facility to the River is approximately 0.0083 µg/day.

7.1.3.3 RIVER BANK STABILIZATION AND RESIDUE CLEANUP

A slope failure on part of the bank of the River, along the Former Flexsys Facility occurred in 2002. The slope failure impacted a limited area (approximately 150 feet) of the bank, upstream of the I-64 bridge. The area was discovered by WV DEP on March 6, 2002, during a site inspection of the Former Flexsys Facility from the River. A blackish-brown residue material was observed in the soil in the limits of a surface slough along the Riverbank. The inspectors reported that the material appeared to have flowed down the bank and had entered the River in at least one location. Potesta sampled the residue on March 15, 2002 at the request of U.S. EPA and WV DEP. Residue samples revealed elevated concentrations of aniline, n-nitrosodiphenylamine, methylene chloride, and 2,3,7,8-TCDD. Potesta reported that the area of concern was centered on a slough or shallow slide near the toe of the existing bank at the water's edge. Solutia formally notified U.S. EPA of the potential release on April 15, 2002, and an Interim Measures work plan was submitted on August 2, 2002.

Potesta reported that in the immediate vicinity of the area of concern, the River is shallow and gently sloping near the edge of the bank with water depth approximately 6 to 8 feet at 20 feet from the water's edge (based on normal pool elevation). Potesta determined that since a located area of residue had migrated into the River, sediment core samples would be retrieved from below the waterline of the River, in the area of the bank failure, in order to determine the nature and extent of the residue material.

Potesta conducted core sampling near the toe of the slide/slough area on June 9, 2002. A total of 18 sediment core samples were collected with recoveries ranging from 3.75 to 19.75 inches. Samples were collected from three transects, with each transect being made up of six individual sediment sample locations. The first transect was located in the River approximately 8 ft from the water's edge, the second was advanced 15 ft from the first (23 ft from the water's edge), and the third was an additional 15 ft from the second transect (38 ft from the water's edge). Potesta reported that none of the recovered cores showed any visual signs of residual material.

Following completion of the investigation, cleanup activities were conducted, consisting of removal and disposal of approximately 400 CY of material. The removed material included construction/demolition materials from the surface; tar residue and commingled soils; and additional stained soils or other residue impacted materials. Confirmation samples of the exposed native soils were collected and tested for TCL volatiles, semi-volatiles, asbestos, and the seventeen 2,3,7,8 chlorine substituted dioxin and furan congeners. The results were screened against the U.S. EPA risk-based concentration Table for residential exposure limits.

The final step involved stabilization of the bank in the area by placement of geotextile and covering with armor stone from the top of the bank down to, and extending below the waterline (normal pool elevation 566 ft AMSL). No data is available for the remainder of the banks on the Former Flexsys Facility.

7.1.4 MONITORED NATURAL RECOVERY (MNR)

MNR involves the use of natural processes to attenuate contaminant concentrations over time in River sediment, including such processes as degradation, dissipation, and burial of contaminants. U.S. EPA identifies in its Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (U.S. EPA, 2005) that MNR should be considered at every site where it may be appropriate.

The most important process of change to sediment chemistry within the bioactive zone is usually the removal or addition of sediment to the profile in areas of erosion or deposition in the waterway. In many cases, these processes are very beneficial to the protection of human health and the environment due to the addition of cleaner sediments from upstream sources (Magar et al. 2009). Where sources are controlled, the accumulation of clean sediment acts as a natural capping process, reducing the concentrations of contaminants in the biologically active zone, i.e., the surface layer of sediment, which is in contact with the aquatic community and the food web, including humans. MNR requires monitoring of one or more media to document the efficiency of this technology in meeting RAOs and to identify the need for any supplemental action. MNR is commonly a component technology of selected RA alternatives for large river remediation projects (Magar et al. 2009).

The success of MNR depends on the effectiveness of source control, the stability of the sediment bed (significant disturbance by unexpected natural or human efforts can affect the natural recovery process), and the rate of reduction of exposure point concentrations over the exposure area for the Site. ICs can be used to help reduce disturbances by human interference.

MNR would require monitoring to verify that recovery is occurring as projected, and may include fish or surface water monitoring, as appropriate, based on Site conditions. Detailed long-term monitoring plans would be developed during remedial design, and would be documented in an operation, maintenance, and monitoring plan (OMMP).

Monitoring requirements typically include sampling at appropriate time intervals based on recovery modeling, to document and evaluate recovery trends.

There are no permit issues associated with implementing this technology. Costs associated with this technology would include capital costs to perform baseline monitoring and ongoing costs for implementation of the OMMP during the anticipated recovery period.

7.1.5 IN SITU TREATMENT

In situ treatment employs the addition of a treatment media (in this application - organic carbon) to accelerate the MNR process (U.S. EPA, 2005). The acceleration of the MNR process is achieved by the introduction of activated carbon to sequester contaminants and reduce the bioavailable concentration of contaminant concentrations within the bioactive zone (through physical and biological mixing of organic carbon with contaminated sediment).

In laboratory studies, activated carbon mixed into surface sediments has demonstrated reduction of bioaccumulation in benthic organisms and reduction in release of bioaccumulative contaminants such as PCBs and dioxins into the water phase at equilibrium (because of similar partitioning characteristics, 2,3,7,8-TCDD treatment with activated carbon is anticipated to be very similar to that of PCBs). As part of an investigation of potential remedial options to reduce PCB bioavailability to fish, Alcoa Aluminum Company with support from U.S. EPA, university researchers, and contractors, implemented the Grasse River Activated Carbon Pilot Study (ACPS) beginning in 2006 (http://nepis.epa.gov/). The key objectives of the ACPS were to evaluate the ability to deliver activated carbon onto and into surface sediments in the field, and measure the resulting change in bioavailability to benthic organisms due to activated carbon amendment. Findings to date are summarized below:

- No water quality impacts due to construction were observed.
- The project successfully applied activated carbon to surface (top 15 cm) sediments in the pilot area at concentrations at or above the target dosage. To date, applied activated carbon has remained in place.
- The extent and rate of sediment PCB desorption was reduced after activated carbon application. When activated carbon doses equaled or exceeded native TOC levels, reductions in aqueous equilibrium PCB concentrations exceeded 95 percent.

- PCB concentrations in benthic worms were reduced by approximately 90 percent in sediment samples with activated carbon levels that met or exceeded the target dose.
- No statistically significant differences in erosion potential of activated carbon-treated sediment were observed.

Results from additional monitoring of the ACPS are pending. Other activated carbon pilot and full-scale application projects at locations with characteristics similar to those of the Kanawha River are also underway to evaluate this promising in situ treatment alternative.

The application of organic carbon can be through a number of direct application techniques (injection, mechanical mixing, injection of pelletized carbon) or by application of a thin layer cap material, typically sand mixed with organic carbon. Many application methods have been developed for the placement of cap materials, including proprietary and non-proprietary methods. Selection of appropriate methods is dependent on the size of the area to be treated, water depth and velocity, cap material properties, and the availability of specialized equipment/operators.

The capital cost of an in situ treatment remedy would include the cost of application and the cost of any baseline and long-term monitoring. OMMP costs would be expected to be similar to an equivalent MNR remedy; however, the length of monitoring may be reduced, resulting in an overall cost savings.

7.1.6 CAPPING

This method refers to the in-situ placement of a cap of clean sand and armor materials over the affected sediment to contain and isolate contaminants from exposure and flux into the water column. Cap placement methods include casting of capping material on the water surface and allowing it to settle through the water column; placement of capping material at the sediment surface using a dredge bucket to deliver the material; or pumping capping material to the sediment surface. All of these methods have been used successfully at sites. Appropriate construction quality assurance is necessary to verify the appropriate thickness and aerial extent of cap material has been placed.

Caps can be constructed of various materials, but are typically constructed of sand, gravel, cobble, rip rap, or similar granular material. Geotextiles, liners, and treatment layers or amendments (organoclays, activated carbon, etc.) may also be included to improve placement and/or effectiveness, depending on site-specific conditions. Caps have been used extensively for sediment cleanup including a wide range of Superfund sites (U.S. EPA, 2005). Caps have also been selected in combination with other approaches such as removal or MNR.

Cap design requirements are described in Palermo et al. (1998) and U.S. EPA (2005), and consider the following factors:

- Water depth limitations and navigational requirements
- Cap armor stability under the anticipated flow regime, propeller wash, vessel wakes, and wind-induced waves
- Slope stability
- Compressibility of sediments
- Access for cap placement
- Impacts to the benthic community and ecosystem
- Groundwater flux
- Thickness of the bioactive zone

Armoring is a layer that can be placed on top of a cap to ensure cap stability under peak shear stress conditions (e.g., high water flow velocity events, propeller wash, and wakes/waves). The size and thickness of the armoring material is designed based on the hydraulic forces the cap will be exposed to. Armoring can improve the effectiveness of capping as an RA technology in waterways with high energy. Examples of various isolation cap designs are presented on Figure 7.2. Based on the hydrodynamic model, gravel-sized or larger armor stone may be necessary in some prospective capping areas to ensure that the cap remains protective under peak shear stress conditions such as the 100-year flood (see Section 4.4.7). Regionally, placement of 2 to 3 feet or relatively large rip rap has been used successfully in other sediment cap applications. In areas removed from peak shear stresses, sand alone would provide the necessary erosion protection.

Any cap placed within the Site would be designed in accordance with U.S. EPA, USACE and other applicable guidance documents (e.g., Palermo et al., 1998; U.S. EPA, 2005). These documents provide technical guidance for using subaqueous, in-situ capping as a remediation technique for affected sediments, and include detailed guidance on site and sediment characterization, cap design, equipment and placement techniques, and monitoring and management considerations. USACE guidance on the design of armor layers, included as Attachment A to the U.S. EPA document *Guidance for In-Situ Subaqueous Capping of Contaminated Sediments* (Palermo et al., 1998) would be utilized as the basis for design of cap armoring in consultation with USACE Huntington District staff. Based on preliminary discussions with USACE Huntington District staff during development of the EE/CA Report, relatively large rip rap armor layer materials have been approved for use on other sites along the river, including the bank stabilization completed for the Former Flexsys Facility. The evaluation of Removal Action Alternatives assumed placement of approximately 2 to 3 feet of relatively large rip rap on top of approximately 1 foot of sand and/or gravel-sized filter materials. If capping is included in the selected Removal Action Alternative for the Site, the design of the cap, including armor layer, would be finalized during detailed design based on the referenced guidance documents and in consultation with USACE Huntington District staff.

The costs associated with this technology would include capital costs for cap materials, placement of the armored cap, and verification of cap installation. OMMP costs for this technology typically include periodic inspection to confirm the integrity of the cap, particularly following high shear stress events.

7.1.7 DREDGING

Dredging can provide mass removal of impacted sediment to facilitate treatment or disposal at an on-Site CDF or at an off-Site landfill facility. Sediments can be dredged either hydraulically or mechanically.

Dredging Methods. Hydraulically dredged material can be transported over long distances and piped directly to a staging/processing area. However, a greater volume of water must be removed from the slurry and discharged and/or treated (U.S. EPA, 2005). The solids content of hydraulically dredged slurries normally averages 5 to 10 percent by weight, but it can vary considerably with the specific gravity, grain size and distribution of the sediment, and depth and thickness of the dredge cut. In general, hydraulic dredges cannot operate in rough water or remove large debris, and they may become clogged with weeds, wood, rocks, and other materials. Stoppages to clean the cutterhead, pump, or pipeline may be frequent at sites where debris and other larger materials are present (EPRI and Northeast Utilities, 1999).

Mechanical dredges have been used extensively for navigation and environmental dredging and are widely available. These dredges remove sediment at about the same water content as the in-situ material, thereby minimizing the ex-situ volume and water content of the dredged material (U.S. EPA, 2005). They can also operate in areas with limited space, and are highly maneuverable. The dredges are able to remove large debris and, at the same time, reduce the amount of water contained in removed sediment. Mechanical dredges are effective where dredged sediment must be transported by barge. Mechanical dredges, however, have the potential for spillage during dredging and unloading (EPRI and Northeast Utilities, 1999). The water contained within the bucket during removal activities must be managed or allowed to leak out, which "generally leads to higher contaminant losses during dredging" (U.S. EPA, 2005).

Both hydraulic and mechanical dredging are potentially viable process options at the Site, as each possesses attributes applicable to specific characteristics of the River. The actual dredging option to be used in implementation of a dredging alternative would be selected during remedial design and would depend on the specific project objectives and associated constraints for both the dredging operation itself as well as subsequent processing steps (e.g., dewatering and disposal), given the interrelationship between these operations. For purposes of evaluation in this EE/CA, mechanical dredging has been carried forward as the representative sediment removal process option for both the main channel and nearshore areas, primarily since mechanical dredging would be required to remove rocks and other debris likely to be encountered in prospective dredging areas of the Site. However, the overall effectiveness and costs of hydraulic and mechanical dredging at the Site are likely to be similar.

Dredging Resuspension, Release, and Residuals. Resuspension is the processes by which a dredge and attendant operations dislodge bedded sediment particles and disperse them into the water column. Release is the process by which the dredging operation results in the transfer of contaminants from sediment porewater and sediment particles into the water column. Residuals are contaminated sediment found at the post-dredging surface of the sediment profile, either within or adjacent to the dredging footprint. Residuals can be broadly grouped into two categories: 1) undisturbed residuals are consolidated or intact contaminated sediments found at the post-dredging sediment surface that have been uncovered by dredging but not fully removed; and 2) generated residuals are contaminated post-dredging disturbed surface sediments that are dislodged or suspended by the dredging operation and are subsequently redeposited on the bottom of the water body.

A number of site operational conditions influence the effectiveness of environmental dredging of contaminated sediment on aquatic systems. A wide range of environmental dredging experiences have demonstrated that resuspension of contaminated sediment and release of contaminants occur during dredging and that contaminated sediment residuals will remain following operations (Patmont and Palermo, 2007; Bridges et al., 2008). It is also understood that these processes affect the magnitude, distribution, and bioavailability of the contaminants and hence the exposure and risk to receptors of concern.

A few quantitative evaluations of contaminant release have been undertaken at environmental dredging sites. For example, during a 1999-2000 pilot study on the Fox River, WI, monitoring data collected 100 to 200 feet from the dredge head, and outside of silt curtains, suggested that approximately 2 percent of the dredged contaminants (PCBs) were transported downstream of the pilot project area (Steuer, 2000). Similarly, monitoring at a pilot dredging project in the Grasse River, NY showed that approximately 3 percent of dredged PCBs were released during dredging and debris removal (Connolly et al., 2007). The latter study also showed a concomitant, short lived (1-yr) increase in fish tissue concentrations downstream of dredging operations, including a station 6 miles downstream of dredging. The release pathway is particularly important because dissolved contaminants are readily bioavailable to fish and other biota (Eggleton and Thomas, 2004). Based on comparisons with other similar environmental dredging projects, the estimated dissolved-phase 2,3,7,8-TCDD release from a dredging action in the River is anticipated to average approximately 2 percent of the mass of 2,3,7,8-TCDD dredged. This assumption was input into the comparative fish tissue recovery trend estimates discussed in Section 8.1, and led to a prediction of a short-term increase in fish tissue concentrations at the Site following dredging, consistent with observations at other environmental dredging sites.

The inevitability of post-dredging residuals and their influence on risk has been increasingly recognized over the last decade. Since the purpose of any sediment RA is to reduce contaminated sediment exposure, dredging residuals, particularly if they are more contaminated than pre-remediation surface sediment, can be a serious concern (Bridges et al., 2008).

The nature and extent of post-dredging sediment residuals are related to multiple environmental factors including sediment geotechnical and geophysical characteristics, the variability in contaminant distributions, and physical site conditions such as the presence of bedrock, hardpan, debris or other obstructions. Operational factors that likely affect residuals include dredging equipment size and type; number of dredge passes; selection of intermediate and final cutline elevations; allowable overdredging; dredge cut slopes; accuracy of positioning; operator experience; and the sequence of operations (Bridges et al., 2008; Palermo et al., 2008; Fuglevand and Webb, 2009).

The presence of debris and hardpan/bedrock and sediment liquidity appear to be the most important site factors determining the potential for higher generated residuals. Sediment with low dry bulk density (e.g., water content exceeding the geotechnical liquid limit) also appears to increase the potential for dredge residuals (Patmont and Palermo, 2007). Complicating factors in the dredging process (e.g., the presence of debris in the sediment bed) can make the sediment removal process and achievement of risk-based clean-up levels difficult as well as costly.

The state of practice in modeling dredging processes is not sufficient to make precise predictions of post-dredging residual contaminant concentrations. In the absence of such modeling capability, empirical approaches have been used at dredging projects. Existing data suggest that the average concentration of contaminants in generated residuals will approximate the mass-weighted average sediment concentration in the final production cut profile (the concentration present in sediments within the final production cut or clean-up pass will have been influenced by overlying sediments previously dredged) (Reible et al., 2003; Palermo et al., 2008). The relative mass of contaminants remaining following dredging has been estimated for 12 project sites on the basis of mass balance calculations (Desrosiers and Patmont, 2009). Generated residuals at these sites ranged from 1 to 11 percent of the mass of contaminants dredged during the last production cut. For environmental dredging projects in the presence of debris and/or hardpan/bedrock, generated residuals averaged approximately 6 percent of the last production cut. Given the presence of hard bottom material (hard pan clay and bedrock) immediately underlying contaminated sediments at the Site, estimated generated residuals resulting from a dredging action in the River are anticipated to average approximately 6 percent of the mass of 2,3,7,8-TCDD dredged in the last production cut.

Fish tissue sampling data collected at sites provides quantitative measurement of the impacts of dredging. Data presented in the attached IEAM article show marked increases in fish tissue concentrations associated with dredging events. The inevitability of dredging-related releases residuals and their influence on risk has been increasingly recognized over the last decade. It is also understood that these processes affect the magnitude, distribution, and bioavailability of the contaminants, and also control exposure/risk recovery trends for receptors of concern. EPA recognizes this limitation on dredging effectiveness in its Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA-540-R-05-012, December 2005). This document states on page 29 that "*A well designed and well placed cap should more quickly reduce the exposure of fish and other biota to contaminated sediment as compared to dredging, as there should be no, or very little contaminant residual on the surface of the cap.*"

Relative Cost and Carbon Footprint of Dredging. The capital costs associated with dredging are significantly higher than those for MNR, in situ treatment, and capping. Capital costs include dredging equipment, monitoring during dredging, sediment transportation to the dewatering area, dewatering of the contaminated sediment, water treatment, transportation and treatment/disposal. Some monitoring of the long-term impacts on the recovery of the Site due to the removal of impacted sediment would be anticipated, but would be expected to be lower than the costs anticipated for MNR, in situ treatment, or capping technologies.

Implementation of a dredging alternative requires the use of additional equipment over a longer period of time as compared to MNR or capping alternatives. The equipment, including dredges, booster pumps, pumping equipment as part of the water treatment system, and equipment to handle dewatered sediments would be powered by diesel engines or electricity from coal fired power plants. In addition, equipment required to construct a disposal facility on-Site, or to transport material to an off-Site disposal facility, would further increase the carbon footprint of a dredging alternative.

The estimated carbon footprint of the dredging alternatives for this Site is discussed in Sections 8.6.2 and 8.7.2

7.1.8 TREATMENT/DISPOSAL

There are treatment activities associated with the management of dredged materials that may be employed to reduce the toxicity, mobility, or volume of contaminants. Stabilization of the contaminants within the sediment through the addition of polymers during the dewatering process may be effective in preparing the sediment for loading, transportation and disposal. Solidification to improve physical properties may be required to allow placement in an on-Site CDF or off-Site Landfill.

Off-Site thermal treatment could potentially be required for some of the material if a land disposal alternative is not available.

Off-Site disposal/treatment may be readily implemented. Disposal in an on-Site CDF may require additional time to allow siting, design, and CDF construction activities to be completed; however, it is possible these activities could be completed within the timeframe of design and implementation of other remedy components.

Capital costs associated with off-Site disposal/treatment costs include transportation costs and disposal/treatment fees and taxes. No OMMP costs are associated with off-Site disposal/treatment.

Costs associated with an on-Site CDF include capital costs for land acquisition, siting investigation, design, construction, operation during filling, and closure. OMMP costs would be anticipated to include leachate management, monitoring and maintenance of the cover system and perimeter fencing, and groundwater monitoring.

7.1.9 SCREENING OF REMOVAL ACTION TECHNOLOGIES

Table 7.1 provides a summary of the screening of RA technologies. Based on the screening, all of the remedial technologies were retained for consideration in the development of RA Alternatives.

7.2 REMOVAL ACTION ALTERNATIVES

The technologies that were retained from the screening step were used to develop several RA Alternatives for evaluation. These include the following:

- Alternative 1 - No Action
- Alternative 2 - Institutional Controls and MNR
- Alternative 3 - Institutional Controls, In Situ Treatment and MNR
- Alternative 4 - Institutional Controls, MNR, and Limited Capping
- Alternative 5A - Institutional Controls, MNR, Limited Dredging, and On-Site CDF
- Alternative 5B - Institutional Controls, MNR, Limited Dredging, and Off-Site Disposal

Each of these alternatives is described in the following sub-sections.

7.2.1 ALTERNATIVE 1- NO ACTION

The No Action Alternative (Alternative 1) is retained as a baseline alternative for comparison purposes consistent with U.S. EPA guidance. The scope of this Alternative is as described in Section 7.1.1.

7.2.2 ALTERNATIVE 2 - INSTITUTIONAL CONTROLS AND MNR

Alternative 2 involves the combination of the River's naturally occurring processes to reduce the concentration and mobility of contaminants, coupled with ICs to reduce exposure to the COCs of concern at the Site. Both alternatives are described in detail in Sections 7.1.2 and 7.1.4.

Based upon the stability and resistance to degradation of 2,3,7,8-TCDD, degradation processes are not expected to provide significant reductions in risk levels at the Site. The evaluation of MNR will focus on natural sedimentation, i.e., natural capping of contaminated sediments with cleaner sediments. Contaminant concentrations are further dissipated by physical and biological mixing processes. The MNR option would also include modeling to predict long-term recovery and a long-term (approximately 30 years) monitoring program for measuring COC concentrations in water, sediment and fish to track progress toward achieving the RAOs.

This Alternative would require that ICs remain in place until the RAOs are achieved. Due to the nature of the Site, physical access restriction would not be feasible, therefore the ICs would involve enhanced outreach activities such as public education and health advisories. Figure 7.1 presents a conceptual representation of Alternative 2 at the Site.

This Alternative assumes that any 2,3,7,8-TCDD sources from the former Flexsys Facility have been controlled, along with control of other 2,3,7,8-TCDD sources that may be identified by U.S. EPA or WV DEP. The Alternative also assumes that WV DEP, WV DNR, and/or the U.S. ACE will provide effective controls on coal recovery dredging through the permitting process (see Section 4.5.3). In previous years, WV DNR and/or WV DEP have denied Section 401 Water Quality Certification for certain reclamation dredging applications based on the potential for water quality impacts. In some cases, the denials were successfully appealed by the applicant, and Section 401 Water Quality Certification was eventually obtained for reclamation dredging.

7.2.3 ALTERNATIVE 3 - INSTITUTIONAL CONTROLS, IN SITU TREATMENT, AND MNR

Alternative 3 involves the combination of the processes and measures described in Alternative 2 with additional measures to accelerate the River's naturally occurring processes to achieve the RAOs at the Site. The in situ treatment portion of this alternative is described in detail in Section 7.1.5.

In situ treatment such as the addition of activated carbon to surface sediments (0 to 15 cm) would be implemented in an approximate 9.4-acre area of the Site where elevated 2,3,7,8-TCDD concentrations were detected, including submerged embankment areas near COR-39 (adjacent to the Former Flexsys Facility) and COR-36 (across the River). In situ treatment of this target area would accelerate natural recovery processes utilized in Alternative 2 by immediately reducing bioavailable surface sediment concentrations of 2,3,7,8-TCDD, achieving a short-term SWAC reduction of approximately 50 percent (see Figure 6.2), and accelerating the reduction of 2,3,7,8-TCDD concentrations in biota. Figure 7.3 depicts the areas were in situ treatment would be implemented. MNR would be utilized for other areas of the Site.

Similar to Alternative 2, this Alternative assumes that potential historic or ongoing 2,3,7,8-TCDD sources from the former Flexsys Facility have been controlled, along with control of other identified potential 2,3,7,8-TCDD sources in the study area. The Alternative also assumes that WVDEP, WVDNR, and/or the U.S. ACE will provide effective controls on coal recovery dredging through the permitting process.

Long-term monitoring and maintenance would be required as described for Alternative 2. Institutional controls would be required until the RAOs are achieved to minimize public risk of exposure.

7.2.4 ALTERNATIVE 4 - INSTITUTIONAL CONTROLS, MNR, AND ARMORED CAPPING OF SELECTED AREAS

Alternative 4 involves the combination of the processes and measures described in Alternative 2 with additional measure to isolate areas with elevated 2,3,7,8-TCDD concentrations in the River. The capping portion of this alternative is described in detail in Section 7.1.6.

Under Alternative 4, engineered armored caps would be constructed in areas which were identified as requiring targeted remediation to achieve the short-term PRG in all of the rolling 3-mile reaches. Based on current data, four areas were identified for armored capping:

- Submerged embankment areas on the left bank (descending) at approximately RM 41.6 at COR-36.
- Submerged embankment areas on the right bank (descending) from approximately RM 42.1 to RM 41.6, adjacent to the Former Flexsys Facility).

- Submerged embankment areas on the right bank (descending) at approximately RM 37.9 at COR-21/COR-22.
- Areas in the right half (descending) of the channel at locations RIV 8, 9, and 10 near RM 31.0.

The following areas will be evaluated utilizing pre-design sampling data and SWACs for these areas re-calculated:

- Submerged embankment areas on the right bank (descending) at approximately RM 33.8 at COR-11.
- Submerged embankment areas on the right bank (descending) at approximately RM 33.4 at KRSD-03.

These areas are identified on Figure 7.4. The extent of capping under this scenario would be finalized based on additional delineation sampling completed as part of the design process if this Removal Action Alternative is selected. The total area to be capped under this alternative is approximately 9.4-acres. Similar to Alternative 3, capping of this target area would accelerate natural recovery processes by immediately reducing bioavailable surface sediment concentrations of 2,3,7,8-TCDD, achieving a short-term SWAC reduction of approximately 85 percent (see Figure 6.2), and accelerating the reduction of 2,3,7,8-TCDD concentrations in biota. MNR would be utilized for other areas of the Site.

Armored cap designs would be developed for individual areas of the Site as appropriate based on water depth, average River current, River current under flood conditions, ice scour and boat traffic. Areas of the River with the potential for scouring and erosion will require armoring. Figure 7.2 presents several example isolation cap designs. A preliminary layout of Alternative 4 is presented on Figure 7.4. Conceptual cross-section layouts of the capping are presented on Figure 7.5. For the purpose of evaluating the Removal Action Alternative, it was assumed all capped areas will be armored utilizing a 9-inch D_{50} rip rap. This material was approved for use by U.S. EPA and USACE for the bank stabilization activities at the Former Flexsys Facility.

Similar to Alternative 2, this Alternative assumes that potential historic or ongoing 2,3,7,8-TCDD sources from the former Flexsys Facility have been controlled along with control of other identified potential 2,3,7,8-TCDD sources in the study area. The Alternative also assumes that WVDEP, WVDNR, and/or the U.S. ACE will provide effective controls on coal recovery dredging through the permitting process.

Engineering controls, monitoring, and best management practices would be in place during installation to minimize the resuspension of sediment and mobilization of contaminants during implementation. Monitoring and maintenance would be required as part of this Alternative to ensure integrity of the cap and isolation of the COCs. Monitoring of fish tissue and surface water concentrations to evaluate recovery trends would also form part of Alternative 4. ICs would be required until the RAOs are achieved to minimize public risk of exposure and to ensure the long-term integrity of the cap.

7.2.5 ALTERNATIVE 5A - INSTITUTIONAL CONTROLS, MNR, DREDGING OF SELECTED AREAS, AND NEAR-SHORE CDF

Alternative 5A involves the combination of the processes and measures described in Alternative 2 plus removal of sediments with high contaminant concentrations in the River. The dredging and treatment/disposal portions of this alternative are described in detail in Section 7.1.7 and 7.1.8, respectively.

Under Alternative 5A (and 5B; see below), dredging would remove approximately 83,400 cy of sediments at the Site containing elevated 2,3,7,8-TCDD concentrations, from the four areas identified in Section 7.2.4 as requiring targeted remediation to achieve short-term PRGs in all of the rolling 3-mile reaches, including re-calculation of the SWACs based on pre-design data collected around COR-11 and KRSD-03. Figure 7.6 depicts the areas were dredging would be performed. To control dredging residuals anticipated in the dredge prism (due in part to difficult dredging conditions associated with the presence of hard bottom material (hard pan clay and bedrock) and debris in these areas), caps would be constructed in the dredge area to achieve the 0.01 µg/kg SWAC PRG discussed in Section 6.3. MNR would be utilized for other areas of the Site.

For this alternative, the dredge prism would be refined during remedial design using additional surface and subsurface sediment sampling. Given the presence of debris and hard bottom material (hard pan clay and bedrock) in the target dredge prism, dredging would likely be achieved using mechanical equipment. However, hydraulic dredging and associated dewatering (either by gravity or mechanical means), water treatment and discharge back to the River would be anticipated to result in incomplete sediment removal. Under Alternative 5A, dredged sediments would be disposed in a secure near-shore CDF constructed on the Former Flexsys Facility. Different combinations of these techniques may be suitable in different areas of the Site and the applicability of these methods will be evaluated and compared in the next section of the EE/CA Report. Figure 7.6, presents a conceptual representation of the environmental dredging process and conceptual design of an on-Site CDF for Alternative 5A at the Site. Figure 7.7 presents a conceptual dredging cross-section.

The implementability of an on-Site CDF is evaluated in the following sections. A CDF would be sited at an upland location on the Former Flexsys Facility.

Similar to Alternative 2, this Alternative assumes that potential historic or ongoing 2,3,7,8-TCDD sources from the former Flexsys Facility have been controlled, along with control of other identified potential 2,3,7,8-TCDD sources in the study area. The Alternative also assumes that WVDEP, WVDNR, and/or the U.S. ACE will provide effective controls on coal recovery dredging through the permitting process.

Similar to Alternative 4, engineering controls, monitoring, and best management practices would be in place during dredging and cap installation to minimize the resuspension of sediment and mobilization of contaminants during implementation. Monitoring and maintenance would be required as part of this Alternative, if capping of residuals is required, to ensure integrity of the cap and isolation of the COCs. Based on the conditions at the Site, which will make complete removal of impacted sediment unlikely, it has been assumed that 50-percent of the dredged area will require capping to achieve the post-dredging SWAC PRG, based on post-dredging verification sampling. The cap design is assumed to be the same as required under Alternative 4. Monitoring of fish tissue and surface water concentrations to evaluate recovery trends would also form part of Alternative 5. ICs would be required until the RAOs are achieved to minimize public risk of exposure during and after dredging activities and post-dredging verification sampling has been completed.

7.2.6 ALTERNATIVE 5B - INSTITUTIONAL CONTROLS, MNR, DREDGING IN SELECTED AREAS, AND OFF-SITE DISPOSAL

This alternative is described in detail in Sections 7.1.7 and 7.1.8 and involves the same methods for achieving the RAOs as Alternative 5A. In this alternative, the sediment would be transported off-Site by truck, rail, and/or barge. The removed sediment would be disposed at an appropriately permitted disposal site in compliance with applicable regulations. Sediment removed by hydraulic dredging would require dewatering. In addition, potential staging and loading areas would need to be evaluated. A conceptual design of Alternative 5B is presented on Figure 7.8. Figure 7.7 presents a preliminary dredging cross-section.

8.0 EVALUATION OF REMOVAL ACTION ALTERNATIVES

8.1 RECOVERY ANALYSIS

The comparative evaluation of the long-term effectiveness of the RA alternatives was performed by performing screening-level recovery modeling of sediment transport and fish tissue bioaccumulation in the Site area. 50-year model simulations were performed to estimate changes in fish tissue 2,3,7,8-TCDD concentrations associated with the implementation of each alternative. A number of assumptions were required by the model to accomplish this, including remedial technology performance based on available literature data, along with relevant Site-specific information. Evaluation metrics included time series plots of projected average fish tissue 2,3,7,8-TCDD concentrations in the 3-mile reach which exhibited the highest SWAC (RM 42 to RM 39). It is important to note that the screening-level recovery modeling performed for this EE/CA was performed solely to develop comparative evaluations of the long-term effectiveness of the RA alternatives under a consistent set of assumptions. Actual recovery trajectories could deviate from these predictions if a different set of assumptions were to be used (e.g., source control effectiveness). The recovery analysis is described in the section below.

Recovery trends within the River will vary between RA Alternatives based on the time frames for reductions in SWACs of 2,3,7,8-TCDD and other factors. Post implementation SWACs will reflect reductions in surface sediment concentrations through capping (e.g., under Alternative 4), and potential increases/decreases in surface sediment concentrations due to dredging (including potential reductions due to capping of residuals, as required) (e.g., under Alternatives 5A and 5B).

While more complex water column-based contaminant exposures may occur that are distinct from sediment transfer processes, the Site-specific BSAFs and other data collected during the EE/CA can be used to develop preliminary bounding-level estimates of anticipated recovery trends in fish tissue data, providing a comparative evaluation between RA alternatives. Preliminary BSAF calculations corresponding to existing conditions at the Site were based on the following average values:

- Measured sediment 2,3,7,8-TCDD SWAC = 0.022 µg/kg (dry wt basis; see above)
- Measured sediment TOC = 0.73 percent (dry wt basis)
- Measured BSAF = 0.083 (TOC/lipid basis; based on gizzard shad data)
- Measured mixed bass species fillet lipid = 1.1 percent (wet wt basis)

The BSAF-derived estimate of average bass tissue fillet concentrations of 2.9 ng/kg in the 3-mile reach from RM 42 to RM 39 is comparable to measured 2004 concentrations in mixed bass of approximately 3.0 ng/kg collected in this same reach and is in the same range as the overall average bass tissue fillet concentrations (6.8 ng/kg) from 2008 sampling. This supports the representativeness of these calculations for use in comparative evaluations between RA alternatives. Existing bass tissue concentrations are currently very close to the risk-based PRG for the protection of human health of 5.09 ng/kg based on a cancer risk of 10^{-4} for the RME scenario, with 7 of the 10 samples collected in 2004 and 2008 having results below this concentration. Similarly, existing bass tissue concentrations are currently only slightly above the non-cancer risk level of 2.80 ng/kg based on a HQ of 1 for the RME scenario. These SWAC-BSAF calculations also provide further support for setting PRGs based on the 2,3,7,8-TCDD SWAC for each rolling 3-mile reach as a means to achieve target reductions in 2,3,7,8-TCDD fish tissue concentrations.

As discussed in Section 7.1.4, the sediment transport model discussed in Section 4.4.7 was used to develop estimates of sediment deposition/transport and projected reductions in SWAC concentrations over time assuming that effective source controls are implemented within the basin. Using the Site-specific BSAF estimates and associated parameter estimates discussed in Section 4.4.2, the SWAC trend estimates were used to develop bounding-level projections of bass tissue fish concentrations over time within the Site area. The BSAF-based fish tissue projections provide a basis for comparative evaluations of the effectiveness of the different RA Alternatives given a consistent set of source control and recovery assumptions.

The fish tissue projections are presented in Figure 8.1, and suggest that with effective watershed source controls, fish tissues may continue to decline by approximately 50 percent in the next 25 to 30 years under Alternative 2 (MNR). Accelerated recovery trends are predicted for Alternatives 3 and 4, based on the short-term SWAC reductions of bioavailable concentrations of 2,3,7,8-TCDD following remedy implementation.

Fish tissue concentrations under Alternative 5 (applicable to both Alternative 5A and 5B) are predicted to increase significantly during and shortly following dredging activities. This increase is typically observed in environmental dredging projects (e.g., see Bridges et al. 2008), due to the temporary increase in water column contaminant concentrations associated with dredging-induced contaminant resuspension and release, which cannot be effectively controlled even by employing best management practices and silt curtains. The predicted short-term increase in fish tissue concentrations associated with the resuspension and release of contaminants from dredging results in a retarded recovery timeframe as compared to Alternatives 3 and 4.

8.2 ALTERNATIVE 1- NO ACTION

The No Action Alternative (Alternative 1) is retained as a baseline alternative for comparison purposes consistent with U.S. EPA guidance. The scope of this Alternative is as described in Section 7.1.1. Table 8.1 presents a summary of the evaluation of Alternatives.

8.2.1 EVALUATION OF REMOVAL ACTION EFFECTIVENESS – ALTERNATIVE 1

Alternative 1 has no active implementation or monitoring components which would contribute to meeting the RAOs.

8.2.2 EVALUATION OF REMOVAL ACTION IMPLEMENTABILITY – ALTERNATIVE 1

Alternative 1 involves no activity and is considered to be implementable; however, it provides no monitoring to determine its ability to meet the RAOs.

8.2.3 EVALUATION OF REMOVAL ACTION COST – ALTERNATIVE 1

There is no capital or Operation, Maintenance, and Monitoring (OMM) cost associated with Alternative 1.

8.3 ALTERNATIVE 2 - INSTITUTIONAL CONTROLS AND MNR

Alternative 2 involves the combination of the River's naturally occurring processes to reduce the concentration and mobility of contaminants with institutional controls to reduce the concentration of bioavailable 2,3,7,8-TCDD at the Site. This reduction in bioavailable 2,3,7,8-TCDD concentrations will result in reductions in fish tissue concentrations over time as generally depicted on Figure 8.1, and corresponding reductions in human health and ecological risks within the Study Area. The remedy assumes source control activities completed and planned to be completed by Solutia for the Former Flexsys Facility. The components of these source control activities are identified on Figure 7.1. Table 8.1 presents a summary of the evaluation of Alternatives.

Key components of the source control activities include:

- Installation of a new storm drainage system and abandonment of the old system
- Consolidation of material with elevated concentrations of 2,3,7,8-TCDD in an area with an impermeable cover
- Installation of clean cover over the property (portions of the Former Flexsys Facility will have permeable cover, and other portions will have impermeable cover)
- Bank stabilization

ICs will be implemented on the Former Flexsys Facility to protect the integrity of the source control measures. In addition, an IC to prevent future coal recovery or aggregate recovery dredging in the study area is necessary to ensure the natural recovery process is not slowed or reversed by the re-introduction 2,3,7,8,-TCDD which is buried, and not bioavailable into surface sediments and the water column.

Fish tissue and water sampling will be performed to monitor recovery of the River and the efficiency of MNR in reducing the concentrations of 2,3,7,8-TCDD in fish tissue and surface water over an approximate 30-year period. Under Alternative 2, long-term surface sediment monitoring would also be performed to verify that the 0.01 μg/kg SWAC PRG is achieved. (Note that this is the only RA Alternative requiring long-term sediment monitoring. Long-term sediment monitoring is not required for the other Alternatives that use active measures to achieve the SWAC-based PRG.).

8.3.1 EVALUATION OF REMOVAL ACTION EFFECTIVENESS – ALTERNATIVE 2

Since MNR relies on the effective control of sources and natural burial processes of the River sediments, the effectiveness of MNR is dependent on the reliability of source control measures and the declines in surface (bioavailable) sediment concentrations over time, as cleaner sediment is deposited over, and mixed with existing surface sediments. The use of ICs increases the effectiveness of MNR by reducing disturbances to the sediment bed due to human interference and by limiting fish consumption during the recovery period through fish advisories. This Alternative would require that ICs remain in place indefinitely. Implementing MNR is not expected to reduce concentrations below risk levels immediately. The recovery rate is dependent on numerous factors including 2,3,7,8-TCDD contributions from sources upstream of the Site, the number and timing of high flow events (which could potentially scour sediments from erosional areas, potentially exposing underlying sediments with higher 2,3,7,8-TCDD concentrations in localized areas), and the lifespan and home ranges of fish species in the River. As identified in Section 8.1, MNR is a process which occurs over a period of years. However, this process has been ongoing since the time of cessation of 2,4,5-T production and has been augmented by source control measures implemented in the past. Historic coal recovery dredging activities are believed to have significantly limited or reversed natural recovery rates temporarily by re-introducing 2,3,7,8-TCDD into the surface sediments and water column.

Alternative 2 would have low short-term effectiveness but moderate long-term effectiveness. The long-term effectiveness of this alternative will be monitored through the periodic collection of fish tissue and surface water data over a period of approximately 30 years to verify the general recovery trajectory depicted on Figure 8.1. The long-term effectiveness and permanence of Alternative 2 is dependent on the effectiveness of source control activities, including activities at the Former Flexsys Facility discussed in Section 7.1.3. The implementation of these measures for the Former Flexsys Facility will be completed prior to implementation of the Kanawha River Removal Action. The risks due to human interference to the areas of MNR can be controlled through the implementation and enforcement of ICs. A limiting factor in the natural recovery process will be the 2,3,7,8-TCDD loading from upstream (i.e., upstream of RM 45) sediments and surface water.

Uncertainty in the effectiveness of this Alternative is associated with the pattern of River flows. Certain areas of the Study Area become erosional under high flow events but are depositional in lower flow periods. Extended periods of low flow can allow additional deposition, accelerating the recovery of surface sediments, while large storm events can erode sediments from these areas, potentially exposing localized areas of higher concentration sediment. Monitoring and adaptive management (including potential contingency actions as appropriate) would be used to ensure that desired risk reductions occur over time.

8.3.2 EVALUATION OF REMOVAL ACTION IMPLEMENTABILITY – ALTERNATIVE 2

The implementation of Alternative 2 does not require any special materials or methods which would impact the potential implementability of Alternative 2. A number of items must be considered as part of the design to ensure source control implementation is completed prior to baseline sampling and ensure the implementability of institutional controls, particularly the dredging restriction which requires the involvement of the U.S. ACE and WV DEP.

There are no permits required or compliance issues expected with implementing this alternative. There will be no disruption to the River sediment and ecosystem and no construction of infrastructure is required.

Fish tissue sampling will require a scientific collector's permit be issued for each event. Surface water sampling events will require coordination with U.S. ACE as the sampling boat will need to anchor at various locations within the navigation channel during sample collection.

The implementation of institutional controls associated with dredging, specifically to prevent coal recovery or aggregate recovery dredging on the River is contingent on U.S. ACE and WV DEP concurrence that such controls are necessary. Should U.S. ACE and WV DEP permit such activities, the potential exists to re-mobilize buried sediment with 2,3,7,8-TCDD into the water column. Control of re-mobilization of stable sediments is critical to the natural recovery process at the Site. An inability to institute such a control restricting dredging could reduce, or reverse the natural recovery process at the Site.

Implementation of Alternative 2 will not change River use or function, with the exception of the restriction on coal recovery dredging. As such, no significant issues with public acceptance or State acceptance are anticipated. The remedy will also involve the collection of data documenting fish tissue 2,3,7,8-TCDD concentrations. This data will be provided to the State and may be useful to the State in evaluating the fish consumption advisory levels for the River.

8.3.3 EVALUATION OF REMOVAL ACTION COST – ALTERNATIVE 2

The capital cost of Alternative 2 is $686,000 associated with the implementation of ICs and baseline sampling. The 30-year net present worth including OMM is $1,692,000. Table 8.2 presents a detailed cost estimate for this alternative. Baseline and ongoing sampling include the collection of fish tissue and surface water data. The estimated cost for each monitoring event is $433,000. The baseline and ongoing sampling programs will be developed as part of the detailed design.

8.4 ALTERNATIVE 3 - INSTITUTIONAL CONTROLS, IN SITU TREATMENT, AND MNR

Alternative 3 involves the combination of the processes and ICs described in Alternative 2 with additional measures to accelerate the River's naturally occurring processes to achieve the RAOs at the Site. Specifically, the treatment of sediment in the area of elevated surface sediment 2,3,7,8-TCDD concentration with activated carbon will be completed. 2,3,7,8-TCDD adsorbs strongly to the activated carbon, reducing bioavailability. Figure 7.3 identifies the components of the Alternative 3. Table 8.1 presents a summary of the evaluation of Alternatives.

8.4.1 EVALUATION OF REMOVAL ACTION EFFECTIVENESS – ALTERNATIVE 3

In situ treatment would be implemented in areas where elevated 2,3,7,8-TCDD concentrations were detected in surface sediments. The area of in situ treatment is approximately 5.9 acres and is shown on Figure 7.3. These areas include the area adjacent and immediately downstream of the Former Flexsys Facility including sample location COR-39 and sediment in the vicinity of sample location COR-36 (upstream of the I-64 bridge on the bank opposite the Former Flexsys Facility). In situ treatment increases the effectiveness of MNR as described for Alternative 2 by immediately reducing bioavailable surface sediment concentrations in areas of higher concentration. Figure 7.3 depicts the areas where in situ treatment would be implemented under Alternative 3, based on results of surface sediment sampling.

As identified in Section 8.1, in situ treatment under Alternative 3 would result in an increased natural recovery rate as compared to Alternative 2, particularly in the initial period of recovery. This is due to the immediate reduction in the amount of bioavailable 2,3,7,8-TCDD.

Alternative 3 would have high short-term effectiveness and higher long-term effectiveness than Alternative 2. Consistent with the results of the Grasse River ACPS (see Section 7.1.5; http://nepis.epa.gov/), little sediment resuspension is anticipated during activated carbon application.

Following application of the activated carbon, core sampling would be completed to confirm that application rates, uniformity, and depth of penetration meet design criteria.

The long-term effectiveness of this alternative will be monitored through the periodic collection of fish tissue and surface water data. The long-term effectiveness and permanence of Alternative 3 is dependent on the effectiveness of source control activities, including activities at the Former Flexsys Facility discussed in Section 7.1.3. The implementation of these measures for the Former Flexsys Facility will be completed prior to implementation of the Kanawha River Removal Action. The risks due to human interference to the areas of MNR can be controlled though the implementation and enforcement of ICs. A limiting factor in the natural recovery process will be the 2,3,7,8-TCDD loading from upstream sediments and surface water.

Uncertainty in the effectiveness of this Alternative is associated with the pattern of river flows. Certain areas of the Study Area become erosional in high flow events but are depositional in lower flow periods. Extended periods of low flow can allow additional deposition, accelerating the recovery of surface sediments, while large storm events can erode sediments and activated carbon from these areas, potentially exposing localized areas of higher concentration sediment, which have not been sequestered by the addition of activated carbon.

Similar to Alternative 2, monitoring and adaptive management (including potential contingency actions as appropriate) would be used to ensure that desired risk reductions occur over time. In the event recovery in fish tissue concentrations plateaus at a concentration higher than an acceptable level, additional actions may be required to augment the recovery process. These items could include:

- Additional application of activated carbon to sequester 2,3,7,8-TCDD in sediment and make it less bioavailable. Application could be within areas previously treated or in additional areas.
- Identification of localized areas of elevated sediment 2,3,7,8-TCDD concentration for additional control by capping (with armor layers as appropriate).

These actions are readily implementable in future if necessary.

8.4.2 EVALUATION OF REMOVAL ACTION IMPLEMENTABILITY – ALTERNATIVE 3

The implementation of Alternative 3 requires specialized equipment to apply the activated carbon. A number of methods and technologies for the application of activated carbon exist including proprietary and non-proprietary methods. As a number of alternatives exist for the application of the activated carbon, availability of equipment and materials are not anticipated to be an issue that would significantly impact the potential implementability of Alternative 3. A number of items must be considered as part of the design to ensure source control implementation is completed prior to baseline sampling and ensure the implementability of institutional controls, particularly the coal recovery dredging restriction as that requires the involvement of the U.S. ACE and WV DEP. The implementation of Alternative 3 would require a support area with river access for the staging of material and equipment. It is anticipated this support area would be located on the Former Flexsys Facility.

No issues are anticipated regarding compliance with action-specific ARARs. Several ARARs will need to be considered during design and implementation; however, none are anticipated to reduce the implementability of Alternative 4. The design of the activated carbon addition must consider all U.S. ACE requirements for filling in the floodplain and navigational requirements. Due to the very limited volume of material to be placed, no measurable impact to flood elevations are anticipated. Coordination during activated carbon placement with U.S. ACE, Winfield Dam staff would be required as temporary encroachment on the navigational channel could be required for working barges. This is not anticipated to occur, but would be considered during design.

Compliance with WV water quality certification standards would be required. Monitoring of the water column to confirm that downstream migration of re-suspended sediment has been controlled would be anticipated to be required. Habitat disruption during activated carbon addition placement would be limited to the area of treatment. The extent of habitat disruption and the mixing-in effectiveness of the activated carbon varies between application methods. These factors, in addition to implementation cost would be considered during detailed design to eliminate unacceptable methods of activated carbon addition.

Fish tissue sampling will require that a scientific collector's permit be issued for each event. Surface water sampling events will require coordination with U.S. ACE as the sampling boat will need to anchor at various locations within the navigation channel during sample collection.

The implementation of institutional controls associated with dredging, specifically to prevent coal recovery or aggregate recovery dredging on the River is contingent on U.S. ACE and WV DEP concurrence that such controls are necessary. Should U.S. ACE and WV DEP permit such activities, the potential exists to re-mobilize buried sediment with 2,3,7,8-TCDD into the water column. Control of re-mobilization of stable sediments is critical to the natural recovery process at the Site. An inability to institute such a control restricting dredging could reduce, or reverse the natural recovery process at the Site.

Implementation of Alternative 3 will not change River use or function, with the exception of the restriction on coal recovery dredging. As such, no issues with public acceptance or State acceptance are anticipated. The remedy will also involve the collection of data documenting fish tissue 2,3,7,8-TCDD concentrations. These data will be provided to the State and may be useful to the State in evaluating the fish consumption advisory levels for the River.

8.4.3 EVALUATION OF REMOVAL ACTION COST – ALTERNATIVE 3

The capital cost of Alternative 3 is $2,029,000 associated with the implementation of institutional controls, activated carbon addition, and baseline sampling. The 30-year net present worth including OMM is $3,035,000. Table 8.3 presents a detailed cost estimate for this alternative. Baseline and ongoing sampling include the collection of fish tissue and surface water data. The estimated cost for each monitoring event is $433,000. The baseline and ongoing sampling programs will be developed as part of the detailed design.

8.5 ALTERNATIVE 4 - INSTITUTIONAL CONTROLS, MNR, AND ARMORED CAPPING OF SELECTED AREAS

Alternative 4 involves the combination of the processes and measures described in Alternative 2 with additional measure to isolate areas of elevated concentration in the River adjacent to the Former Flexsys Facility, across the River from the Former Flexsys Facility. The area of cap placement is approximately 9.39 acres and is shown on Figure 7.4. These areas include the area adjacent and immediately downstream of the Former Flexsys Facility including sample location COR-39, sediment in the vicinity of sample location COR-36 (upstream of the I-64 bridge on the bank opposite the Former Flexsys Facility), sediment in the vicinity of COR-21/COR-22, and an area near RM 31 at historic sample locations RIV8/9/10. Cap placement is entirely outside of the navigational channel for the River being either outside the horizontal extents of the channel, or below the depth of navigation within the channel. Table 8.1 presents a summary of the evaluation of Alternatives.

The cap design in the area adjacent to the Former Flexsys Facility will be integrated with bank stabilization activities that have been completed by Solutia for the Former Flexsys Facility, as described in Section 7.1.3.

The conceptual cap profile (see Figure 7.5) includes from bottom to top, a 6-inch sand layer to provide a barrier between the impacted sediment and potential receptors, and where appropriate, an armor stone layer with a thickness of at least twice the average (D_{50}) particle size. For the purpose of the EE/CA evaluation, it was assumed that the entire cap area will be armored. The selection of armor stone gradation will be finalized in detailed design. The USACE Huntington District office has identified materials in common usage for bank armoring. Two materials have been identified, which USACE identifies as 9-inch rip rap and 15-inch rip rap. The selection of the preferred material and the depth of placement below the water line will be reviewed and finalized in consultation with USACE as part of the detailed design. Relatively large-sized armor materials may be required for areas adjacent to existing dock facilities or in shallow (less than 4-foot water depth) areas, as these areas may experience higher scour velocities and wave action. For the purposes of evaluation of the Removal Action Alternatives, all capped areas were assumed to be armored using the 9-inch rip rap identified by USACE and approved for use as part of the bank stabilization activities at the Former Flexsys Facility. Detailed design would be completed in accordance with U.S. EPA and USACE guidance documents and in consultation with USACE. The armor design will be modified as appropriate to reflect areas of higher or lower shear stress, wave action, prop wash, or risk of damage.

Final extent of cap placement and rock size selection will be completed as part of detailed design. Final design will be based on water depth, average River current (shear stress), River current under flood conditions, wave action and boat traffic. Solutia completed the bank stabilization activities required by the RCRA CA Program.

In addition to baseline, and periodic, fish tissue and surface water sampling to monitor recovery of the River, additional maintenance would be required as part of this Alternative to ensure integrity of the cap and isolation of the underlying material. Institutional controls including the Waterway Use Restrictions IC would be required ensure the long-term integrity of the cap.

8.5.1 EVALUATION OF REMOVAL ACTION EFFECTIVENESS – ALTERNATIVE 4

Capping of the area of elevated 2,3,7,8-TCDD concentrations in the area adjacent to the Former Facility would provide an immediate and permanent reduction in the mobility of underlying impacted sediments and surface weighted average concentration of sediments within the Site. An estimated reduction in SWAC concentration across the Site area of over 50 percent would be realized immediately following cap placement

The reduction in SWAC would support and be expected to accelerate continued natural recovery trends in the River by reducing concentrations of 2,3,7,8-TCDD in bioavailable sediment. Recovery would be most rapid in prey fish (e.g., gizzard shad) which have a limited home range and limited life-span. The recovery in sport fish and bottom feeders would require a longer period of time to become evident due to the longer lifespan of the target fish and the existing 2,3,7,8-TCDD body burden of fish developed under pre-RA implementation conditions.

The most significant human health risks are associated with fish consumption from the River. Risks under existing conditions were identified to be slightly outside of the 10^{-4} to 10^{-6} target excess cancer risk range, and above 1 for non-cancer risk under certain consumption scenarios, utilizing the risk assumptions presented in Section 5.1.5. A reduction in fish tissue concentrations of approximately 60-percent would reduce all risks to within the U.S. EPA acceptable ranges for cancer and non-cancer risks, based on the HHRA presented in Section 5.1.7. This reduction would be anticipated to occur as a result of natural recovery processes (Section 8.1) in the River, however; the immediate SWAC reduction resulting from capping would be anticipated to accelerate the process.

Alternative 4 would have high short-term and long-term effectiveness. Worker contact with impacted materials would not be required as work would be completed from the bank or barges, with material being placed through the water column and tracked carefully to confirm cap placement. During implementation, short-term effectiveness will be ensured through the implementation of engineering controls and utilizing best management practices in the placement of cap materials. Engineering controls could potentially include silt curtains to minimize transport of re-suspended sediment downstream. Turbidity monitoring outside of the curtain could be completed to confirm sediment re-suspension has been minimized. Cap material placement methods would be employed to minimize sediment re-suspension. Such practices would include scheduling work to be completed during periods where low flows are typical, selecting sand cap material which has minimal fine-grained (silt/clay) particles, and lowering armor stone through the water column to minimize disturbance of underlying material.

A limited amount of material and equipment would need to be brought to the Site. No unusual transportation or construction methods would be required; therefore, risks to workers completing these activities should be readily defined and controlled. The remaining components associated with implementation of Alternative 4 (institutional controls and baseline monitoring for natural recovery) would not impact short-term effectiveness.

The long-term effectiveness of this remedy will be monitored through the periodic collection of fish tissue and surface water data, including a baseline sampling event, and periodic inspection of the cap to confirm its integrity. The long-term effectiveness and permanence of Alternative 4 is dependent on the effectiveness of source control activities (including activities at the Former Flexsys Facility discussed in Section 7.1.3), and cap integrity continuing to isolate the impacted material from potential receptors. The implementation of these measures for the Former Flexsys Facility will be completed prior to implementation of the Kanawha River Removal Action. Cap repairs would be made if necessary based on inspections. The risks to cap integrity are minimal. Modeling of anticipated shear stresses in the River will be utilized to select appropriately sized armor stone to resist scour. Due to the Site location, ice scour is not anticipated to be a risk for damaging the cap. Wave action and prop wash will be accounted for in the design and may result in larger and/or thicker armoring in some areas. Placement of necessary armoring will not interfere with navigation as the majority of the cap placement is outside the navigation channel. The potential exists for damage to the cap from hulls of barges or boats that may enter the shoreline area. In the event this occurs, damage would be localized and easily repaired.

8.5.2 EVALUATION OF REMOVAL ACTION IMPLEMENTABILITY – ALTERNATIVE 4

The implementation of Alternative 4 does not require any special materials or methods which would impact the potential implementability of Alternative 4. A number of items must be considered as part of the design to ensure coordination with source control activities, achievement of RAO, and implementability of ICs.

No issues are anticipated regarding compliance with action-specific ARARs. Several ARARs will need to be considered during design and implementation; however, none are anticipated to reduce the implementability of Alternative 4. The design of the cap must consider all substantive U.S. ACE requirements for filling in the floodplain and navigational requirements. As the normal pool elevation of the River within the areas to be capped is controlled by the Winfield Dam, no impact to normal pool elevation would result. Due to cap placement below normal pool elevation, no impact to flood storage or flood elevation is anticipated; however modeling would be completed as part of detailed design to confirm that the increase in flood elevation associated with the 100-year flood is below the U.S. ACE criteria (0.1-foot). Coordination during cap placement with U.S. ACE, Winfield Dam staff would be required as temporary encroachment on the navigational channel could be required for working barges. This is not anticipated to occur, but would be considered during design.

Compliance with WV water quality certification standards would be required. Monitoring of the water column to confirm that downstream migration of re-suspended sediment has been controlled would be anticipated to be required. Habitat disruption during cap placement should be limited to the area of cap placement.

Fish tissue sampling will require a scientific collector's permit be issued for each event. Surface water sampling events will require coordination with U.S. ACE as the sampling boat will need to anchor at various locations within the navigation channel during sample collection.

The implementation of ICs associated with dredging, specifically to prevent coal recovery or aggregate recovery dredging on the River is contingent on U.S. ACE and WV DEP concurrence that such controls are necessary. Should U.S. ACE and WV DEP permit such activities, the potential exists to re-mobilize buried sediment with 2,3,7,8-TCDD into the water column, and dredging in capped areas would damage the cap, and re-mobilize impacted sediments. Control of re-mobilization of stable sediments is critical to the natural recovery process at the Site. An inability to institute such a control restricting coal recovery dredging could reduce, or reverse the natural recovery process at the Site.

Implementation of Alternative 4 provides active remediation of key sediment deposits to augment the natural recovery rates of fish in the River. No change to River use or function, with the exception of the restriction on coal recovery dredging will occur. As such, no issues with public acceptance or State acceptance are anticipated. The remedy will also involve the collection of data documenting fish tissue and surface water 2,3,7,8-TCDD concentrations. These data will be provided to the State and may be useful to the State in evaluating the fish consumption advisory levels for the River.

8.5.3 EVALUATION OF REMOVAL ACTION COST – ALTERNATIVE 4

The capital cost of Alternative 4 is $7,109,000. The 30-year net present worth including OMM is $8,158,000. Table 8.4 presents a detailed cost estimate for this alternative. Fish tissue and surface water baseline, and periodic monitoring is based on implementing the monitoring program as identified in Alternatives 2 and 3. The estimated cost for each monitoring event is $433,000.

The uncertainty associated with the cost of implementing this alternative is minimal as the costs for the materials necessary for cap construction are established and stable. Variation in implementation cost will vary based primarily on the aerial extent and armor stone thickness of the final cap design, and any cost savings which may be realized by coordinating cap construction with bank stabilization activities at the Former Flexsys Facility.

8.6 ALTERNATIVE 5A - INSTITUTIONAL CONTROLS, MNR, DREDGING OF SELECTED AREAS, AND NEAR-SHORE CDF

Alternative 5A involves the combination of MNR and institutional controls described in Alternative 2 with additional removal of sediments via dredging from areas of higher concentration in the River. Specifically, the areas to be dredged under this alternative total approximately 9.39 acres. These areas include the area adjacent and immediately downstream of the Former Flexsys Facility including sample location COR-39 and sediment in the vicinity of sample location COR-36 (upstream of the I-64 bridge on the bank opposite the Former Flexsys Facility). Hydraulic or mechanical dredging would be utilized with dewatering of the sediment either by gravity or mechanically. The water would then be treated and discharged back to the River and sediments disposed of in a CDF constructed on the Former Flexsys Facility. The location of the dewatering area and CDF are presented on Figure 7.6. Table 8.1 presents a summary of the evaluation of Alternatives.

8.6.1 EVALUATION OF REMOVAL ACTION EFFECTIVENESS – ALTERNATIVE 5A

Dredging of areas of elevated 2,3,7,8-TCDD concentrations in the area adjacent to and across from the Former Flexsys Facility would provide an immediate and permanent reduction in the mass of 2,3,7,8-TCDD in the river. However due to the physical configuration of the sideslopes of the River in the areas to be dredged, including rock outcrops and the likelihood of significant vegetative and other debris from decades of industrial use of the River, the potential effectiveness of dredging for the removal of all targeted sediment is limited. An increase in SWAC concentration across the Site area would be anticipated immediately following dredging due to resuspension of impacted sediments during dredging.

The increase in SWAC would disrupt the ongoing natural recovery trends in the River by increasing concentrations of 2,3,7,8-TCDD in bioavailable sediment and the water column. This would be anticipated to result in an approximate doubling of fish tissue concentrations following dredging (Figure 8.1). A recovery period of 5 to 10 years would be required for fish tissue concentrations to approach levels anticipated under Alternative 4.

Significant residuals (up to 10 percent of the contaminant mass targeted for dredging; see Patmont and Palermo 2007) are expected to remain that cannot be effectively removed, or which result from resuspension during dredging. Based on the evaluation framework presented in Patmont and Palermo (2007), the presence of sediments at depth with significantly higher concentrations than surface sediments will likely result in post-dredging surface sediment concentrations that are more than 10 times higher than current pre-dredging conditions, requiring the placement of a cap to achieve the SWAC PRG. The design of the cap would follow the same performance criteria described for Alternative 4.

In addition to the potential for post-dredge SWACs to require the additional placement of a cap, resuspension of sediments during dredging will result in a short-term spike in fish tissue concentrations retarding the natural recovery trends, as discussed in Section 8.1.

Sediment that has been dredged and dewatered will be placed in a containment cell constructed on the Former Flexsys Facility. If necessary based on the physical strength of the dewatered sediment, the sediment may be stabilized prior to placement to ensure stability of the disposal cell. The final location and configuration of the cell would be determined as part of the detailed design; however, the anticipated area for the CDF is identified on Figure 7.6. The CDF would be developed on a portion of the former Flexsys Facility and coordinated with and approved under the RCRA CA process at the Former Flexsys Facility. The Facility would be anticipated to be designed generally consistent with RCRA Subtitle C requirements to include a double containment liner system with leachate collection and leak detection, and a low permeability cap. Perimeter groundwater monitoring would be completed utilizing the existing groundwater monitoring network at the facility to the extent possible. Additional wells would be installed as necessary.

The most significant Human Health Risks are associated with fish consumption from the River. Risks under existing conditions were identified to be slightly outside of the 10^{-4} to 10^{-6} target excess cancer risk range, and above 1 for non-cancer risk under certain consumption scenarios, utilizing the risk assumptions presented in Section 5.1.5. A reduction in fish tissue concentrations of approximately 60 percent would reduce all risks to within the U.S. EPA acceptable ranges for cancer and non-cancer risks, based on the HHRA presented in Section 5.1.7. However, the recovery of the fish tissue concentrations would be delayed by a short-term spike in fish tissue concentrations resulting from resuspension of impacted sediment during dredging (Figure 8.1).

Alternative 5A would have low short-term effectiveness. Long-term effectiveness is primarily dependent on the extent of the rise in fish tissue concentrations resulting from dredge re-suspension during implementation as well as residual surface sediment concentrations. These impacts cannot be predicted definitively; however, experience gained from other projects has been utilized to evaluate recovery trends following dredging as discussed in Section 8.1. As generally depicted on Figure 8.1, fish tissue concentrations under Alternative 5 (applicable to both Alternative 5A and 5B), are predicted to increase significantly during and shortly following dredging activities. The predicted short-term increase in fish tissue concentrations associated with the resuspension and release of contaminants from dredging results in a retarded recovery timeframe as compared to Alternatives 3 and 4.

Worker exposure to impacted materials is more likely during dredging, dewatering and placement activities. During implementation, short-term impacts will be controlled as practicable through the implementation of engineering controls and utilizing best management practices in dredging and the placement of cap materials (if necessary). Engineering controls would include silt curtains to minimize transport of re-suspended sediment downstream. Turbidity monitoring outside of the curtain could be completed to confirm sediment re-suspension has been minimized. Dredging best practices, such as limiting the depth of cut, temporarily ceasing work in high flow events, and using cap material placement best practices would be employed to minimize sediment re-suspension. However, as discussed in Section 8.1 fish tissue concentrations under Alternative 5 (applicable to both Alternative 5A and 5B) are predicted to increase significantly during and shortly following dredging activities. This is due to the temporary increase in water column contaminant concentrations associated with dredging-induced contaminant resuspension and release, which cannot be effectively controlled even by employing best management practices and silt curtains. The likelihood of disrupting, and temporarily reversing the ongoing recovery trends in fish tissue recovery, limit the benefit of this remedy.

Dredging will require specialized equipment for dredging and dewatering to be brought to the Site. Risks to workers completing Alternative 5A work activities should be readily defined and controlled. The remaining components associated with implementation of Alternative 5A (ICs and baseline monitoring for natural recovery) would not impact short-term effectiveness.

The long-term effectiveness of this remedy will be monitored through the periodic collection of fish tissue and surface water data, including a baseline sampling event, and periodic inspection of the cap (if installed) to confirm its integrity. Periodic inspection and groundwater monitoring of the CDF would be completed as well as leachate removal and off-Site disposal (as needed).

The long-term effectiveness and permanence of Alternative 5A is dependent on the effectiveness of source control activities (including activities at the Former Facility discussed in Section 7.1.3), the ability to control dredge re-suspension and residual concentrations, and cap integrity continuing to isolate the impacted material from potential receptors (if capping is required). The implementation of these measures for the Former Flexsys Facility will be completed prior to implementation of the Kanawha River Removal Action.

Residuals are defined as contaminated sediment that remains at the post-dredging surface either within or adjacent to the dredging footprint, and can be broadly grouped into two categories:

- **Undisturbed residuals**: consolidated or intact contaminated sediments found at the post-dredging sediment surface that have been uncovered by dredging but not fully removed
- **Generated residuals**: contaminated post-dredging disturbed surface sediments that are dislodged or suspended by the dredging operation and are subsequently redeposited on the bottom of the water body

No dredging technology can remove every particle of contaminated sediment and all dredging operations leave some residual contaminated sediment, particularly generated residuals. The nature and extent of generated residuals are related to sediment geotechnical and geophysical characteristics, the variability in contaminant distributions, and physical site conditions such as the presence of bedrock, hardpan, debris, or other obstructions. The cross-sections illustrate the irregularities identified on the river bank and river bottom areas from detailed geophysical surveys. Due to the presence of bedrock and irregularities in the bottom immediately underlying contaminated sediments and presence of debris at the Site, and based on comparisons with literature values (Bridges et al., 2010), at least 6 percent of the mass of 2,3,7,8-TCDD that would be dredged in the last production cut (e.g., from COR-36 and COR-39) would be anticipated to remain at the post-dredge *surface* as a generated residual layer, with concentrations one to two orders of magnitude higher than current *surface* sediment conditions.

The assumption regarding the mass of 2,3,7,8-TCDD residual is based on data from other environmental dredging projects which provide useful data regarding dredge residuals. The referenced article (Bridges et al., 2010) presents a summary of information compiled from case studies completed on 12 well documented projects. These projects represent a range of project sizes, sediment characteristics, dredging methods, slopes, and bottom materials. Generated residual masses measured on these projects varied from 1 percent to 11 percent with the presence of debris or rock/hardpan resulting in higher generated residuals.

In addition to the mass of generated dredge residuals, the post-dredging surface sediment concentration is also affected by the dredging conditions, with up a 40-fold increase in post-dredge surficial sediment concentrations observed at sites, depending on site conditions. EPA's Office of Research and Development conducted a detailed study to assess dredging residuals at the Ashtabula River site in Ohio. Dredging at the site was completed by EPA under the Great Lakes National Program Office (GLNPO). Within the study area, a 9.5-fold increase in surface concentrations were observed following dredging, even following a cleanup pass by the dredge. This information is presented in the Field Study of Environmental Dredging Residuals: Ashtabula River, Volume 1, Final Report, September 2010 (EPA/600/R-10/126). Section 3.3.2 of this report identified that "*the post-dredged surface sediment PCB concentrations were higher than the pre-dredge concentrations for similar evaluations at 28 of the 30 locations.*" As discussed in the attached IEAM article, similar results have been reported at numerous environmental dredging sites.

The inevitability of dredging-related releases residuals and their influence on risk has been increasingly recognized over the last decade. It is also understood that these processes affect the magnitude, distribution, and bioavailability of the contaminants, and also control exposure/risk recovery trends for receptors of concern. EPA recognizes this limitation on dredging effectiveness in its Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA-540-R-05-012, December 2005). This document states on page 29 that "*A well designed and well placed cap should more quickly reduce the exposure of fish and other biota to contaminated sediment as compared to dredging, as there should be no, or very little contaminant residual on the surface of the cap.*"

Cap repairs would be made if necessary based on inspections. The risks to cap integrity are minimal. Modeling of anticipated shear stresses in the River will be utilized to select appropriately sized armor stone to resist scour. Due to the Site location, ice scour is not anticipated to be a risk for damaging the cap. Wave action and prop wash will be accounted for in the design and may result in larger and/or thicker armoring in some areas. Placement of necessary armoring will not interfere with navigation as cap placement is mostly outside the navigation channel. Figures 7.1, 7.3, 7.4, 7.6, and 7.8 identify the navigational sailing line and navigational channel of the Site. The potential exists for damage to the cap from hulls of barges or boats utilizing the river. In the event this occurs, damage would be localized and easily repaired.

8.6.2 EVALUATION OF REMOVAL ACTION IMPLEMENTABILITY – ALTERNATIVE 5A

The implementation of Alternative 5A requires specialty dredging and dewatering equipment; however, this equipment should be readily available. A number of items must be considered as part of the design to ensure coordination with source control activities, achievement of RAOs, and implementability of ICs.

Scheduling of dredging activities in the area adjacent to the Former Flexsys Facility should be coordinated with the ongoing RCRA CA at the Facility to ensure all necessary source control activities are completed.

Implementation of Alternative 5A requires compliance with the largest number of action-specific ARARs. Several ARARs will need to be considered during design and implementation; however, none are expected to preclude the implementation of Alternative 5A. Dredging activities, and capping if necessary, will be required to comply with U.S. ACE dredging and filling requirements, navigational requirements, and WV DEP water quality certification requirements. The completion of all work outside the navigational channel should simplify the U.S. ACE review and approval process. CDF siting and design activities will need to be coordinated with the ongoing RCRCA CA at the Former Flexsys Facility, and be approved under the Removal Action Program as part of this Project. Preliminary discussions with WV DEP RCRA staff for the Former Flexsys Facility indicated that the siting of the CDF on the Former Flexsys

Facility is an acceptable concept. Formal approval should be obtained prior to any decision to select this Alternative 5A.

Compliance with a NPDES discharge permit standards for discharge of treated water from the dewatering of sediment will be required.

Air monitoring during dewatering and placement activities would be anticipated to monitor worker exposure and potential exposure to off-Site receptors.

Monitoring of the water column to confirm that downstream migration of re-suspended sediment during dredging and capping has been controlled would be anticipated to be required. Habitat disruption during dredging and cap placement should be limited to the area of dredging and areas immediately downstream. Mitigation, if required, could be completed above the cap or in adjacent areas.

Fish tissue sampling will require a scientific collector's permit be issued for each event. Surface water sampling events will require coordination with U.S. ACE as the sampling boat will need to anchor at various locations within the navigation channel during sample collection.

The implementation of ICs associated with future dredging, specifically to prevent coal recovery or aggregate recovery dredging on the River is contingent on U.S. ACE and WV DEP concurrence that such controls are necessary. Should U.S. ACE and WV DEP permit such activities, the potential exists to re-mobilize buried sediment with 2,3,7,8-TCDD into the water column, and dredging in capped areas would damage the cap, and re-mobilize impacted sediments. Control of re-mobilization of stable sediments is critical to the natural recovery process at the Site. An inability to institute such a control restricting coal recovery dredging could reduce, or reverse the natural recovery process at the Site.

Implementation of Alternative 5A provides active remediation of key sediment deposits to remove contaminant mass. No change to River use or function, with the exception of the restriction on dredging will occur. As such, no issues with public acceptance or State acceptance are anticipated. Coordination of activities between the CERCLA RA and RCRA CA programs will require additional effort in the development of a detailed design and during implementation of this Alternative 5A.

The remedy will also involve the collection of data documenting fish tissue 2,3,7,8-TCDD concentrations. This data will be provided to the State and may be useful to the State in evaluating the fish consumption advisory levels for the River.

8.6.3 EVALUATION OF REMOVAL ACTION COST – ALTERNATIVE 5A

The capital cost of Alternative 5A is $24,582,000. The 30-year net present worth including OMM is $26,020,000. Table 8.5 presents a detailed cost estimate for this alternative. Fish tissue baseline, and periodic monitoring is based on implementing the monitoring program as identified in Alternatives 2 and 3. The estimated cost for each monitoring event is $433,000. Annual monitoring and maintenance costs for the CDF are estimated to be approximately $22,000 per year.

The uncertainty associated with the cost of implementing this Alternative is significant as dredging and dewatering costs are highly variable based on sediment characteristics, the physical conditions of the dredge area, and the presence of debris.

8.7 ALTERNATIVE 5B - INSTITUTIONAL CONTROLS, MNR, DREDGING OF SELECTED AREAS, AND OFF-SITE DISPOSAL

This Alternative 5B involves the same methods for achieving the RAOs as Alternative 5A; however, in this alternative sediment would be transported for off-Site disposal rather than being disposed in an on-Site CDF. The dredged sediment would be dewatered, loaded on trucks, and transported to a licensed landfill for disposal in compliance with applicable regulations. Table 8.1 presents a summary of the evaluation of Alternatives.

8.7.1 EVALUATION OF REMOVAL ACTION EFFECTIVENESS – ALTERNATIVE 5B

The effectiveness of Alternative 5B is equivalent to Alternative 5A, except that no on-Site disposal facility is required. Based on available data, the sediments are not considered RCRA hazardous waste; however, some landfills are reluctant to accept dioxin containing materials. This may increase the haul distance and related cost associated with implementation of this Alternative. The transport of dewatered sediments to an off-Site facility for disposal increases the potential for traffic accidents due to significantly increased truck traffic as compared to all other Alternatives. No additional issues with the loading or transport of materials to a commercial landfill are anticipated.

8.7.2 EVALUATION OF REMOVAL ACTION IMPLEMENTABILITY – ALTERNATIVE 5B

The implementability of Alternative 5B is equivalent to Alternative 5A, except that the elimination of the on-Site CDF would be anticipated to eliminate a number of necessary approvals and simplify coordination between the CERCLA and RCRA projects.

8.7.3 EVALUATION OF REMOVAL ACTION COST – ALTERNATIVE 5B

The capital cost of Alternative 5B is $40,051,000. The 30-year net present worth including OMM is $41,100,000. Table 8.6 presents a detailed cost estimate for this alternative. Fish tissue baseline and periodic monitoring is based on implementing the monitoring program as identified in Alternatives 2 and 3. The estimated cost for each monitoring event is $433,000.

The uncertainty associated with the cost of implementing this Alternative is significant as dredging and dewatering costs are highly variable based on sediment characteristics, the physical conditions of the dredge area, and the presence of debris. Disposal costs also vary significantly with market demand which can significantly impact Project cost.

9.0 PREFERRED REMEDY SELECTION

Based on the evaluation presented in Section 8.0, and summarized on Table 8.1, for the Removal Action Alternatives, Alternative 4 – Institutional Controls, Monitored Natural Recovery, and Limited Armored Capping has been identified as the preferred remedy.

Alternative 1 was rejected as it does not provide any reduction in 2,3,7,8-TCDD loading or bioavailability, and provides no means of monitoring its effectiveness.

Alternatives 2 and 3 were both considered effective in reducing sediment and fish tissue concentration over time in a cost-effective manner. Alternative 2 provided the lowest cost acceptable remedy. Alternative 3 provides a slightly accelerated natural recovery trend without significant additional cost by reducing the bioavailability of the 2,3,7,8-TCDD in activated carbon treated sediments. However, both Alternatives 2 and 3 had higher levels of uncertainty related to the potential for localized re-exposure of elevated concentration 2,3,7,8-TCDD resulting from high flow events in the River. In particular, the area around COR-39, near the upstream limit of the Former Flexsys Facility, and COR-36 (across the River from the Facility) are subject to potential erosion during high flow events. The potential for localized higher exposure and increased risk of future additional actions makes these alternatives less desirable than Alternative 4.

Alternative 4 assumes that potential historic or ongoing 2,3,7,8-TCDD sources from the former Flexsys Facility have been controlled. Alternative 4 enhances the ongoing natural recovery trend through the implementation of Interim Measures for the former Flexsys Facility and the placement of a cap over the areas of sediment with elevated 2,3,7,8-TCDD concentrations where modeling showed potential instability. The cap placement also provides an immediate and permanent reduction in the surface-weighted average concentration of 2,3,7,8-TCDD, accelerating the natural recovery trend as compared to Alternatives 2 and 3. Implementation of Alternative 4 would not result in the short-term increase in fish tissue 2,3,7,8-TCDD concentrations as a result of sediment resuspension that would occur under the dredging Alternatives 5A and 5B. Thus, Alternative 4 would have a faster anticipated recovery trend than the dredging alternatives. In addition, Alternatives 5A and 5B would be expected to leave significant dredge residuals with surface 2,3,7,8-TCDD concentrations exceeding those currently at the Site, requiring capping of some or all of the dredged areas.

No implementability issues are associated with Alternative 4. Capping materials are readily available and cap placement would not be limited by site conditions. As the majority of capping would be completed outside the navigation channel, or within the navigation channel at depths well below the required draft, cap thickness will not impact navigation. Dredging (Alternatives 5A and 5B) would be expected to be incomplete as rock outcrops along the banks would impede complete sediment removal. Incomplete removal and the dredge residuals resulting from normal dredging activities would be expected to result in significant portions of the areas to be dredged requiring capping.

The higher capital and overall (Net Present Worth) costs for Alternative 4 as compared to Alternatives 2 and 3 appear to be justified given the increased protectiveness and superior recovery trend offered by the addition of limited capping.

Alternatives 5A and 5B are less effective than Alternative 4 due to the spike in fish tissue concentrations which will result from dredging and the limited effectiveness dredging will have in the River setting in mass removal (Figure 8.1). Alternatives 5A and 5B have significantly higher capital and overall costs than Alternative 4, while providing lower short-term protectiveness and equivalent or lower long-term protectiveness. While Alternatives 5A and 5B do provide some contaminant mass removal, no additional protectiveness results from this removal.

Figure 9.1 compares the cost of each RA alternative with the projected average fish tissue concentration achieved within the next 30 years, consistent with reasonable maximum exposure assumptions used in the human health risk assessment (Section 5.1). The Figure 9.1 plot suggests that the incremental costs of implementing Alternatives 5A and 5B are substantial and disproportionate to the degree of protection that would be achieved, particularly relative to Alternatives 3 and 4.

9.1 PRE-DESIGN INVESTIGATION

Additional data will be required to support detailed design of the preferred remedy. A Pre-Design Investigation Work Plan will be developed and submitted for review and approval following U.S EPA issuance of an Action Memoarandum selecting the remedy for the Site. The components of the Pre-Design Investigation Work Plan will include:

- Updated sediment bathymetry for areas to be capped
- Additional surficial sampling (0-6 inches) in the COR-11 and KRSD-03 areas to provide sufficient data to determine the SWACs which include these areas
- Additional sediment delineation data to refine and finalize the limits of the cap in areas to be capped.

Field methods for the Pre-Design Investigation will be consistent with approved methods for the EOC Study. Identification of data requirements and the resulting sample locations will be presented in the Pre-Design Investigation Work Plan. Additional sampling will be conducted utilizing composite samples collected on a grid basis. The grid size, shape, and sampling frequency will vary in different areas based on the data needs, sampling location, the extent of existing information, and the size of the cap.

10.0 PROJECT SCHEDULE

10.1 COORDINATION OF ACTIVITIES

Implementation of the selected remedy should be coordinated with the implementation of source control activities at the Former Flexsys Facility (completed as part of the RCRA CA) to ensure recontamination of areas which are addressed by the selected remedy does not occur.

Should the selected remedy for the Site incorporate removal and consolidation of sediments on the Former Flexsys Facility, additional coordination of activities between the upland work and in-River work will be required to optimize efficiency and minimize potential short-term risks and constructability issues.

10.2 CURRENT RCRA CA SCHEDULE – FORMER FLEXSYS FACILITY

The RCRA CA for the Former Flexsys Facility is being completed on a schedule which will result in source control measures being put in place prior to the River EE/CA implementation. A number of Interim Measures have been completed, including the completion of site cover systems and river bank armoring. Remaining activities at the Former Flexsys Facility associated with the RCRA CA are not anticipated to interfere with activities in the River as part of the River EE/CA implementation. The River EE/CA implementation would be anticipated to enter design in 2015 following completion of a legal instrument governing the implementation of the selected remedy. Dependent on the components of the selected remedy, field implementation would be anticipated to commence in 2016. Implementation of the River EE/CA would be expected to be completed in one construction season.

A conceptual project schedule is presented on Figure 10.1.

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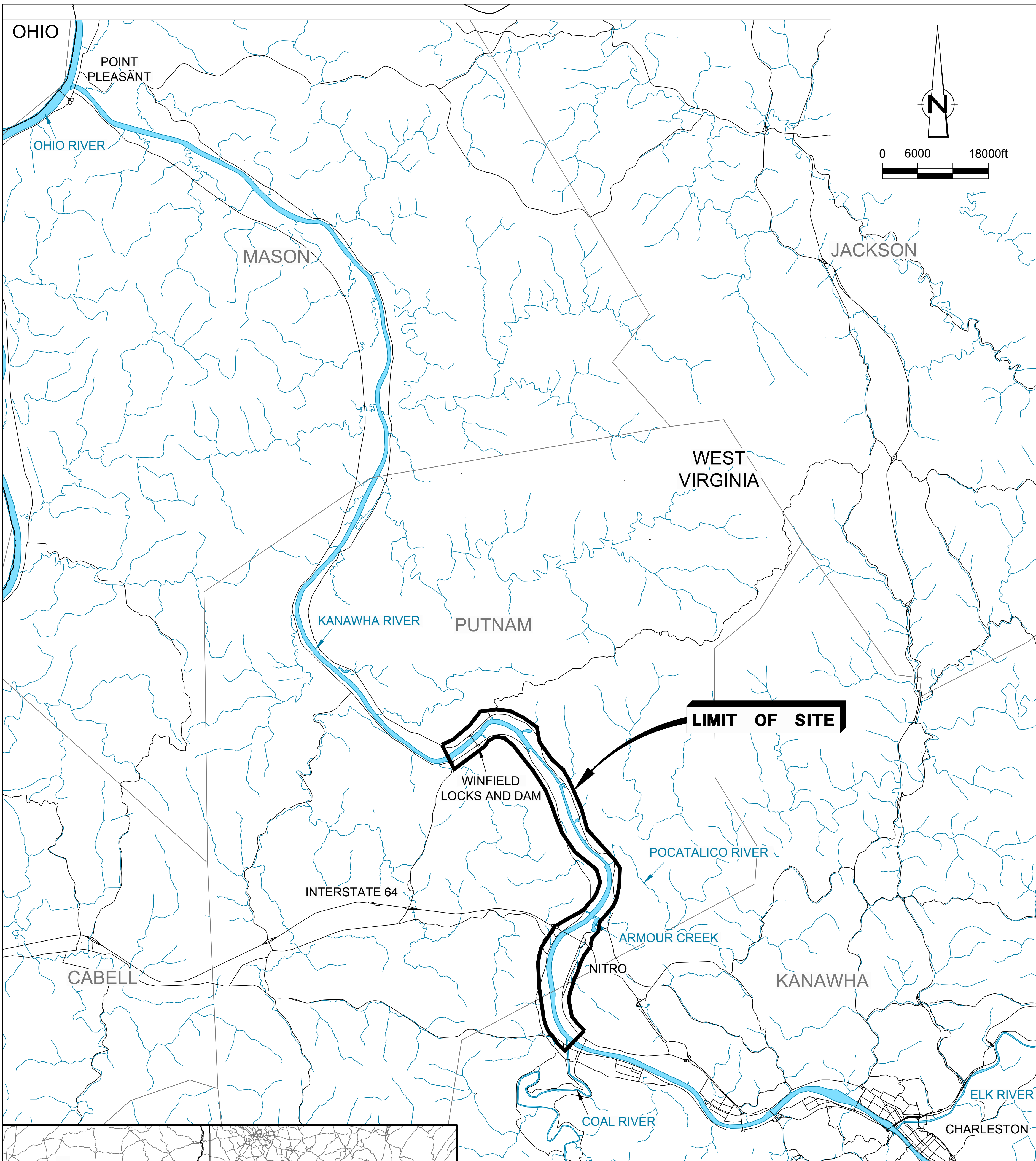
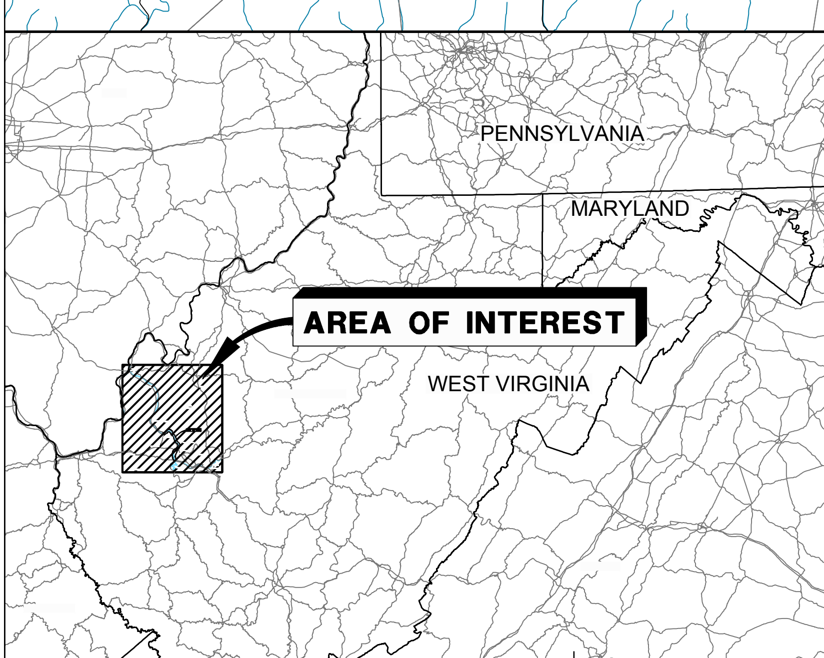


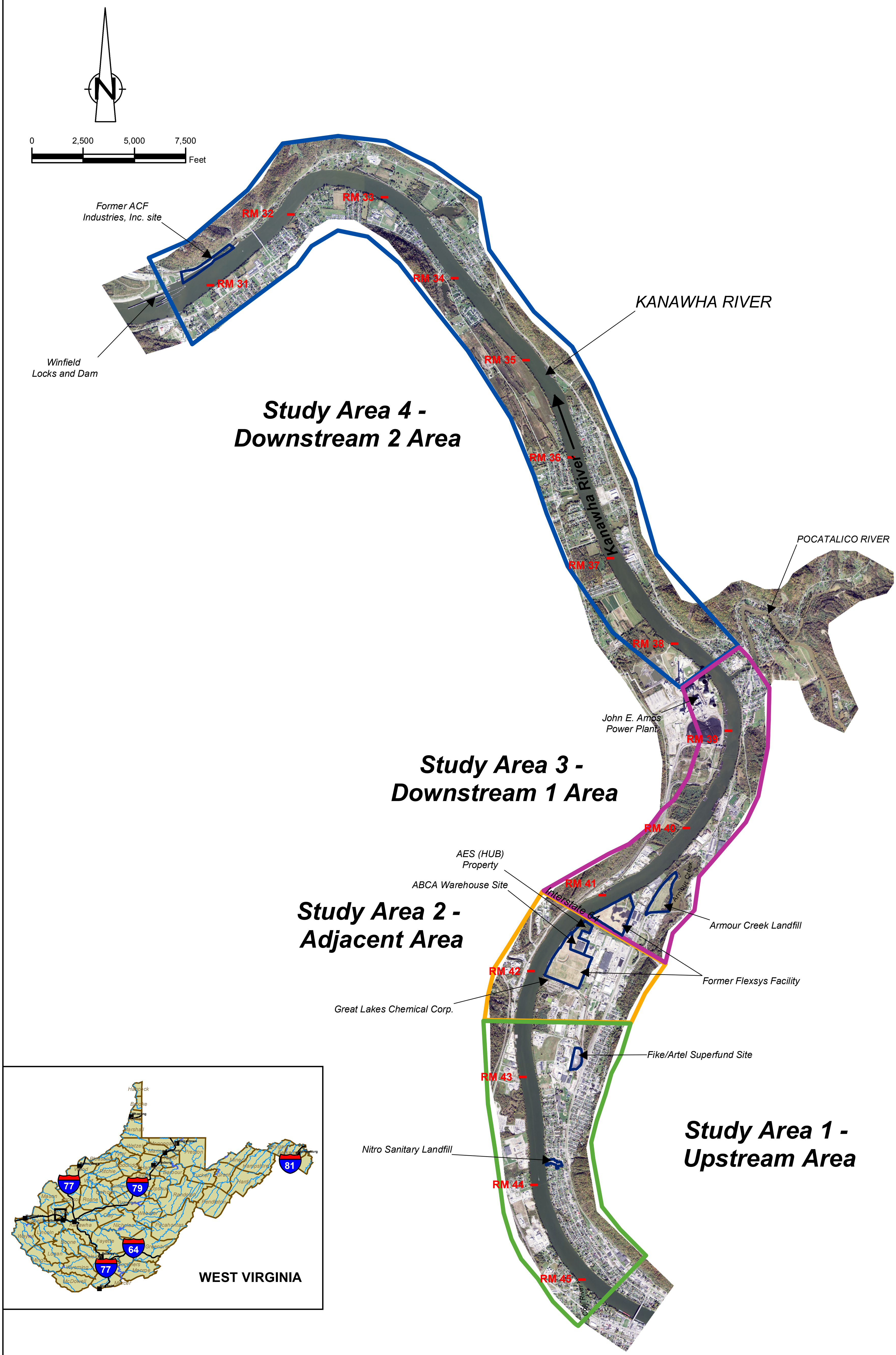


KEY MAP
SCALE: 1" = 350000'

figure 2.1

SITE LOCATION
EE/CA REPORT
Kanawha River, West Virginia

31884-00(051)GN-WA001 FEB 20/2015

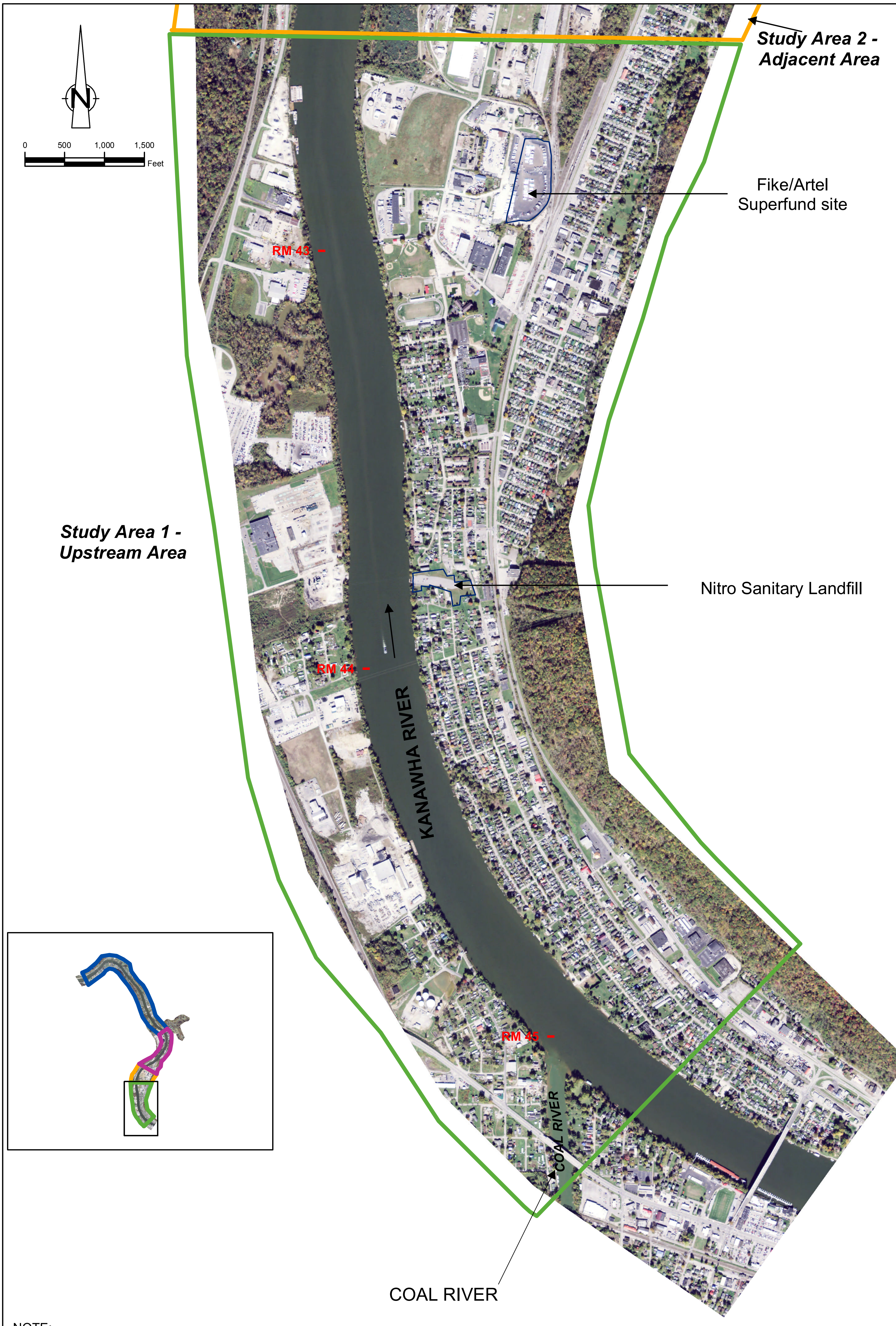


NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 2.2

SITE PLAN
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA



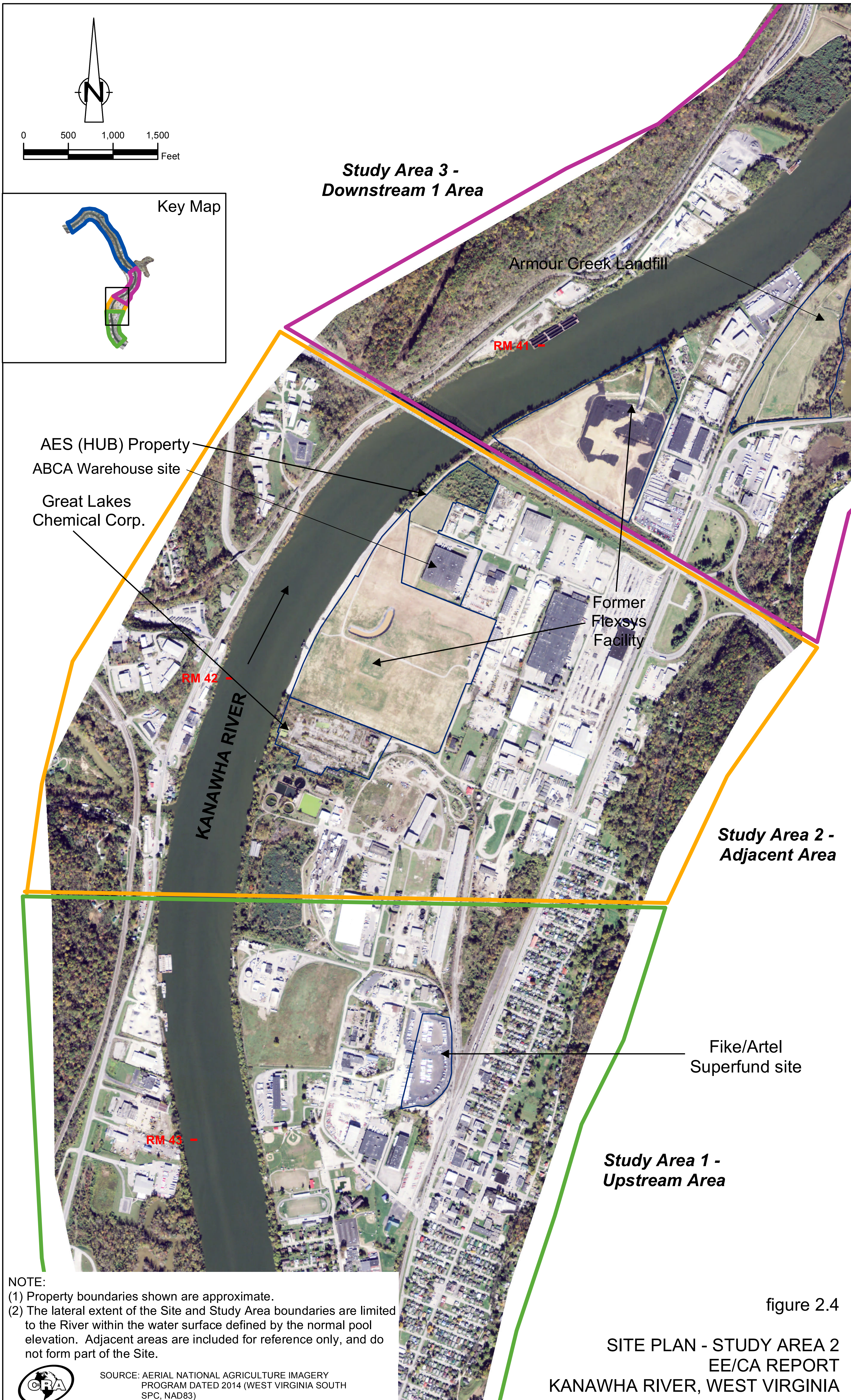
NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

CRA

figure 2.3

SITE PLAN - STUDY AREA 1
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 2.4

SITE PLAN - STUDY AREA 2
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

031884-00(REP051)GIS-WA003 February 23, 2015

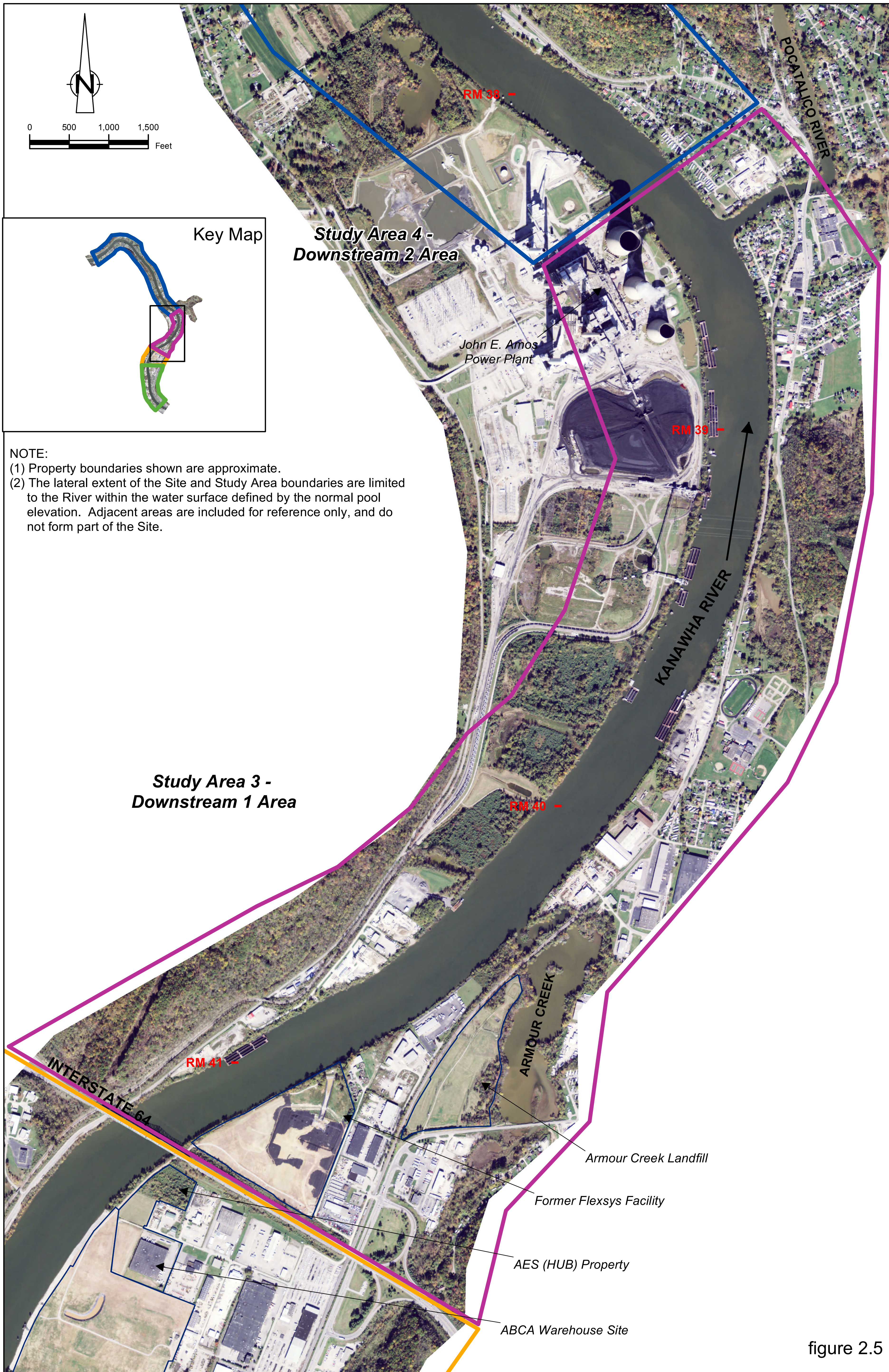
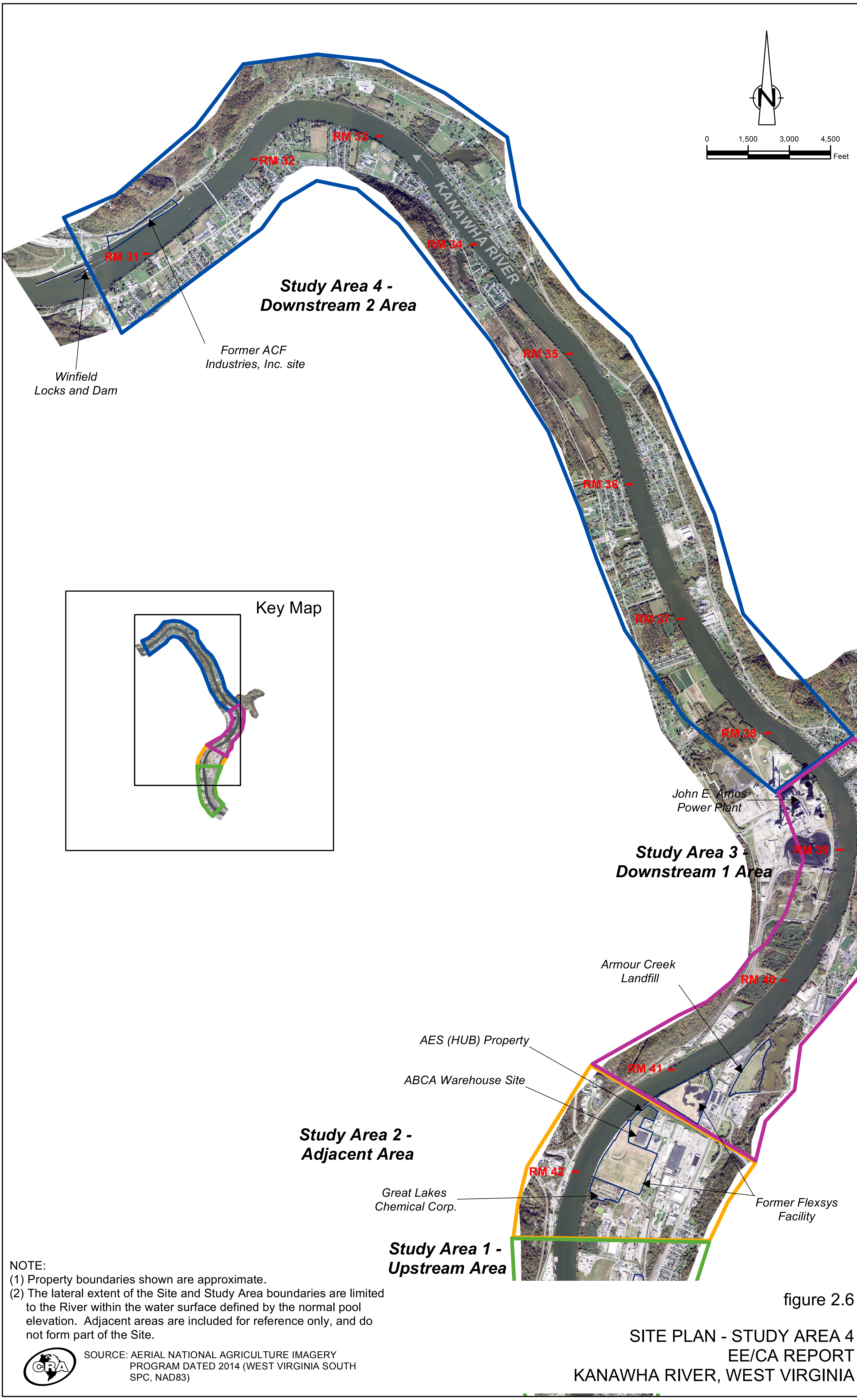


figure 2.5

SITE PLAN - STUDY AREA 3
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

031884-00(REP051)GIS-WA004 February 27, 2015

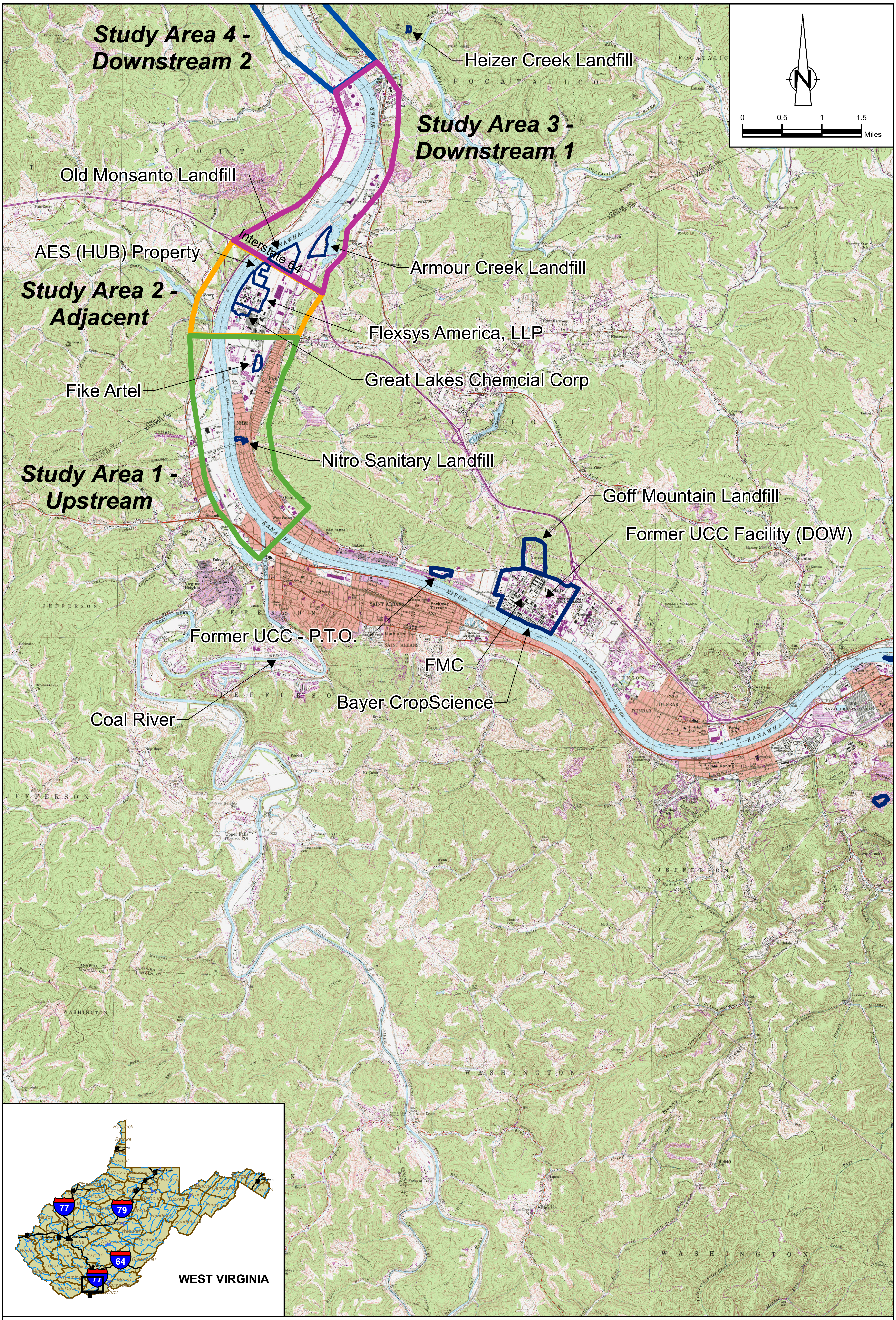


NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 2.6

SITE PLAN - STUDY AREA 4
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

figure 3.1

POTENTIAL UPSTREAM SOURCES – KANAWHA RIVER – KANAWHA COUNTY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

DATA SOURCE: MAPTECH, INC.

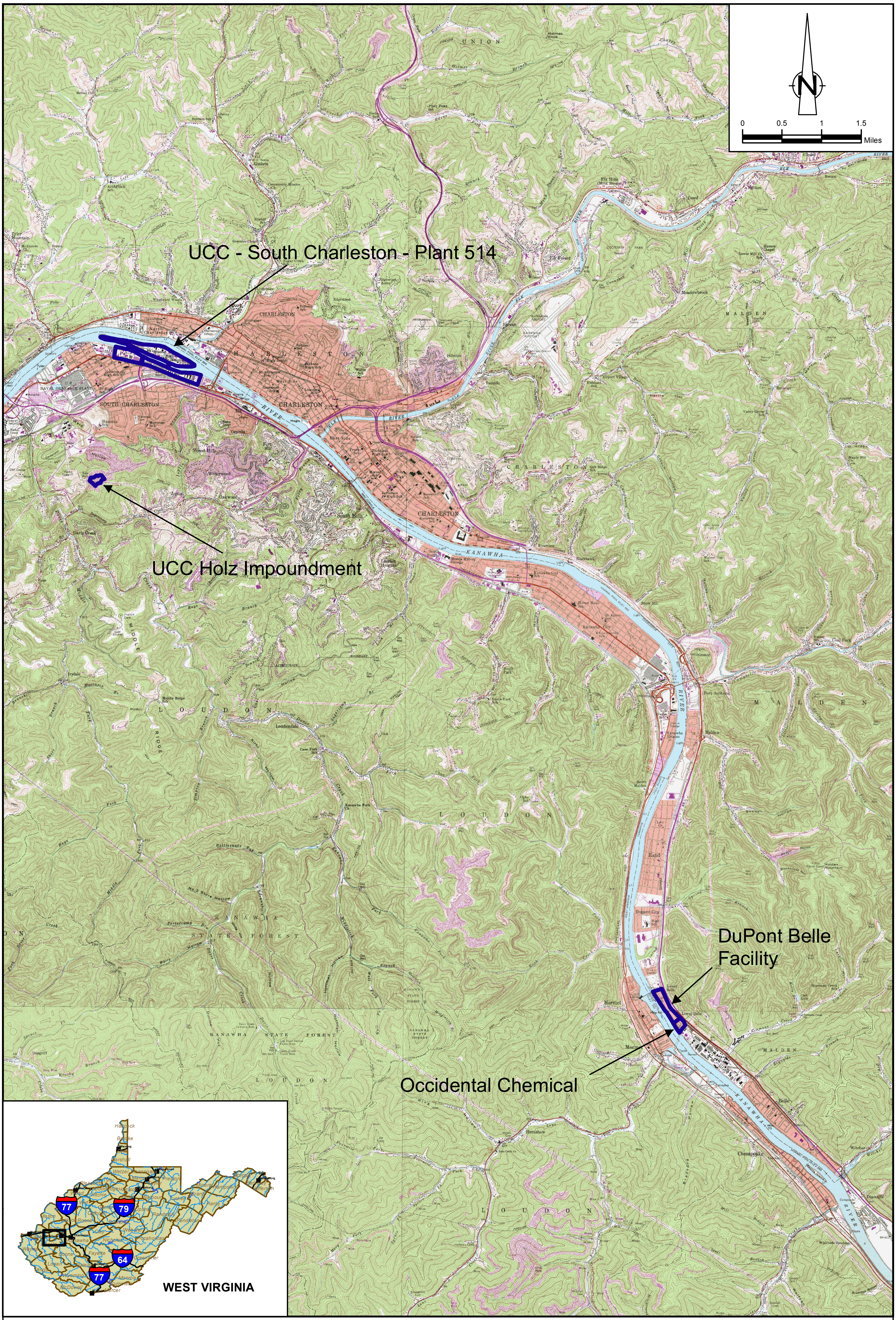
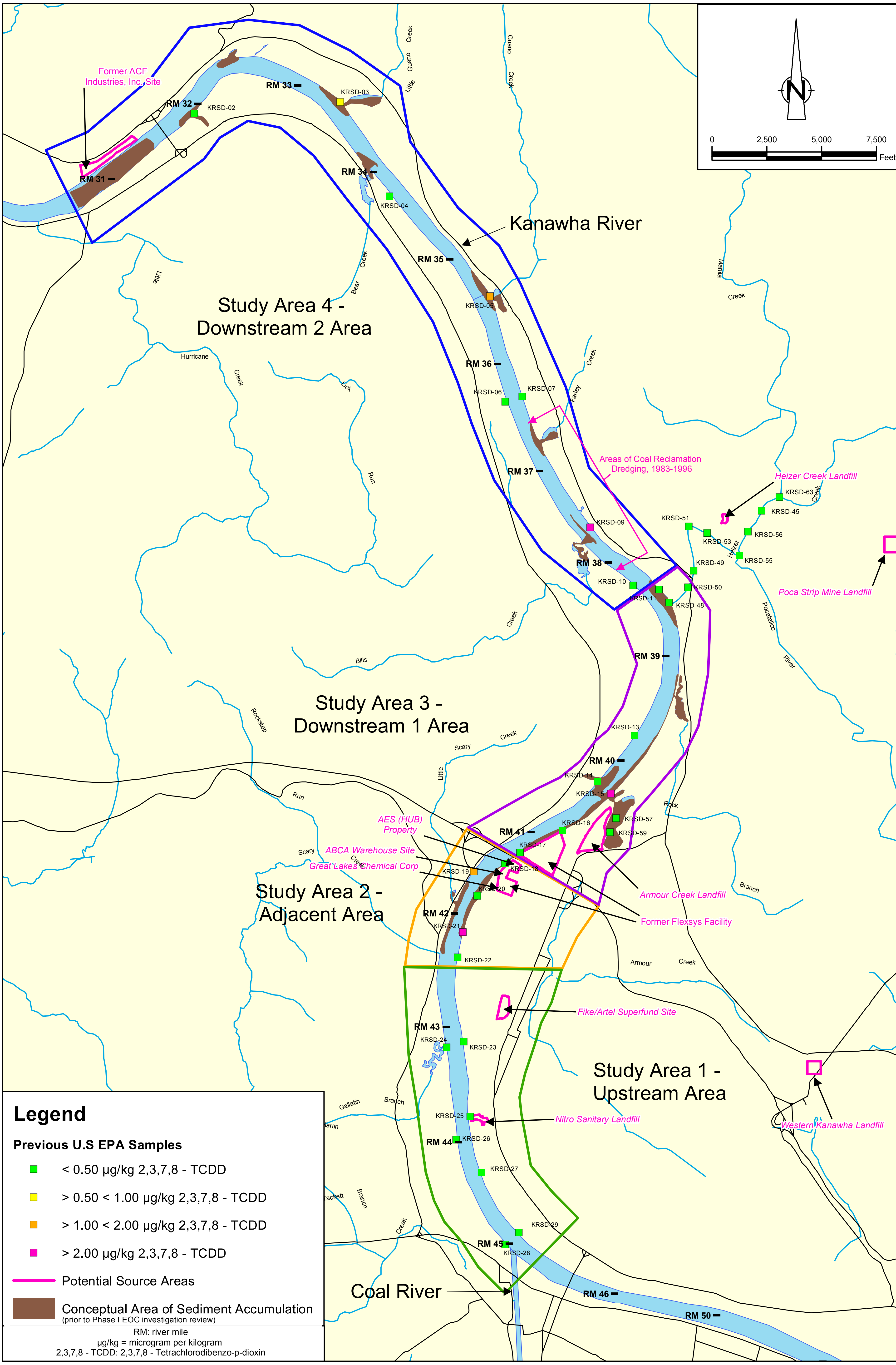


figure 3.2

POTENTIAL UPSTREAM SOURCES
KANAWHA RIVER - SOUTH CHARLESTON TO DICKENSON
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

DATA SOURCE: MAPTECH, INC.

031884-00(REP051)GIS-WA117 February 27, 2015



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

figure 3.3

SPATIAL DISTRIBUTION OF 2,3,7,8 - TCDD IN RIVER SEDIMENT
EE/CA REPORT
Kanawha River, West Virginia

AR100384

031884-00(REP051)GIS-WA024 February 27, 2015

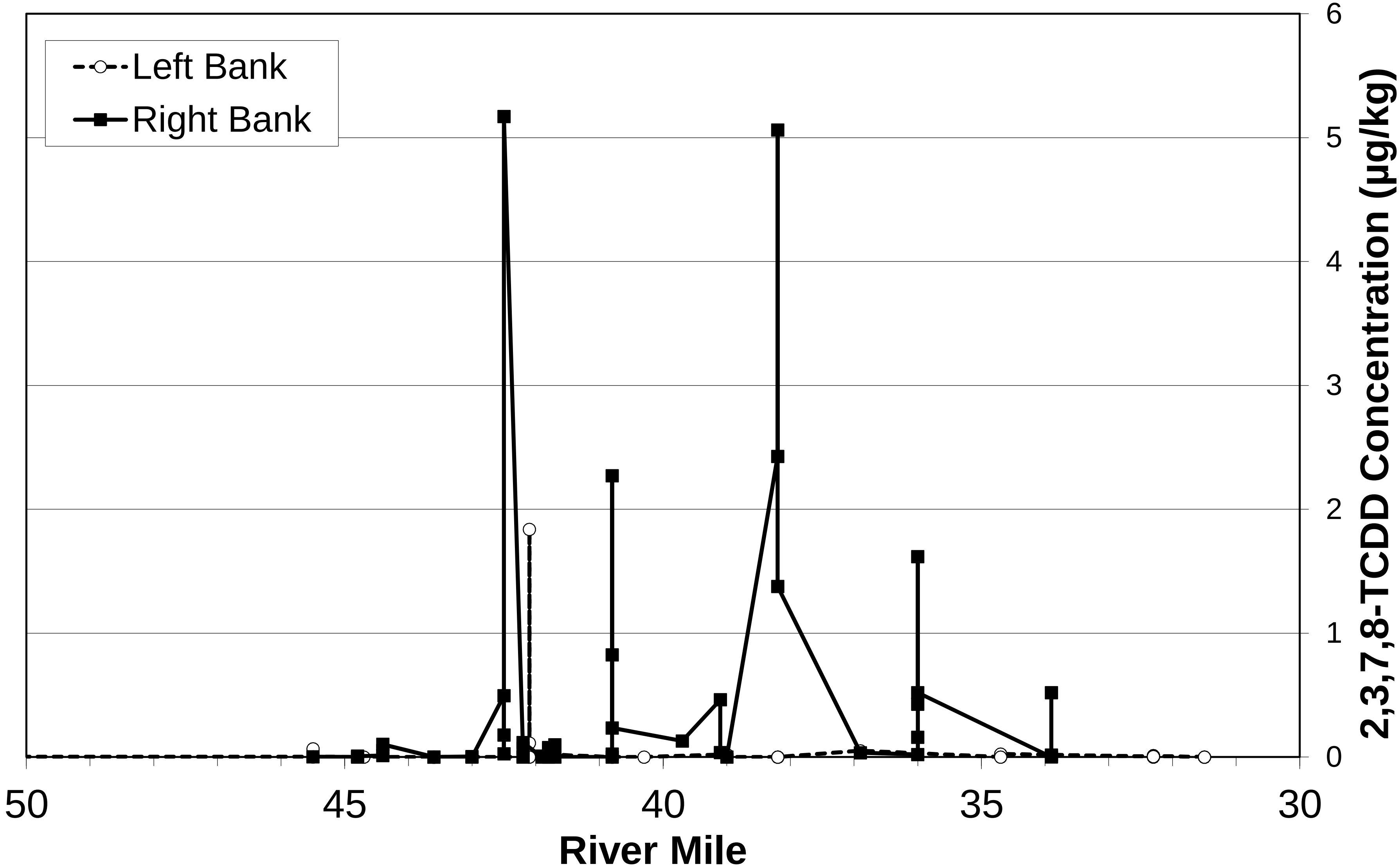


figure 3.4
SEDIMENT 2,3,7,8-TCDD CONCENTRATIONS - RIGHT BANK VERSUS LEFT BANK
EE/CA REPORT
Kanawha River, West Virginia

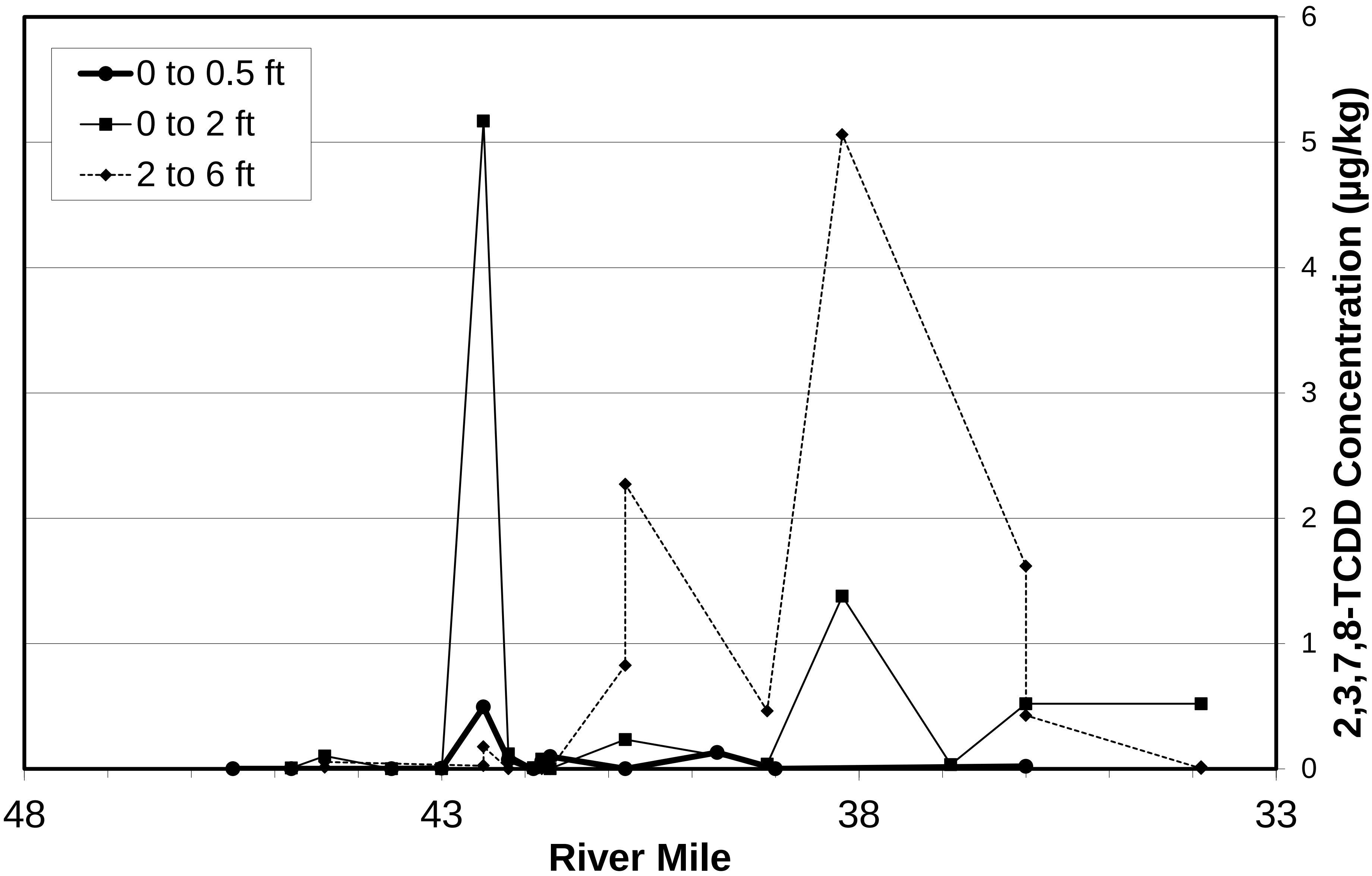


figure 3.5
2,3,7,8-TCDD CONCENTRATION VERSUS DEPTH IN SEDIMENTS
EE/CA REPORT
Kanawha River, West Virginia

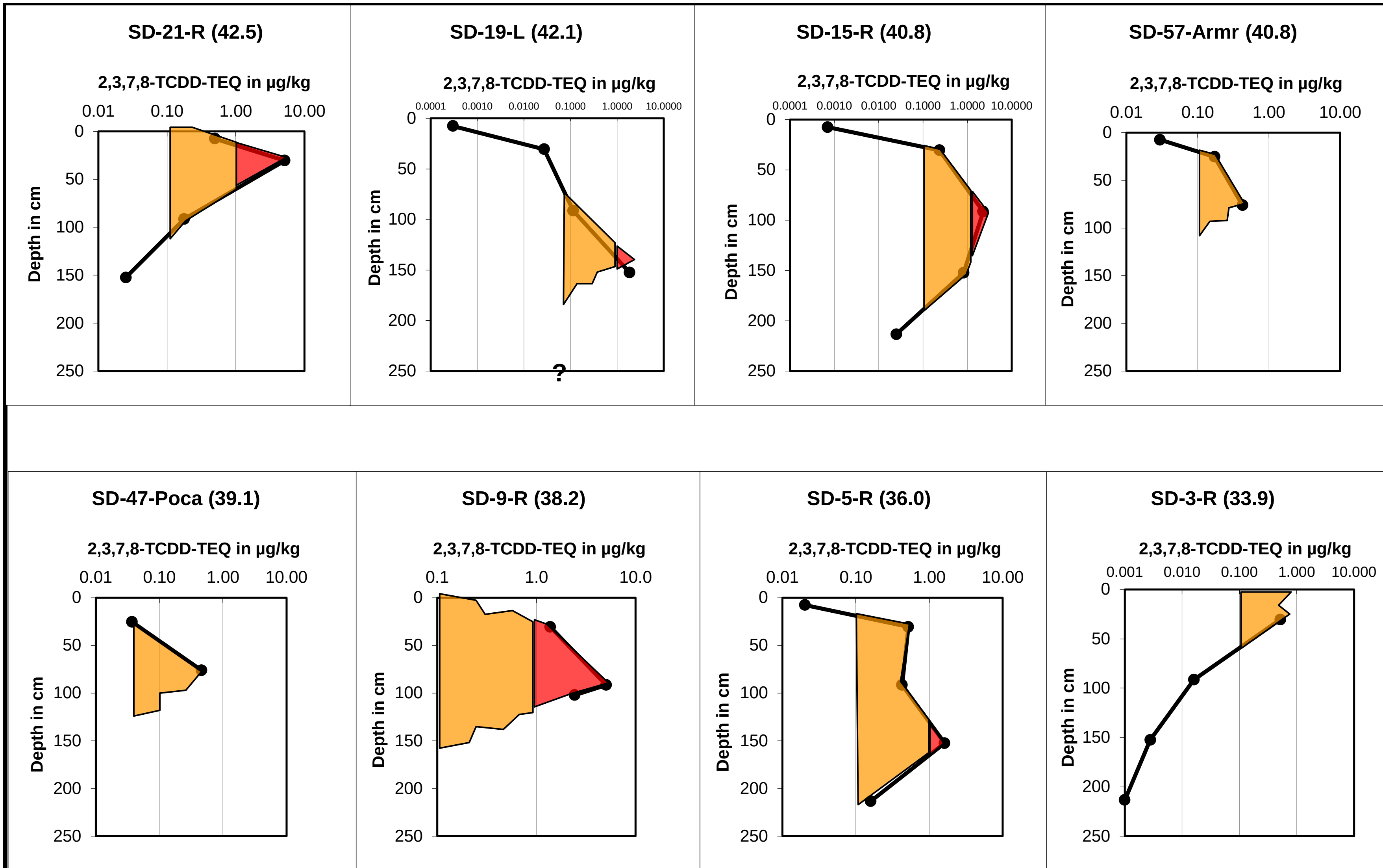


figure 3.6

2,3,7,8-TCDD PROFILES IN SEDIMENT CORES (U.S. EPA, 2001)

EE/CA REPORT

Kanawha River, West Virginia

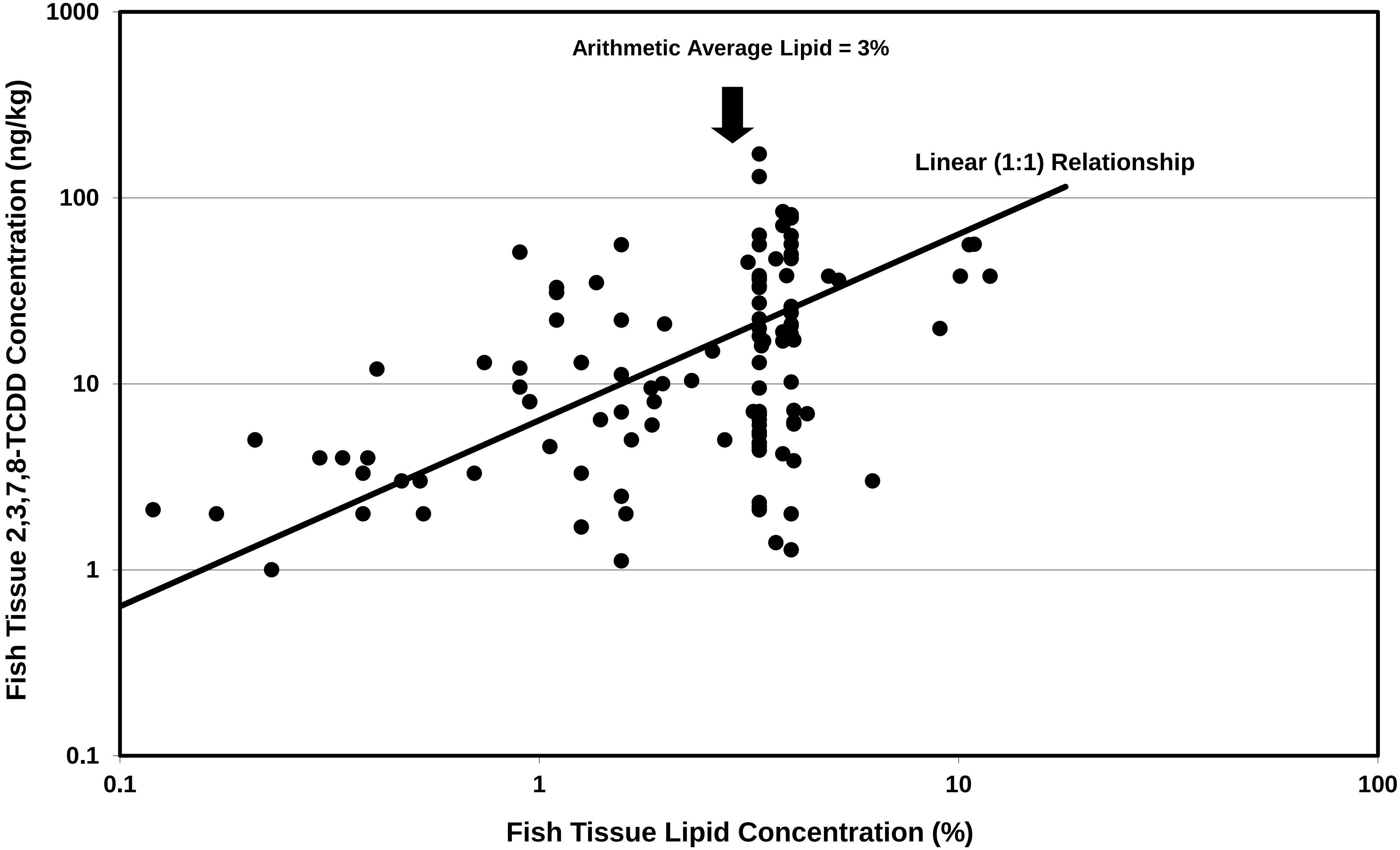


figure 3.7
FISH TISSUE LIPID CONTROL OF 2,3,7,8-TCDD LEVELS
EE/CA REPORT
Kanawha River, West Virginia

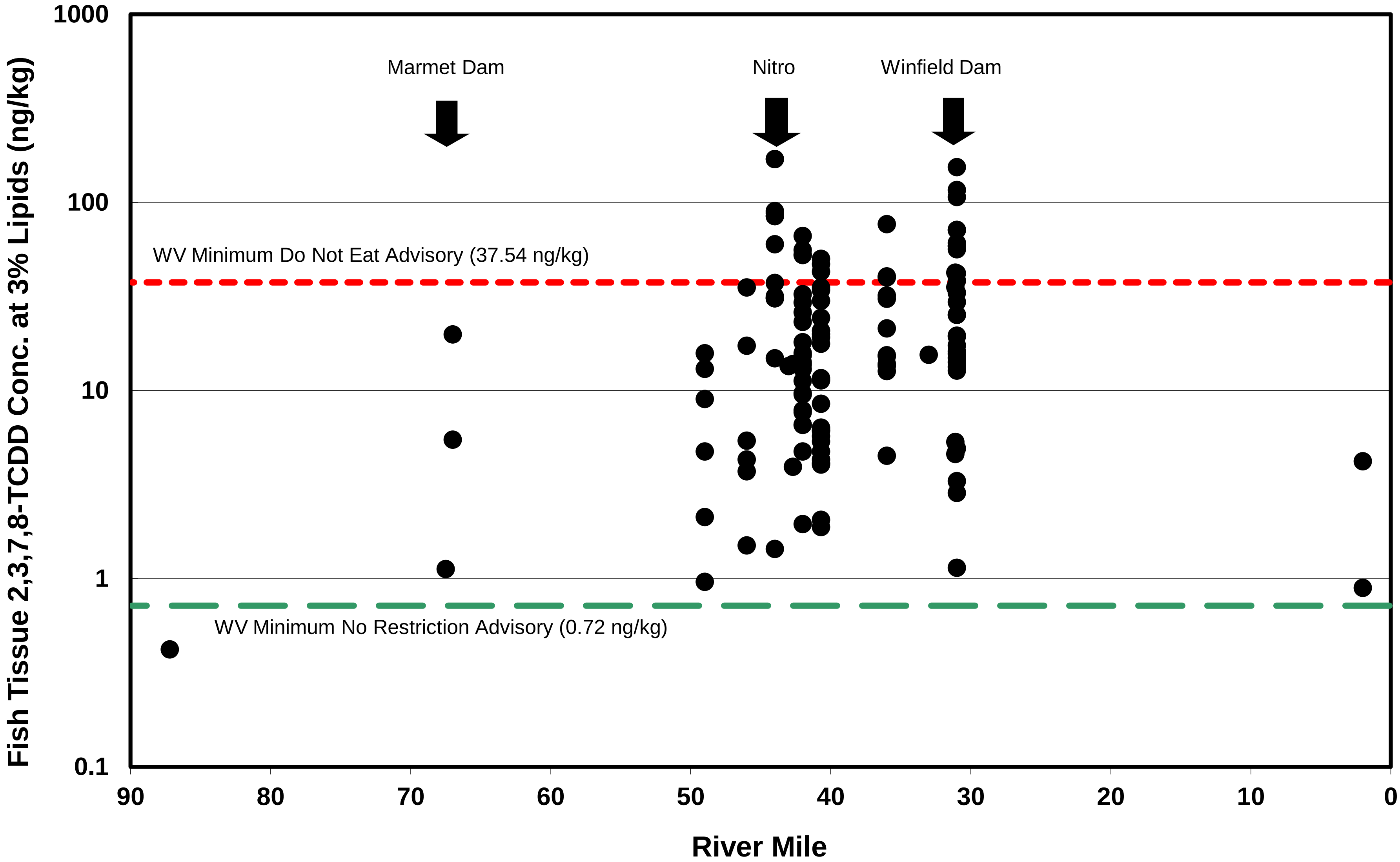


figure 3.8
DOWNSTREAM VARIABILITY IN FISH TISSUE 2,3,7,8-TCDD CONCENTRATIONS
EE/CA REPORT
Kanawha River, West Virginia

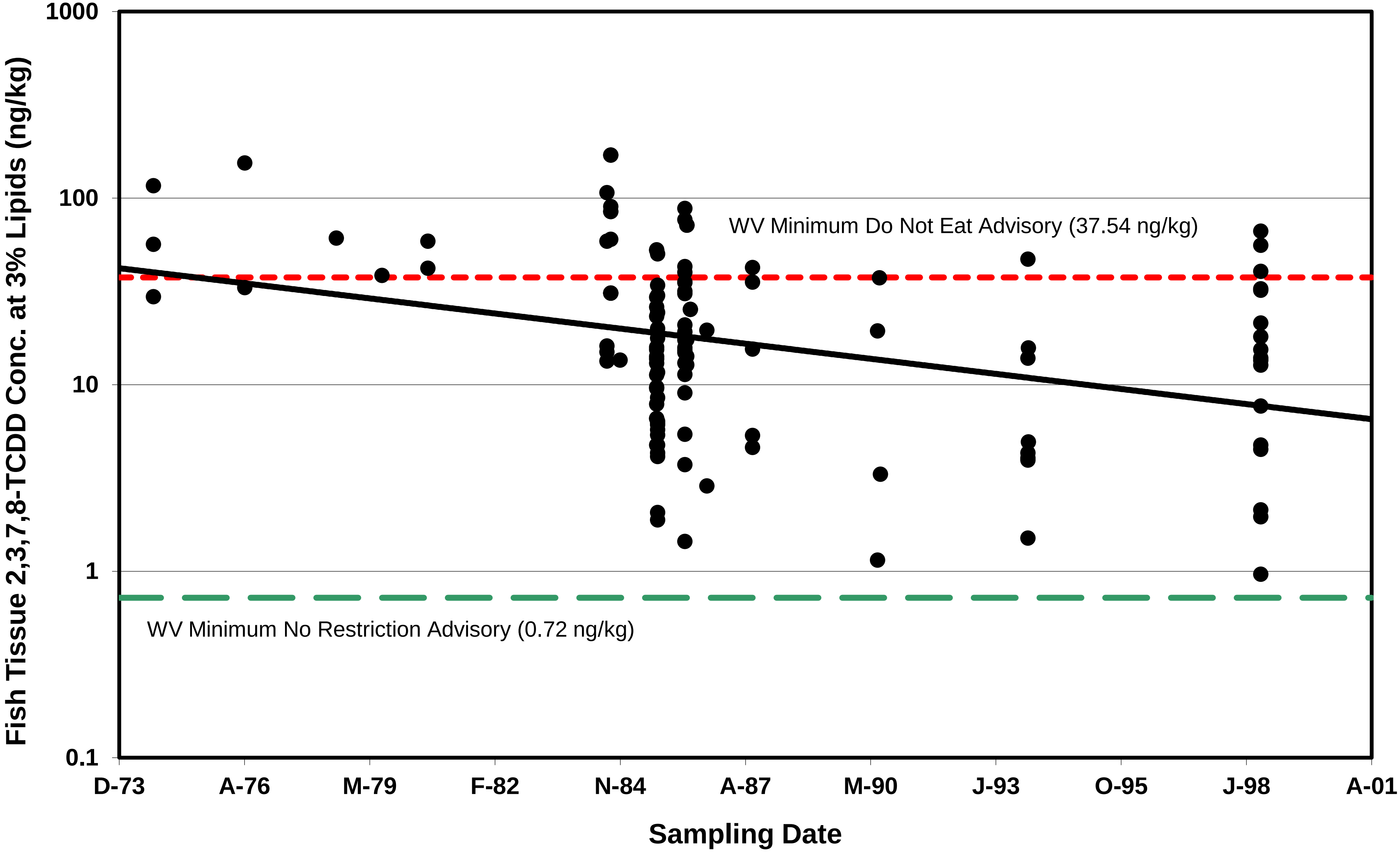
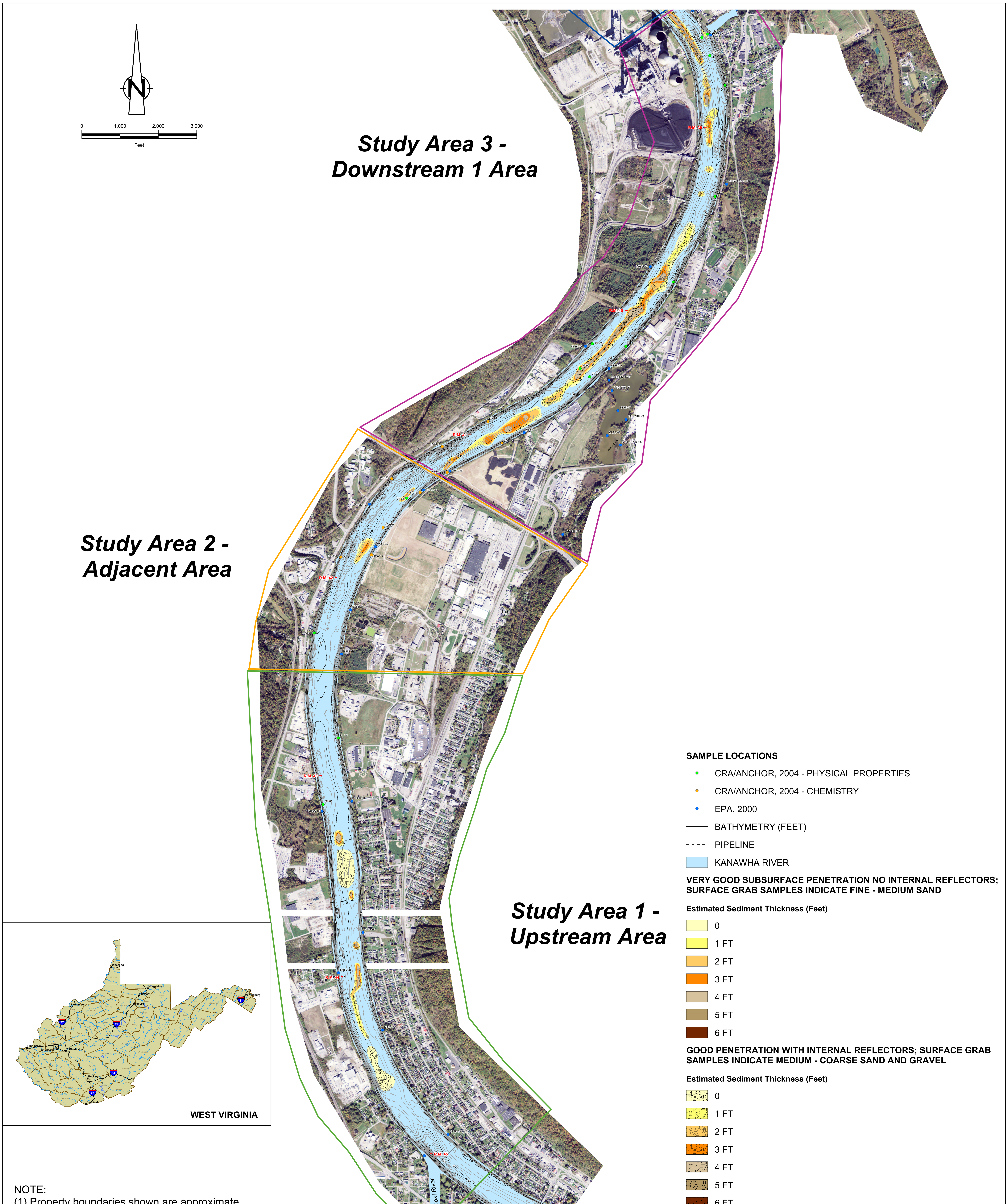


figure 3.9
DECLINE IN FISH TISSUE 2,3,7,8-TCDD CONCENTRATION WITH TIME
EE/CA REPORT
Kanawha River, West Virginia

CRA



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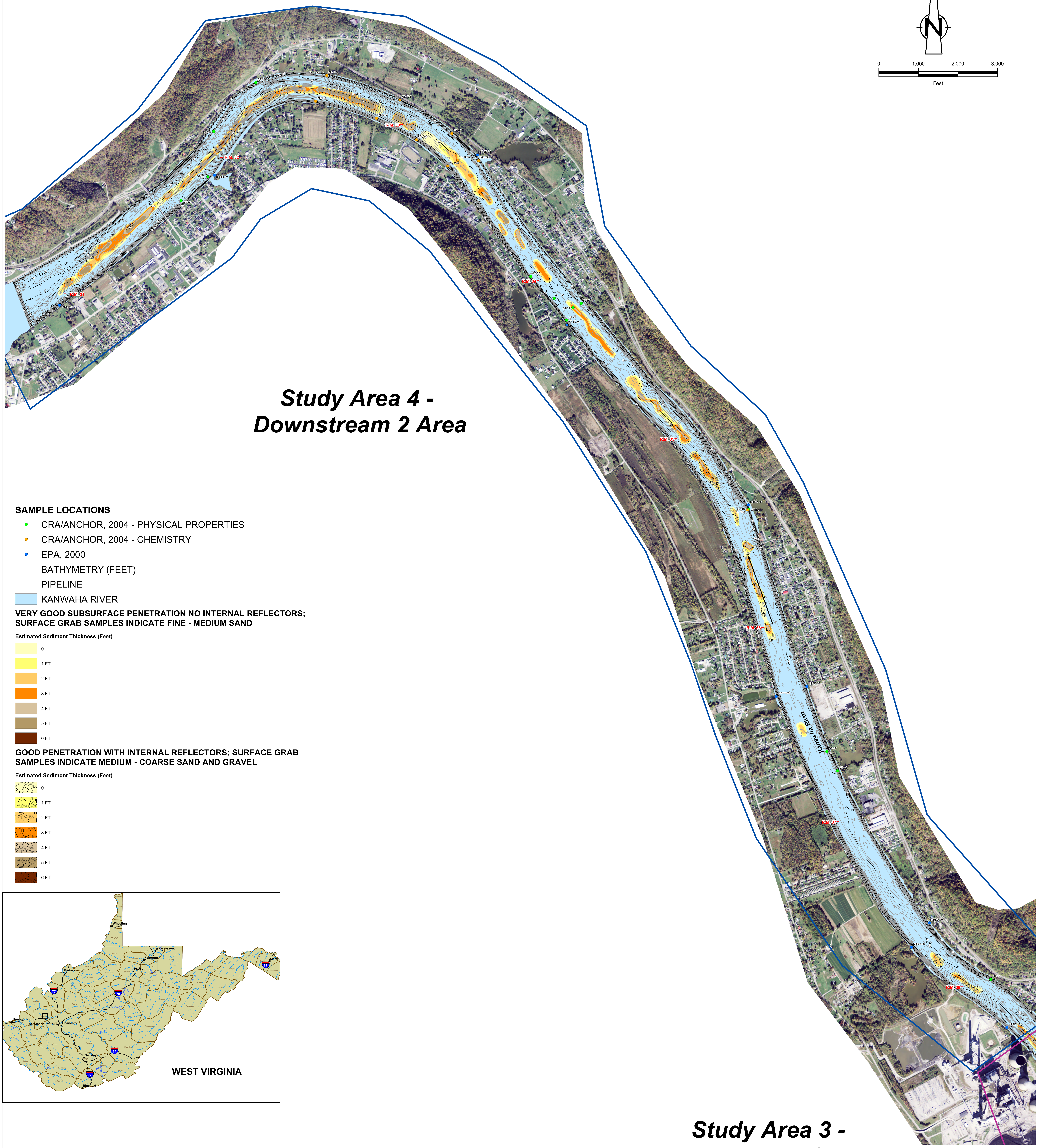
SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 4.1
BATHYMETRY, GEOLOGIC INTERPRETATION AND ISOPACH MAP FOR STUDY AREA 1, 2 AND 3
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

031884-00(REP051)GIS-WA007 February 23, 2015

AR100391



SAMPLE LOCATIONS

- CRA/ANCHOR, 2004 - PHYSICAL PROPERTIES
- CRA/ANCHOR, 2004 - CHEMISTRY
- EPA, 2000
- BATHYMETRY (FEET)
- PIPELINE
- KANWAHA RIVER

VERY GOOD SUBSURFACE PENETRATION NO INTERNAL REFLECTORS; SURFACE GRAB SAMPLES INDICATE FINE - MEDIUM SAND

Estimated Sediment Thickness (Feet)

- 0
- 1 FT
- 2 FT
- 3 FT
- 4 FT
- 5 FT
- 6 FT

GOOD PENETRATION WITH INTERNAL REFLECTORS; SURFACE GRAB SAMPLES INDICATE MEDIUM - COARSE SAND AND GRAVEL

Estimated Sediment Thickness (Feet)

- 0
- 1 FT
- 2 FT
- 3 FT
- 4 FT
- 5 FT
- 6 FT

NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 4.2
BATHYMETRY, GEOLOGIC INTERPRETATION AND ISOPACH MAP FOR STUDY AREA 4
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

031884-00(REP051)GIS-WA008 February 23, 2015

AR100392

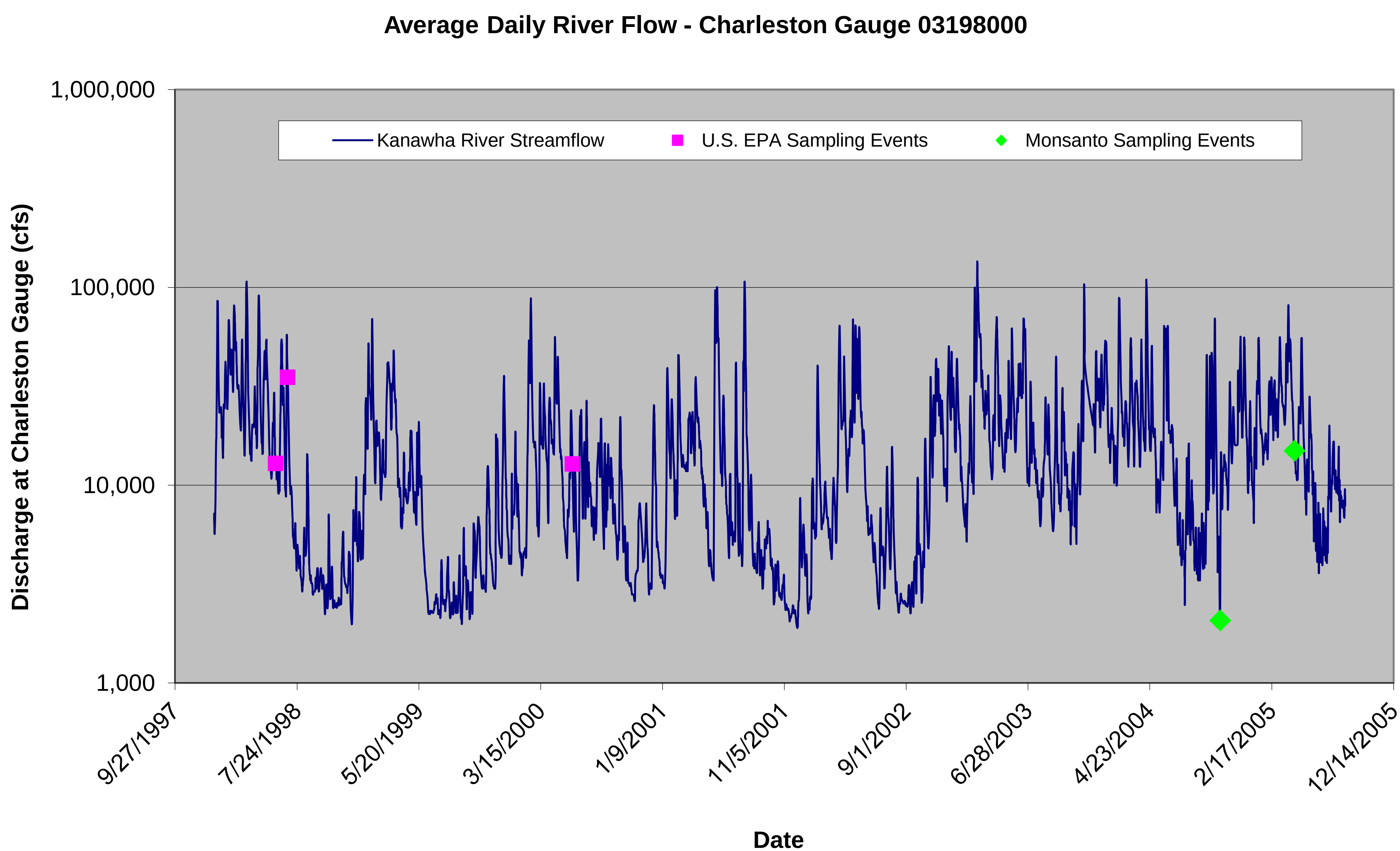
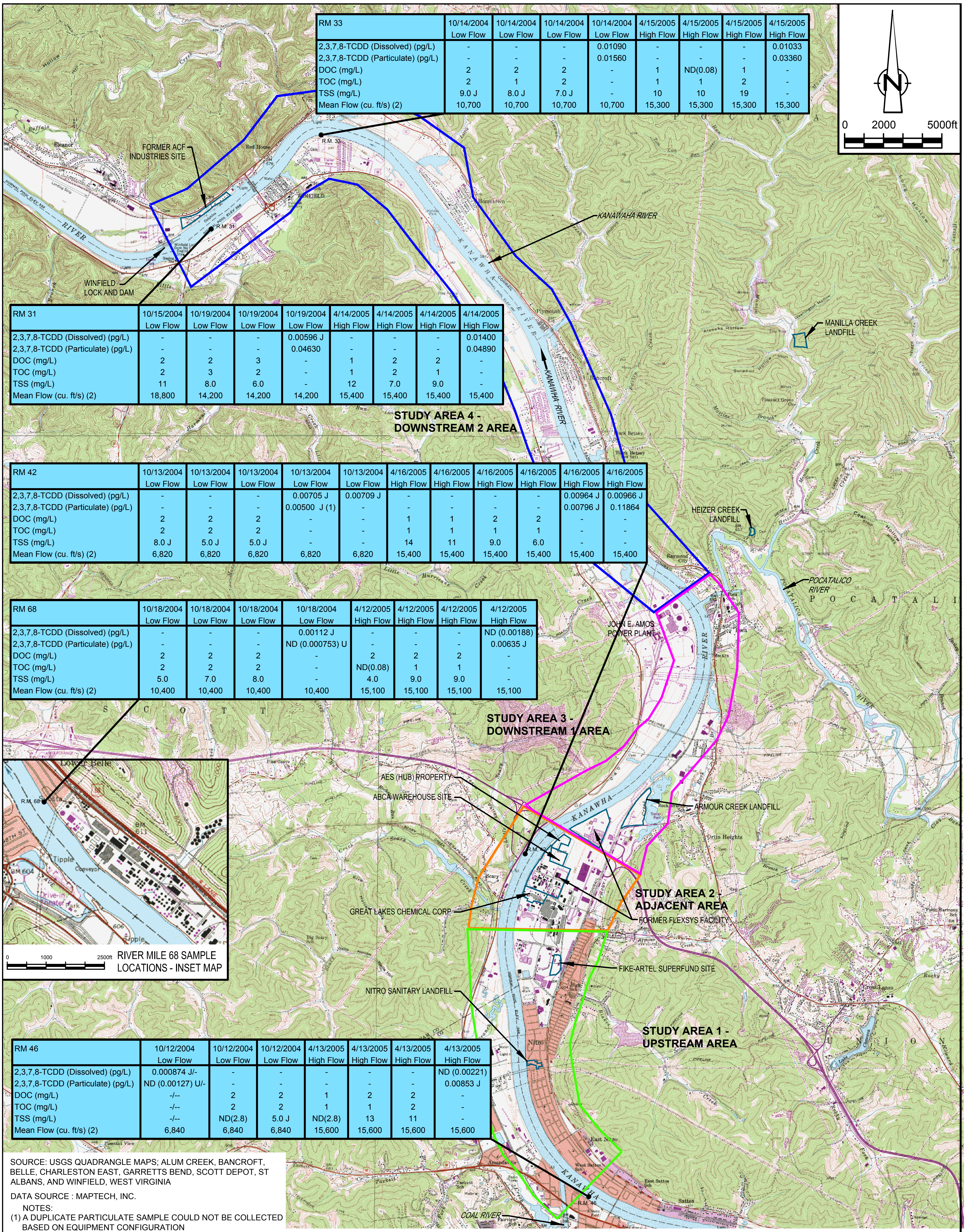


figure 4.3
AVERAGE DAILY RIVER FLOW - CHARLESTON GAUGE 03198000
EE/CA REPORT
Kanawha River, West Virginia



RM 33	10/14/2004 Low Flow	10/14/2004 Low Flow	10/14/2004 Low Flow	10/14/2004 Low Flow	4/15/2005 High Flow	4/15/2005 High Flow	4/15/2005 High Flow	4/15/2005 High Flow
2,3,7,8-TCDD (Dissolved) (pg/L)	-	-	-	0.01090	-	-	-	0.01033
2,3,7,8-TCDD (Particulate) (pg/L)	-	-	-	0.01560	-	-	-	0.03360
DOC (mg/L)	2	2	2	-	1	ND(0.08)	1	-
TOC (mg/L)	2	1	2	-	1	1	2	-
TSS (mg/L)	9.0 J	8.0 J	7.0 J	-	10	10	19	-
Mean Flow (cu. ft/s) (2)	10,700	10,700	10,700	10,700	15,300	15,300	15,300	15,300

RM 31	10/15/2004 Low Flow	10/19/2004 Low Flow	10/19/2004 Low Flow	10/19/2004 Low Flow	4/14/2005 High Flow	4/14/2005 High Flow	4/14/2005 High Flow	4/14/2005 High Flow
2,3,7,8-TCDD (Dissolved) (pg/L)	-	-	-	0.00596 J	-	-	-	0.01400
2,3,7,8-TCDD (Particulate) (pg/L)	-	-	-	0.04630	-	-	-	0.04890
DOC (mg/L)	2	2	3	-	1	2	2	-
TOC (mg/L)	2	3	2	-	1	2	1	-
TSS (mg/L)	11	8.0	6.0	-	12	7.0	9.0	-
Mean Flow (cu. ft/s) (2)	18,800	14,200	14,200	14,200	15,400	15,400	15,400	15,400

RM 42	10/13/2004 Low Flow	10/13/2004 Low Flow	10/13/2004 Low Flow	10/13/2004 Low Flow	10/13/2004 Low Flow	4/16/2005 High Flow	4/16/2005 High Flow	4/16/2005 High Flow	4/16/2005 High Flow	4/16/2005 High Flow	4/16/2005 High Flow
2,3,7,8-TCDD (Dissolved) (pg/L)	-	-	-	0.00705 J	0.00709 J	-	-	-	-	0.00964 J	0.00966 J
2,3,7,8-TCDD (Particulate) (pg/L)	-	-	-	0.00500 J (1)	-	-	-	-	-	0.00796 J	0.11864
DOC (mg/L)	2	2	2	-	-	1	1	2	2	-	-
TOC (mg/L)	2	2	2	-	-	1	1	1	1	-	-
TSS (mg/L)	8.0 J	5.0 J	5.0 J	-	-	14	11	9.0	6.0	-	-
Mean Flow (cu. ft/s) (2)	6,820	6,820	6,820	6,820	6,820	15,400	15,400	15,400	15,400	15,400	15,400

RM 68	10/18/2004 Low Flow	10/18/2004 Low Flow	10/18/2004 Low Flow	10/18/2004 Low Flow	4/12/2005 High Flow	4/12/2005 High Flow	4/12/2005 High Flow	4/12/2005 High Flow
2,3,7,8-TCDD (Dissolved) (pg/L)	-	-	-	0.00112 J	-	-	-	ND (0.00188)
2,3,7,8-TCDD (Particulate) (pg/L)	-	-	-	ND (0.000753) U	-	-	-	0.00635 J
DOC (mg/L)	2	2	2	-	2	2	2	-
TOC (mg/L)	2	2	2	-	ND(0.08)	1	1	-
TSS (mg/L)	5.0	7.0	8.0	-	4.0	9.0	9.0	-
Mean Flow (cu. ft/s) (2)	10,400	10,400	10,400	10,400	15,100	15,100	15,100	15,100

RM 46	10/12/2004 Low Flow	10/12/2004 Low Flow	10/12/2004 Low Flow	4/13/2005 High Flow	4/13/2005 High Flow	4/13/2005 High Flow	4/13/2005 High Flow
2,3,7,8-TCDD (Dissolved) (pg/L)	0.000874 J/-	-	-	-	-	-	ND (0.00221)
2,3,7,8-TCDD (Particulate) (pg/L)	ND (0.00127) U/-	-	-	-	-	-	0.00853 J
DOC (mg/L)	-/--	2	2	1	2	2	-
TOC (mg/L)	-/--	2	2	1	1	2	-
TSS (mg/L)	-/--	ND(2.8)	5.0 J	ND(2.8)	13	11	-
Mean Flow (cu. ft/s) (2)	6,840	6,840	6,840	15,600	15,600	15,600	15,600

SOURCE: USGS QUADRANGLE MAPS; ALUM CREEK, BANCROFT, BELLE, CHARLESTON EAST, GARRETTS BEND, SCOTT DEPOT, ST ALBANS, AND WINFIELD, WEST VIRGINIA

DATA SOURCE : MAPTECH, INC.

NOTES:

(1) A DUPLICATE PARTICULATE SAMPLE COULD NOT BE COLLECTED BASED ON EQUIPMENT CONFIGURATION

(2) MEAN FLOW AT CHARLESTON GAGE (USGS 03198000)

(3) THE LATERAL EXTENT OF THE SITE AND STUDY AREA BOUNDARIES ARE LIMITED TO THE RIVER WITHIN THE WATER SURFACE BY THE NORMAL POOL ELEVATION. ADJACENT AREAS ARE INCLUDED FOR REFERENCE ONLY, AND DO NOT FORM PART OF THE SITE

LEGEND

R.M. 31 ● RIVER MILE

SAMPLE NAME

SAMPLE DATE

FLOW CONDITIONS

RM 46	10/12/2004 Low Flow	10/12/2004 Low Flow
2,3,7,8-TCDD (Dissolved) (pg/L)	0.000874 J/-	-
2,3,7,8-TCDD (Particulate) (pg/L)	ND (0.00127) U/-	-
DOC (mg/L)	-/--	2
TOC (mg/L)	-/--	2

RESULT

PARAMETER

J	ESTIMATED CONCENTRATION
U	NOT DETECTED AT OR ABOVE THE ASSOCIATED VALUE
ND	NOT DETECTED AT OR ABOVE THE ASSOCIATED VALUE
-	PARAMETER NOT ANALYZED
cu.ft/s	CUBIC FEET PER SECOND
mg/L	MILLIGRAMS PER LITER
pg/L	PICOGRAMS PER LITER
LOW FLOW	OCTOBER 2004 SAMPLING EVENT
HIGH FLOW	APRIL 2005 SAMPLING EVENT

CRA

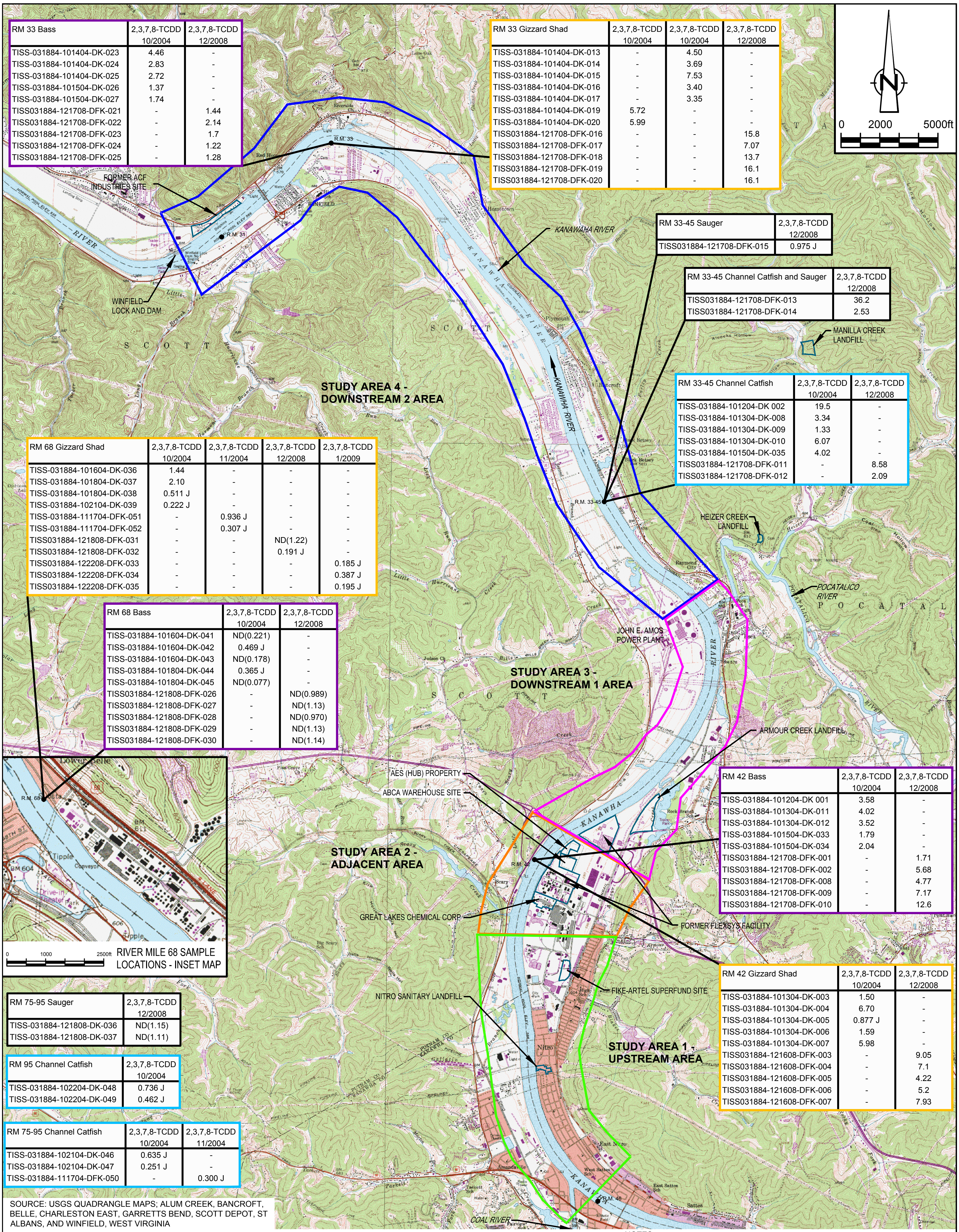
figure 4.4

SURFACE WATER SAMPLING LOCATIONS AND RESULTS

EE/CA REPORT

Kanawha River, West Virginia

31884-00(051)GN-WA002 FEB 20/2015



RM 33 Bass	2,3,7,8-TCDD 10/2004	2,3,7,8-TCDD 12/2008
TISS-031884-101404-DK-023	4.46	-
TISS-031884-101404-DK-024	2.83	-
TISS-031884-101404-DK-025	2.72	-
TISS-031884-101504-DK-026	1.37	-
TISS-031884-101504-DK-027	1.74	-
TISS031884-121708-DFK-021	-	1.44
TISS031884-121708-DFK-022	-	2.14
TISS031884-121708-DFK-023	-	1.7
TISS031884-121708-DFK-024	-	1.22
TISS031884-121708-DFK-025	-	1.28

RM 33 Gizzard Shad	2,3,7,8-TCDD 10/2004	2,3,7,8-TCDD 10/2004	2,3,7,8-TCDD 12/2008
TISS-031884-101404-DK-013	-	4.50	-
TISS-031884-101404-DK-014	-	3.69	-
TISS-031884-101404-DK-015	-	7.53	-
TISS-031884-101404-DK-016	-	3.40	-
TISS-031884-101404-DK-017	-	3.35	-
TISS-031884-101404-DK-019	5.72	-	-
TISS-031884-101404-DK-020	5.99	-	-
TISS031884-121708-DFK-016	-	-	15.8
TISS031884-121708-DFK-017	-	-	7.07
TISS031884-121708-DFK-018	-	-	13.7
TISS031884-121708-DFK-019	-	-	16.1
TISS031884-121708-DFK-020	-	-	16.1

RM 33-45 Sauger	2,3,7,8-TCDD 12/2008
TISS031884-121708-DFK-015	0.975 J

RM 33-45 Channel Catfish and Sauger	2,3,7,8-TCDD 12/2008
TISS031884-121708-DFK-013	36.2
TISS031884-121708-DFK-014	2.53

RM 33-45 Channel Catfish	2,3,7,8-TCDD 10/2004	2,3,7,8-TCDD 12/2008
TISS-031884-101204-DK 002	19.5	-
TISS-031884-101304-DK-008	3.34	-
TISS-031884-101304-DK-009	1.33	-
TISS-031884-101304-DK-010	6.07	-
TISS-031884-101504-DK-035	4.02	-
TISS031884-121708-DFK-011	-	8.58
TISS031884-121708-DFK-012	-	2.09

RM 68 Gizzard Shad	2,3,7,8-TCDD 10/2004	2,3,7,8-TCDD 11/2004	2,3,7,8-TCDD 12/2008	2,3,7,8-TCDD 1/2009
TISS-031884-101604-DK-036	1.44	-	-	-
TISS-031884-101804-DK-037	2.10	-	-	-
TISS-031884-101804-DK-038	0.511 J	-	-	-
TISS-031884-102104-DK-039	0.222 J	-	-	-
TISS-031884-111704-DFK-051	-	0.936 J	-	-
TISS-031884-111704-DFK-052	-	0.307 J	-	-
TISS031884-121808-DFK-031	-	-	ND(1.22)	-
TISS031884-121808-DFK-032	-	-	0.191 J	-
TISS031884-122208-DFK-033	-	-	-	0.185 J
TISS031884-122208-DFK-034	-	-	-	0.387 J
TISS031884-122208-DFK-035	-	-	-	0.195 J

RM 68 Bass	2,3,7,8-TCDD 10/2004	2,3,7,8-TCDD 12/2008
TISS-031884-101604-DK-041	ND(0.221)	-
TISS-031884-101604-DK-042	0.469 J	-
TISS-031884-101604-DK-043	ND(0.178)	-
TISS-031884-101804-DK-044	0.365 J	-
TISS-031884-101804-DK-045	ND(0.077)	-
TISS031884-121808-DFK-026	-	ND(0.989)
TISS031884-121808-DFK-027	-	ND(1.13)
TISS031884-121808-DFK-028	-	ND(0.970)
TISS031884-121808-DFK-029	-	ND(1.13)
TISS031884-121808-DFK-030	-	ND(1.14)

RM 42 Bass	2,3,7,8-TCDD 10/2004	2,3,7,8-TCDD 12/2008
TISS-031884-101204-DK 001	3.58	-
TISS-031884-101304-DK-011	4.02	-
TISS-031884-101304-DK-012	3.52	-
TISS-031884-101504-DK-033	1.79	-
TISS-031884-101504-DK-034	2.04	-
TISS031884-121708-DFK-001	-	1.71
TISS031884-121708-DFK-002	-	5.68
TISS031884-121708-DFK-008	-	4.77
TISS031884-121708-DFK-009	-	7.17
TISS031884-121708-DFK-010	-	12.6

RM 75-95 Sauger	2,3,7,8-TCDD 12/2008
TISS-031884-121808-DK-036	ND(1.15)
TISS-031884-121808-DK-037	ND(1.11)

RM 42 Gizzard Shad	2,3,7,8-TCDD 10/2004	2,3,7,8-TCDD 12/2008
TISS-031884-101304-DK-003	1.50	-
TISS-031884-101304-DK-004	6.70	-
TISS-031884-101304-DK-005	0.877 J	-
TISS-031884-101304-DK-006	1.59	-
TISS-031884-101304-DK-007	5.98	-
TISS031884-121608-DFK-003	-	9.05
TISS031884-121608-DFK-004	-	7.1
TISS031884-121608-DFK-005	-	4.22
TISS031884-121608-DFK-006	-	5.2
TISS031884-121608-DFK-007	-	7.93

RM 95 Channel Catfish	2,3,7,8-TCDD 10/2004
TISS-031884-102204-DK-048	0.736 J
TISS-031884-102204-DK-049	0.462 J

RM 75-95 Channel Catfish	2,3,7,8-TCDD 10/2004	2,3,7,8-TCDD 11/2004
TISS-031884-102104-DK-046	0.635 J	-
TISS-031884-102104-DK-047	0.251 J	-
TISS-031884-111704-DFK-050	-	0.300 J

SOURCE: USGS QUADRANGLE MAPS; ALUM CREEK, BANCROFT, BELLE, CHARLESTON EAST, GARRETTS BEND, SCOTT DEPOT, ST ALBANS, AND WINFIELD, WEST VIRGINIA

DATA SOURCE : MAPTECH, INC.

LEGEND

- R.M. 31 • RIVER MILE
- RIVER MILE AND FISH SPECIES
- PARAMETER
- SAMPLE DATE
- RESULT (pg/g)
- SAMPLE NAME

RM 95 Channel Catfish	2,3,7,8-TCDD 10/2004
TISS-031884-102204-DK-048	0.736 J
TISS-031884-102204-DK-049	0.462 J

- BASS
- CHANNEL CATFISH
- GIZZARD SHAD
- SAUGER
- J ESTIMATED CONCENTRATION
- ND NOT DETECTED AT OR ABOVE THE ASSOCIATED VALUE
- pg/g PICOGRAMS PER GRAM
- 2,3,7,8-TCDD 2,3,7,8-Tetrachlorodibenzo-p-dioxin

NOTES:
(1) SAMPLES TISS-031884-101404-DK-018 THROUGH -022 ARE DUPLICATE SAMPLES OF GIZZARD SHAD AT RIVER MILE 33. SAMPLES -018, -021, AND -022 WERE PUT ON HOLD AND WERE NOT ANALYZED SINCE THE 1/20 DUPLICATE FREQUENCY REQUIREMENT HAD ALREADY BEEN MET

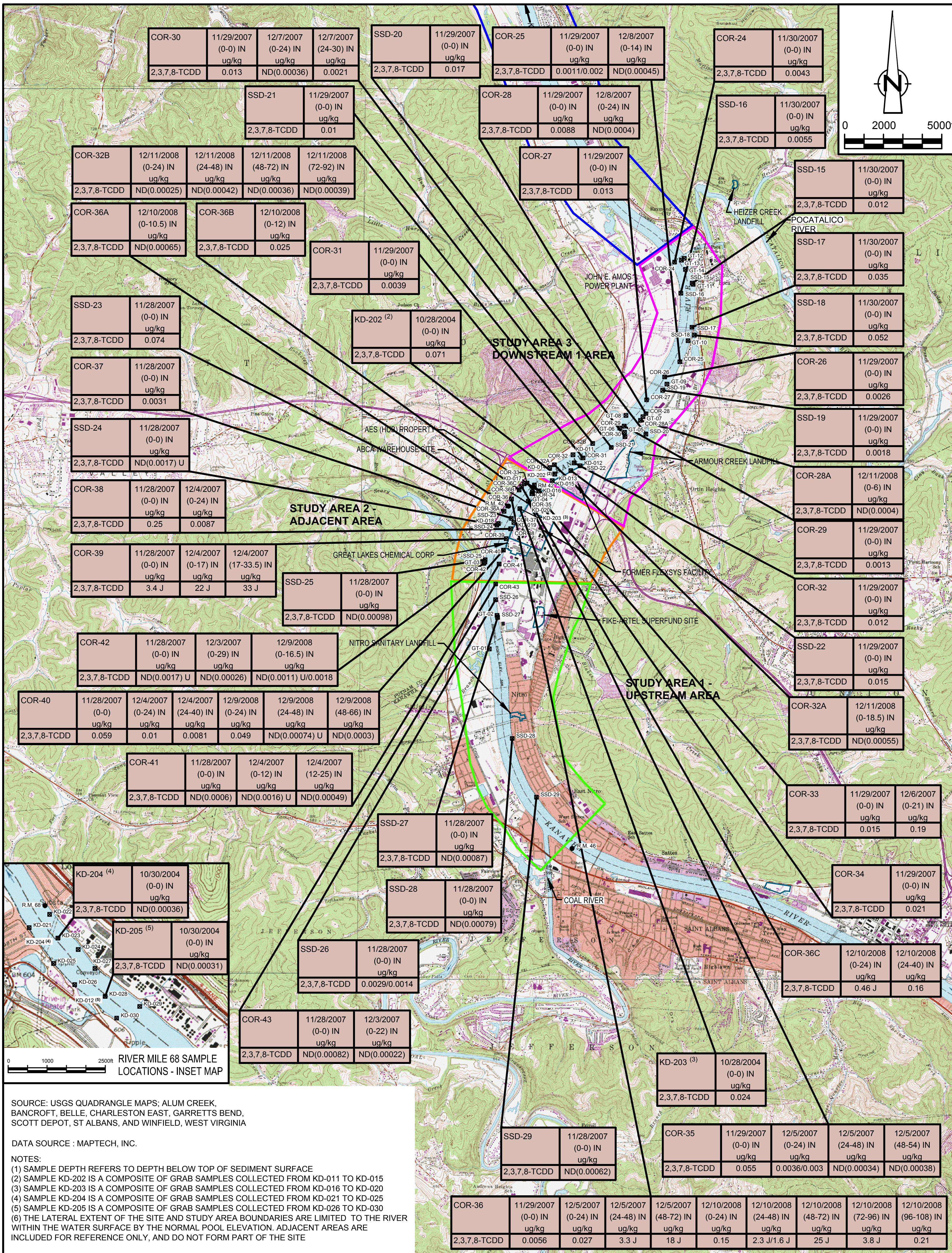
(2) THE LATERAL EXTENT OF THE SITE AND STUDY AREA BOUNDARIES ARE LIMITED TO THE RIVER WITHIN THE WATER SURFACE BY THE NORMAL POOL ELEVATION. ADJACENT AREAS ARE INCLUDED FOR REFERENCE ONLY, AND DO NOT FORM PART OF THE SITE

figure 4.5

FISH TISSUE SAMPLING LOCATIONS AND RESULTS
EE/CA REPORT
Kanawha River, West Virginia

CRA

31884-00(051)GN-WA004 FEB 20/2015



COR-30	11/29/2007 (0-0) IN ug/kg	12/7/2007 (0-24) IN ug/kg	12/7/2007 (24-30) IN ug/kg
2,3,7,8-TCDD	0.013	ND(0.00036)	0.0021

SSD-20	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.017

COR-25	11/29/2007 (0-0) IN ug/kg	12/8/2007 (0-14) IN ug/kg
2,3,7,8-TCDD	0.0011/0.002	ND(0.00045)

COR-24	11/30/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.0043

SSD-21	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.01

COR-28	11/29/2007 (0-0) IN ug/kg	12/8/2007 (0-24) IN ug/kg
2,3,7,8-TCDD	0.0088	ND(0.0004)

SSD-16	11/30/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.0055

COR-32B	12/11/2008 (0-24) IN ug/kg	12/11/2008 (24-48) IN ug/kg	12/11/2008 (48-72) IN ug/kg	12/11/2008 (72-92) IN ug/kg
2,3,7,8-TCDD	ND(0.00025)	ND(0.00042)	ND(0.00036)	ND(0.00039)

COR-27	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.013

SSD-15	11/30/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.012

COR-36A	12/10/2008 (0-10.5) IN ug/kg
2,3,7,8-TCDD	ND(0.00065)

COR-36B	12/10/2008 (0-12) IN ug/kg
2,3,7,8-TCDD	0.025

SSD-17	11/30/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.035

COR-31	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.0039

SSD-23	11/28/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.074

KD-202 (2)	10/28/2004 (0-0) IN ug/kg
2,3,7,8-TCDD	0.071

SSD-18	11/30/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.052

COR-26	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.0026

COR-37	11/28/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.0031

SSD-19	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.0018

SSD-24	11/28/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	ND(0.0017) U

COR-28A	12/11/2008 (0-6) IN ug/kg
2,3,7,8-TCDD	ND(0.0004)

COR-38	11/28/2007 (0-0) IN ug/kg	12/4/2007 (0-24) IN ug/kg
2,3,7,8-TCDD	0.25	0.0087

COR-29	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.0013

COR-39	11/28/2007 (0-0) IN ug/kg	12/4/2007 (0-17) IN ug/kg	12/4/2007 (17-33.5) IN ug/kg
2,3,7,8-TCDD	3.4 J	22 J	33 J

SSD-25	11/28/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	ND(0.00098)

COR-32	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.012

COR-42	11/28/2007 (0-0) IN ug/kg	12/3/2007 (0-29) IN ug/kg	12/9/2008 (0-16.5) IN ug/kg
2,3,7,8-TCDD	ND(0.0017) U	ND(0.00026)	ND(0.0011) U/0.0018

SSD-22	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.015

COR-40	11/28/2007 (0-0) ug/kg	12/4/2007 (0-24) IN ug/kg	12/4/2007 (24-40) IN ug/kg	12/9/2008 (0-24) IN ug/kg	12/9/2008 (24-48) IN ug/kg	12/9/2008 (48-66) IN ug/kg
2,3,7,8-TCDD	0.059	0.01	0.0081	0.049	ND(0.00074) U	ND(0.0003)

COR-32A	12/11/2008 (0-18.5) IN ug/kg
2,3,7,8-TCDD	ND(0.00055)

COR-41	11/28/2007 (0-0) IN ug/kg	12/4/2007 (0-12) IN ug/kg	12/4/2007 (12-25) IN ug/kg
2,3,7,8-TCDD	ND(0.0006)	ND(0.0016) U	ND(0.00049)

COR-33	11/29/2007 (0-0) IN ug/kg	12/6/2007 (0-21) IN ug/kg
2,3,7,8-TCDD	0.015	0.19

SSD-27	11/28/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	ND(0.00087)

KD-204 (4)	10/30/2004 (0-0) IN ug/kg
2,3,7,8-TCDD	ND(0.00036)

COR-34	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.021

SSD-28	11/28/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	ND(0.00079)

KD-205 (5)	10/30/2004 (0-0) IN ug/kg
2,3,7,8-TCDD	ND(0.00031)

SSD-26	11/28/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.0029/0.0014

COR-36C	12/10/2008 (0-24) IN ug/kg	12/10/2008 (24-40) IN ug/kg
2,3,7,8-TCDD	0.46 J	0.16

COR-43	11/28/2007 (0-0) IN ug/kg	12/3/2007 (0-22) IN ug/kg
2,3,7,8-TCDD	ND(0.00082)	ND(0.00022)

KD-203 (3)	10/28/2004 (0-0) IN ug/kg
2,3,7,8-TCDD	0.024

COR-35	11/29/2007 (0-0) IN ug/kg	12/5/2007 (0-24) IN ug/kg	12/5/2007 (24-48) IN ug/kg	12/5/2007 (48-54) IN ug/kg
2,3,7,8-TCDD	0.055	0.0036/0.003	ND(0.00034)	ND(0.00038)

SSD-29	11/28/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	ND(0.00062)

COR-36	11/29/2007 (0-0) IN ug/kg	12/5/2007 (0-24) IN ug/kg	12/5/2007 (24-48) IN ug/kg	12/5/2007 (48-72) IN ug/kg	12/10/2008 (0-24) IN ug/kg	12/10/2008 (24-48) IN ug/kg	12/10/2008 (48-72) IN ug/kg	12/10/2008 (72-96) IN ug/kg	12/10/2008 (96-108) IN ug/kg
2,3,7,8-TCDD	0.0056	0.027	3.3 J	18 J	0.15	2.3 J/1.6 J	25 J	3.8 J	0.21

SOURCE: USGS QUADRANGLE MAPS; ALUM CREEK, BANCROFT, BELLE, CHARLESTON EAST, GARRETTS BEND, SCOTT DEPOT, ST ALBANS, AND WINFIELD, WEST VIRGINIA

DATA SOURCE : MAPTECH, INC.

NOTES:
(1) SAMPLE DEPTH REFERS TO DEPTH BELOW TOP OF SEDIMENT SURFACE
(2) SAMPLE KD-202 IS A COMPOSITE OF GRAB SAMPLES COLLECTED FROM KD-011 TO KD-015
(3) SAMPLE KD-203 IS A COMPOSITE OF GRAB SAMPLES COLLECTED FROM KD-016 TO KD-020
(4) SAMPLE KD-204 IS A COMPOSITE OF GRAB SAMPLES COLLECTED FROM KD-021 TO KD-025
(5) SAMPLE KD-205 IS A COMPOSITE OF GRAB SAMPLES COLLECTED FROM KD-026 TO KD-030
(6) THE LATERAL EXTENT OF THE SITE AND STUDY AREA BOUNDARIES ARE LIMITED TO THE RIVER WITHIN THE WATER SURFACE BY THE NORMAL POOL ELEVATION. ADJACENT AREAS ARE INCLUDED FOR REFERENCE ONLY, AND DO NOT FORM PART OF THE SITE

J	ESTIMATED CONCENTRATION
U	NOT DETECTED AT OR ABOVE THE ASSOCIATED VALUE
ND	NOT DETECTED AT OR ABOVE THE ASSOCIATED VALUE
µg/kg	MICROGRAMS PER KILOGRAM
IN	INCHES
ft	FEET
2,3,7,8-TCDD	2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

LEGEND

R.M. 31 ● RIVER MILE

COR-31	11/29/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.0039

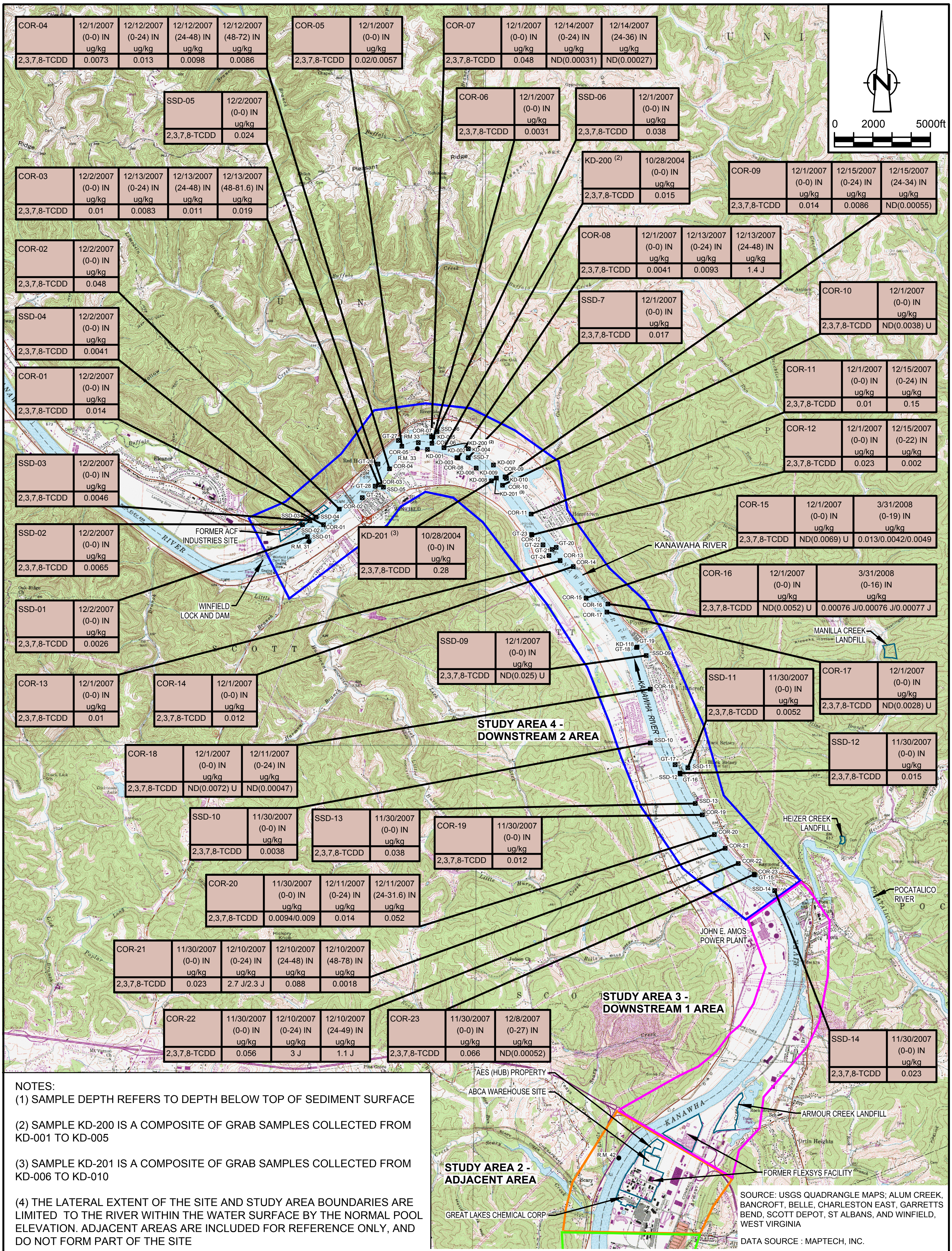
SAMPLE LOCATION
SAMPLE DATE
SAMPLE DEPTH (1)
RESULT UNIT
RESULT
PARAMETER

CRA

figure 4.6a

SEDIMENT SAMPLING LOCATIONS AND RESULTS
STUDY AREAS 1, 2, AND 3
EE/CA REPORT
Kanawha River, West Virginia

31884-00(051)GN-WA006 FEB 20/2015



SOURCE: USGS QUADRANGLE MAPS; ALUM CREEK, BANCROFT, BELLE, CHARLESTON EAST, GARRETTS BEND, SCOTT DEPOT, ST ALBANS, AND WINFIELD, WEST VIRGINIA

DATA SOURCE : MAPTECH, INC.

NOTES:

(1) SAMPLE DEPTH REFERS TO DEPTH BELOW TOP OF SEDIMENT SURFACE

(2) SAMPLE KD-200 IS A COMPOSITE OF GRAB SAMPLES COLLECTED FROM KD-001 TO KD-005

(3) SAMPLE KD-201 IS A COMPOSITE OF GRAB SAMPLES COLLECTED FROM KD-006 TO KD-010

(4) THE LATERAL EXTENT OF THE SITE AND STUDY AREA BOUNDARIES ARE LIMITED TO THE RIVER WITHIN THE WATER SURFACE BY THE NORMAL POOL ELEVATION. ADJACENT AREAS ARE INCLUDED FOR REFERENCE ONLY, AND DO NOT FORM PART OF THE SITE

J	ESTIMATED CONCENTRATION
U	NOT DETECTED AT OR ABOVE THE ASSOCIATED VALUE
ND	NOT DETECTED AT OR ABOVE THE ASSOCIATED VALUE
μg/kg	MICROGRAMS PER KILOGRAM
IN	INCHES
ft	FEET
2,3,7,8-TCDD	2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

LEGEND

R.M. 31 ● RIVER MILE

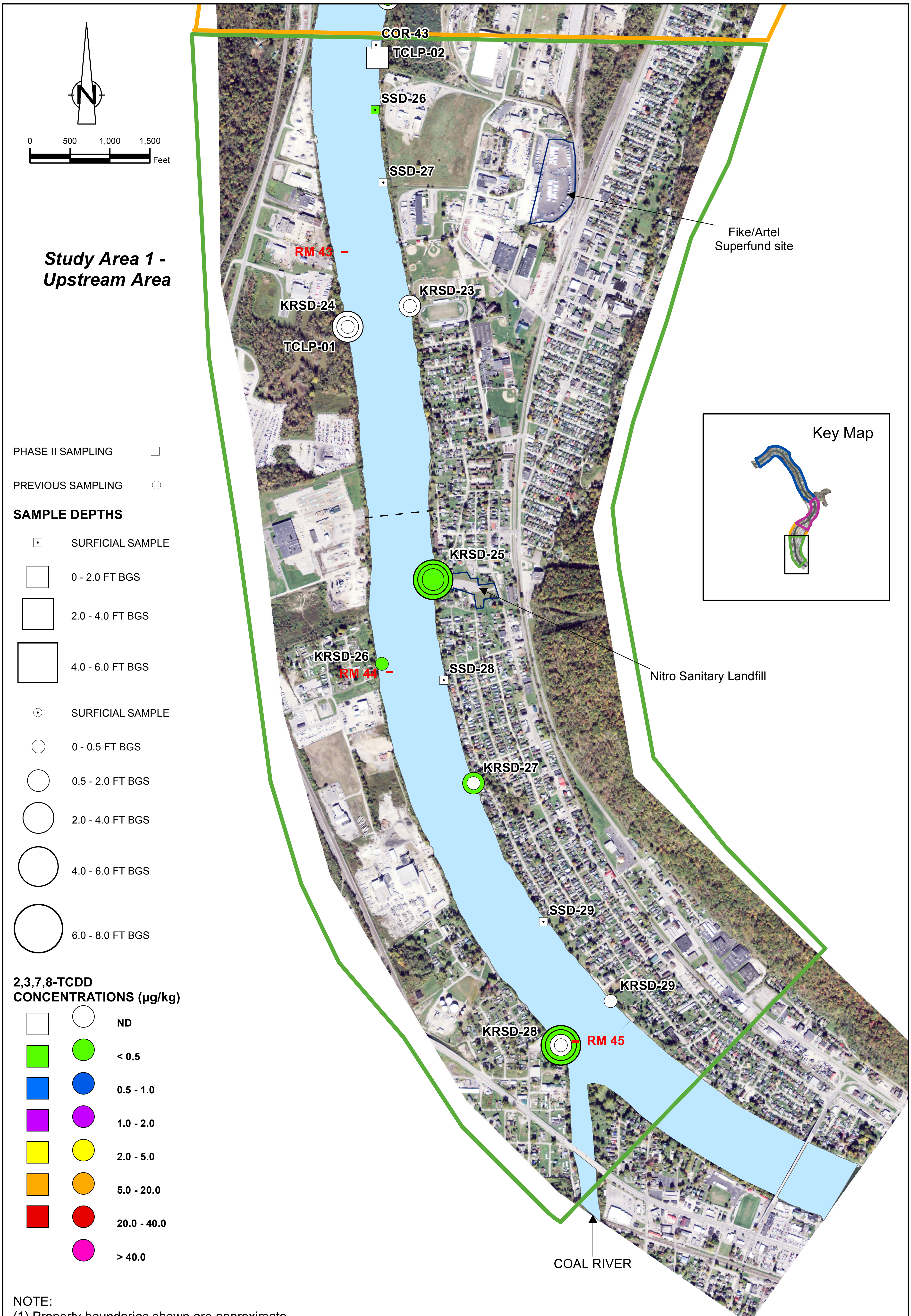
COR-14	12/1/2007 (0-0) IN ug/kg
2,3,7,8-TCDD	0.012

SAMPLE LOCATION
SAMPLE DATE
SAMPLE DEPTH (1)
RESULT UNIT
RESULT
PARAMETER

figure 4.6b

SEDIMENT SAMPLING LOCATIONS AND RESULTS
STUDY AREA 4
EE/CA REPORT
Kanawha River, West Virginia

31884-00(051)GN-WA005 FEB 20/2015



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

figure 4.7

SEDIMENT SAMPLING LOCATIONS AND RESULTS – STUDY AREA 1
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

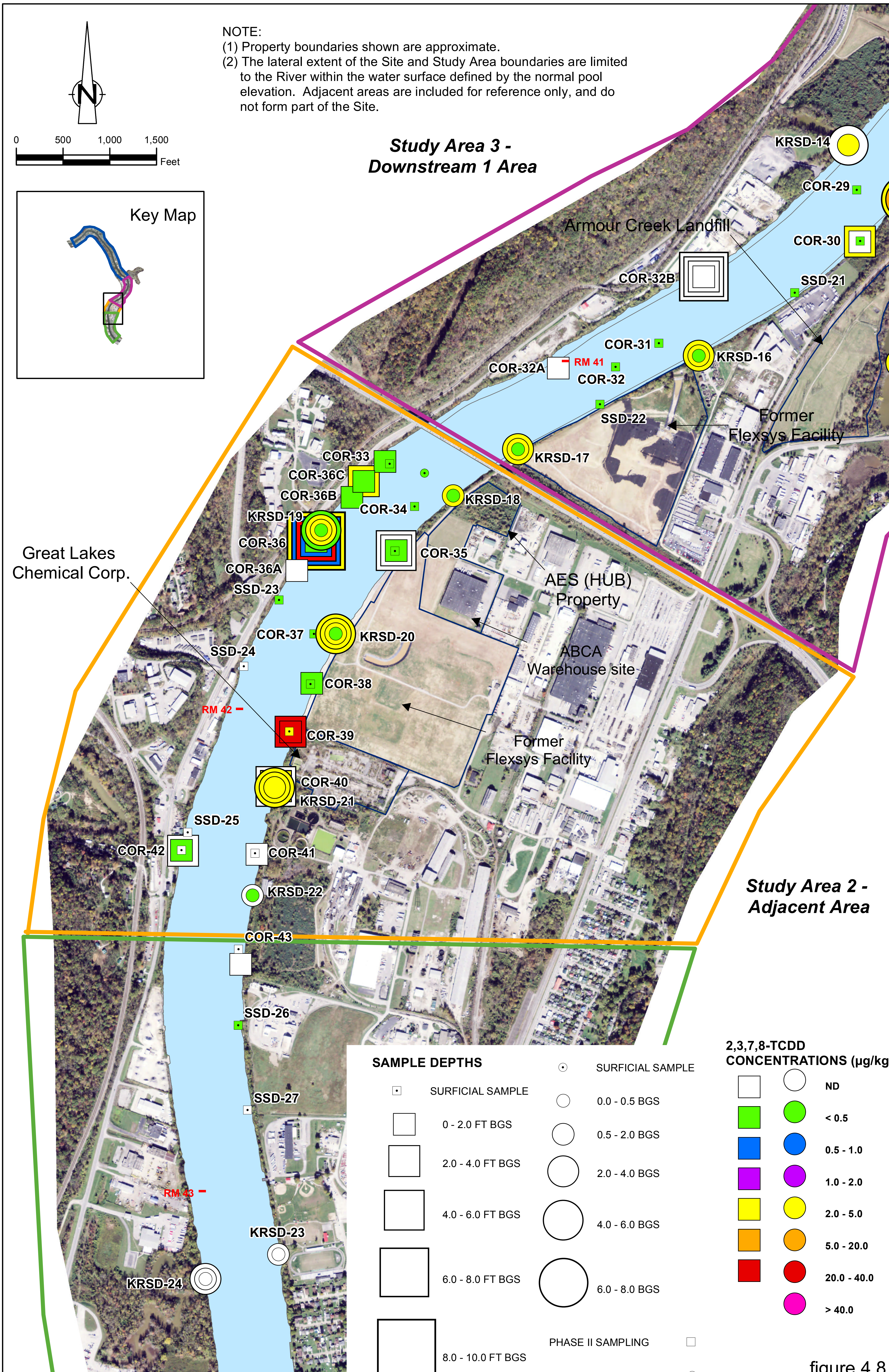


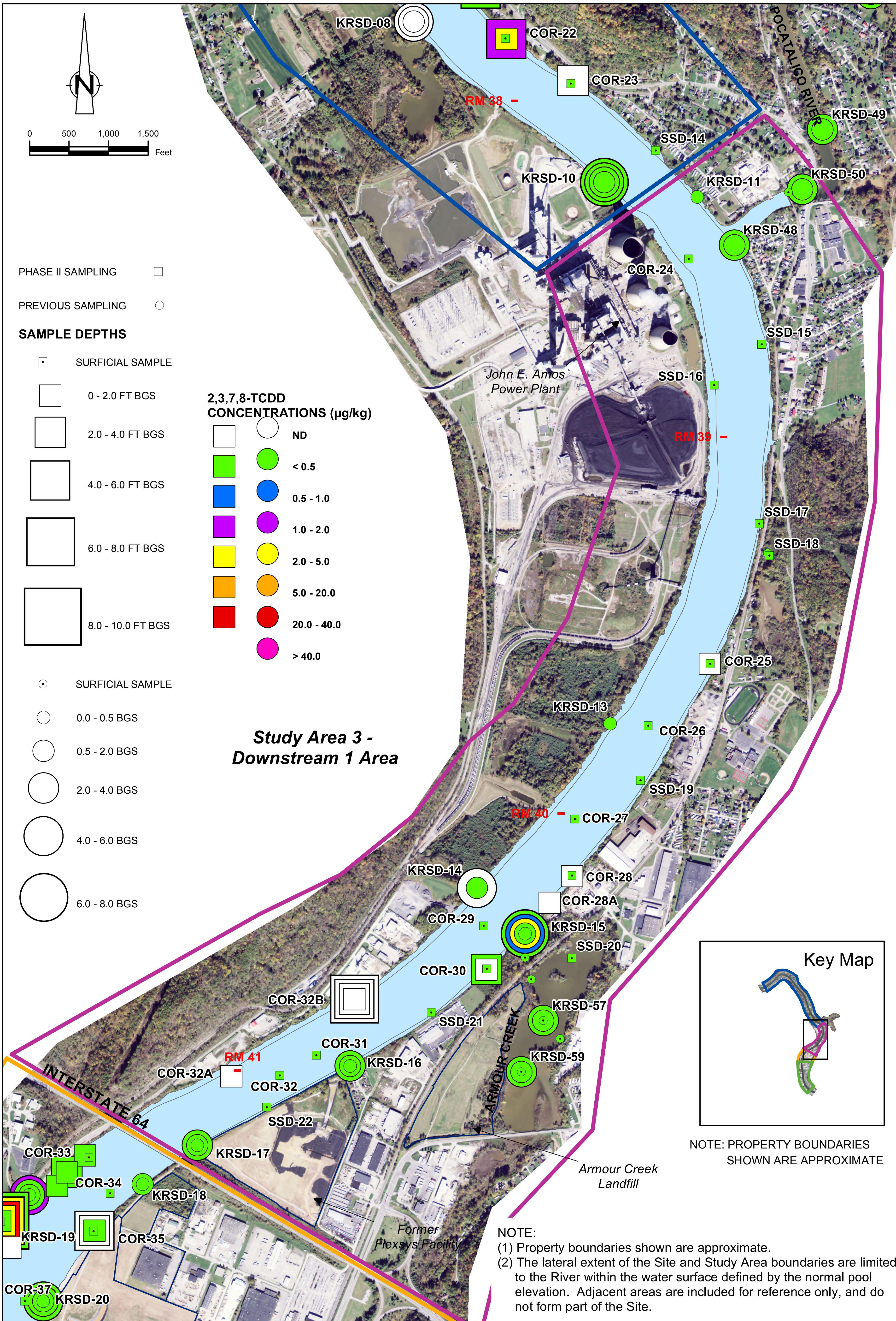
figure 4.8

SEDIMENT SAMPLING LOCATIONS AND RESULTS - STUDY AREA 2
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

031884-00(REP051)GIS-WA022 February 23, 2015

AR100399



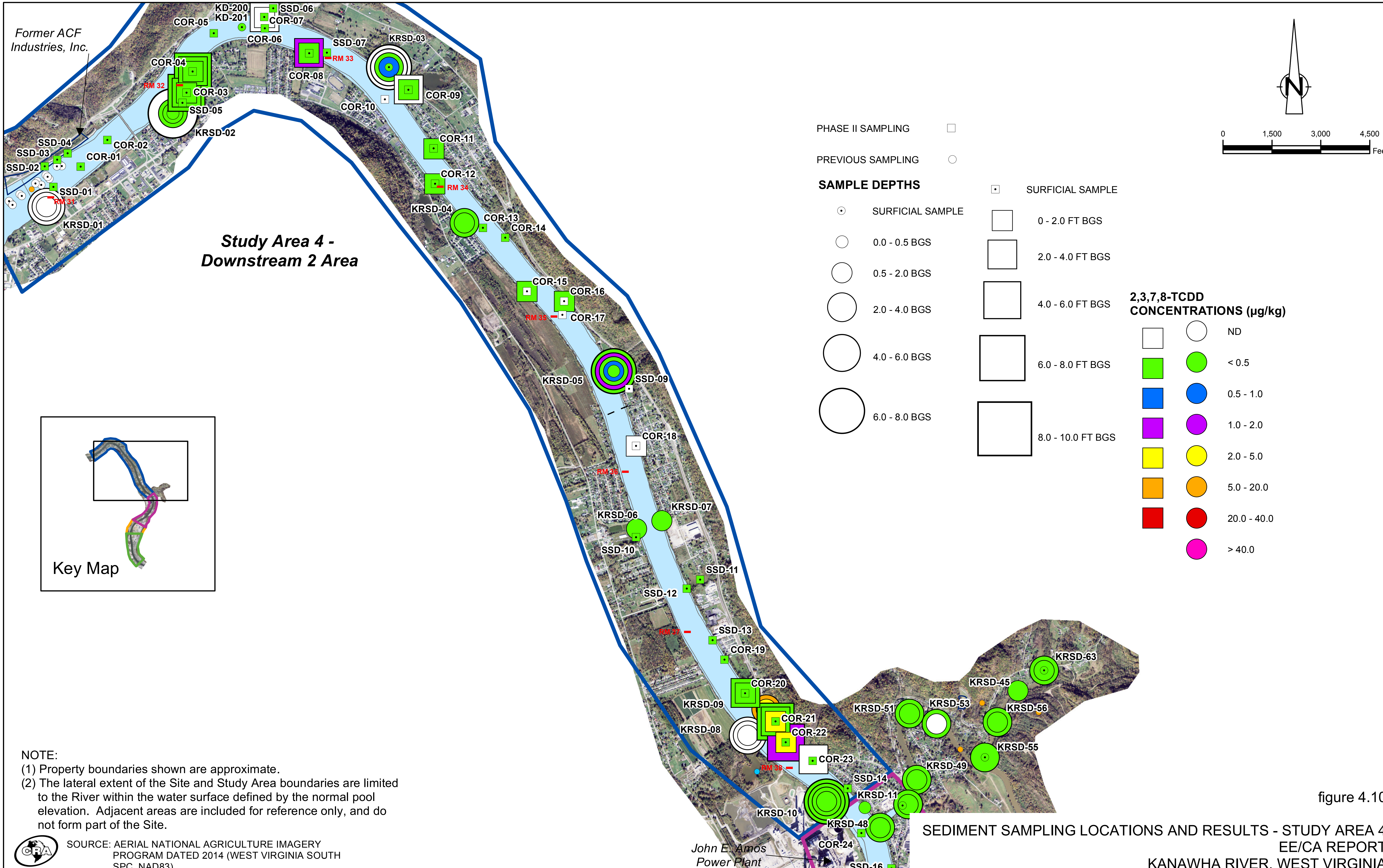
NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

figure 4.9

SEDIMENT SAMPLING LOCATIONS AND RESULTS - STUDY AREA 3
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

031884-00(REP051)GIS-WA023 February 23, 2015

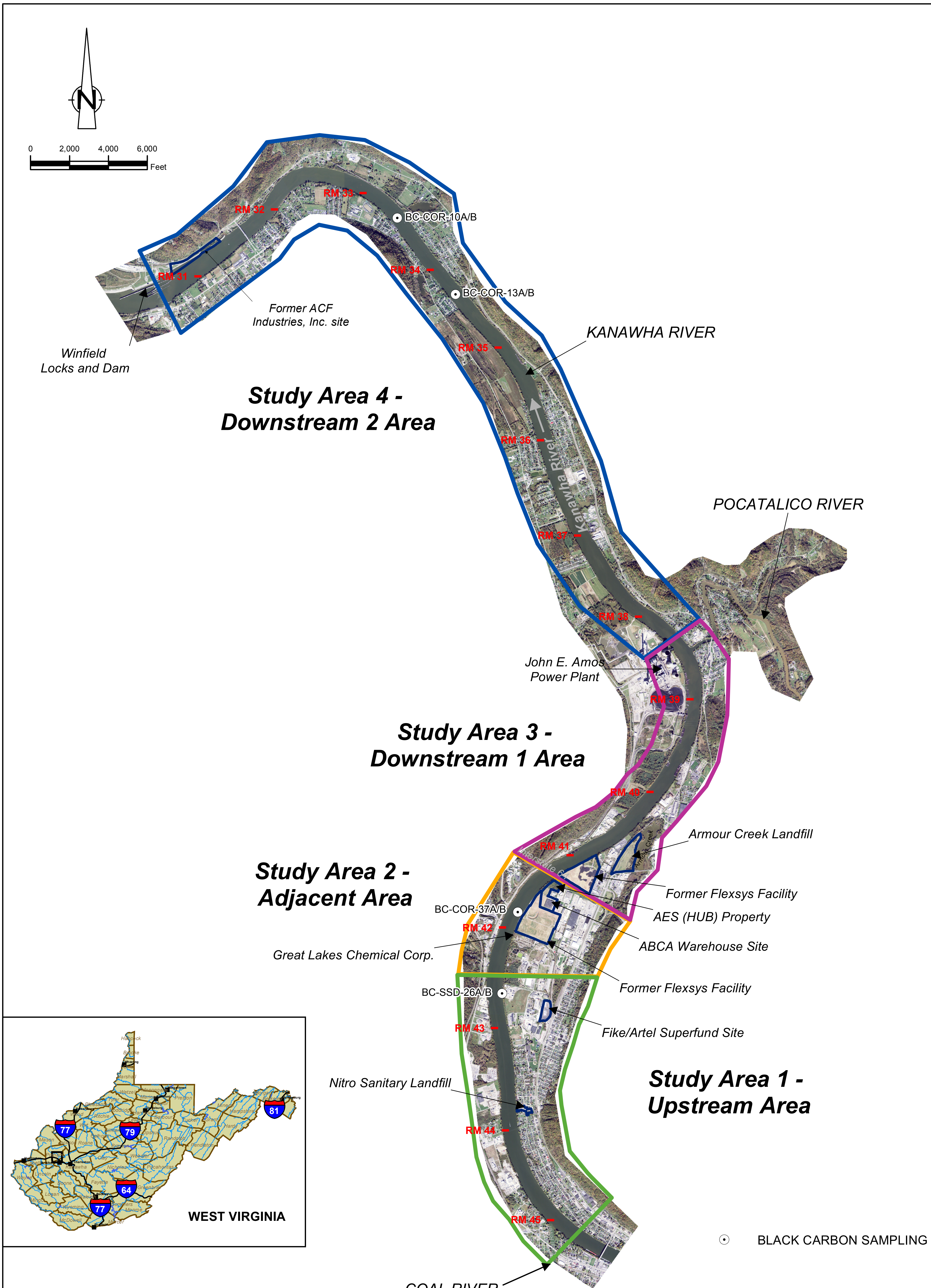


NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 4.10

SEDIMENT SAMPLING LOCATIONS AND RESULTS - STUDY AREA 4
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA



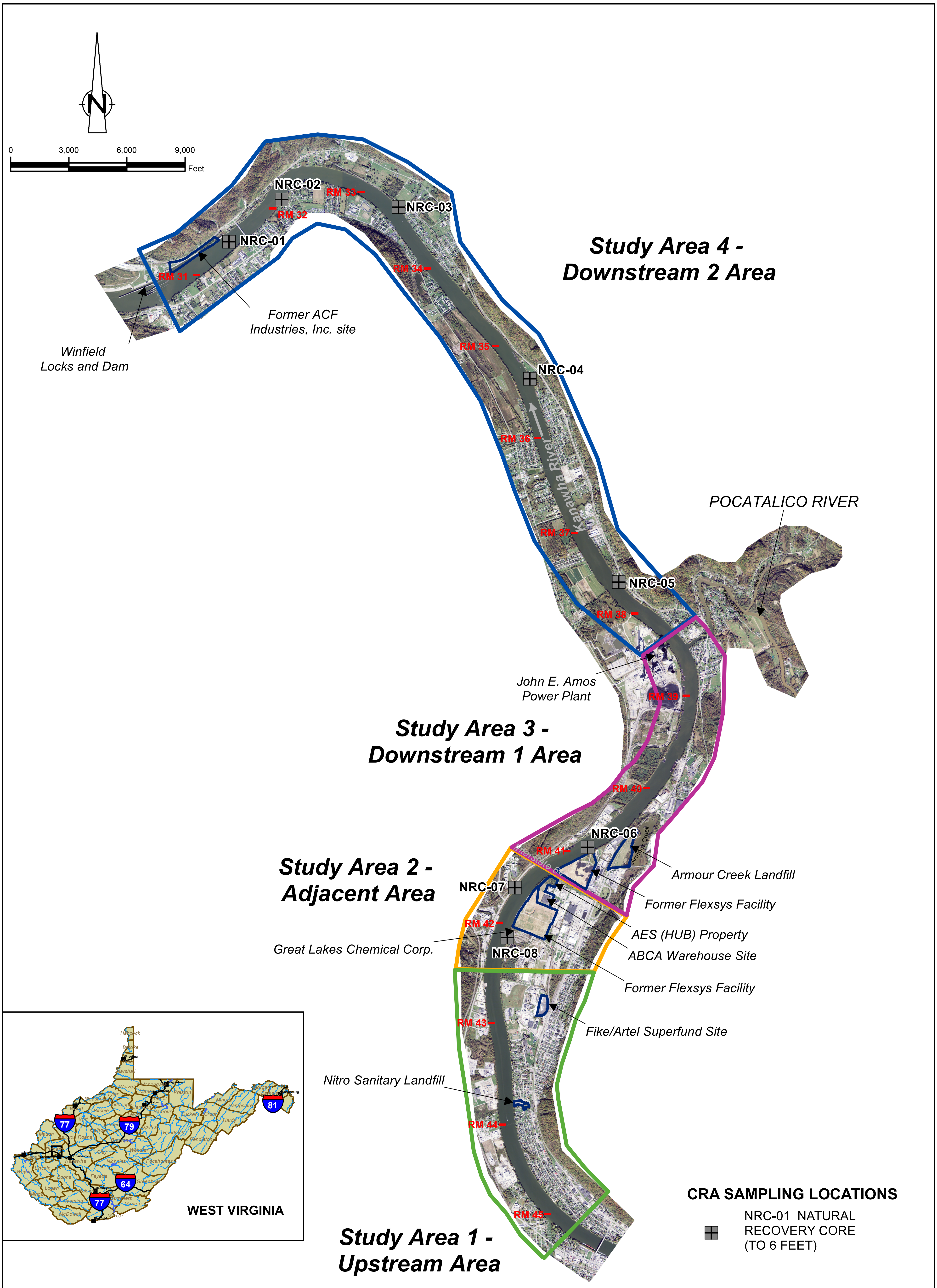
NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 4.11

BLACK CARBON SAMPLING LOCATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

031884-00(REP051)GIS-WA018 February 23, 2015



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 4.12

NRC SAMPLING LOCATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

031884-00(REP051)GIS-WA025 February 23, 2015

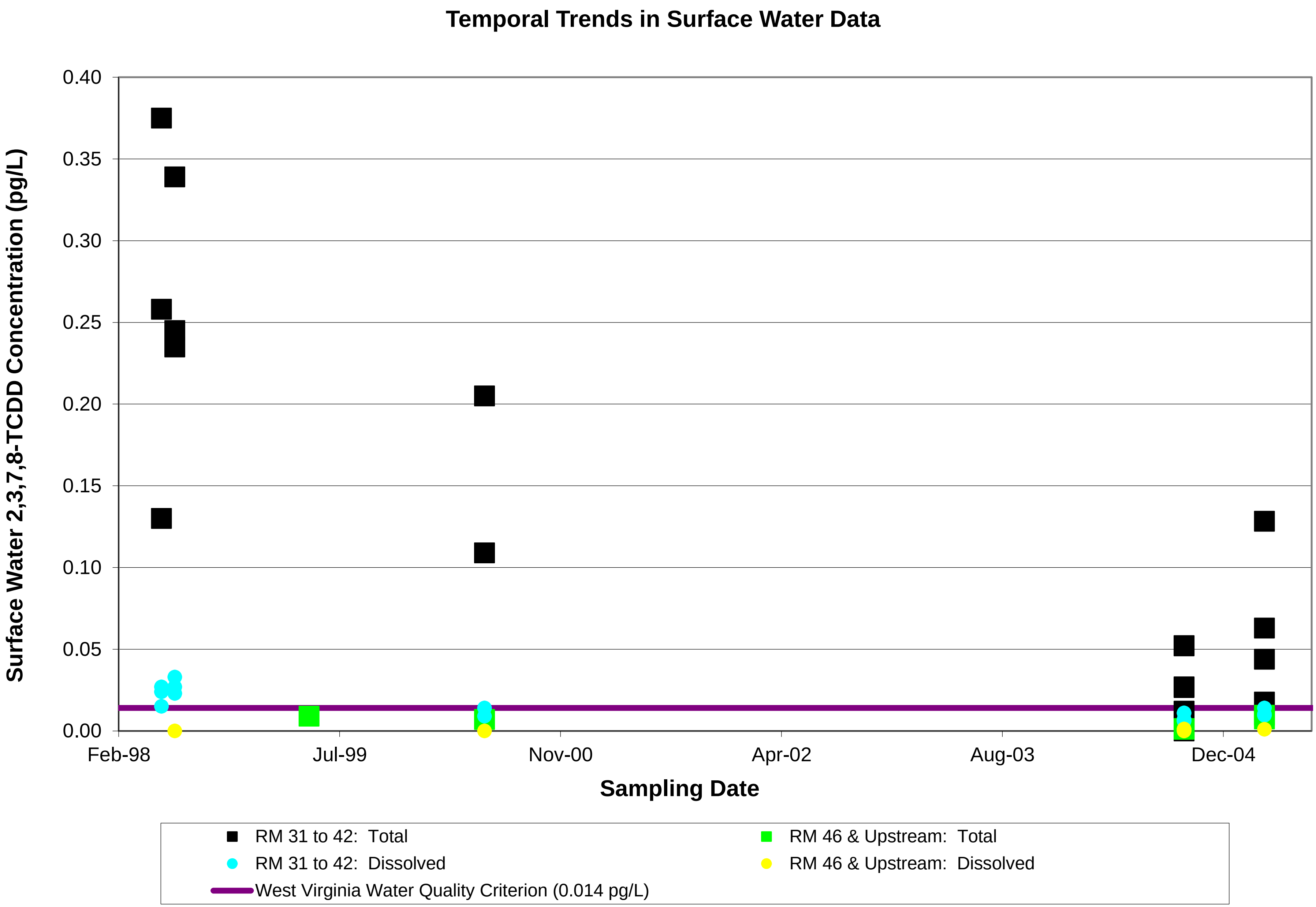


figure 4.13
2,3,7,8-TCDD TEMPORAL TRENDS IN SURFACE WATER DATA
EE/CA REPORT
Kanawha River, West Virginia

Spatial Trends in Surface Water Data

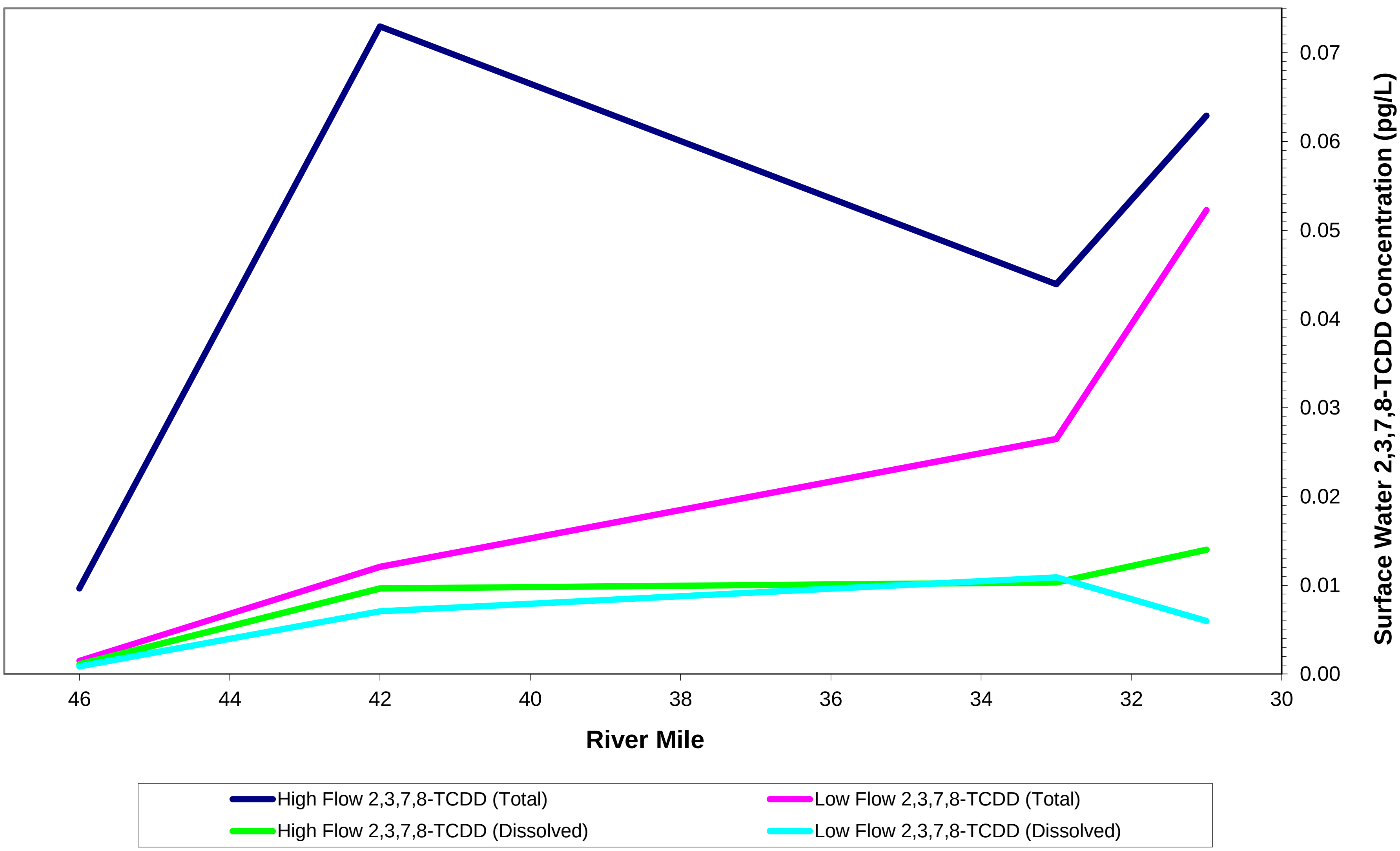


figure 4.14
2,3,7,8-TCDD SPATIAL TRENDS IN SURFACE WATER DATA
EE/CA REPORT
Kanawha River, West Virginia

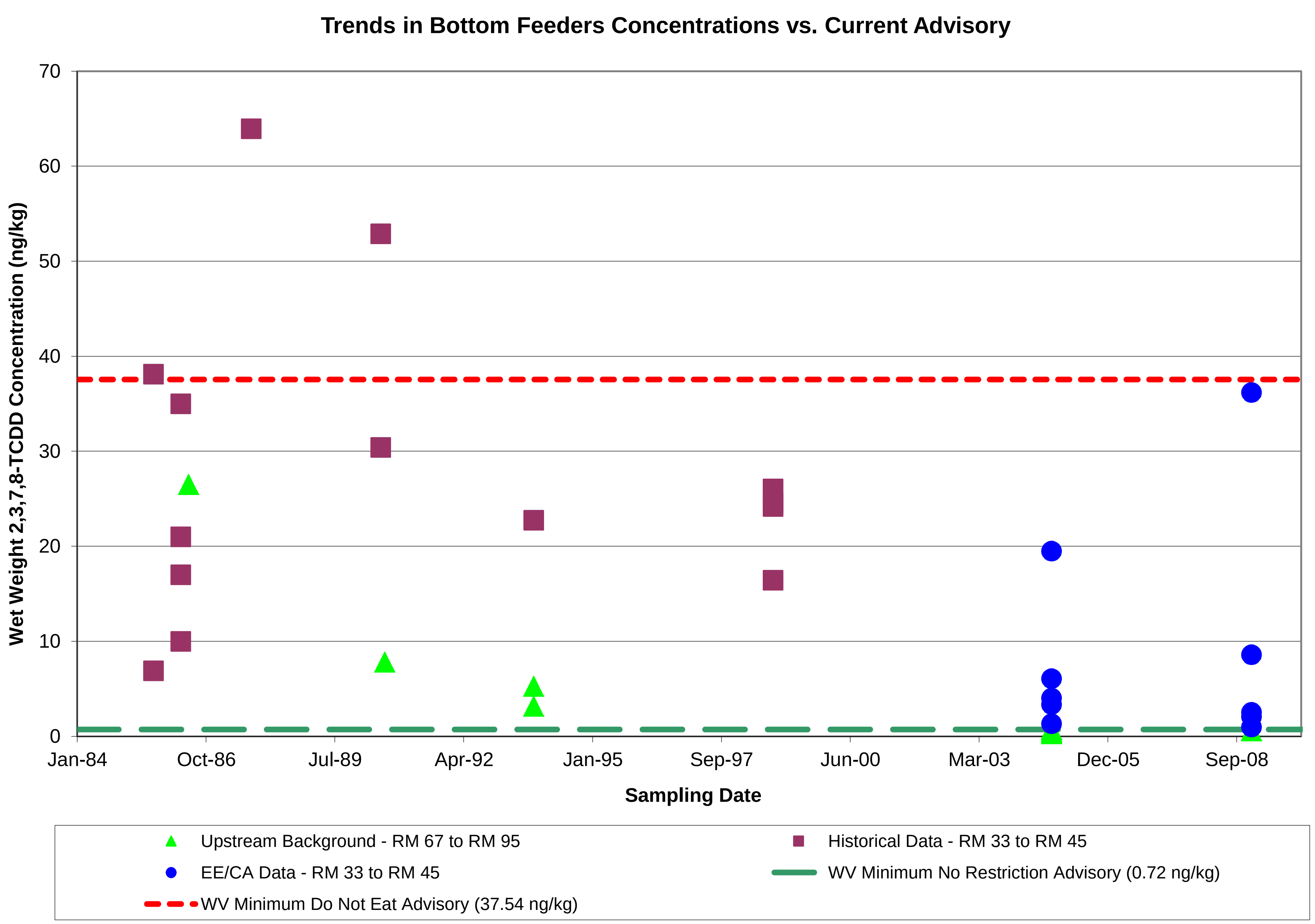


figure 4.15

2,3,7,8-TCDD TEMPORAL TRENDS IN BOTTOM FEEDER TISSUE DATA (WET WEIGHT)

EE/CA REPORT

Kanawha River, West Virginia

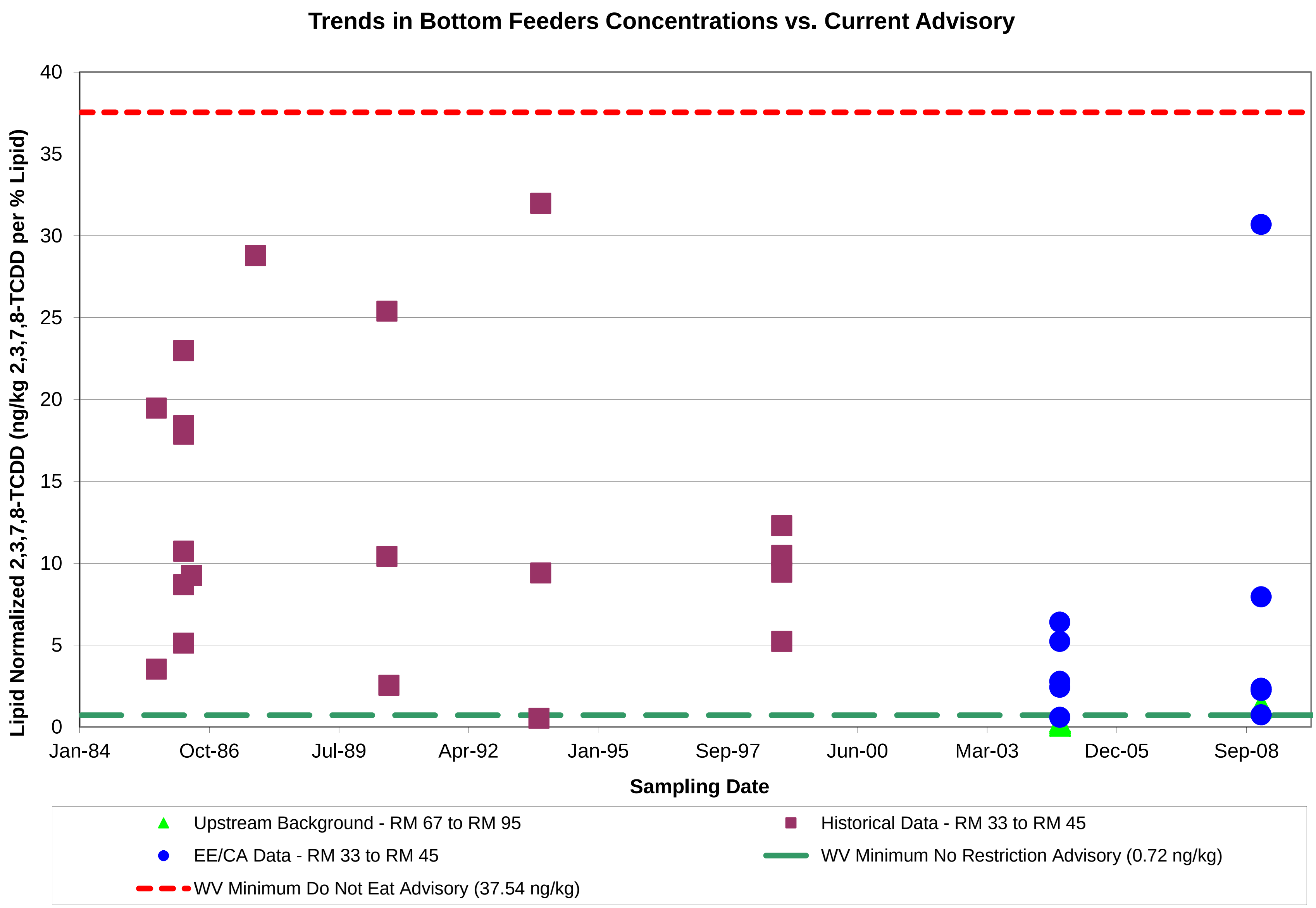


figure 4.16
2,3,7,8-TCDD TEMPORAL TRENDS IN BOTTOM FEEDER TISSUE DATA (LIPID NORMALIZED)
EE/CA REPORT
Kanawha River, West Virginia

031884-00(REP051) - figure 4.16 February 26, 2015

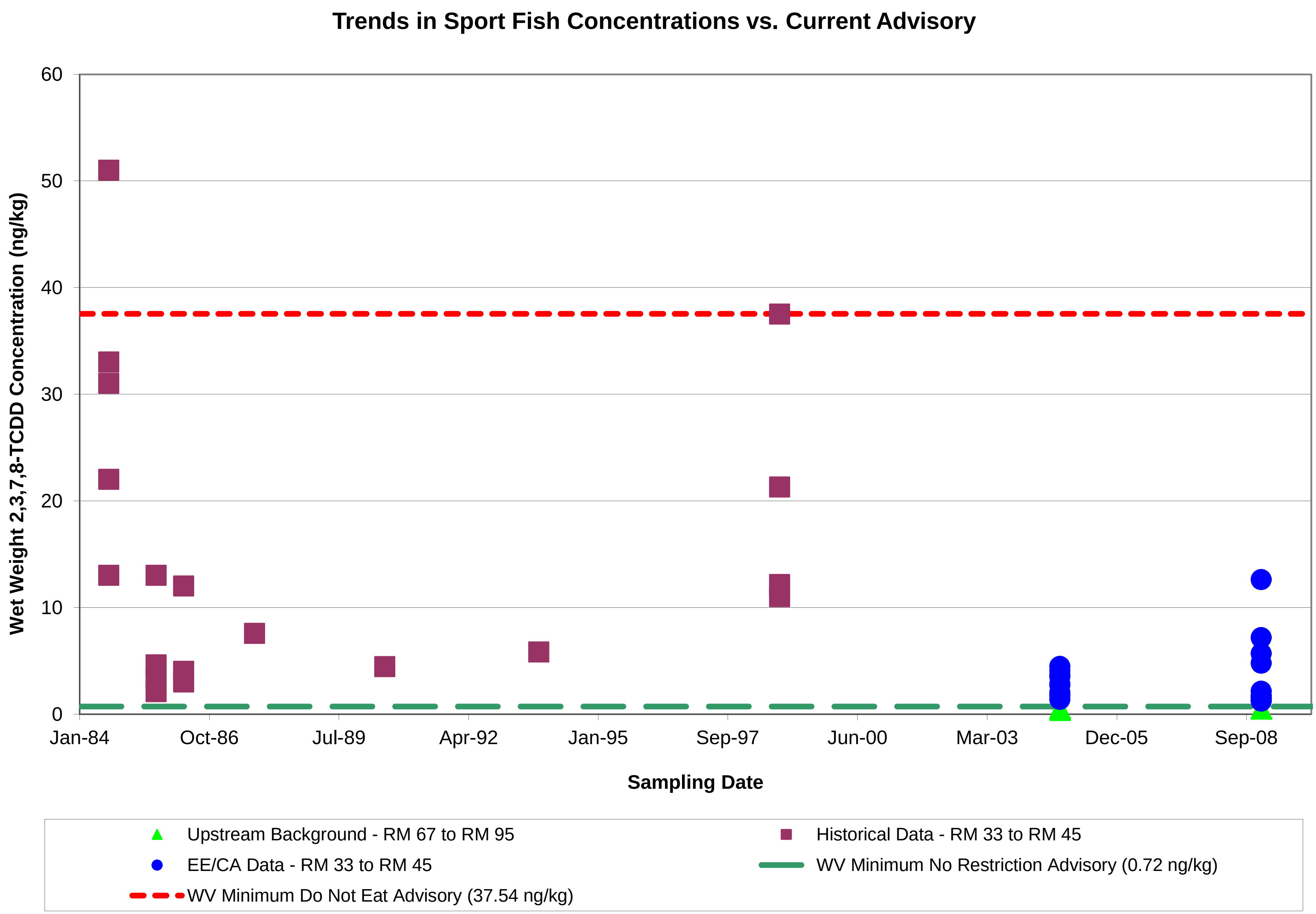


figure 4.17
2,3,7,8-TCDD TEMPORAL TRENDS IN SPORT FISH TISSUE DATA (WET WEIGHT)
EE/CA REPORT
Kanawha River, West Virginia

031884-00(REP051) - figure 4.17 February 26, 2015

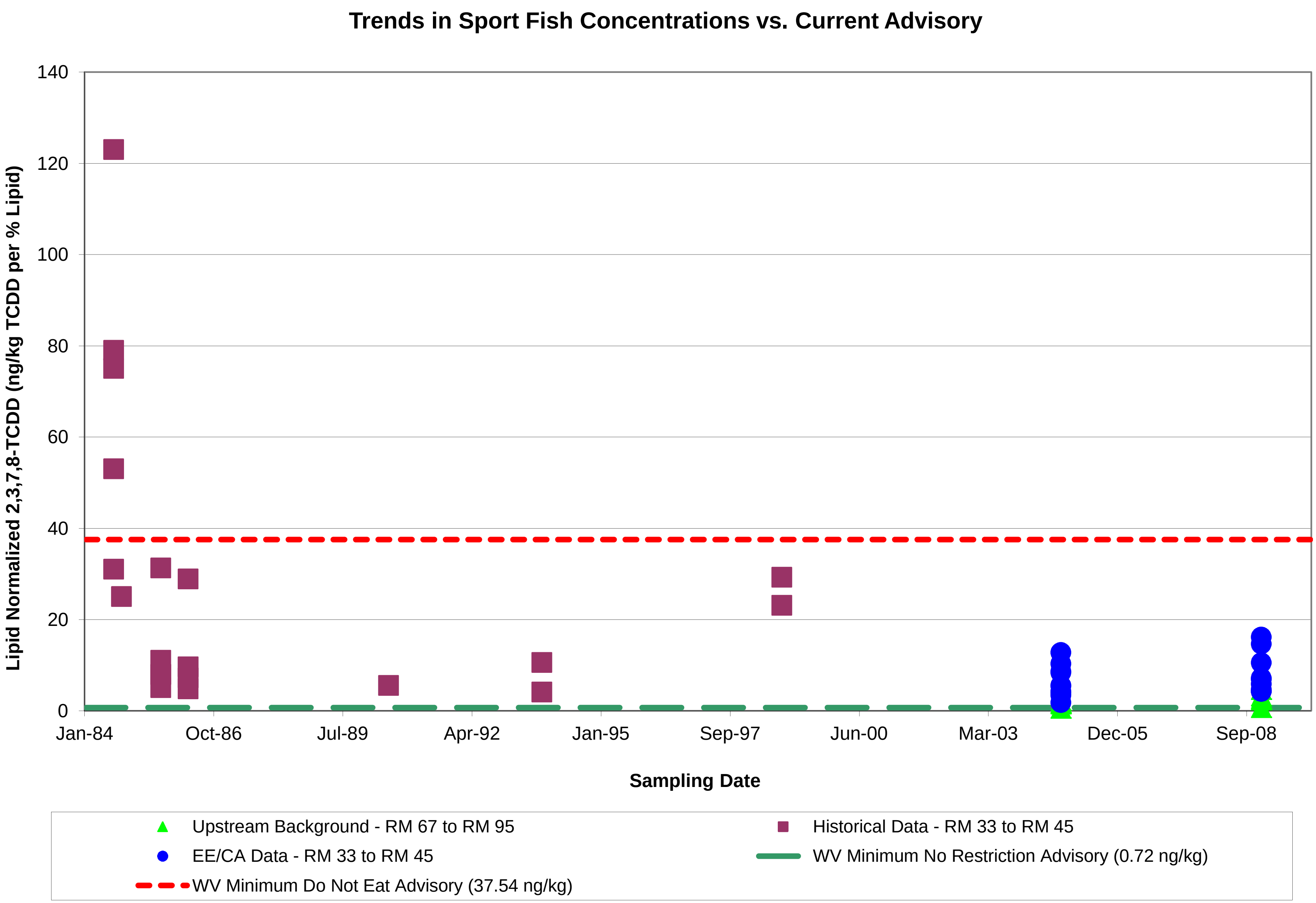


figure 4.18

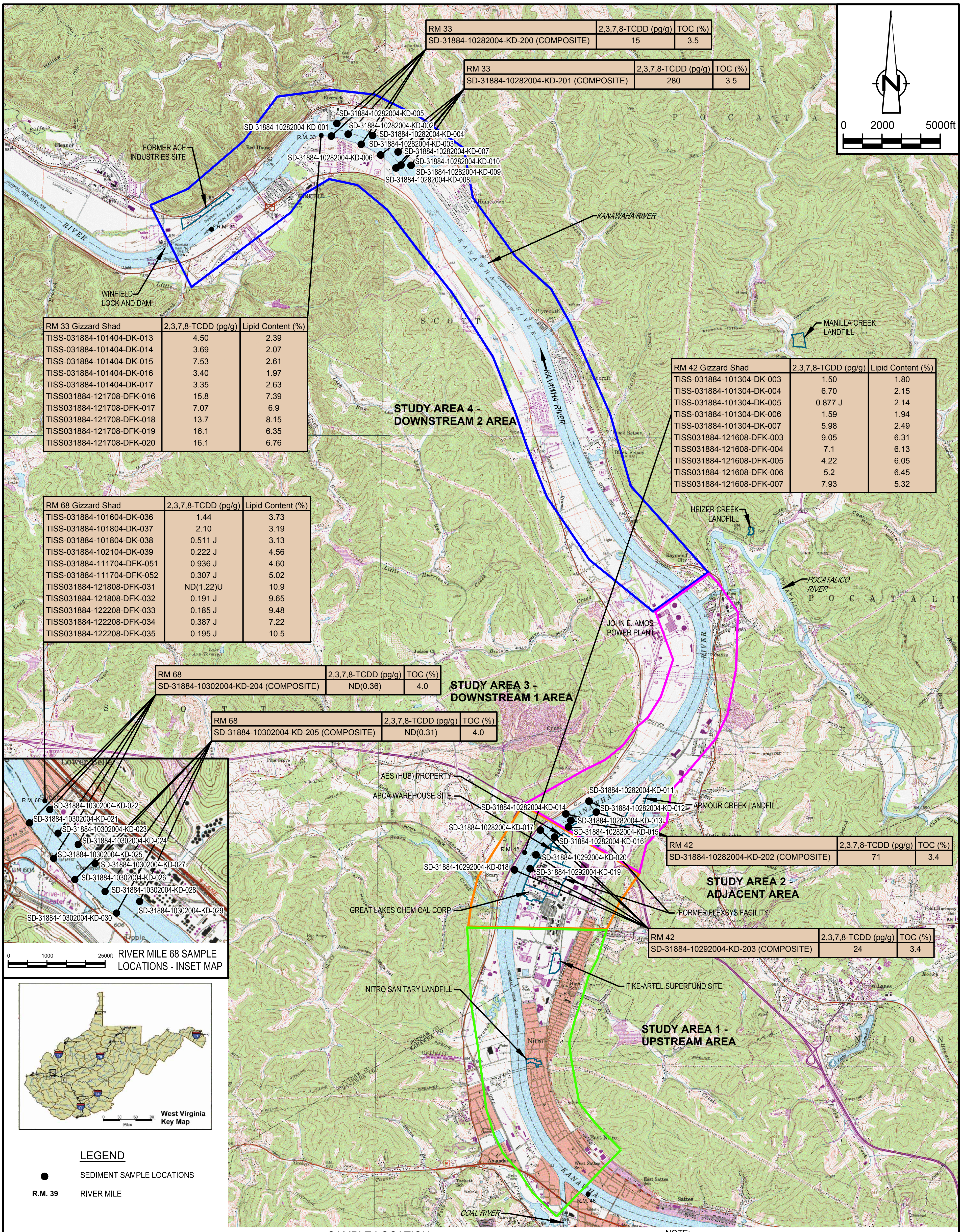
2,3,7,8-TCDD TEMPORAL TRENDS IN SPORT FISH TISSUE DATA (LIPID NORMALIZED)

EE/CA REPORT

Kanawha River, West Virginia

031884-00(REP051) - figure 4.18 February 26, 2015

AR100409



RM 33	2,3,7,8-TCDD (pg/g)	TOC (%)
SD-31884-10282004-KD-200 (COMPOSITE)	15	3.5

RM 33	2,3,7,8-TCDD (pg/g)	TOC (%)
SD-31884-10282004-KD-201 (COMPOSITE)	280	3.5

RM 33 Gizzard Shad	2,3,7,8-TCDD (pg/g)	Lipid Content (%)
TISS-031884-101404-DK-013	4.50	2.39
TISS-031884-101404-DK-014	3.69	2.07
TISS-031884-101404-DK-015	7.53	2.61
TISS-031884-101404-DK-016	3.40	1.97
TISS-031884-101404-DK-017	3.35	2.63
TISS031884-121708-DFK-016	15.8	7.39
TISS031884-121708-DFK-017	7.07	6.9
TISS031884-121708-DFK-018	13.7	8.15
TISS031884-121708-DFK-019	16.1	6.35
TISS031884-121708-DFK-020	16.1	6.76

RM 42 Gizzard Shad	2,3,7,8-TCDD (pg/g)	Lipid Content (%)
TISS-031884-101304-DK-003	1.50	1.80
TISS-031884-101304-DK-004	6.70	2.15
TISS-031884-101304-DK-005	0.877 J	2.14
TISS-031884-101304-DK-006	1.59	1.94
TISS-031884-101304-DK-007	5.98	2.49
TISS031884-121608-DFK-003	9.05	6.31
TISS031884-121608-DFK-004	7.1	6.13
TISS031884-121608-DFK-005	4.22	6.05
TISS031884-121608-DFK-006	5.2	6.45
TISS031884-121608-DFK-007	7.93	5.32

RM 68 Gizzard Shad	2,3,7,8-TCDD (pg/g)	Lipid Content (%)
TISS-031884-101604-DK-036	1.44	3.73
TISS-031884-101804-DK-037	2.10	3.19
TISS-031884-101804-DK-038	0.511 J	3.13
TISS-031884-102104-DK-039	0.222 J	4.56
TISS-031884-111704-DFK-051	0.936 J	4.60
TISS-031884-111704-DFK-052	0.307 J	5.02
TISS031884-121808-DFK-031	ND(1.22)U	10.9
TISS031884-121808-DFK-032	0.191 J	9.65
TISS031884-122208-DFK-033	0.185 J	9.48
TISS031884-122208-DFK-034	0.387 J	7.22
TISS031884-122208-DFK-035	0.195 J	10.5

RM 68	2,3,7,8-TCDD (pg/g)	TOC (%)
SD-31884-10302004-KD-204 (COMPOSITE)	ND(0.36)	4.0

RM 68	2,3,7,8-TCDD (pg/g)	TOC (%)
SD-31884-10302004-KD-205 (COMPOSITE)	ND(0.31)	4.0

RM 42	2,3,7,8-TCDD (pg/g)	TOC (%)
SD-31884-10282004-KD-202 (COMPOSITE)	71	3.4

RM 42	2,3,7,8-TCDD (pg/g)	TOC (%)
SD-31884-10292004-KD-203 (COMPOSITE)	24	3.4

LEGEND

- ● SEDIMENT SAMPLE LOCATIONS
- R.M. 39 RIVER MILE

RM 42	2,3,7,8-TCDD (pg/g)	TOC (%)
SD-31884-10292004-KD-203 (COMPOSITE)	24	3.4

SAMPLE LOCATION — CHEMICAL NAME — RESULT — SAMPLE ID

NOTE:
(1) THE LATERAL EXTENT OF THE SITE AND STUDY AREA BOUNDARIES ARE LIMITED TO THE RIVER WITHIN THE WATER SURFACE BY THE NORMAL POOL ELEVATION. ADJACENT AREAS ARE INCLUDED FOR REFERENCE ONLY, AND DO NOT FORM PART OF THE SITE

J	ESTIMATED CONCENTRATION
U	NOT DETECTED AT OR ABOVE THE ASSOCIATED VALUE
ND	NOT DETECTED AT OR ABOVE THE ASSOCIATED VALUE
TOC	TOTAL ORGANIC CARBON
2,3,7,8-TCDD	2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN
pg/g	PICOGRAMS PER GRAM
%	PERCENTAGE

SOURCE: USGS QUADRANGLE MAPS; ALUM CREEK, BANCROFT, BELLE, CHARLESTON EAST, GARRETTS BEND, SCOTT DEPOT, ST ALBANS, AND WINFIELD, WEST VIRGINIA

DATA SOURCE : MAPTECH, INC.

figure 4.19

BSAF SAMPLING LOCATIONS
EE/CA REPORT
Kanawha River, West Virginia

31884-00(051)GN-WA016 FEB 20/2015

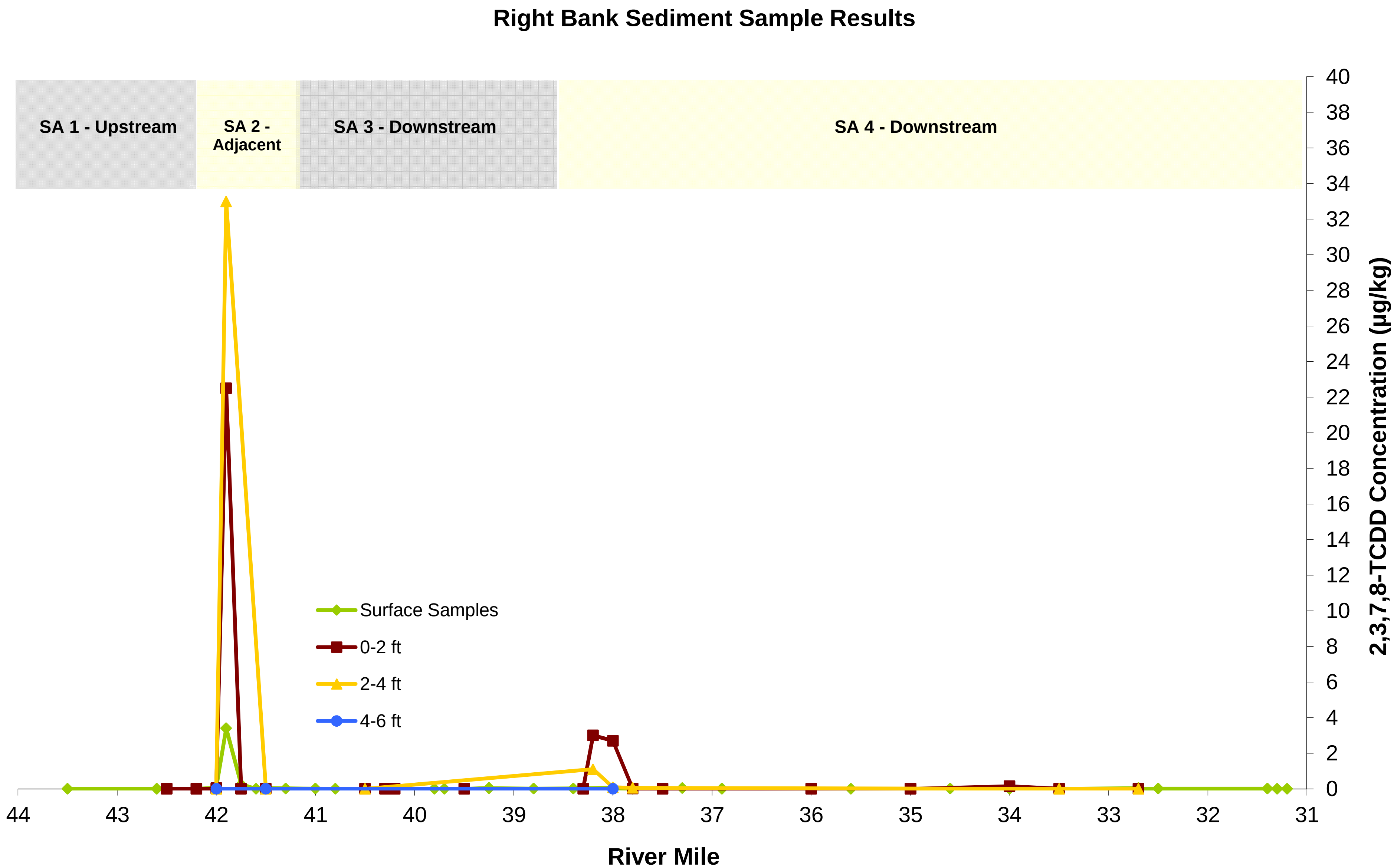


figure 4.20
PHASE II EOC INVESTIGATION SEDIMENT DATA PROFILE - RIGHT BANK
EE/CA REPORT
Kanawha River, West Virginia

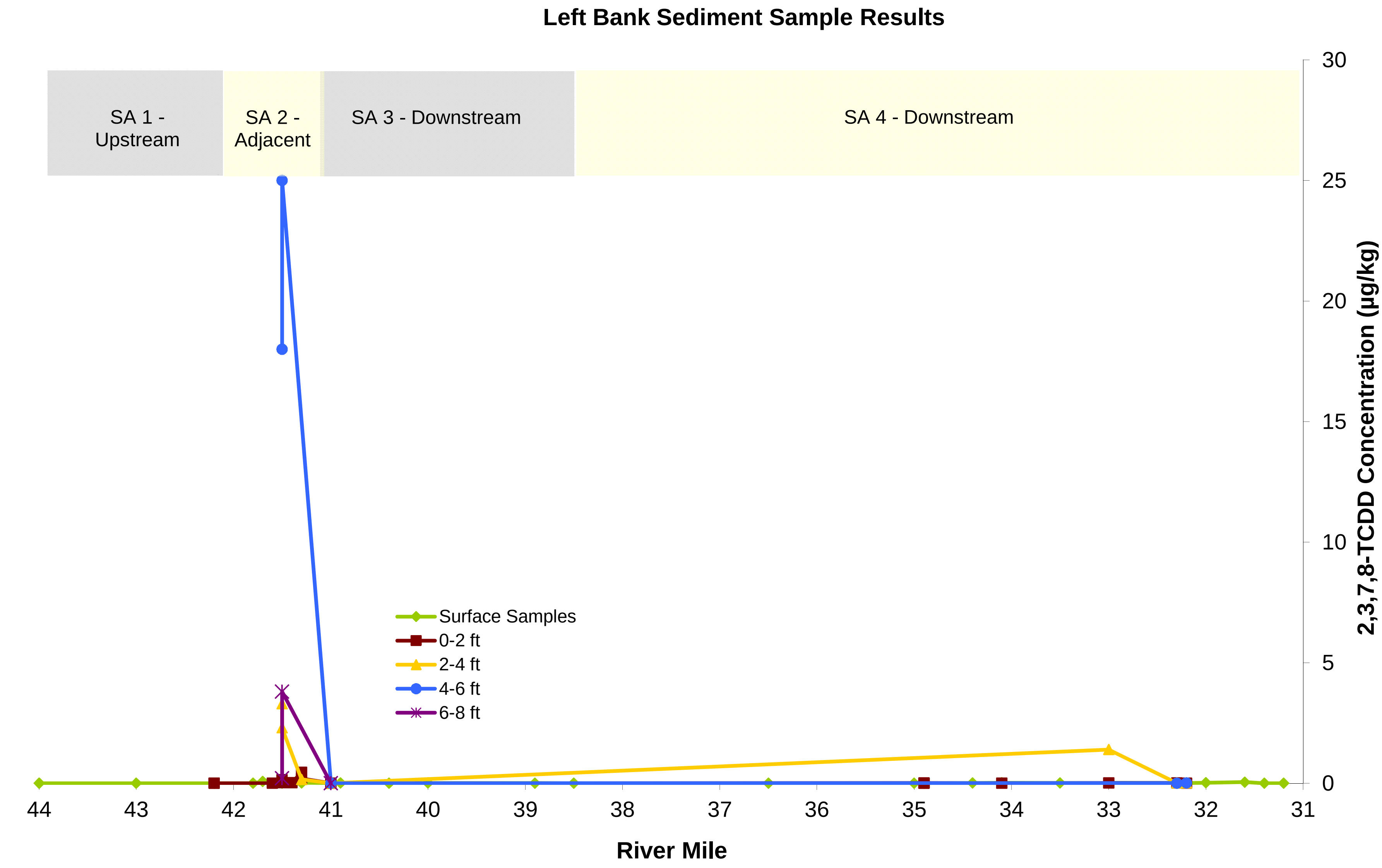
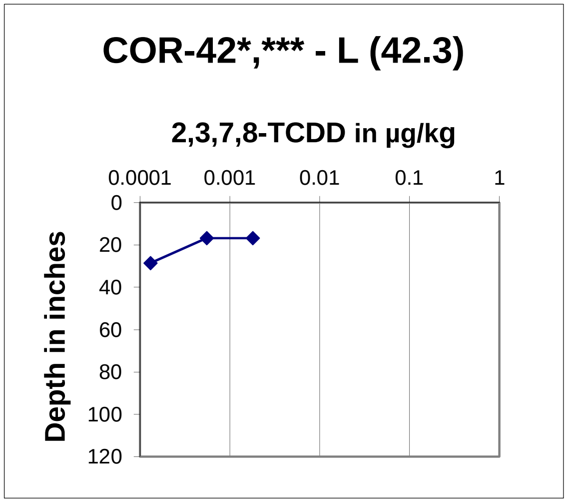
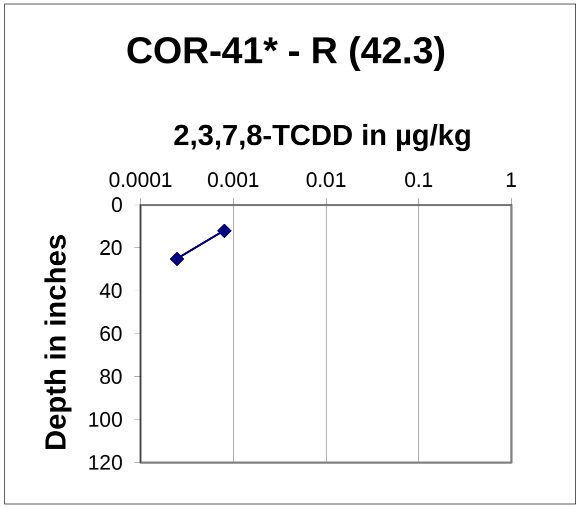
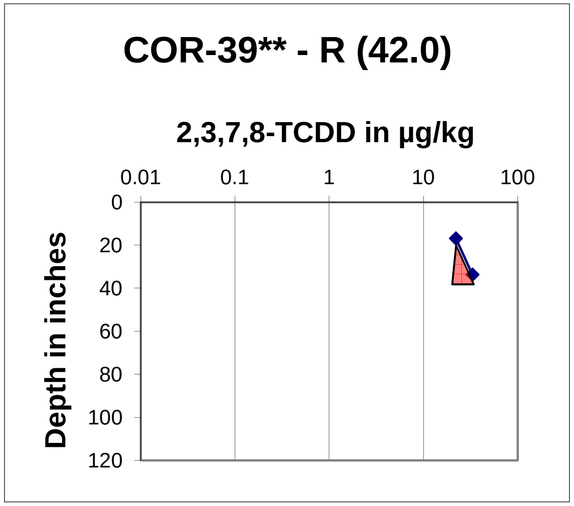
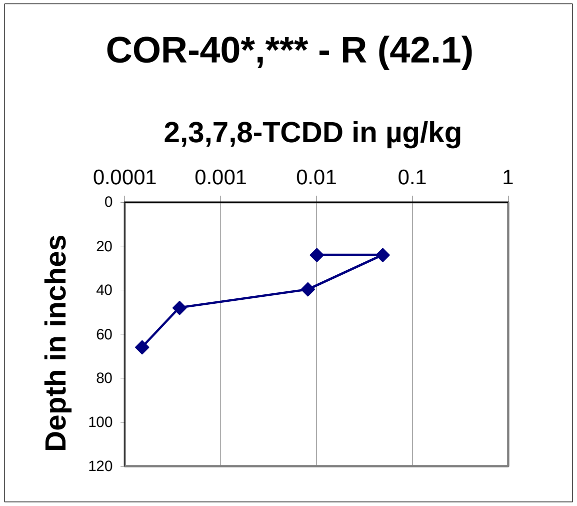


figure 4.21
PHASE II EOC INVESTIGATION SEDIMENT DATA PROFILE - LEFT BANK
EE/CA REPORT
Kanawha River, West Virginia



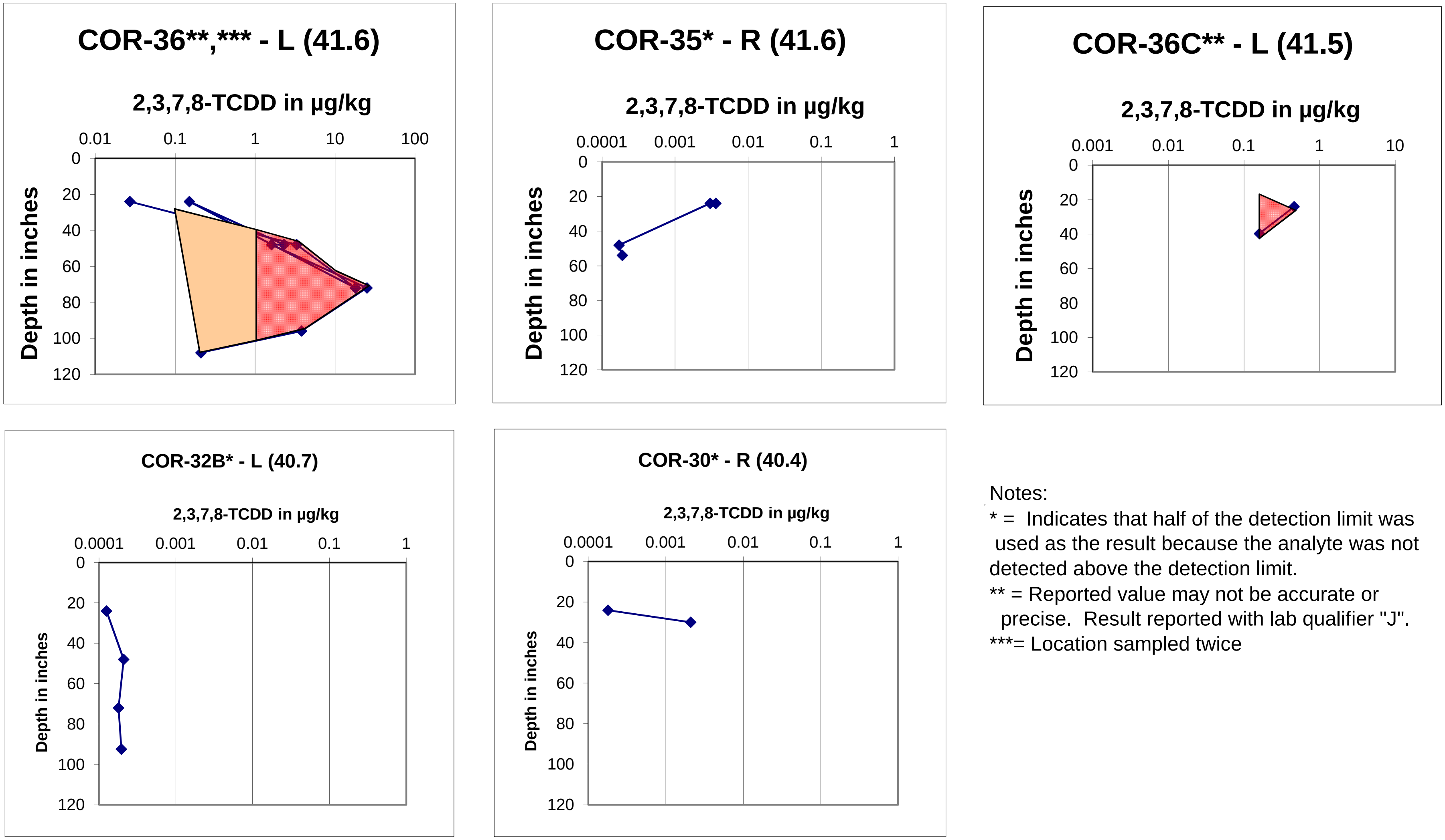






Notes:
* = Indicates that half of the detection limit was used as the result because the analyte was not detected above the detection limit.
** = Reported value may not be accurate or precise. Result reported with lab qualifier "J".
***= Location sampled twice

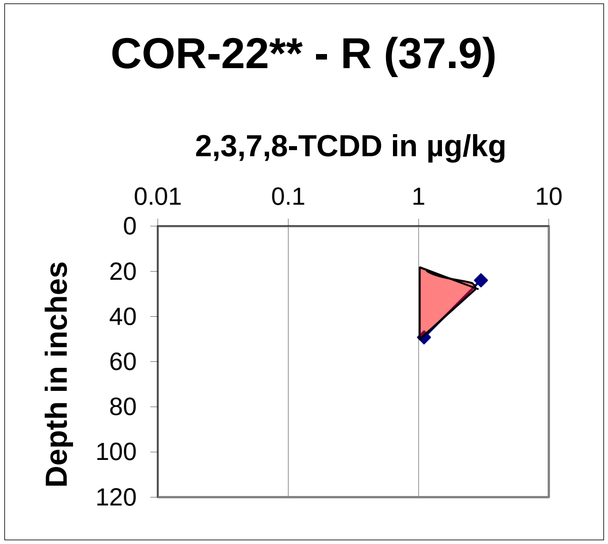
figure 4.22
PHASE II EOC INVESTIGATION SEDIMENT CORE PROFILE - STUDY AREA 2
EE/CA REPORT
Kanawha River, West Virginia

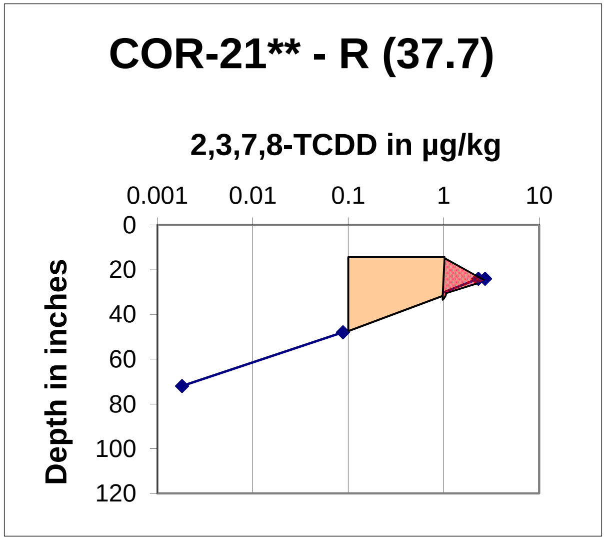


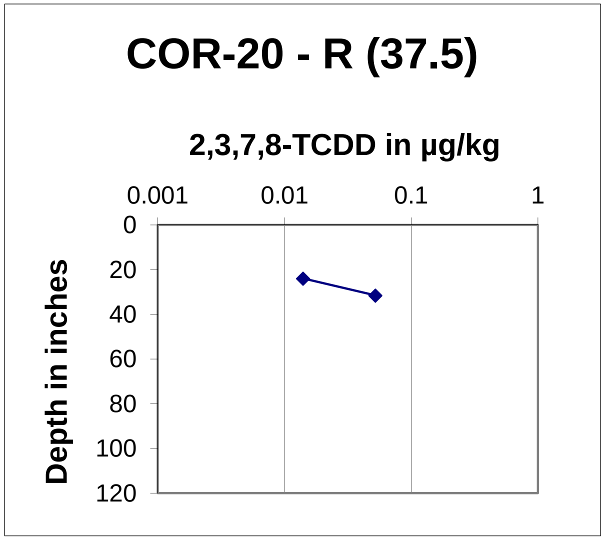
Notes:
* = Indicates that half of the detection limit was used as the result because the analyte was not detected above the detection limit.
** = Reported value may not be accurate or precise. Result reported with lab qualifier "J".
***= Location sampled twice

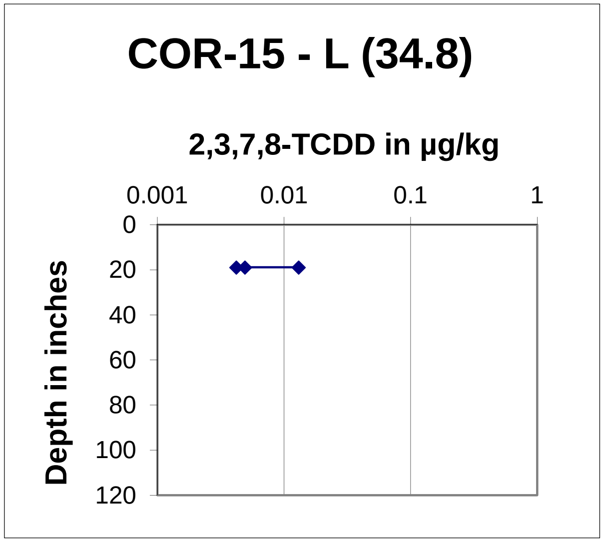
figure 4.23
PHASE II EOC INVESTIGATION SEDIMENT CORE PROFILES - STUDY AREA 2 AND 3
EE/CA REPORT
Kanawha River, West Virginia

CRA



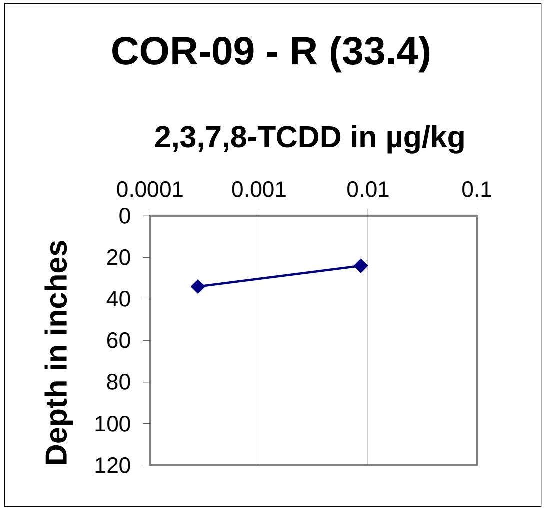


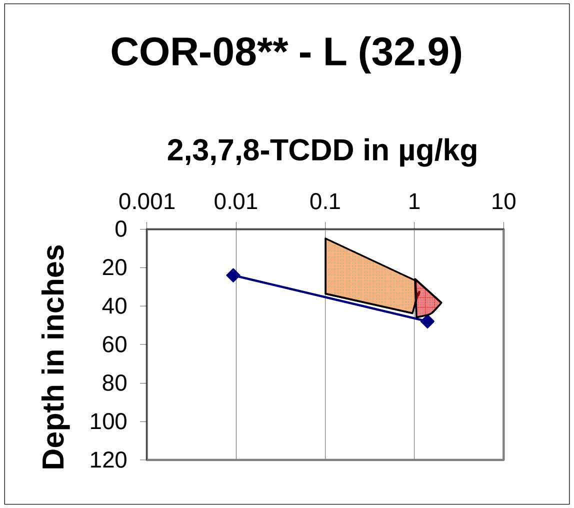


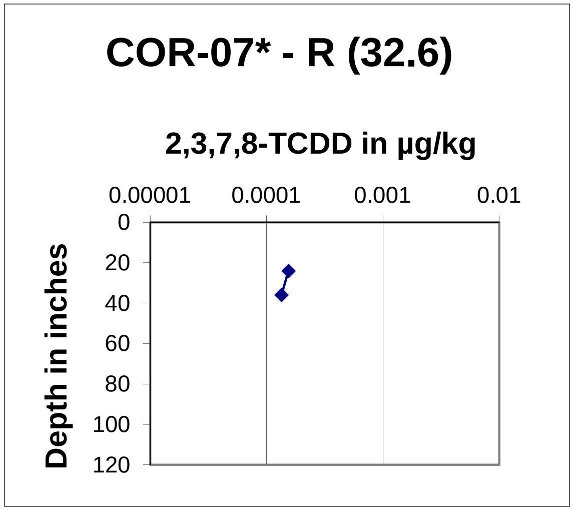


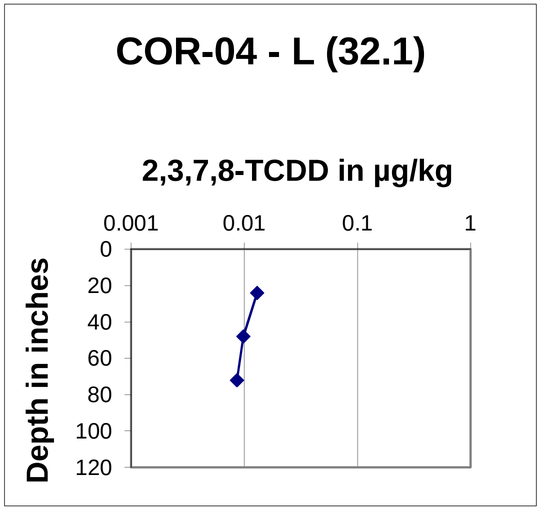
Note:
** = Reported value may not be accurate or precise. Result reported with lab qualifier "J".

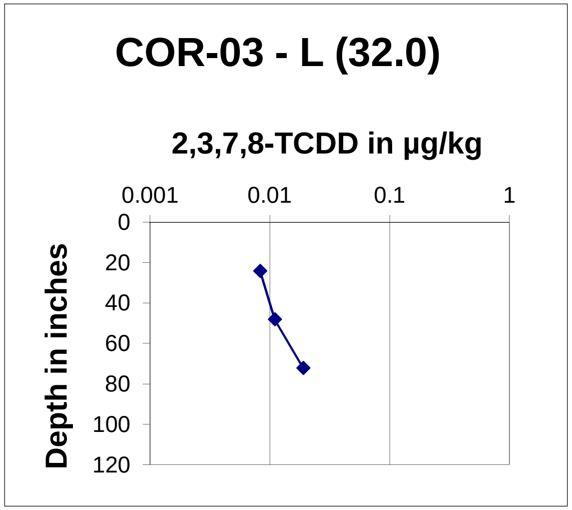
figure 4.24
PHASE II EOC INVESTIGATION SEDIMENT CORE PROFILES - STUDY AREA 4
EE/CA REPORT
Kanawha River, West Virginia







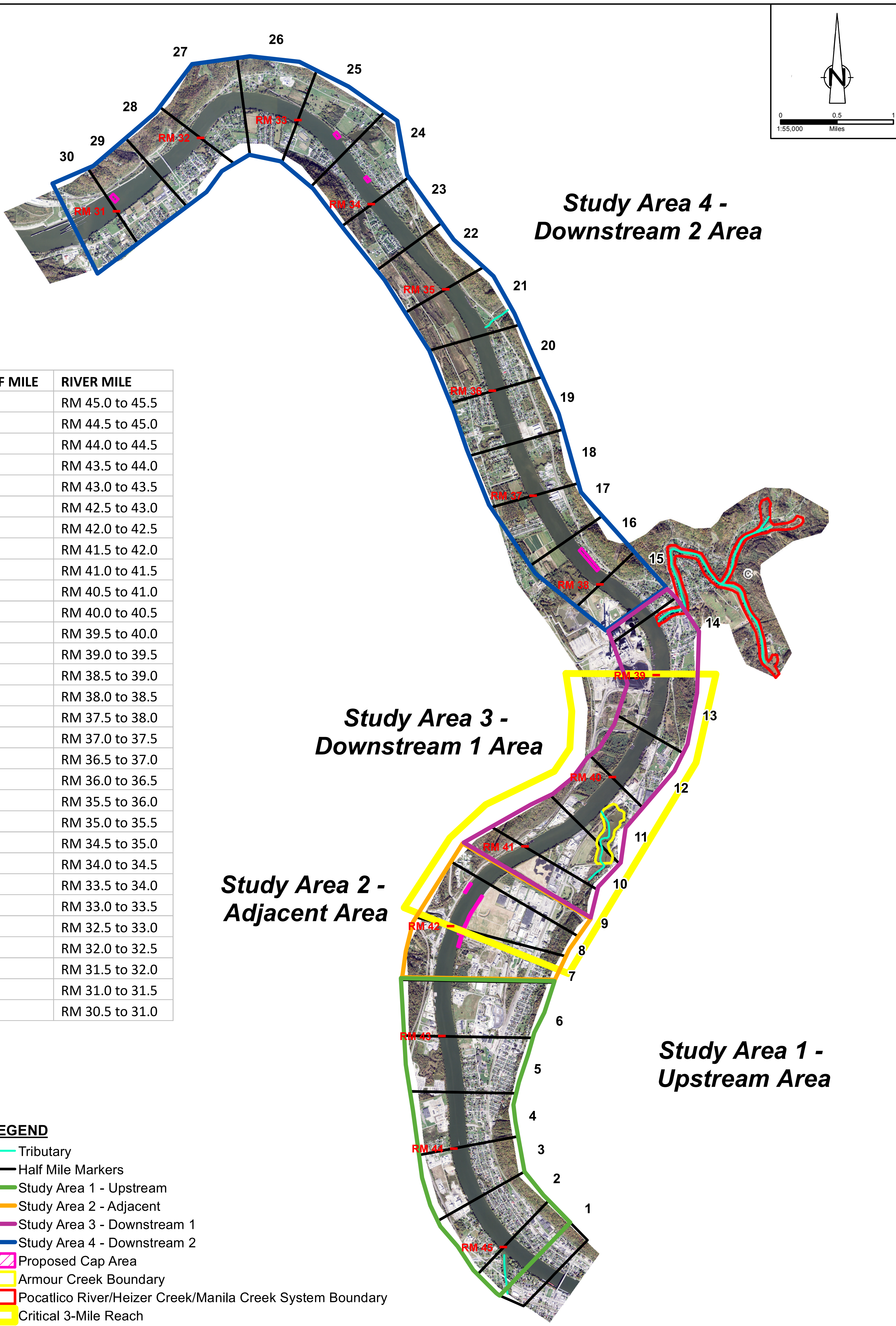




Notes:
* = Indicates that half of the detection limit was used as the result because the analyte was not detected above the detection limit.
** = Reported value may not be accurate or precise. Result reported with lab qualifier "J".

figure 4.25
PHASE II EOC INVESTIGATION SEDIMENT CORE PROFILES - STUDY AREA 4
EE/CA REPORT
Kanawha River, West Virginia

CRA



HALF MILE	RIVER MILE
1	RM 45.0 to 45.5
2	RM 44.5 to 45.0
3	RM 44.0 to 44.5
4	RM 43.5 to 44.0
5	RM 43.0 to 43.5
6	RM 42.5 to 43.0
7	RM 42.0 to 42.5
8	RM 41.5 to 42.0
9	RM 41.0 to 41.5
10	RM 40.5 to 41.0
11	RM 40.0 to 40.5
12	RM 39.5 to 40.0
13	RM 39.0 to 39.5
14	RM 38.5 to 39.0
15	RM 38.0 to 38.5
16	RM 37.5 to 38.0
17	RM 37.0 to 37.5
18	RM 36.5 to 37.0
19	RM 36.0 to 36.5
20	RM 35.5 to 36.0
21	RM 35.0 to 35.5
22	RM 34.5 to 35.0
23	RM 34.0 to 34.5
24	RM 33.5 to 34.0
25	RM 33.0 to 33.5
26	RM 32.5 to 33.0
27	RM 32.0 to 32.5
28	RM 31.5 to 32.0
29	RM 31.0 to 31.5
30	RM 30.5 to 31.0

LEGEND

- Tributary
- Half Mile Markers
- Study Area 1 - Upstream
- Study Area 2 - Adjacent
- Study Area 3 - Downstream 1
- Study Area 4 - Downstream 2
- Proposed Cap Area
- Armour Creek Boundary
- Pocatlico River/Heizer Creek/Manila Creek System Boundary
- Critical 3-Mile Reach

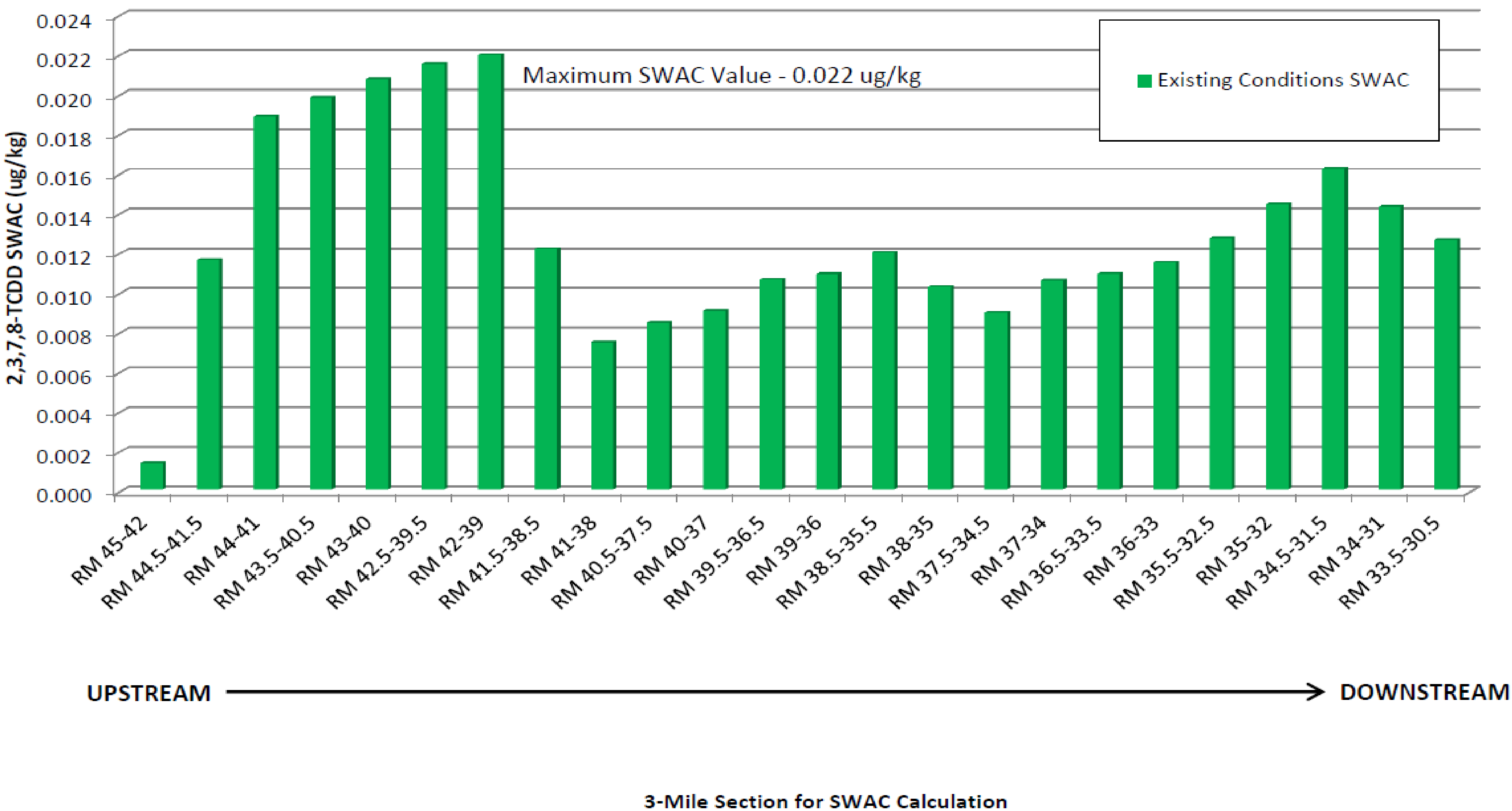
Aerial: National Agriculture Imagery Program Dated 2014 (West Virginia South SPC, NAD83); Coordinate System: NAD 1983 StatePlane West Virginia South FIPS 4702 Feet

NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.
(3) Proposed cap areas to be defined during the design process.

figure 4.26

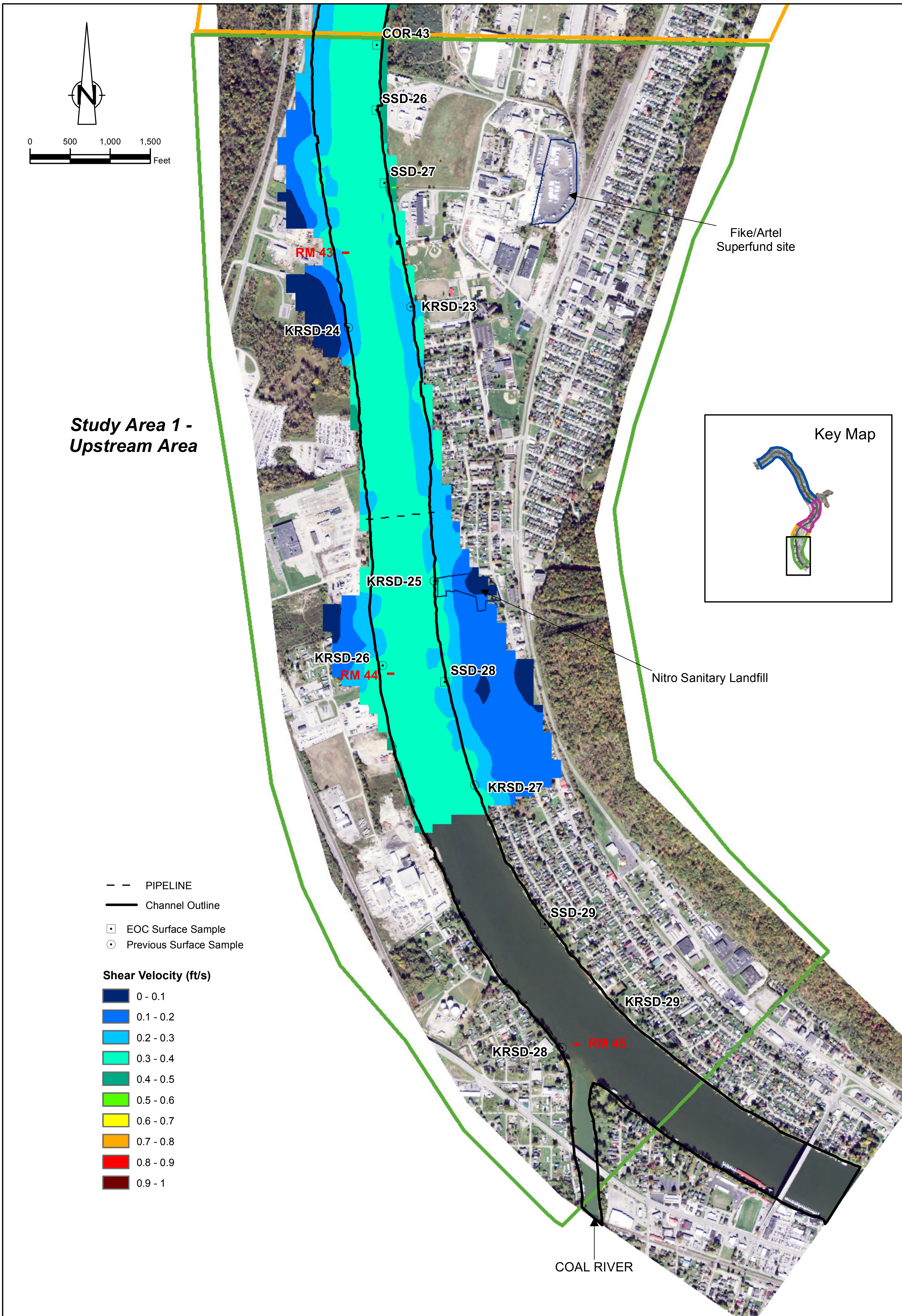
SWAC CALCULATION - HALF-MILE BOUNDARY LOCATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

031884-00(REP051)GIS-WA115 February 27, 2015



Note: Study Area 1 corresponds to approximately RM 45.5 to 42.5, Study Area 2 - RM 42.5 to 41.5, Study Area 3 - RM 41.5 to 38.5, and Study Area 4 - RM 38.5 to 30.5.

figure 4.27
EXISTING CONDITION SWAC FOR ROLLING 3-MILE RANGE
EE/CA REPORT
Kanawha River, West Virginia

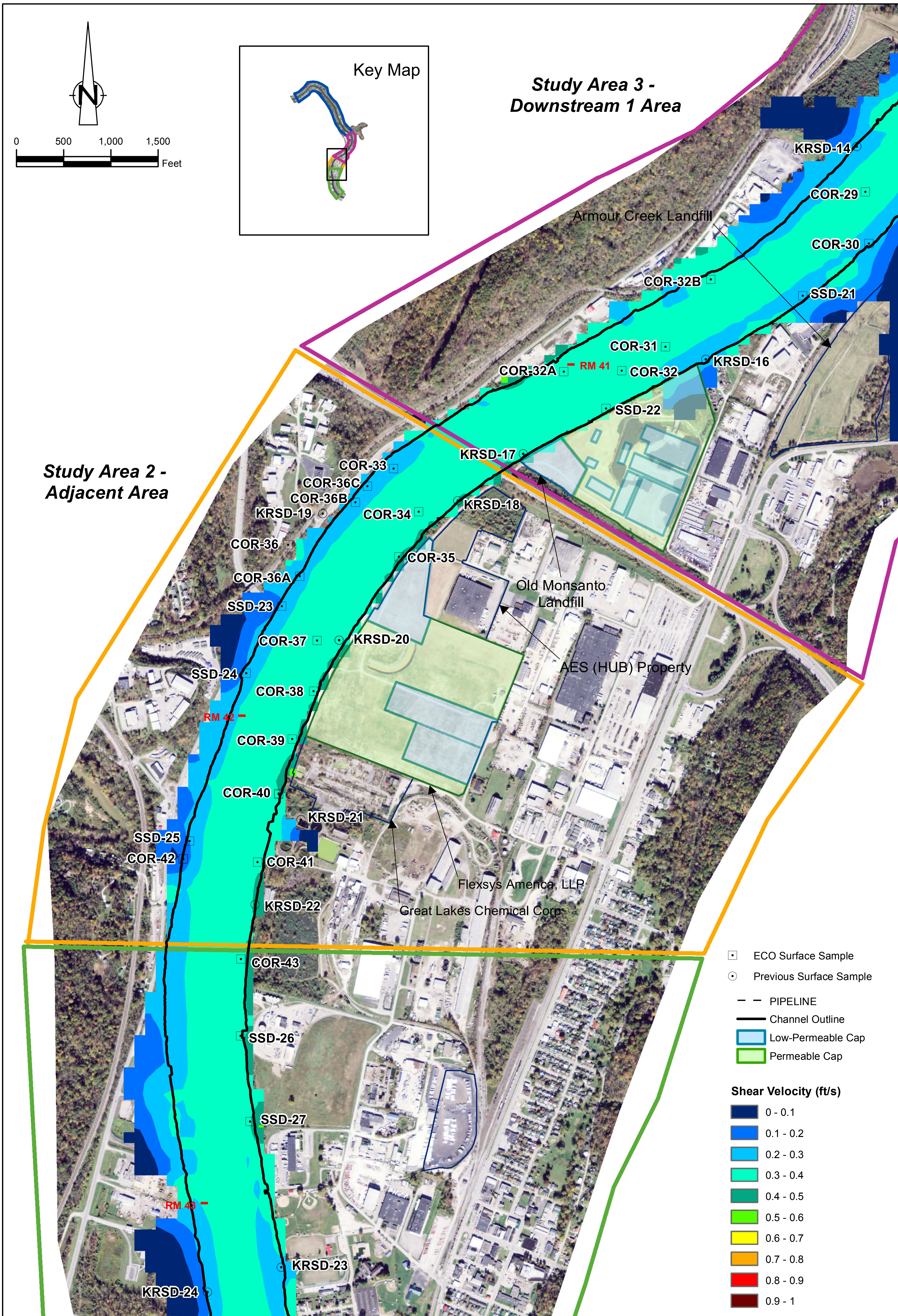


NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 4.28

SHEAR VELOCITY MAPPING - STUDY AREA 1
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

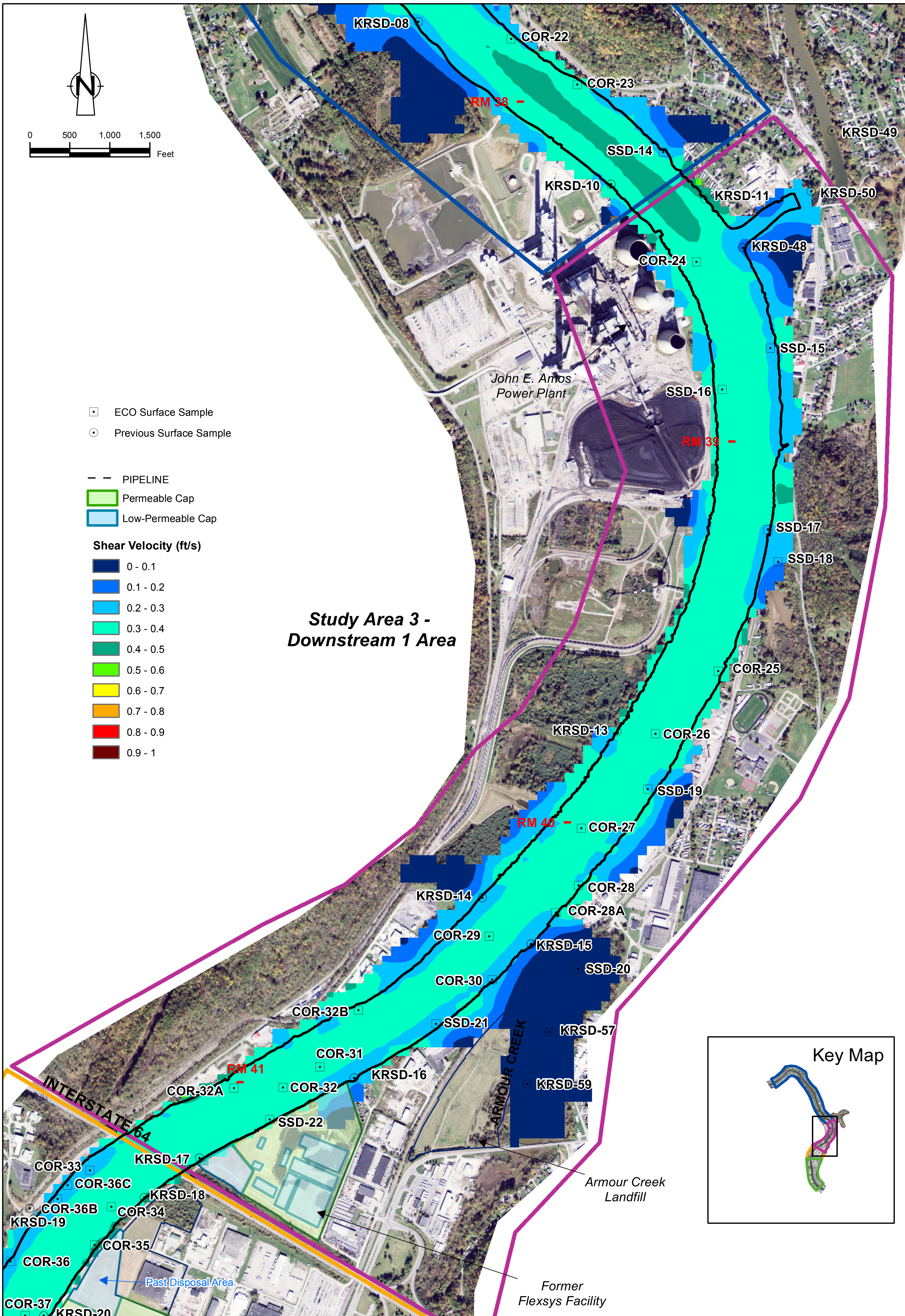
figure 4.29

SHEAR VELOCITY MAPPING – STUDY AREA 2
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

CRA

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

031884-00(REP051)GIS-WA051 February 25, 2015



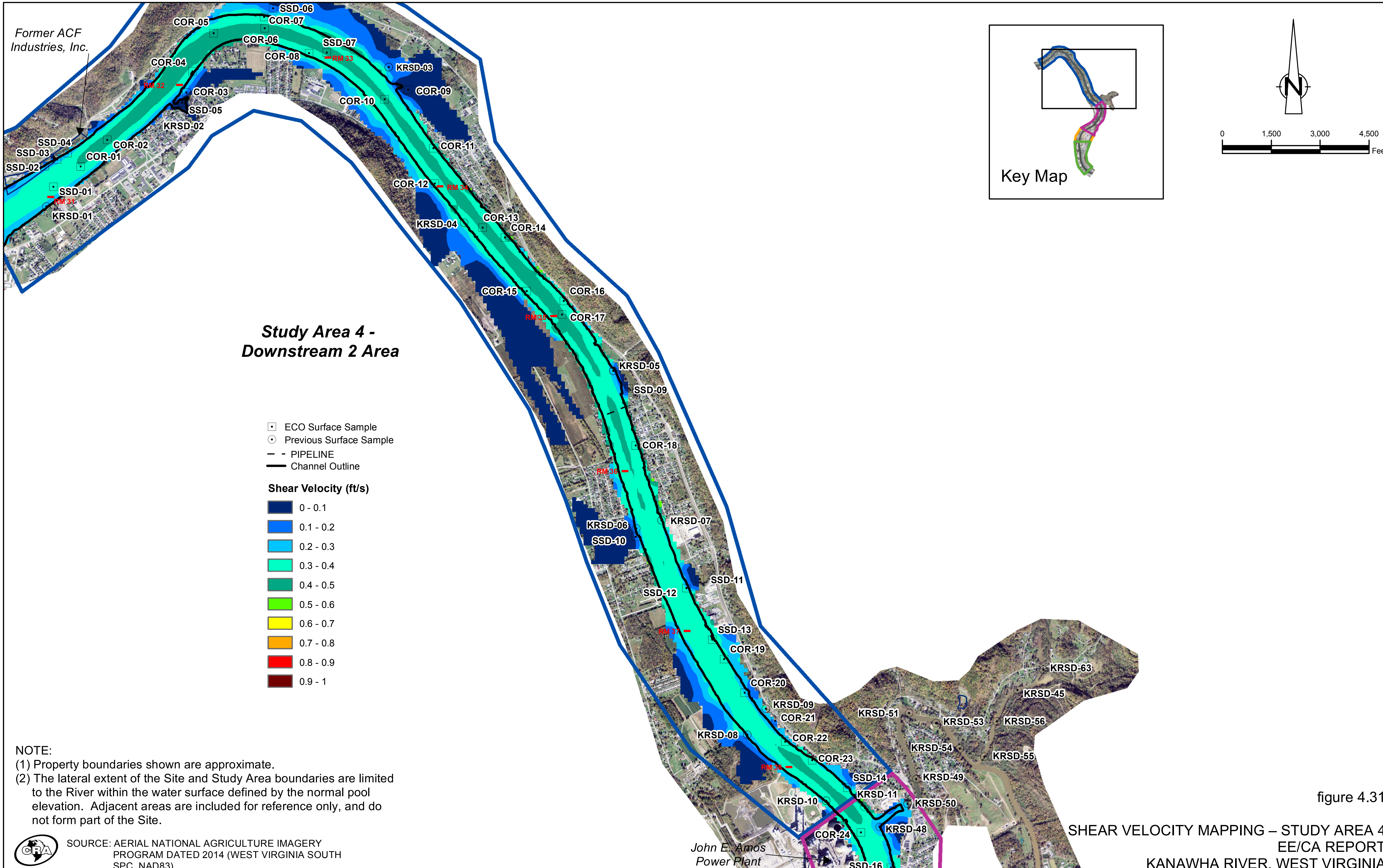
NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 4.30

SHEAR VELOCITY MAPPING – STUDY AREA 3
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

031884-00(REP051)GIS-WA052 February 25, 2015



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 4.31

SHEAR VELOCITY MAPPING – STUDY AREA 4
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

031884-00(REP051)GIS-WA053 February 25, 2015

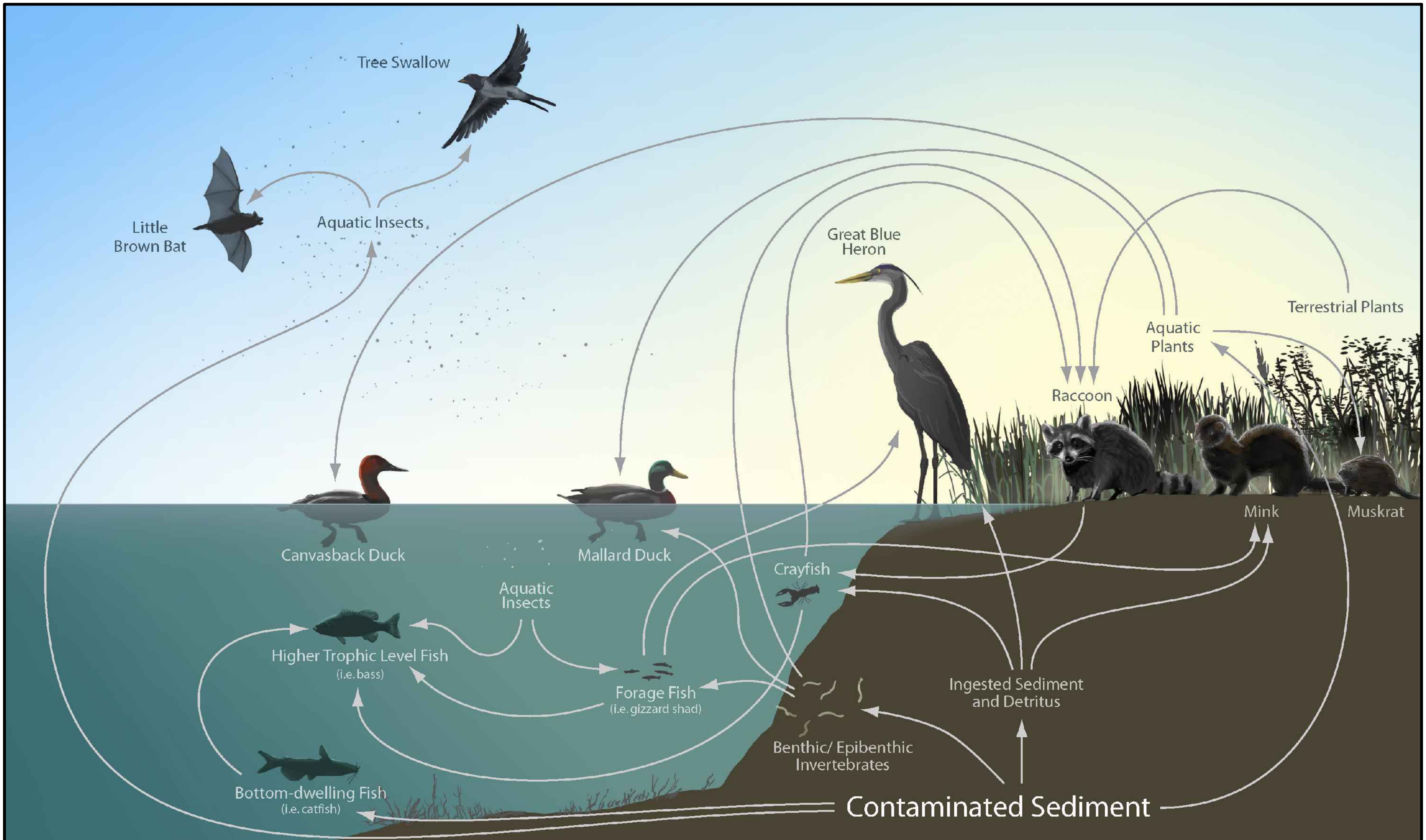


figure 4.32

EXPOSURE PATHWAYS OF ECOLOGICAL RECEPTORS
EE/CA REPORT
Kanawha River, West Virginia

31884-00(051)GN-WA009 FEB 20/2015

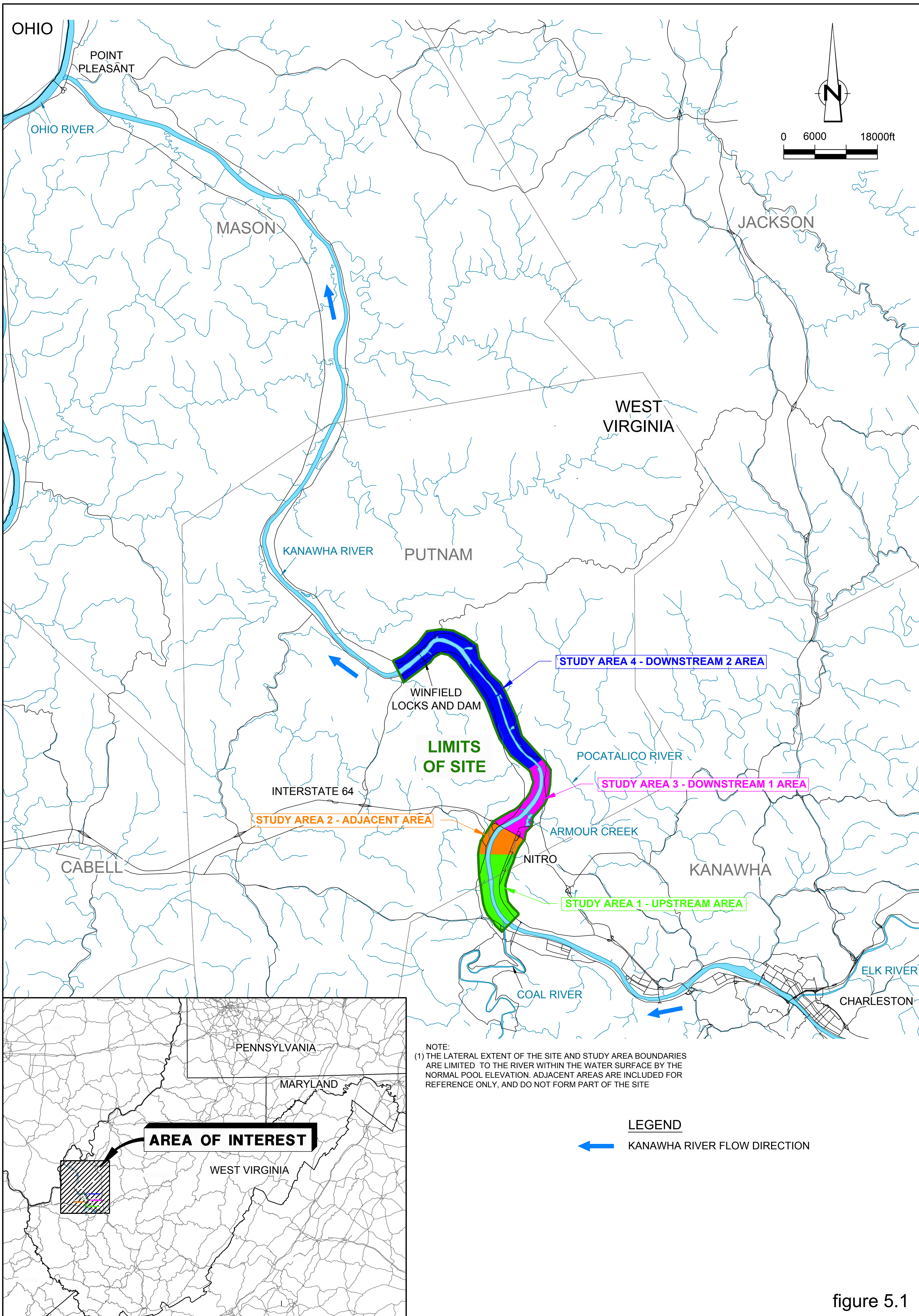


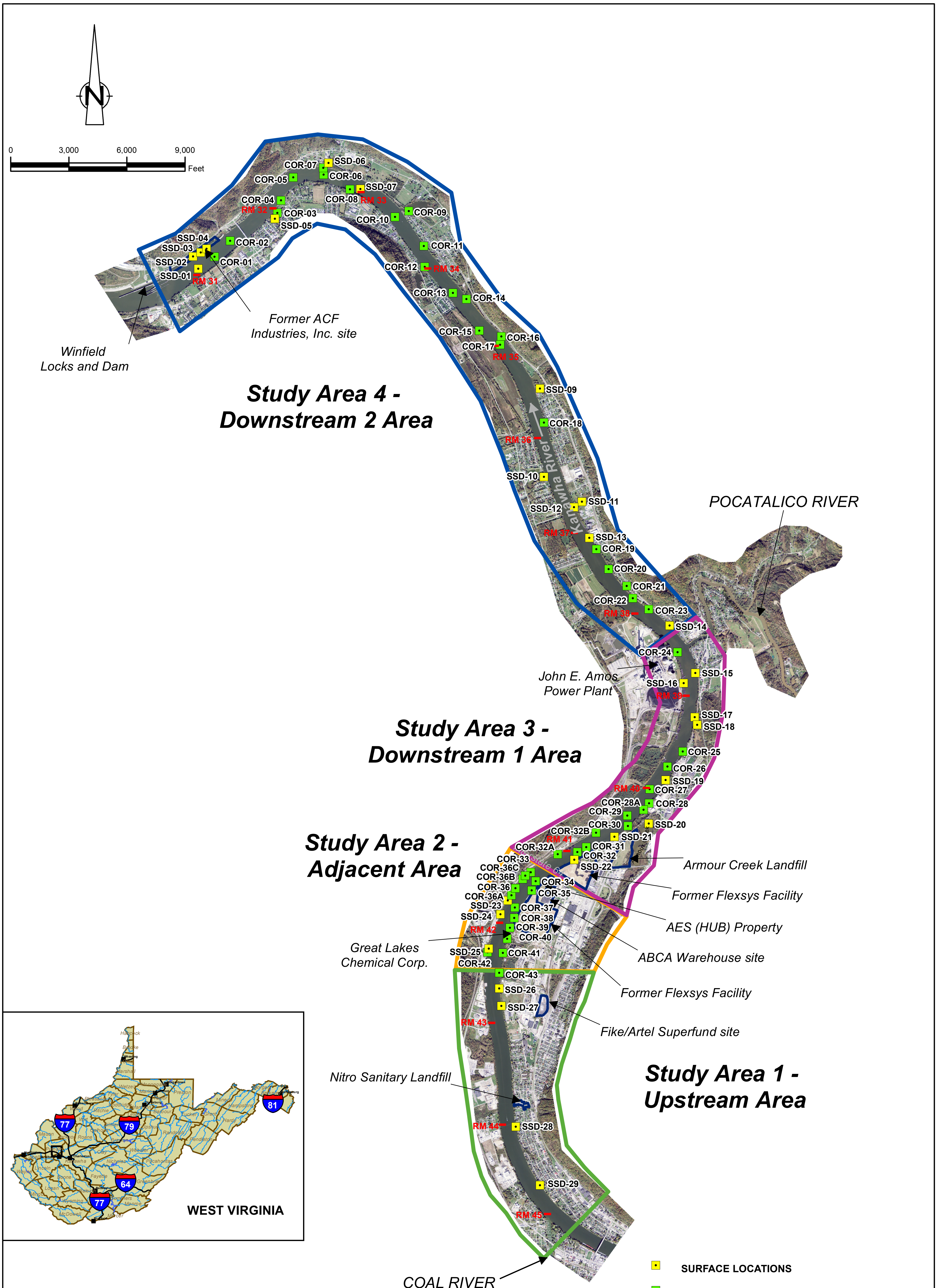
figure 5.1

SITE LOCATION - ECOLOGICAL RISK ASSESSMENT
EE/CA REPORT
Kanawha River, West Virginia

CRA

31884-00(051)GN-WA008 FEB 20/2015

AR100424



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

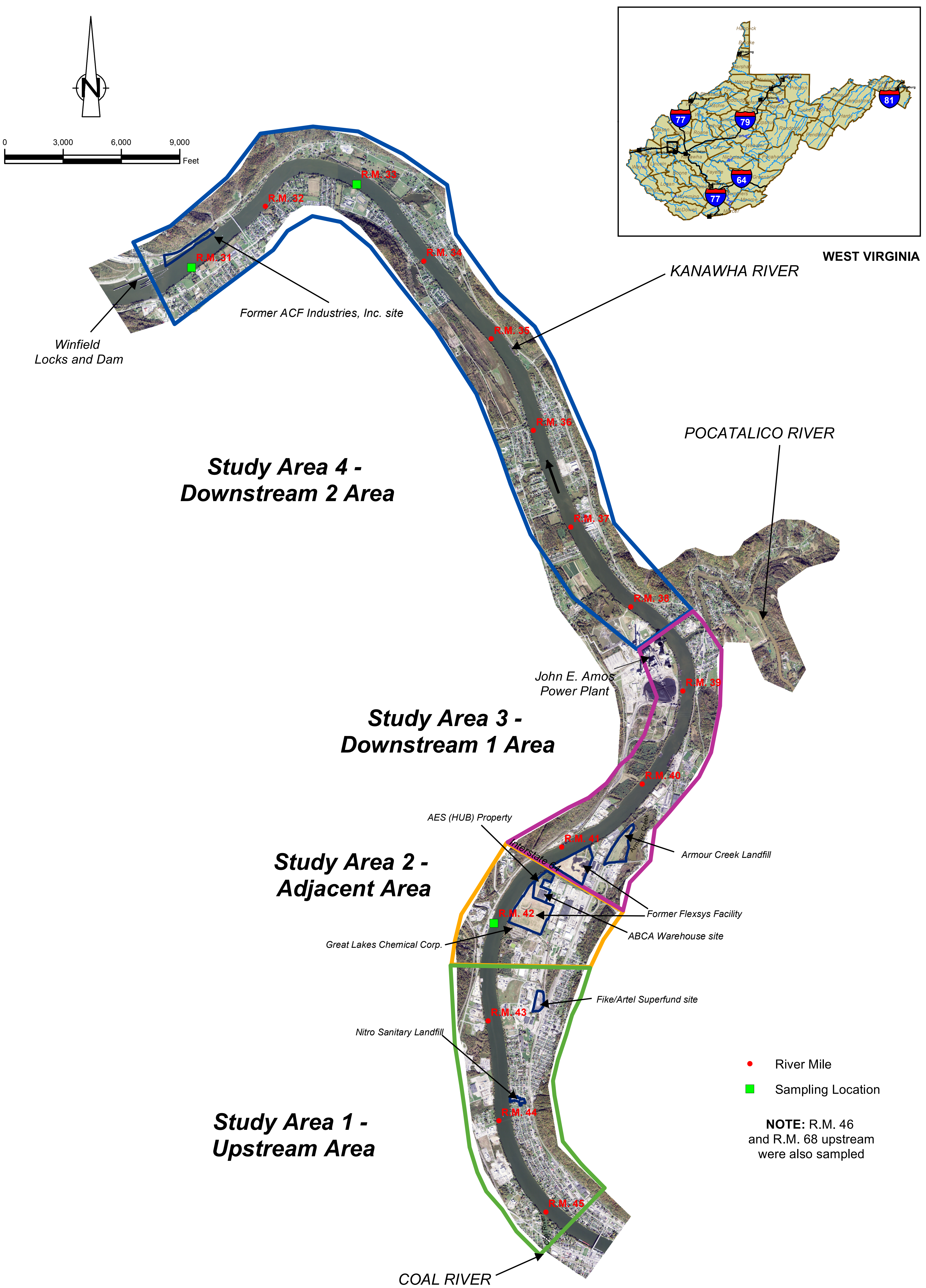
figure 5.2

SURFACE AND SUBSURFACE SEDIMENT SAMPLING LOCATIONS - ECOLOGICAL RISK ASSESSMENT
EE/CA REPORT
Kanawha River, West Virginia

CRA

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

031884-00(REP051)GIS-WA026 February 23, 2015



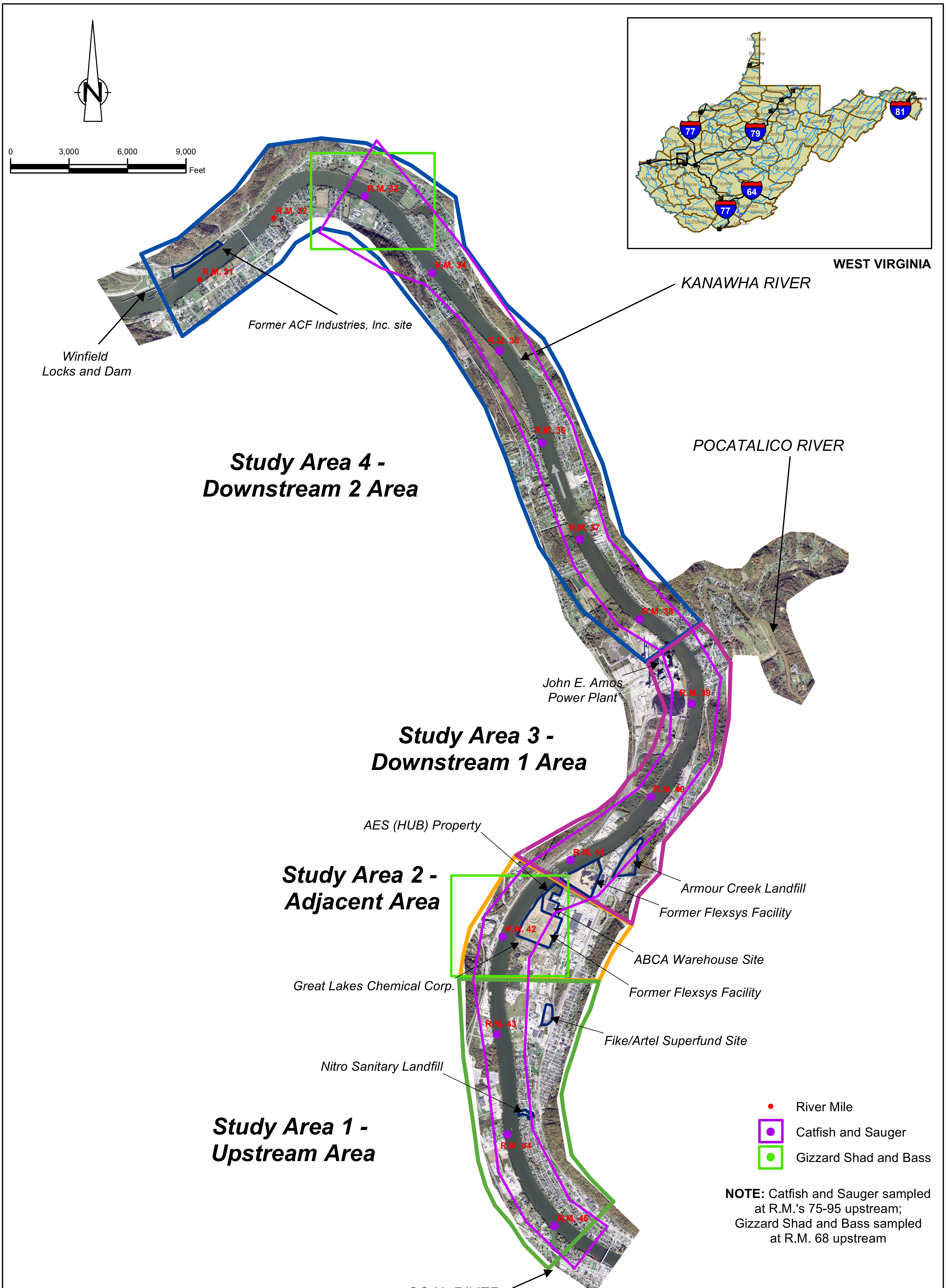
NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

figure 5.3

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

SURFACE WATER SAMPLING LOCATIONS - ECOLOGICAL RISK ASSESSMENT
EE/CA REPORT
Kanawha River, West Virginia

031884-00(REP051)GIS-WA027 February 23, 2015



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

figure 5.4

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

FISH TISSUE SAMPLING LOCATIONS - ECOLOGICAL RISK ASSESSMENT
EE/CA REPORT
Kanawha River, West Virginia

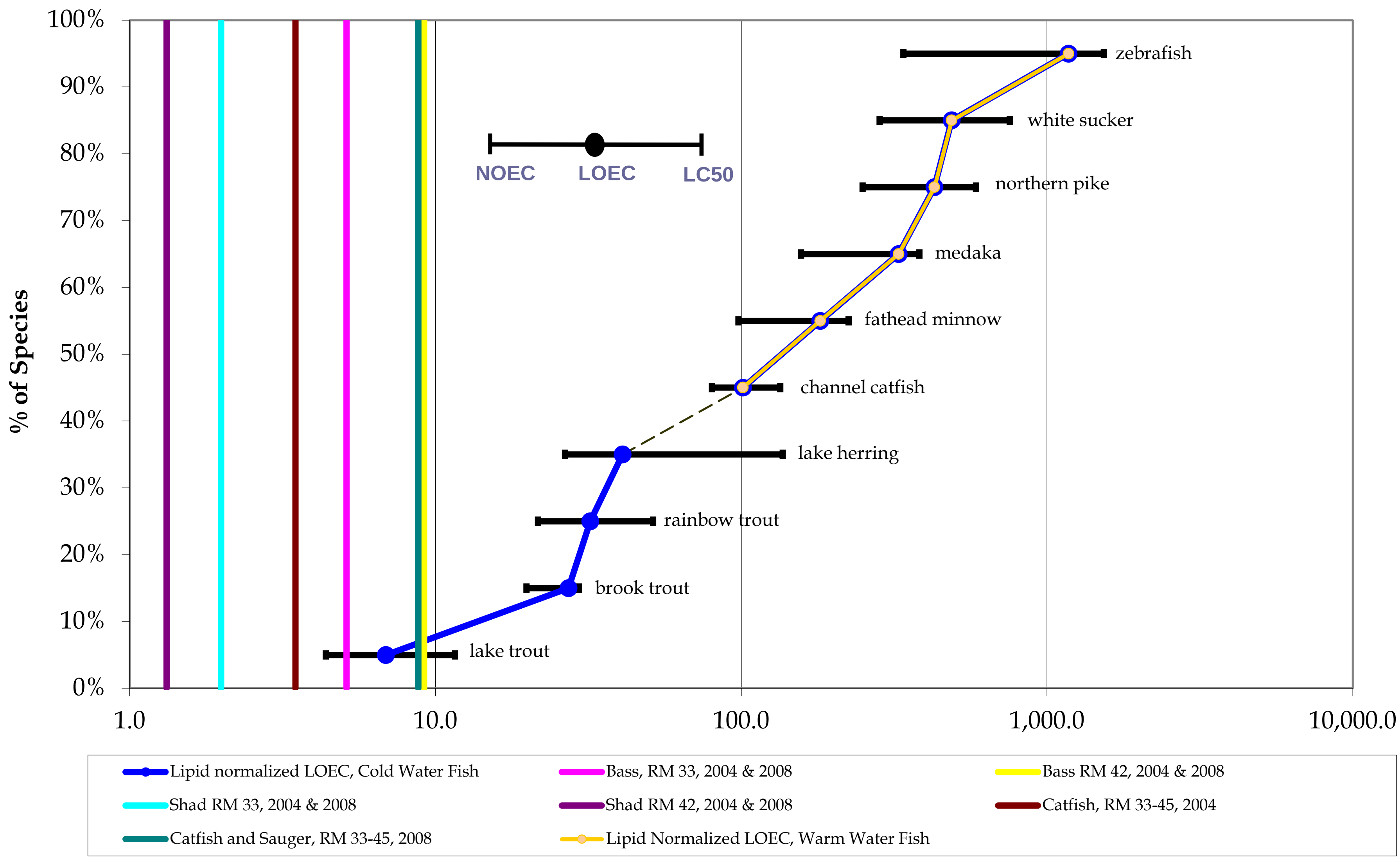


figure 5.5

SPECIES SENSITIVITY CURVE - NOEC, LOEC, LC_{50} BODY BURDENS BY SPECIES

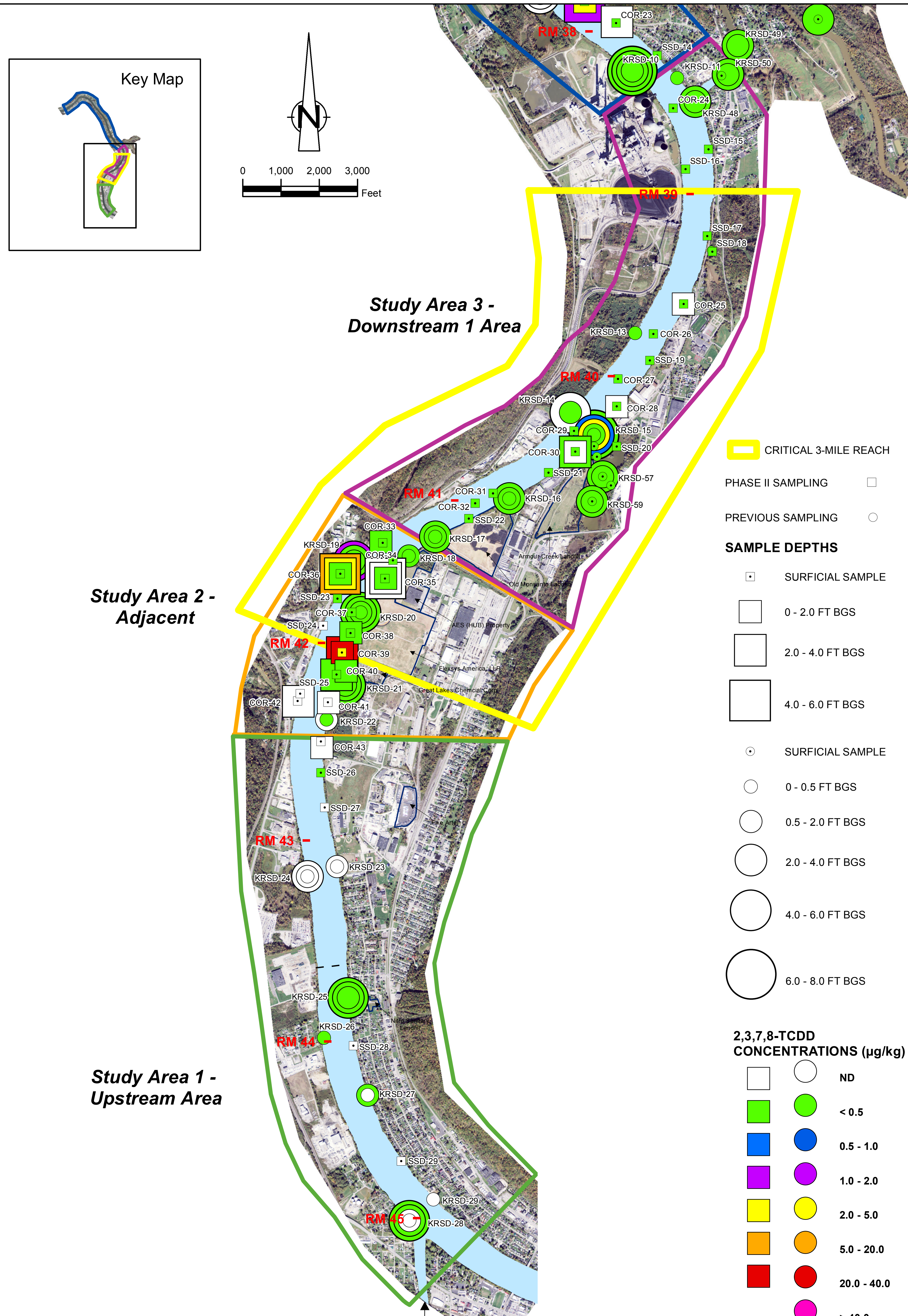
EE/CA REPORT

Kanawha River, West Virginia

ANCHOR QEA

CRA

031884-00(REP051) - figure 5.5 February 26, 2015



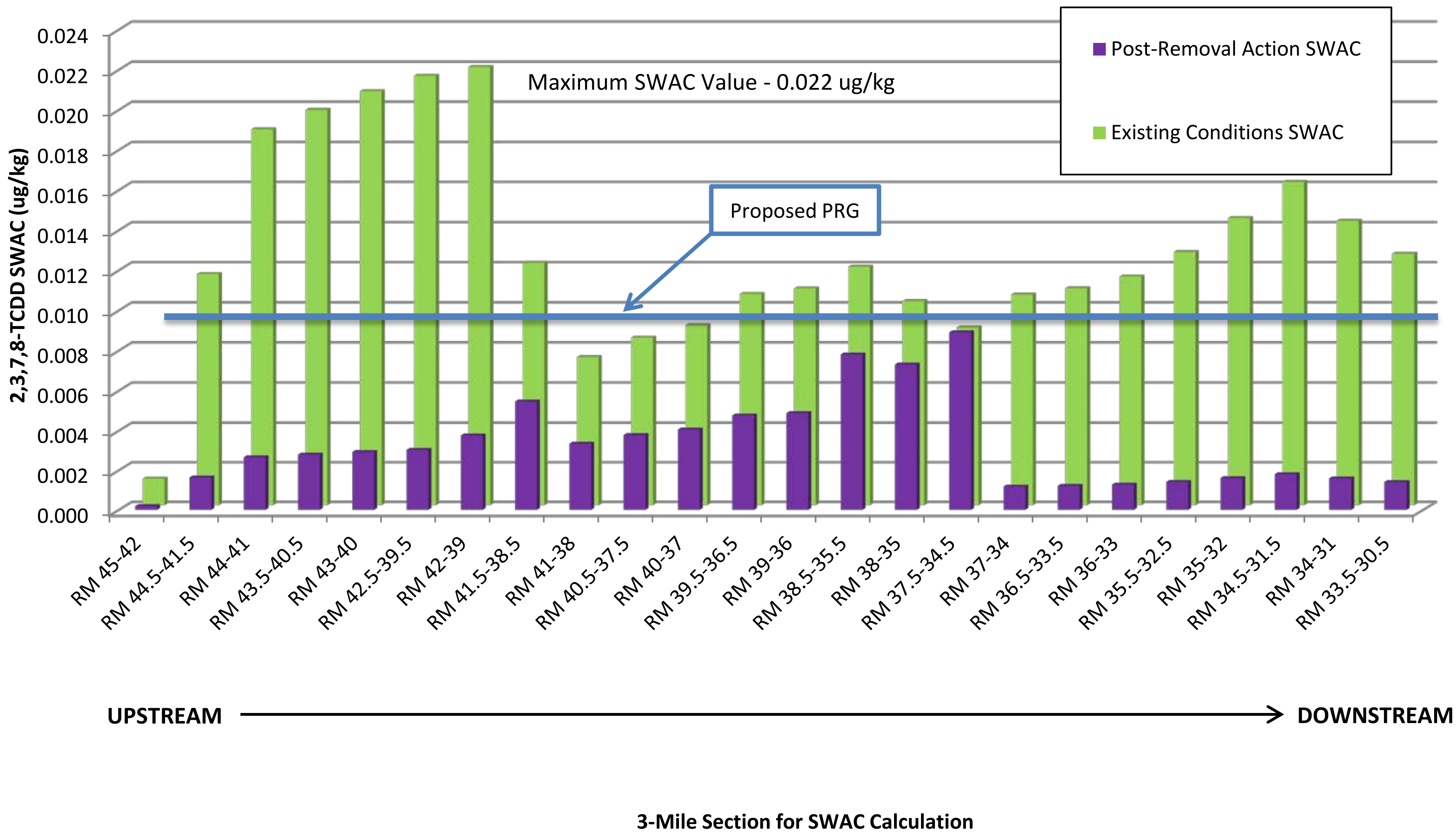
NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

figure 6.1

RM 39-42 - 3-MILE REACH WITH HIGHEST EXISTING CONDITION SWAC
EE/CA REPORT
Kanawha River, West Virginia

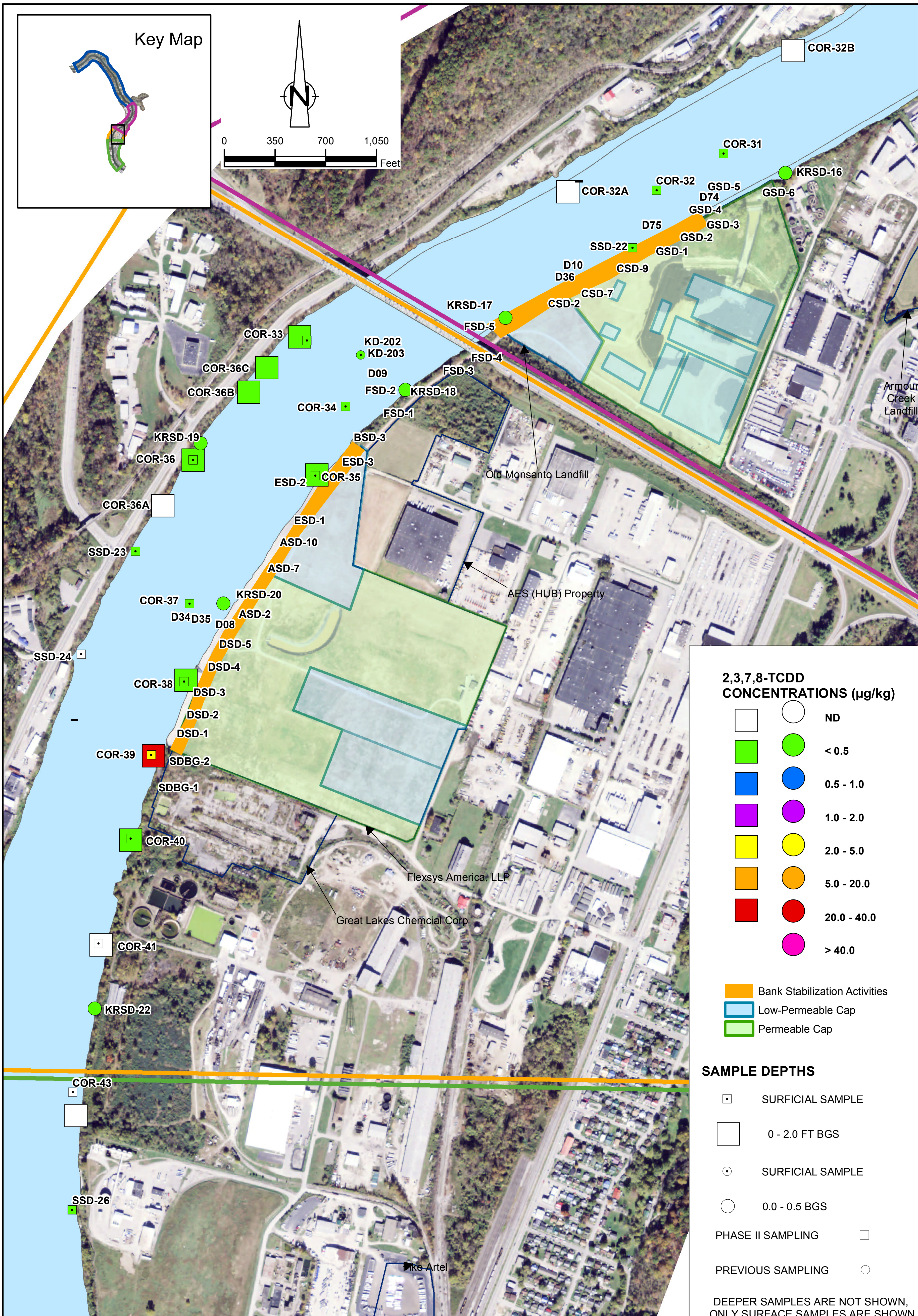
SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

031884-00(REP051)GIS-WA059 February 25, 2015



Note: Study Area 1 corresponds to approximately RM 45.5 to 42.5, Study Area 2 - RM 42.5 to 41.5, Study Area 3 - RM 41.5 to 38.5, and Study Area 4 - RM 38.5 to 30.5.

figure 6.2
POST-REMOVAL ACTION SWAC FOR ROLLING 3-MILE RANGE
EE/CA REPORT
Kanawha River, West Virginia



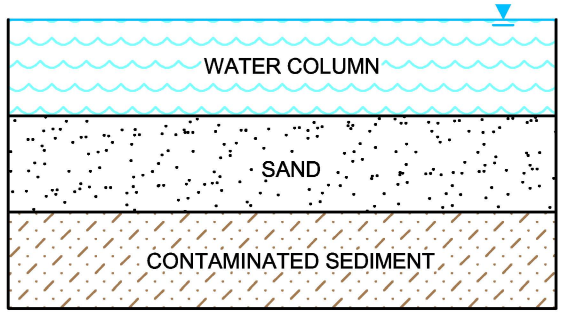
NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

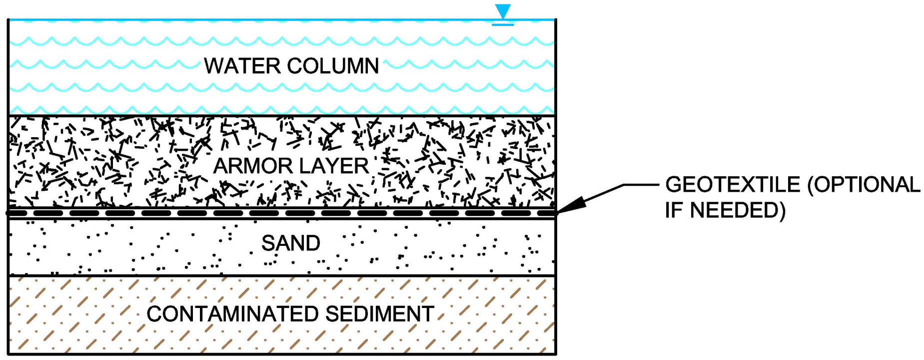
figure 7.1

PRELIMINARY LAYOUT - REMOVAL ACTION ALTERNATIVE 2
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

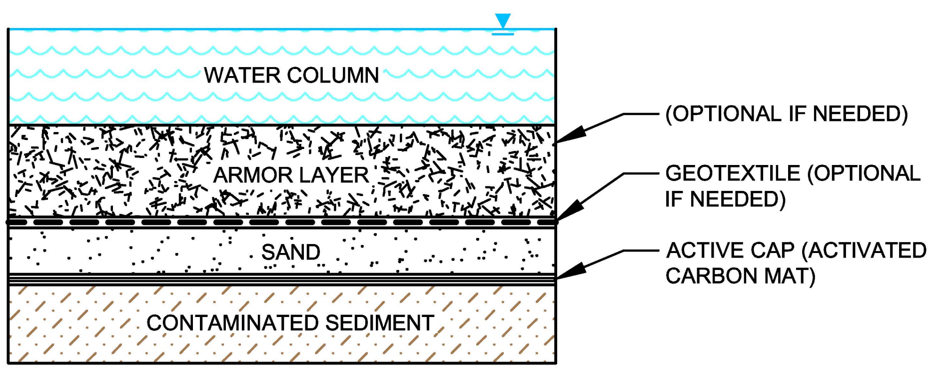
031884-00(REP051)GIS-WA030 February 23, 2015



SAND CAP
N.T.S.



ARMORING
N.T.S.

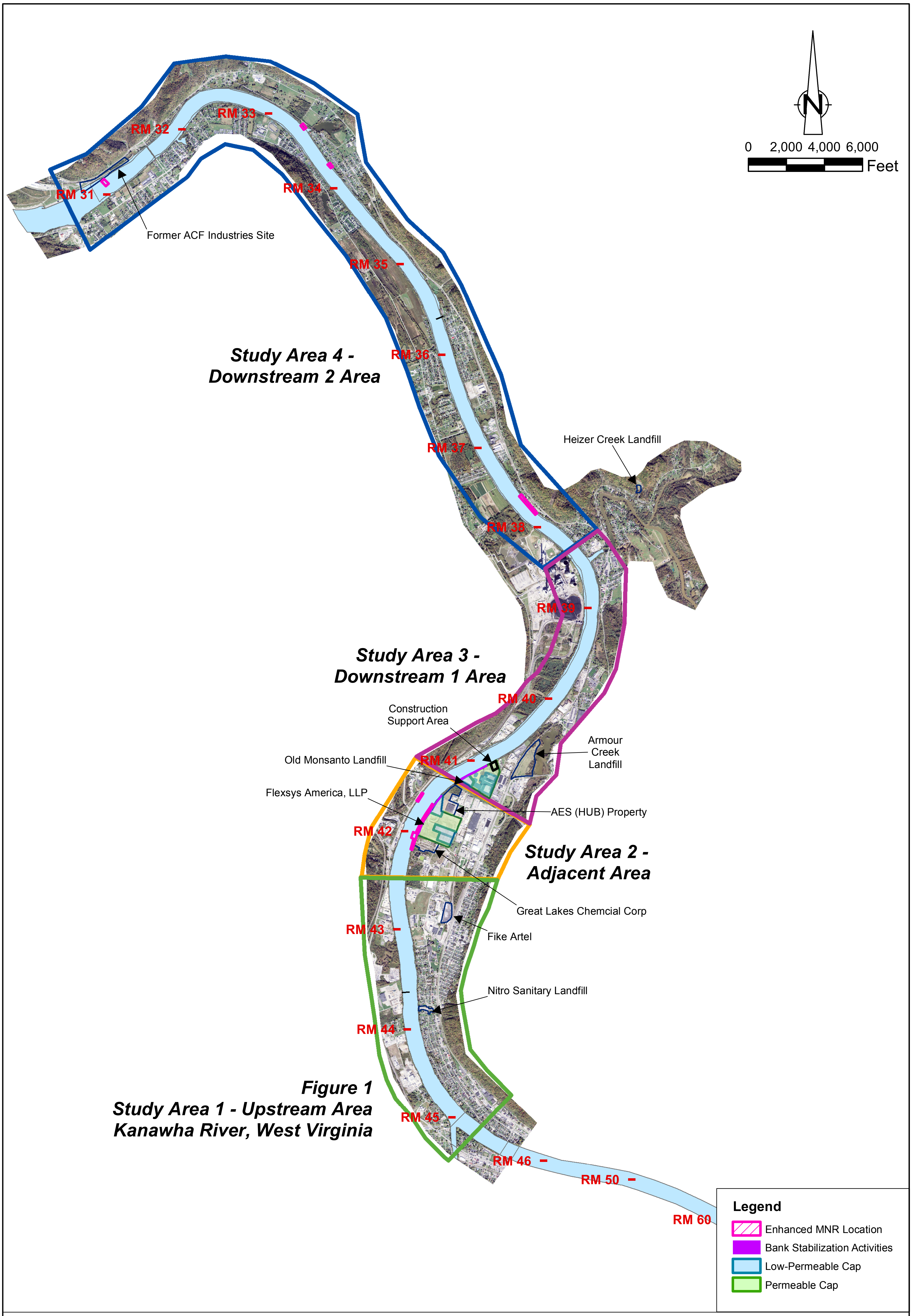


ACTIVE CAP
N.T.S.

figure 7.2

EXAMPLE ISOLATION CAP DESIGN
EE/CA REPORT
Kanawha River, West Virginia

CRA



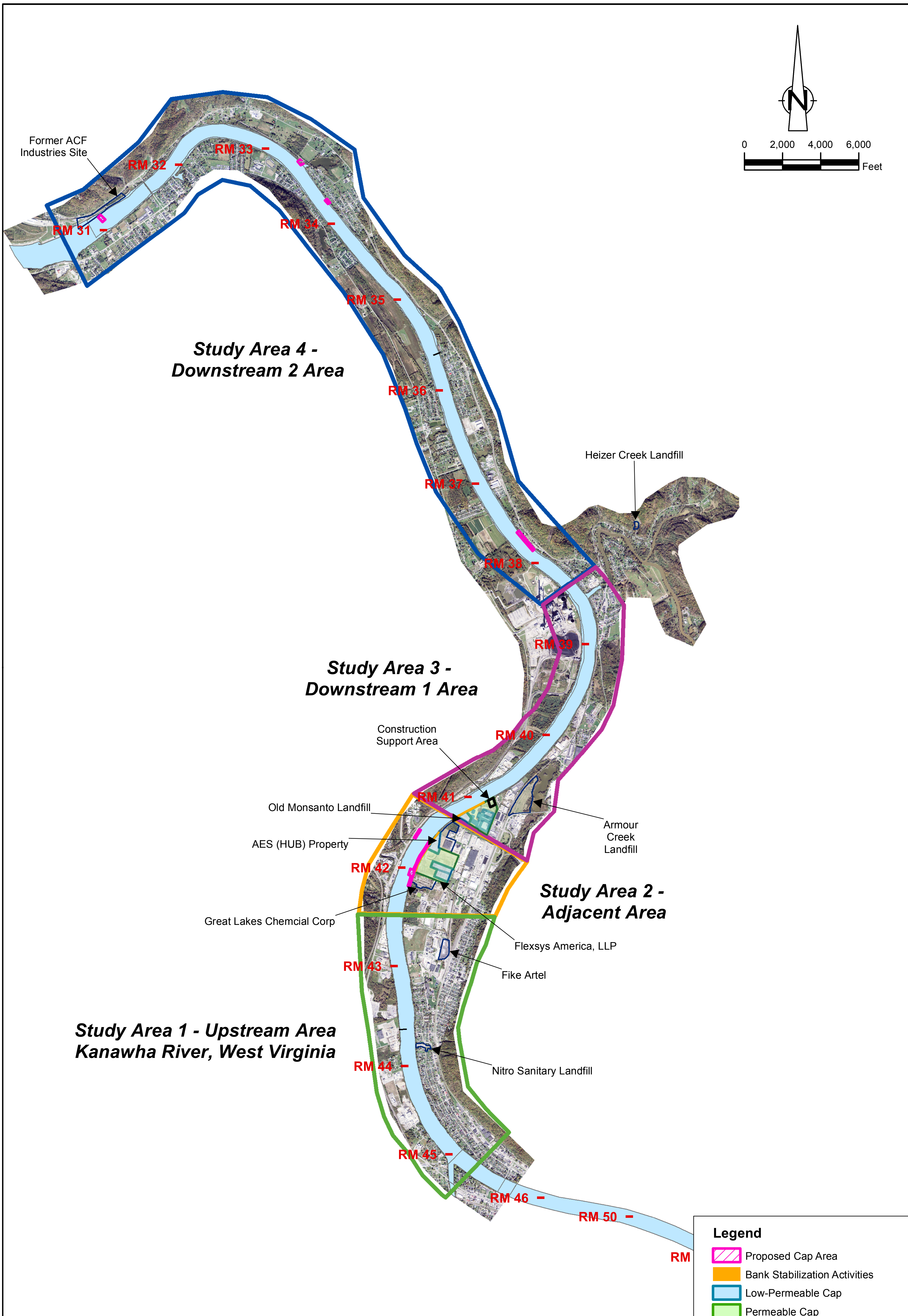
NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 7.3

PRELIMINARY LAYOUT - REMOVAL ACTION ALTERNATIVE 3
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

031884-00(REP051)GIS-WA029 February 23, 2015



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.
(3) Proposed cap areas to be defined during the design process.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 7.4

PRELIMINARY LAYOUT -
REMOVAL ACTION ALTERNATIVE 4
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

031884-00(REP051)GIS-WA031 February 27, 2015

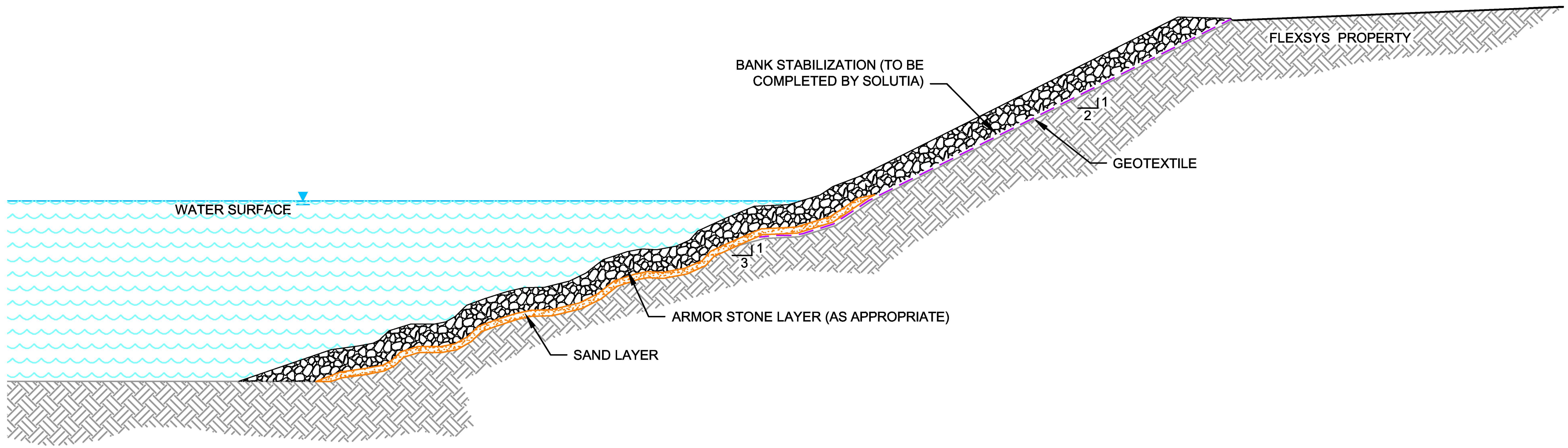
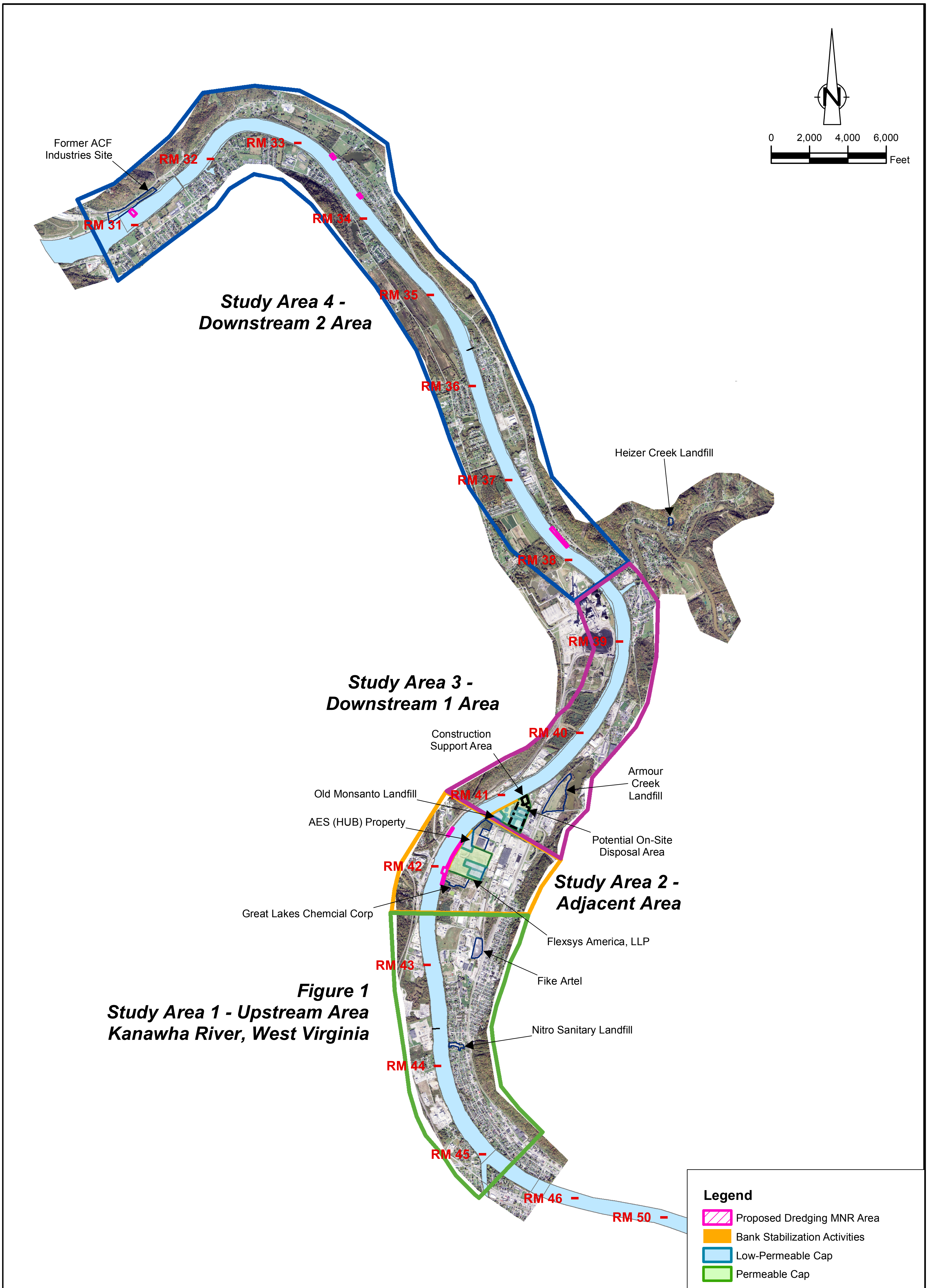


figure 7.5

CONCEPTUAL CAP CROSS-SECTION - REMOVAL ACTION ALTERNATIVE 4
EE/CA REPORT
Kanawha River, West Virginia

31884-00(051)GN-WA017 FEB 20/2015



NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

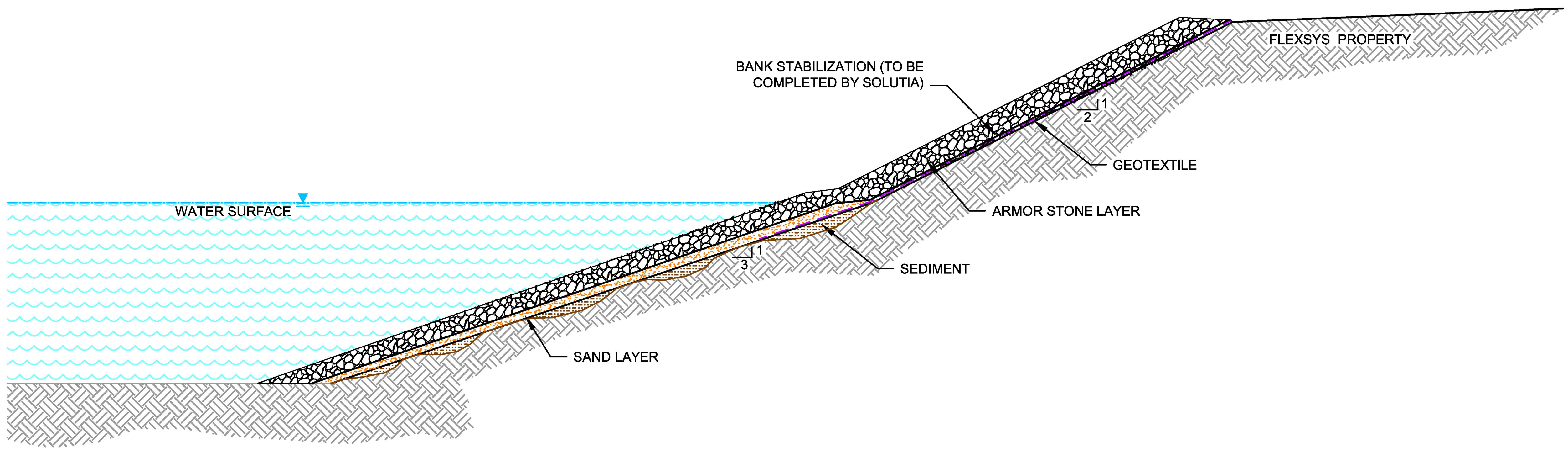
figure 7.6

PRELIMINARY LAYOUT -
REMOVAL ACTION ALTERNATIVE 5A
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

CRA

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

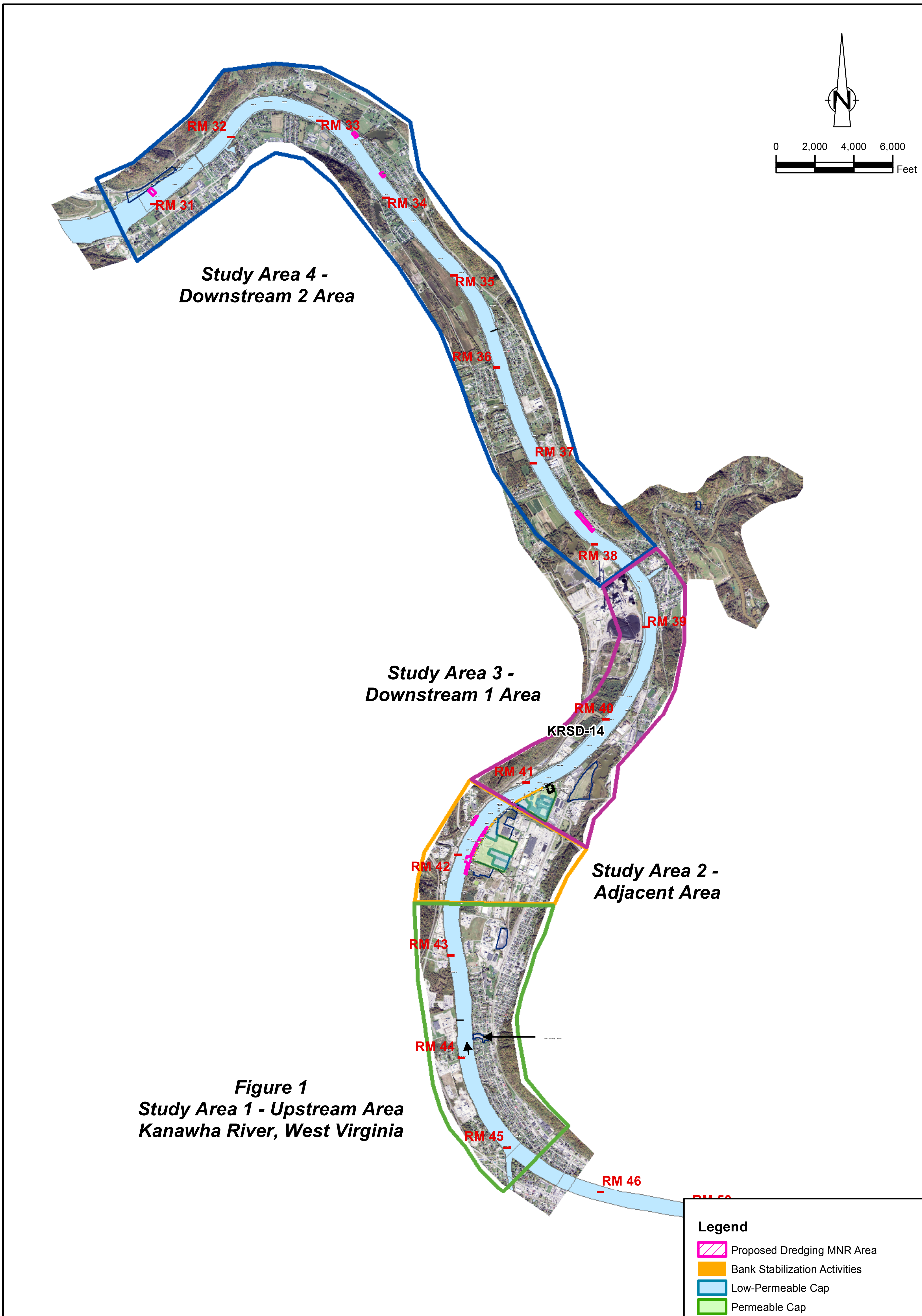
031884-00(REP051)GIS-WA032 February 27, 2015



NOTE:
(1) APPROXIMATELY 84,400 CY OF SEDIMENT WILL BE DREDGED AND THE EXTENT OF CAPPING WILL BE DETERMINED BASED ON THE EXTENT OF RESIDUALS PRESENT AFTER DREDGING. FOR THE PURPOSE OF THE EE/CA, CAPPING OF THE ONE HALF OF DREDGED AREA IS ASSUMED TO BE REQUIRED

figure 7.7

CONCEPTUAL DREDGING CROSS-SECTION - REMOVAL ACTION ALTERNATIVES 5A AND 5B
EE/CA REPORT
Kanawha River, West Virginia

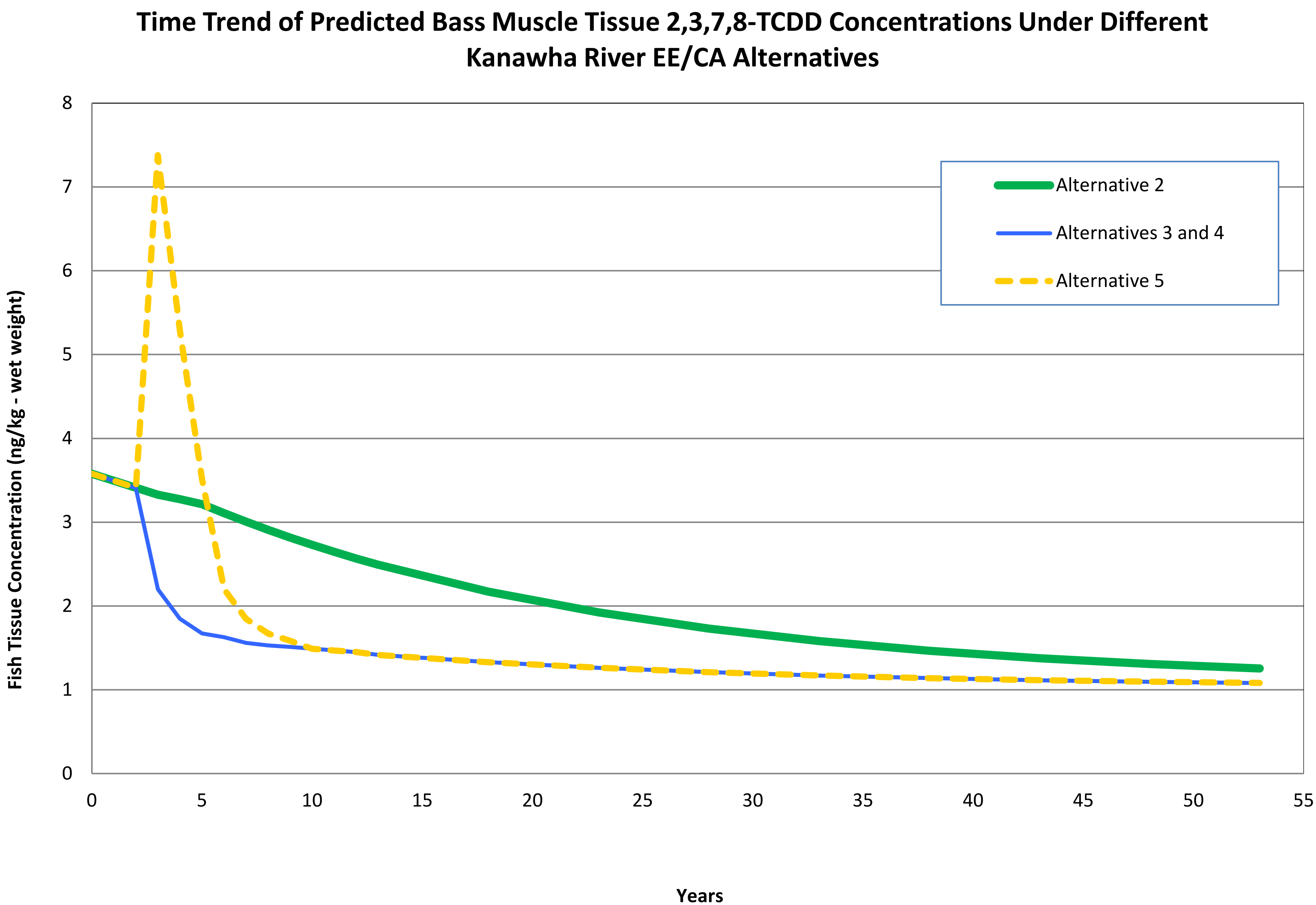


NOTE:
(1) Property boundaries shown are approximate.
(2) The lateral extent of the Site and Study Area boundaries are limited to the River within the water surface defined by the normal pool elevation. Adjacent areas are included for reference only, and do not form part of the Site.

SOURCE: AERIAL NATIONAL AGRICULTURE IMAGERY PROGRAM DATED 2014 (WEST VIRGINIA SOUTH SPC, NAD83)

figure 7.8

PRELIMINARY LAYOUT -
REMOVAL ACTION ALTERNATIVE 5B
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA



Note: It is important to note that the screening-level recovery modeling performed for this EE/CA was performed solely to develop comparative evaluations of the long-term effectiveness of the RA alternatives under a consistent set of assumptions. Actual recovery trajectories could deviate from these predictions if a different set of assumptions were to be used (e.g., source control effectiveness).

figure 8.1
FISH TISSUE RECOVERY TRENDS FOR REMOVAL ACTION ALTERNATIVES 2 THROUGH 5
EE/CA REPORT
Kanawha River, West Virginia

ANCHOR QEA

CRA

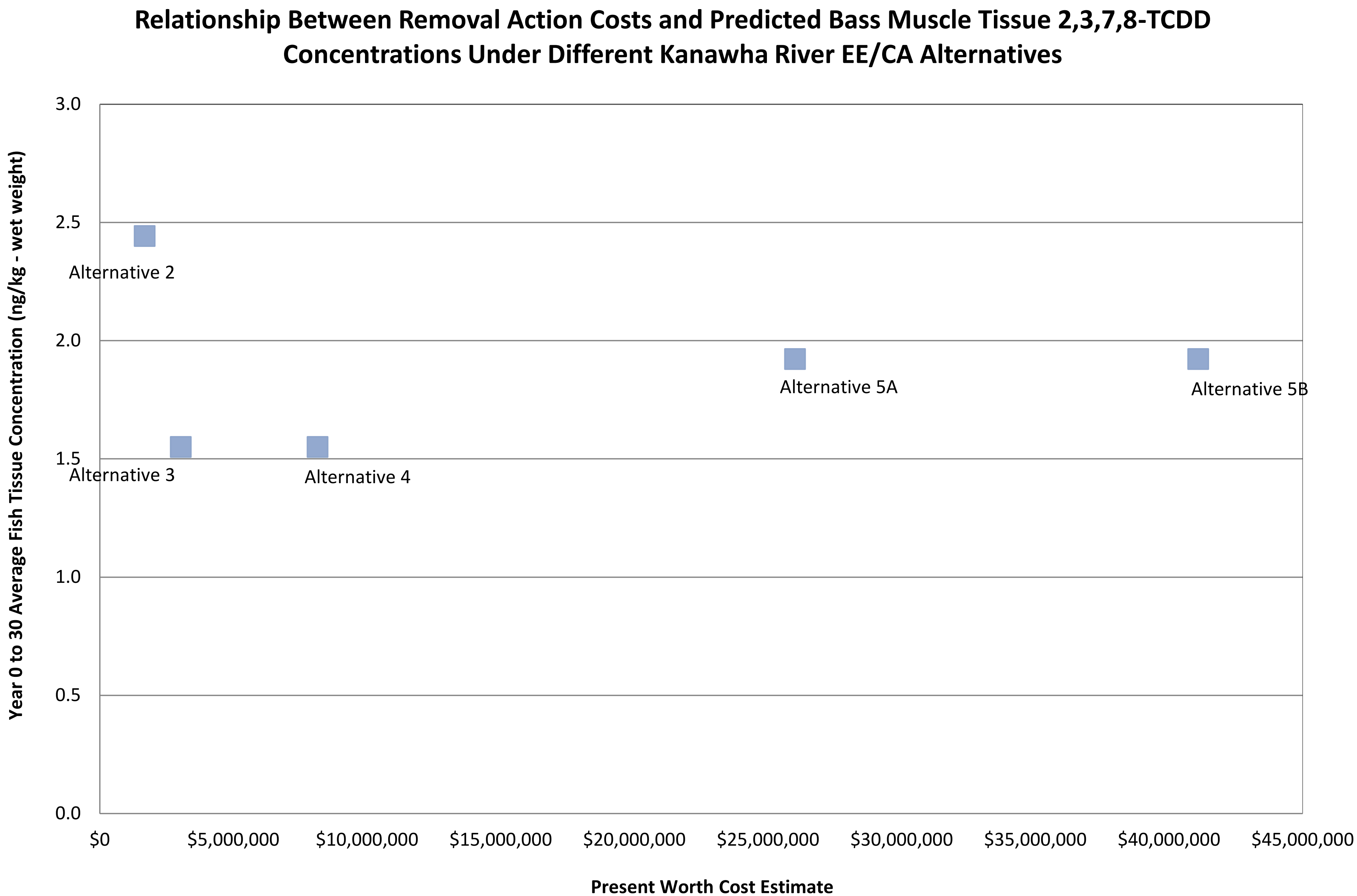


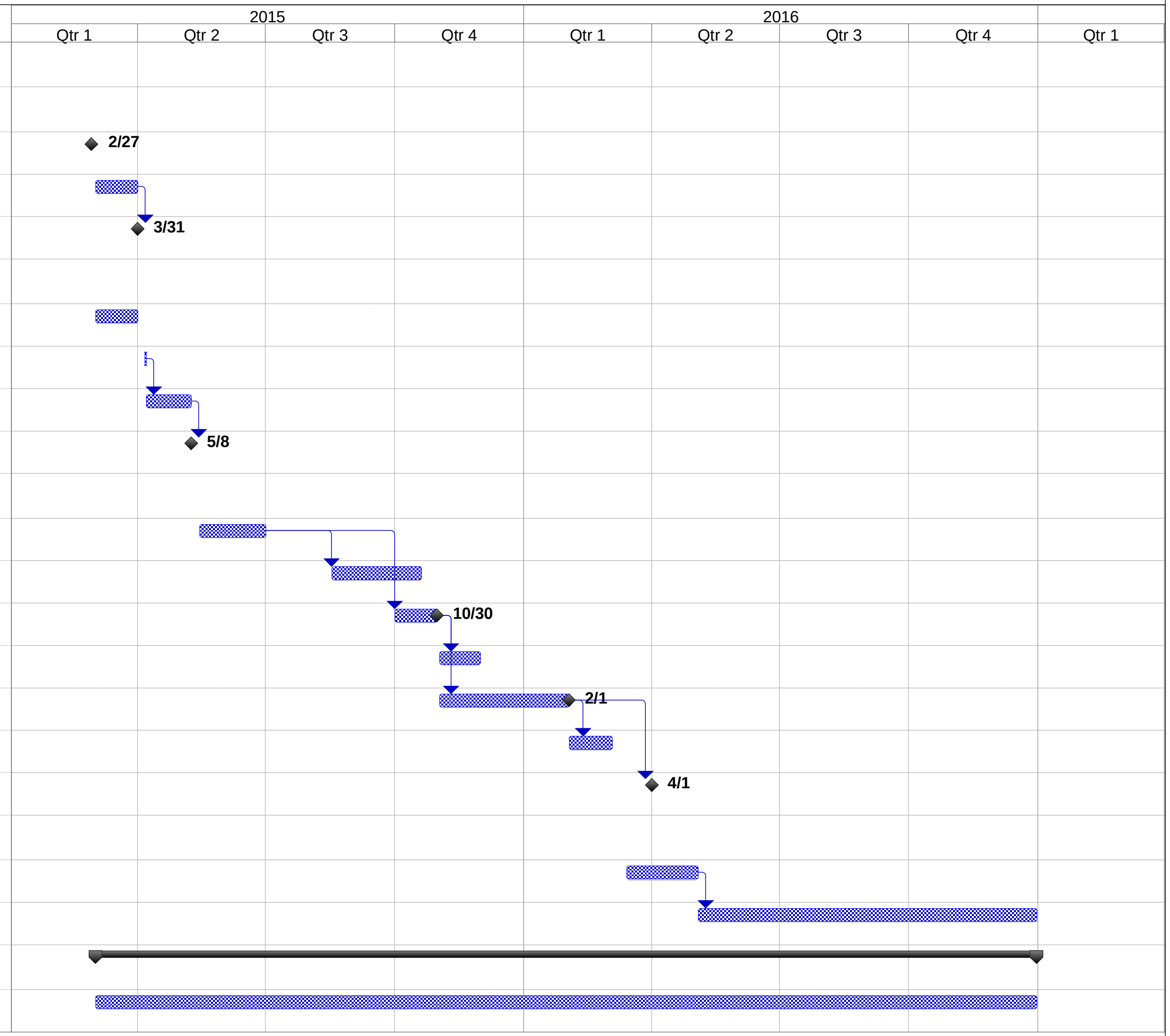
figure 9.1
COST VERSUS FISH TISSUE RECOVERY FOR RA ALTERNATIVES 2 THROUGH 5
EE/CA REPORT
Kanawha River, West Virginia

ANCHOR QEA CRA

031884-00(REP051) - figure 9.1 February 27, 2015

DRAFT

ID	Task Name	Start	Finish
1	**Kanawha River**	**Fri 2/27/15**	**Wed 8/2/17**
2	**EE/CA Report**	**Fri 2/27/15**	**Mon 3/30/15**
3	Submit revised Draft EE/CA	Fri 2/27/15	Fri 2/27/15
4	Agency Review/Public Comment	Mon 3/2/15	Tue 3/31/15
5	Approval of EE/CA Report	Tue 3/31/15	Tue 3/31/15
6	**Action Memorandum/AOC**	**Wed 4/1/15**	**Tue 6/30/15**
7	Development of the Action Memorandum by USEPA	Mon 3/2/15	Tue 3/31/15
8	Finalize Action Memorandum	Mon 4/6/15	Mon 4/6/15
9	Negotiate AOC for Selected Removal Action	Tue 4/7/15	Fri 5/8/15
10	Executed AOC	Fri 5/8/15	Fri 5/8/15
11	**Design**	**Wed 7/1/15**	**Wed 9/30/15**
12	Pre-design Investigations	Fri 5/15/15	Tue 6/30/15
13	Coordinate with USACE on Design	Mon 8/17/15	Mon 10/19/15
14	Develop and submit to Agency 30% Design	Thu 10/1/15	Fri 10/30/15
15	Agency Review	Mon 11/2/15	Mon 11/30/15
16	Develop and submit to Agency 95% Design	Mon 11/2/15	Mon 2/1/16
17	Agency Review	Tue 2/2/16	Thu 3/3/16
18	Submit 100% Design	Fri 4/1/16	Fri 4/1/16
19	**Construction**	**Mon 2/1/16**	**Fri 12/30/16**
20	Contractor Procurement	Mon 3/14/16	Tue 5/3/16
21	Removal Action Implementation	Wed 5/4/16	Fri 12/30/16
22	**Former Flexsys Facility RCRA Corrective Action**	**Mon 3/2/15**	**Fri 12/30/16**
23	Interim Measures Implementation	Mon 3/2/15	Fri 12/30/16



Project: 031884(RPT051) - figure 10.1
Date: Thu 2/26/15

Task | Milestone ◆ | Summary

NOTES:
The schedule dates are preliminary and may need to be revised based on the final scope of selected RA, agency review and approval time and the need to coordinate activities in the River with source control activities at the Former Flexsys Facility.

It is assumed that the schedule will be adjusted to allow pre-design activities to occur during suitable weather conditions during late spring/summer months and that the remedy implementation will commence in the spring, allowing implementation to occur within one construction season.

figure 10.1
CONCEPTUAL PROJECT SCHEDULE
EE/CA REPORT

TABLE 3.1

SUMMARY OF PREVIOUS INVESTIGATIONS OF THE KANAWHA RIVER
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Report Date	*Title of Investigation*	*Prepared By*	*Prepared For*	*Contained Relevant Information**
September 3, 1962	Memorandum - Nitro Refuse Dump on Poca River	Bern Wright, Chief	WV DWR	Yes
March 12, 1973	Memorandum to WV DNR Filing, from Donald C. Thomas, WV DNR, Re: Performance of Wastewater Plant	WV DNR	WV DNR	Yes
May 16, 1977	WV DNR, Division of Water Resources Application for Water Pollution Control Permit, Disposal of Industrial Waste, Union Carbide Corporation, Chemicals and Plastics, Institute Plant	Union Carbide Corporation	WV DEP	Yes
February, 1978	Compliance Monitoring and Wastewater Characterization of Fike Chemicals, Inc., Coastal Tank Lines, Inc., and Cooperative Sewage Treatment, Inc., Nitro, West Virginia	U.S. EPA, Region III	U.S. EPA, Region III	Yes
August, 1978	Evaluation of Hazardous Waste Disposal Holz Pond	D'Appolonia Consulting Engineers, Inc.	Union Carbide Corporation	Yes
February 2, 1979	Letter to Mr. Scott MacMillin, WV DWR, from George F. Hurley, UCC	UCC	UCC	Yes
May 25, 1979	EPA to Inspect Monsanto Dump at Nitro	Robert Morris	The Charleston Gazette	Yes
1980	Field Investigation of Uncontrolled Hazardous Waste Sites, FIT Project, Nitro Landfill	Ecology and Environment, Inc.	NA	Yes
April 25, 1980	Results of Site Investigation and Leachate Sample Analysis	Fred C. Hart Associates, Inc.	Department of Natural Resources	Yes
June, 1980	Hazardous Site Inspection - Fike Chemicals, Inc.	National Enforcment Investigations Center	U.S. EPA, Region III	Yes
June, 1980	Hazardous Site Inspection - Fike Chemicals, Inc.	National Enforcement Investigations Center	EPA	Yes
September, 1980	Sampling and Analysis of Fish Tissues for Toxic Substances, EPA/FWS IAG-DY-01001, Final Report	U.S. Fish and Wildlife Service	U.S. Fish and Wildlife Service	Yes
January 6, 1981	Field Investigations of Uncontrolled Hazardous Waste Sites - Holmes Madden Landfill	Ecology & Environmental, Inc.	U.S. EPA, Region III	Yes
June 29, 1981	Site Inspection, Manila Creek	WV DWR	WV DNR	Yes
May, 1982	Groundwater Monitoring at the "B" Outfall Lagoon	Michael Baker, Jr., Inc.	Weirton Steel	No
May 25, 1982	Site Investigation Summary Sheet, Manila Creek, Site Number WV-1	WV DEP	WV DEP	Yes
August 20, 1982	Field Trip Report of nitro Sanitation TDD No. F8-8108-14A	Ecology Environmental Inc.	EPA Region III	Yes
October, 1982	Federal On-Scene Coordinator's Report, Immediate Removal Action, Poca, West Virginia	US EPA	U.S. EPA	Yes
December 6, 1982	Request for Information - Union Carbide Corporation North Charleston Storage Area Past Waste Disposal	Union Carbide Corporation	WV DWR	Yes
December 22, 1982	Inter-Office Memorandum - Manila Creek Benthic Survey	Janice Fisher, WV DWR	WV DNR	Yes
July 29, 1983	Letter to Robert L. Collings, U.S. EPA, Region III, from Bruce P. Smith, U.S. EPA, Region III, Re: Fike Chemical	Bruce P. Smith, Chief	U.S. EPA, Region III	Yes
August 12, 1983	Memorandum: to Kenneth E. Biglane, U.S. EPA, Washington, from Benton M. Wilmoth, OSC, U.S. EPA, Region III, Re: Request for Assistance of ERT for a Technical Assessment of the Current Environmental Corrective Work at Fike Chemical Company, Nitro , West Virginia	Benton M. Wilmoth, OSC	U.S. EPA, Region III	Yes
August 23, 1983	Enforcement Review of Available Data for Nitro Sanitation, West Virginia	NUS Corporation	U.S. EPA - Hazardous Control Division	Yes
October 17, 1983	Preliminary Assessment - Heizer Creek	NUS Corporation	U.S. EPA, Region III	Yes
December 29, 1983	DRAFT - Site Inspection of Manila Creek Dump	NUS Corporation	U.S. EPA	Yes
May 11, 1984	A Preliminary Assessment of Republic Steel Corporation Container Division, Nitro, West Virginia	WV DNR	WV DNR	Yes
July 31, 1984	Preliminary Assessment, Putnam County Drum Dump	WV DWR	WV DEP	Yes
December 26, 1984	A Field Trip Report for Manila Creek	NUS Corporation	U.S. EPA, Region III	Yes
January, 1985	RCRA Part B Permit Application - Institute Plant	Union Carbide Corporation Agricultural Products Company	US EPA Division of Water Resources	Yes
March 18, 1985	Field Trip Report for Heizer Creek	NUS Corporation	U.S. EPA, Region III	Yes
April, 1985	Feasibility Study of Manila Creek Site	Dale K. Wilson, Monsanto	Monsanto	Yes
April 4, 1985	Application for Permit to Construct Fluidize Bed Incinerator for Incineration of Hazardous Wastes	Mobay Chemical Corporation	US EPA Division of Water Resources	No
May 9, 1985	Burns received by Leroy Whitt after handling scrap material from Allied Chemical Plant, Ironton, OH	Rebecca J. Robertson	WV DNR	Yes
May 14, 1985	Non-sampling Site Reconnaissance Summary Report, Republic Steel Corporation, Nitro, WV	NUS Corporation	NUS Corporation	Yes
June, 1985	Feasibility Study of Monsanto Landfill Site	Monsanto Company - Corporate Engineering Department	Monsanto Polymer Products Company	Yes
June 28, 1985	Site Inspection for the Heizer Creek Landfill	NUS Corporation	U.S. EPA, Region III	Yes
June 28, 1985	A Site Inspection for the Heizer Creek	NUS Corporation	U.S. EPA	Yes
June 28, 1985	Memorandum - 2,3,7,8-TCDD Contamination of Fish in the Kanawha River, Nitro, West Virginia	Georgi A. Jones	Centers for Disease Control	Yes
July 26, 1985	DRAFT - Letter Report, Nitro Municipal Dump	NUS Corporation	U.S. EPA	Yes

TABLE 3.1

SUMMARY OF PREVIOUS INVESTIGATIONS OF THE KANAWHA RIVER
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Report Date	*Title of Investigation*	*Prepared By*	*Prepared For*	*Contained Relevant Information**
October 28, 1985	Report - Sampling and Investigation Report	WV DNR	U.S. EPA	Yes
November 18, 1985	Groundwater Quality Assessment Plan	Union Carbide Corporation	State of WV Department of Natural Resources	Yes
1986	Federal On-Scene Coordinator's Report - Clark Property Site	U.S. EPA, Region III	U.S. EPA, Region III	Yes
1986	Feasibility Study of Heizer Creek Site	Dale K. Wilson, Monsanto	Monsanto	Yes
January 22, 1986	Subsurface Investigation, Manila Creek Site, Nitro, West Virginia	REMCOR	Monsanto Company	Yes
February 14, 1986	DRAFT - Assessment of Lifetime Cancer Risk from Consuming Fish Contaminated with 2,3,7,8-Tetrachlorobenzp-p-dioxin from the Kanawha River	Roy L. Smith et al.	U.S. EPA	Yes
February 25, 1986	Resource Conservation and Recovery Act (RCRA) Part B Permit Application	IT Corporation	Union Carbide Corporation	Yes
March 10, 1986	DRAFT - Work/Quality Assurance Project Plan, An Evaluation of Dioxin Contamination in Fish Tissue and Sediments in the Kanawha and Mud Rivers, West Virginia	WV DNR	WV DNR	Yes
April 4, 1986	Internal Memorandum from Roy L. Smith, U.S. EPA Region III: Sampling of Kanawha River Fish and Sediments for Dioxin Analysis	Roy L. Smith	U.S. EPA	Yes
April 28, 1986	Non-Sampling Site Reconnaissance Summary Report - Holmes and Madden Landfill	NUS Corporation	U.S. EPA, Region III	No
April 28, 1986	Non-Sampling Site Reconnaissance Summary Report - Holmes and Madden Landfill	NUS Corporation	USEPA	No
June 1, 1986	Kanawha River Navigation Study, Winfield Lock Replacement, Interim Feasibility Study, Main Report and Draft Environmental Impact Statement, Vol 1	Corps	Corps	Yes
July, 1986	Manila Creek Site Water Level and Highwall Study	ERM-Midwest, Inc.	Monsanto Company	Yes
July 17, 1986	Site visit with Pamela Hayes as Requested by Mr. Boggess of St. Albans	Rebecca J. Robertson	WV DNR	Yes
August, 1986	Feasibility Study of Manila Creek Site	Monsanto Chemical Company	Monsanto Chemical Company	Yes
August, 1986	Feasibility Study of Manila Creek Site	Dale K. Wilson, Monsanto	Monsanto	Yes
August, 1986	Phase II, RCRA Facility Assessment of the Monsanto Company, Nitro, West Virginia	A. T. Kearney, Inc.	U.S. EPA, Region III	Yes
August, 1986	Feasibility Study of Manila Creek Site	Monsanto Chemical Company	Monsanto Chemical Company	Yes
September 26, 1986	Preliminary Assessment of Shippers Car Line, Division of ACF Industries	NUS Corporation	US EPA	Yes
December 1, 1986	Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Sediments in the Kanawha River, West Virginia and Proposal for Further Sediment Sampling	Roy L. Smith et al.	U.S. EPA, Region III	Yes
January 9, 1987	Letter to BF Goodrich, Re: Correspondence of December 11, 1986, Applicability of Solid Waste Regulations, Industrial Solid Waste Registration No. 31077	Kelly L. Melloy, Texas Water Commission	Texas Water Commission	No
September 9, 1987	Site Visit Summary Report for Raleigh Junk - Sattes	NUS Corporation	U.S. EPA	Yes
November, 1987	Summary Report of Remedial Actions at Manila Creek, Project No. 127-06	ERM-Midwest, Inc.	Monsanto Company	Yes
November 13, 1987	Letter from U.S. EPA to Robert C. Lee, U.S. ACE: Final Environmental Impact Statement on Kanawha River Navigation Study for Winfield Lock Replacement	Jeffrey M. Alper	U.S. EPA Region III	Yes
December 9, 1987	Environmental Assessment - EA of the Smith Street Landfill in Nitro, WV for the Presence of Phenol and 2-4 Dimethylphenol	ERT Engineering	City of Nitro, WV	Yes
1988	Attachment 2: Inspection Schedule through Attachment 13: GW Monitoring Investigation Plan	NA	NA	No
June, 1988	A Study of Dioxin Contamination in Sediments in the Kanawha River Basin, EPS-QA87-004, Final Project Report	EPA Region III	EPA Region III	Yes
June 13, 1988	Site Inspection of Raleigh Junk - Sattes	NUS Corporation	U.S. EPA	Yes
June 13, 1988	Field Trip Report for Nitro Sanitation Landfill	NUS Corporation	U.S. EPA	Yes
July, 1988	Union Carbide South Charleston Plant - Holz Impoundment Delisting Petition (Volume I and II)	Union Carbide Corporation		Yes
July 19, 1988	USEPA - Draft Permit for Corrective Action	USEPA Region III	Rhone-Poulenc Ag Company	Yes
July 21, 1988	RCRA Part B Application, Union Carbide Corporation, Sistersville, West Virginia - Revision V - Book 1 of 4	Union Carbide Corporation	U.S. EPA Region III/ WV DEP	Yes
July 21, 1988	RCRA Part B Application, Union Carbide Corporation, Sistersville, West Virginia - Revision V - Book 2 of 4	Union Carbide Corporation	U.S. EPA Region III/ WV DEP	Yes
July 21, 1988	RCRA Part B Application, Union Carbide Corporation, Sistersville, West Virginia - Revision V - Book 3 of 4	Union Carbide Corporation	U.S. EPA Region III/ WV DEP	Yes
July 21, 1988	RCRA Part B Application, Union Carbide Corporation, Sistersville, West Virginia - Revision V - Book 4 of 4	Union Carbide Corporation	U.S. EPA Region III/ WV DEP	Yes
September, 1988	RCRA Tank System Variance Demonstration - Volume I Narrative	Rhone-Poulenc AG Company	NUS Corporation	No
September 29, 1988	Attachment A: Record of Decision Declaration, Fike (Artel) Chemicals Site, Nitro, West Virginia	U.S. EPA Region III	U.S. EPA Region III	Yes
October 26, 1988	Investigation of Complaint at Raleigh Junk, Sattes Yard	Rebecca Robertson	WV DNR	Yes
March 1, 1989	1988 West Virginia Hazardous Waste Activity Report	Rhone-Poulenc AG Company	WV DNR	Yes
April 17, 1989	Memorandum: Policy for Superfund Compliance With the RCRA Land Disposal Restrictions	U.S. EPA	U.S. EPA	No
September 22, 1989	Memorandum to Max Robertson, WV DNR, from Pam Hayes, WV DNR	WV DNR	WV DNR	Yes

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October 23, 1989	Draft - RCRA Part B Permit for Rhone-Poulenc AG Company, Institute Plant, Book 1 of 2	Rhone-Poulenc	WV DNR	Yes
October 23, 1989	DRAFT - RCRA Part B Permit for Rhone-Poulenc AG Company, Institute Plant, Book 1 of 2	Rhone-Poulenc	WV DNR	Yes
December 14, 1989	1999 Characterization of the Residues Burned at the No.1 Powerhouse	Rhone-Poulenc AG Company	WV DNR	Yes
February 15, 1990	Letter to Paul de Percin, U.S. EPA, from Darius Ostrauskas, U.S. EPA, Re: Potential Treatability Studies for the Fike Chemical Site	U.S. EPA, Region III	U.S. EPA, Region III	Yes
June, 1990	Focused Feasibility Study for Buried Drums and Containers	CH2M Hill	U.S. EPA, Region III	Yes
August 1, 1990	Letter to Ms. Sadia Kissoon-Parker, CH2M Hill, from Darius Ostrauskas, U.S. EPA, Region III, Re: Fike Chemical RI/FS	U.S. EPA, Region III	U.S. EPA, Region III	No
August 6, 1990	Public Hearing, Nitro, WV, In the Matter of Fike Chemical Site Public Meeting, Transcript of Proceedings	Hudson Reporting	NA	Yes
August 6, 1990	Statement by Elmer A. Fike, August 6, 1990	NA	NA	Yes
August 10, 1990	Groundwater Corrective Action Program - Semi Annual Progress Report	Rhone-Poulenc AG Company	WV DNR	Yes
October 4, 1990	Compliance Evaluation Inspection Report	Joyce Moore	WV DCLER	Yes
October 26, 1990	Letter to Mr. Darius Ostrauskas, U.S. EPA, Region III, from J. Greg Mott, CH2M Hill	CH2M Hill	U.S. EPA, Region III	No
November 13, 1990	Letter to Mr. Darius Ostrauskas, U.S. EPA, Region III, from J. Greg Mott, CH2M Hill	CH2M Hill	U.S. EPA, Region III	No
December, 1990	Fike Chemicals Site, Phase II RI/FS Work Plan, Work Assignment No. 90-24-3L10, Contract No. 68-W8-0090	CH2M HILL	U.S. EPA, Region III	No
January 3, 1991	Letter to Charles E. Vandevelde, Chief, Corps, from G. Maxwell Robertson, Chief, WV Department of Commerce, Labor and Environmental Resources	G. Maxwell Robertson	WV Department of Commerce, Labor and Environmental Resources	No
February 7, 1991	Groundwater Corrective Action Program – Goff Mountain RCRA Part B Permit, Compliance Monitoring – 4th Quarter	Rhone-Poulenc AG Company	WV DNR	Yes
February 7, 1991	Groundwater Corrective Action Program – 4th Quarter Sampling and Analysis (1990)	Rhone-Poulenc AG Company	WV DNR	Yes
March 1, 1991	Memorandum to Pam Hayes, WV DEP, from Riad Tannir, Re: Meeting with PRP's and EPA in Philadelphia	Riad Tannir	WV DNR	No
March, 1991	Holz Dam and Dike Inspection	TRIAD Engineering, Inc.	Union Carbide Corporation	Yes
March 6, 1991	Memorandum to Pam Hayes, WV DEP, from Riad Tannir, Re: Meeting with PRP's and EPA in Philadelphia	WV DNR	WV DNR	No
June 18, 1991	Letter to Mr. Jackie Setliff, Dana Transport, Inc., from Dwight L. McClure, WV DEP, Re: WV/NPDES Permit No. WV0050130	WV DEP	WV DEP	Yes
June 18, 1991	DRAFT - Sections 1 and 2 of the Focused Feasibility Study for Buried Drums at Fike Chemicals Site, Nitro, West Virginia	CH2M Hill	U.S. EPA, Region III	Yes
July, 1991	Phase 1 – Contamination Evaluation at the Former American Car & Foundry Site	TCT-St. Louis.	US Army Corps of Engineers	Yes
July 1, 1991	Pond Closure Plan (Coal Slurry Pond #1), Preliminary Test Results Summary	Gilbert Associates, Inc.	US Department of Energy	Yes
July, 1991	Closure Documentation - Building 12 Remediation Project	ERM-Midwest, Inc.	Rhone-Poulenc AG Company	Yes
July 19, 1991	Groundwater Protection Procedure Evaluation Phase Report	Union Carbide Chemicals & Plastics Co.		Yes
July 21, 1991	Decision Document, Winfield Locks and Dam, Kanawha River, Former ACF Industries Facility, Red House, WV	Corps	Corps	Yes
August 26, 1991	Compliance Evaluation Inspection Report - Union Carbide Chemicals & Plastics Co., Inc.	State of WV, Department of Commerce, Labor, and Environmental Resources	Union Carbide Chemicals & Plastics Co.	Yes
September 3, 1991	Letter to Charles E. Vandevelde, Chief, Corps, from G. Maxwell Robertson, Chief, WV Department of Commerce, Labor and Environmental Resources	G. Maxwell Robertson	WV Department of Commerce, Labor and Environmental Resources	No
September 18, 1991	Dioxin Sampling at the Former American Car & Foundry Site, Winfield Locks and Dam Project, Red House, WV	Corps	Corps	Yes
September 19, 1991	Union Carbide Chemicals and Plastics Company Inc, North Charleston Distribution Center, WVD 98 055 4828, 1990 Hazardous Waste Report	Union Carbide	WV Department of Commerce, Labor, and Environmental Resources	Yes
September 25, 1991	Letter to G. Maxwell Robertson, Chief, Waste Management Section, WV Department of Commerce, Labor & Environmental Resources, from Charles E. Vandevelde, Chief, Corps	Corps	Corps	Yes
October 4, 1991	Letter to Dale Farley, Director, WV Air Pollution Control Commission, from Charles E. Vandevelde, Corps	Charles E. Vandevelde	Corps	Yes
October 7, 1991	Letter to G. Maxwell Robertson, Chief, Waste Management Section, WV Department of Commerce, Labor & Environmental Resources, from James R. Van Epps, Corps	James R. Van Epps	Corps	Yes
November, 1991	Site Assessment Plan for Determination of Contamination at Paint Mix Shop	Waste-Tron, Inc.	ACF Industries, Inc.	Yes
December 2, 1991	Quality Assurance Review of Environmental Investigations Performed by the U.S. Army Corps of Engineers at the Former ACF Facility in Red House, WV	John Mathes & Associates, Inc.	ACF Industries	Yes

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1992	Winfield Locks harbor $100 million mess, feds find	Rick Steelhammer	The Charleston Gazette	Yes
January 24, 1992	Letter to Riad Tanner, WV DNR, from R.J. Conner, Corps, Re: Advance Copy of Action Level Letter on Winfield Site	R. J. Conner, Chief, Engineering-Planning Division	Corps	Yes
January 31, 1992	Letter to Colonel James R. Van Epps, from J. Edward Hamrick III, Director, WV Department of Commerce, Labor & Environmental Resources, Waste Management Section	J. Edward Hamrick III	WV Department of Commerce, Labor & Environmental Resources, Waste Management Section	Yes
February 20, 1992	Letter to Ms. Judith A. White, President, Don's Disposal, from Richard P. Cooke, WV DEP	WV DEP	WV DEP	Yes
February 25, 1992	Letter to Mr. Leo Arbaugh, WV DEP, from W. Kyle Stollings, City of Charleston, Re: Union Carbide Proposal for Supplying Rubble to City of Charleston	W. Kyle Stollings	City of Charleston	Yes
April, 1992	Quality Control Summary Report for Winfield Locks and Dam Site	Law Environmental, Inc.	US Army Corps of Engineers	Yes
May 5, 1992	EE/CA for Removal and Treatment of Contaminated Soil at the former ACF Industries, Incorporated Site, Red House, West Virginia	U.S. ACE	U.S. ACE	Yes
May 5, 1992	Engineering Evaluation/Cost Analysis (EE/CA) for Removal & Treatment of Contaminated Soil	US Army Corps of Engineers		Yes
May 15, 1992	Corps Tries to Get Company To Pay Costs of Dioxin Clean Up At Site Of Ohio River Project	Environment Reporter	Environment Reporter	Yes
June 1, 1992	Letter to James R. Van Epps, Corps, from William L. Finn, ACF Industries	William L. Finn, ACF	ACF	Yes
June, 1992	Site Assessment Plan for Contamination at Paint Mix Room Additional Activities May 1992	Waste-Tron, Inc.	ACF Industries, Inc.	Yes
June 5, 1992	Memorandum: Winfield Additional Lock and Gate Bay, Meeting With WV DNR to Discuss Corps/ WV DNR Coordination During Removal Action on the Former ACF Site	Kennard M. Waddell	Corps	Yes
June 8, 1992	Letter to Colonel James R. Van Epps, from J. Edward Hamrick III, Director, WV Department of Commerce, Labor & Environmental Resources, Waste Management Section	J. Edward Hamrick III	WV Department of Commerce, Labor & Environmental Resources, Waste Management Section	Yes
June 18, 1992	Letter to Rolley Moore, Wetzel County Solid Waste Authority, from Brian A. Farkas, WV Division of Environmental Protection	Brian A. Farkas	WV Division of Environmental Protection	Yes
July 1, 1992	Memorandum to Brad Swiger, District 1 Supervisor, Re: Wetzel County Landfill Suspected Dioxin Investigation	Jamie Fenske	WV DNR	Yes
July 1, 1992	Memorandum: Wetzel County Landfill Suspected Dioxin Investigation	Jamie Fenske, WV DNR	WV DNR	Yes
July 2, 1992	Review of Available U.S. Army Corps of Engineers Data, Former ACF Property, Red House, WV	Burlington Environmental	ACF Industries	Yes
July 7, 1992	Letter to Mr. Paul Leonard, U.S. EPA, Region III, from Warren L. Smull, de maximus, inc., Re: Fike Chemical Superfund Site, OU-2, RDWP Comment/Response Submittal	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust/ de maximus, inc.	Yes
July 7, 1992	Letter to Colonel James Van Epps, Corps, from William Finn, Vice President, ACF Industries	William Finn, Vice President, ACF	ACF Industries	Yes
July 10, 1992	Trip Report: Site Visit of the #20 Sump Area, Union Carbide Chemicals and Plastics Company, Inc., Plant 514	Chris Gatens	WV DEP	Yes
July 23, 1992	Letter to Colonel Van Epps, Corps, from Jonathan P. Deason, Director, Office of Environmental Affairs, U.S. Department of the Interior	Jonathan P. Deason	U.S. Department of the Interior	Yes
July 24, 1992	Letter to Colonel James R. Van Epps, Corps, from Abraham Ferdas, Associate Division Director for the Superfund Program, U.S. EPA, Region III	Abraham Ferdas	U.S. EPA Region III	Yes
July 24, 1992	Letter to Colonel James R. Van Epps, Corps, from Abraham Ferdas, Associate Division Director for the Superfund Program, U.S. EPA, Region III	Abraham Ferdas	U.S. EPA Region III	Yes
August, 1992	Additional Site Assessment Activities	Waste-Tron, Inc.	ACF Industries, Inc.	Yes
August 6, 1992	Comments Upon EE/CA Document for Remediation at ACF Site, Letter to Colonel James R. Van Epps, Corps	David C. Callaghan, Director	WV DEP	No
August 24, 1992	Letter to William L. Finn, Vice President, ACF, from Earle C. Richardson, Corps	Corps	Corps	Yes
September 15, 1992	Letter to Earle C. Richardson, Corps, from William L. Finn, ACF Industries	William L. Finn, ACF	ACF	Yes
January 4, 1993	Memorandum: Corps of Engineers Response to the WV DEP Comments on EE/CA Document for Remediation at the ACF Winfield Site - Dated August 6, 1992	B.F. Smith, Chief, WV DEP	WV DEP	No
January 22, 1993	Dioxin Site Letter Report for the Georges Creek Site	Halliburton NUS Environmental Corp.	U.S. EPA, Region III	Yes
February 9, 1993	Final Dioxin Site Report	Halliburton NUS Corporation	U.S. EPA, Region III	Yes
March 1, 1993	Health Consultation: ACF Industries, Inc. Site (aka Winfield Lock and Dam), Red House, WV	Department of Health& Human Services	Department of Health & Human Services	Yes
April 21, 1993	Fike/Artel Superfund Site, Operable Unit 2, Preliminary Remedial Design Submittal	NA	NA	Yes
April 22, 1993	Letter to Ms. Pam Hayes, WV DEP, from Eugene P. Wingert, U.S. EPA, Region III, Re: Explanation of Significance Differences, Fike/Artel Chemical Site, Operable Unit 3, Nitro, West Virginia	Eugene P. Wingert	U.S. EPA, Region III	Yes
May 4, 1993	Fike/Artel Meeting - ACOE & Smull & OU-2 Contractors	Michael I. Stratton	WV DEP	Yes

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June 23, 1993	Letter to Ms. Judith A. White, President, Don's Disposal, from Richard P. Cooke, WV DEP	WV DEP	WV DEP	Yes
June 30, 1993	Memorandum: to Mike Stratton, from Lew Baker, Re: Fike OU#3 Meeting at EPA Region III	Mike Stratton	WV DEP	Yes
July 9, 1993	RCRA Facility Investigation Workplan (Revision 1.0), Occidental Chemical Corporation, Belle, West Virginia	ERM-Midwest, Inc.	OxyChem/ U.S. EPA Region III	Yes
July 26, 1993	Compliance Evaluation Inspection, Union Carbide Chemicals & Plastics Co., Inc. - Holz Impoundment	WV DEP	WV DEP	Yes
August 4, 1993	Letter to Ms. Judith A. White, President, Don's Disposal, from Richard P. Cooke, WV DEP	WV DEP	WV DEP	Yes
August 19, 1993	OxyChem Response to U.S. EPA Region III Comments, Round 2: Description of Current Conditions and RFI Work Plan, Occidental Chemical Corporation, Belle, WV	ERM-Midwest, Inc.	OxyChem/ U.S. EPA Region III	No
September, 1993	Community Relations Plan, RCRA Corrective Action Program, Occidental Chemical Corporation, Belle, WV - Revision 1.0	ERM-Midwest, Inc.	OxyChem/ U.S. EPA Region III	No
October 8, 1993	RCRA Facility Investigation Program Fact Sheet, Occidental Chemical Corporation	ERM-Midwest, Inc.	OxyChem/ U.S. EPA Region III	Yes
October 12, 1993	RCRA Corrective Action Program Bimonthly Progress Report, Occidental Chemical Corporation, Belle, WV	ERM-Midwest, Inc.	OxyChem/ U.S. EPA Region III	Yes
October 25, 1993	Letter to Mr. Eugene P. Wingert, U.S. EPA, Region III, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-3 ROD, Air Emissions Control	Warren L. Smull	Fike/Artel Site Trust	Yes
October 26, 1993	Letter to Mr. Eugene P. Wingert, U.S. EPA, Region III, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-3 ROD, Air Emissions Control	Warren L. Smull	Fike/Artel Site Trust	Yes
February 25, 1994	Final Project Report for Tank Contents Removal and Disposal at the Fike/Artel Chemical Site	OHM Remediation Services Corporation	Corps	Yes
March 24, 1994	Letter to Mrs. Judith White, President, Don's Disposal, form Richard P. Cooke, WV DEP	WV DEP	WV DEP	Yes
March 24, 1994	Materials in Departments at Nitro, WV	NA	NA	No
March 31, 1994	Letter to David M. Flannery, Attorney-at-Law, Robinson & McElwee, from Max Robertson, Chief, WV DEP	Max Robertson	WV DEP	Yes
April 1, 1994	Letter to Mr. Eugene P. Wingert, U.S. EPA, Region III, from Michael I. Stratton, WV DEP, Re: Fike/Artel OU-3 - Review and Comments on Remedial Design Documents Dated November 23, 1993	Michael I. Stratton	WV DEP	Yes
April 12, 1994	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2 RA, Dioxin Suspect Materials	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
April 27, 1994	Site Status Report #1 for The Chemical Leaman - Scary Creek Site, St. Albans, Putnam County, WV	WV DEP	WV DEP	Yes
May 11, 1994	Site Status Report #2 for The Chemical Leaman - Scary Creek Site, St. Albans, Putnam County, WV	WV DEP	WV DEP	Yes
June 3, 1994	Letter to Mr. Dick Cooke, WV DEP, from Charles A. Moses, WV DEP, Re: Groundwater Sampling Inspection, Don's Disposal Landfill, SW-048-93	WV DEP	WV DEP	Yes
June 3, 1994	Letter - Groundwater Sampling Inspection (GSI) at Don's Disposal Landfill	WV DEP	WV DEP - Waste Management	Yes
June 17, 1994	Soil Boring Program, Stormwater Collection/ Treatment System Location, Occidental Chemical Corporation, Belle, WV	ERM-Midwest, Inc.	Occidental Chemical Corporation	Yes
June 17, 1994	Soil Boring Program, Stormwater Collection/ Treatment System Location, Occidental Chemical Corporation, Belle, WV	ERM-Midwest, Inc.	Occidental Chemical Corporation	Yes
June 30, 1994	Letter to Mr. V. G. Long, Rhone-Poulenc, from Mark A. Scott, Chief, WV DEP, Re: WV/NPDES Permit No. WV0000086, Rhone-Poulenc AG Company	WV DEP	WV DEP	Yes
June 30, 1994	WV/NPDES Permit for Rhone Poulenc Ag Company	DEP - Water Resources	Rhone Poulenc Ag Company	Yes
July 8, 1994	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2, June 1994 Monthly Progress Report, #29	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
July 26, 1994	Letter to Mr. Warren L. Smull, Fike/Artel Site Trust, from Eugene P. Wingert, U.S. EPA, Region III, Re: Additional Response Actions, Portable Unit 2, Fike/Artel Superfund Site	Eugene P. Wingert	U.S. EPA, Region III	Yes
August 31, 1994	Letter to Eugene P. Wingart, U.S. EPA, Region III, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2, Laboratory Audit Report	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	No
September 8, 1994	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2, August 1994 Monthly Progress Report, #31	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
September 9, 1994	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2, Supplemental Work Plan Comments/Response Submittal	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	No
September 23, 1994	Compliance Monitoring Evaluation, Monsanto Chemical Company	WV DEP	WV DEP	Yes
September 26, 1994	Letter to Mr. Gene Wingert, U.S. EPA, Region III, from Janet K. Wolfe, WV DEP, Re: Fike/Artel OU-3, Review and Comments on August 12, 1994 Remedial Design: Work Plan, Sampling and Analysis Plan, and Site Health and Safety Plan	Janet K, Wolfe	WV DEP	No

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October 7, 1994	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2, September 1994 Monthly Progress Report, #32	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
October 12, 1994	RCRA Corrective Action Program Bimonthly Progress Report, Occidental Chemical Corporation, Belle, WV	ERM-Midwest, Inc.	OxyChem/ U.S. EPA Region III	Yes
November 1, 1994	Letter to Dave Dorko, Plant Manager, Occidental Chemical Corporation, from Thomas A. Fisher, WV DEP	Thomas A. Fisher	WV DEP, Department of Commerce, Labor & Environmental Resources	Yes
November, 1994	Closure Documentation - Report for Boiler #10	Environmental Resources Management	E.I. DuPont de Nemours & Company	Yes
November 23, 1994	Letter to Dave Dorko, Plant Manager, OxyChem, from Thomas A. Fisher, WV DEP	WV DEP	Occidental Chemical Corporation	Yes
November 23, 1994	Compliance Evaluation Inspection Report - Occidental Chemical Corporation, Belle Plant, Belle, WV	Thomas A. Fisher	WV DEP, Department of Commerce, Labor & Environmental Resources	Yes
December 9, 1994	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2, November 1994 Monthly Progress Report, #34	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
December 15, 1994	RCRA Corrective Action Program Bimonthly Progress Report, Occidental Chemical Corporation, Belle, WV	ERM-Midwest, Inc.	U.S. EPA Region III	Yes
January 6, 1995	Sampling and Analysis Plan for Operable Unit Four Site-Wide Remedial Investigation and Feasibility Study	ICF Kaiser Engineers, inc.	Fike Chemical Superfund Site	Yes
January 9, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2, December 1994 Monthly Progress Report, #35	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
February 13, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3 Preliminary Design Submittal	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
March, 1995	Groundwater Corrective Action System - Rhone-Poulenc Wastewater Treatment Unit, Progress Report #12	Rhone-Poulenc AG Company	Triad Engineering, Inc	Yes
March 9, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, Region III, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, February 1995 Monthly Progress Report #18	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
March 15, 1995	Interim Analytical Reports to Mr. Terry Johnson, Occidental Chemical Corporation	Rachel L. Kreamer, Lancaster Laboratories, Inc.	Terry Johnson, Occidental Chemical Corp.	Yes
March 18, 1985	Field Trip report for Heizer Creek	NUS Corporation	USEPA	Yes
April 4, 1995	Letter to Eugene P. Wingart, U.S. EPA, Region III, from Michael I. Stratton, WV DEP, Re: WV DEP-OWM comments on Operable Unit 2 Supplemental Remedial Action Work Plan, Fike/Artel Superfund Site	Michael I. Stratton	WV DEP	Yes
April 13, 1995	Ground Water Samples Collected 2 November through 15 December 1994, In Association with the RCRA Facility Investigation, Occidental Chemical Corporation, Belle, WV	Environmental Resources Management, Inc.	U.S. EPA Region III	Yes
April 19, 1995	Compliance Evaluation Inspection, Raleigh Junk Company	Henry Haas, WV DEP	WV DEP	Yes
April 25, 1995	Letter to Mr. Warren Smull, Fike/Artel Site Trust, from Eugene P. Wingert, U.S. EPA, Region III, Re: Fike/Artel Superfund Site, Supplemental Remedial Action Work Plan, Operable Unit 2	Eugene P. Wingert	U.S. EPA, Region III	Yes
May 5, 1995	RFI Report and Stabilization/Corrective Measures Plan, Volume I of II, Monsanto Nitro Plant	Roux Associates, Inc.	Monsanto Company	Yes
May 9, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, April 1995 Monthly Progress Report, #20	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
May 10, 1995	Compliance Sampling Inspection Report - OxyChem (Occidental Chemical Corporation)	Henry E. Hass, Jr., WV DEP	WV DEP	Yes
May 31, 1995	Memorandum: Safe Drinking Water Act MCL and Health Advisory Update, U.S. EPA, Region III	U.S. EPA, Region III	U.S. EPA, Region III	No
June 9, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, May1995 Monthly Progress Report, #21	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
July 7, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, June 1995 Monthly Progress Report, #22	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
July 10, 1995	Fike/Artel Trust, Sampling Audit for the Baker Tank, Fike/Artel Superfund Site	ERM, Inc.	Fike/Artel Site Trust	Yes
July 12, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, Region III, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2 SW, Sampling Audit	Warren L. Smull	Fike/Artel Site Trust	Yes
July 30, 1995	Contaminated Putnam Soil OK for Shipment to Utah	The Associated Press	The Herald-Dispatch - Huntington, WV	Yes
August 9, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2, July 1995 Monthly Progress Report, #42	Warren L. Smull	Fike/Artel Site Trust	Yes
August 9, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, July 1995 Monthly Progress Report, #23	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
August 14, 1995	Letter to Mr. Mike Zeto, WV DEP, from Kevin H. Keys, Rhone-Poulenc	Rhone-Poulenc	Rhone-Poulenc	Yes
October 9, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site, OU-2, September 1995 Monthly Progress Report, #44	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
October 23, 1995	Union Carbide Corporation, South Charleston Plant, South Charleston, WV 25303, EPA ID No. WVD 005 005 483	Union Carbide	Union Carbide	Yes

TABLE 3.1

SUMMARY OF PREVIOUS INVESTIGATIONS OF THE KANAWHA RIVER
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Report Date	*Title of Investigation*	*Prepared By*	*Prepared For*	*Contained Relevant Information**
November 9, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-2, October 1995 Monthly Progress Report, #45	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
December 4, 1995	Draft Consent Decree - Fike Chemical	U.S. EPA	U.S. EPA	Yes
December 8, 1995	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, November 1995 Monthly Progress Report, #27	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
December 18, 1995	Transmittal to Pam Hayes, WV DEP, from Eugene Wingert, U.S. EPA, Region III	U.S. EPA, Region III	U.S. EPA, Region III	Yes
January 1996	Application for NPDES Permit for Dana Transport, Nitro, West Virginia Site	LRI Consulting & Technologies	WV DEP - Water Resources	Yes
January 17, 1996	Signed Consent Order HW-491-95 for the UCC Private Trucking Operation (PTO) Facility	WV DEP	WV DEP	Yes
January 30, 1996	Renewal Application for NPDES Permit to Cover Wastewater Treatment Plant Discharge and Storm Water Run-off, Dana Transport, Nitro, WV	LRI Consulting & Technologies	Dana Transport	Yes
April 1, 1996	Letter to Ms. Constance J. Stephens, City of Nitro Sanitary Board, from Robert W. Rule, Fike/Artel Site Trust, Re: Fike Chemical Superfund Site - Discharge of Non-Domestic Wastewater	Robert W. Rule, Alternate Project Coordinator	Fike/Artel Site Trust	Yes
April 10, 1996	Letter to Eugene Wingert, U.S. EPA, Region III, from Michael I. Stratton, WV DEP, Re: Fike/Artel OU-4 RI/FS Sampling and Analysis Plan and Work Plan	Michael I. Stratton, Site Remediation Program Mana	WV DEP	Yes
April 10, 1996	Letter to Eugene Wingert, U.S. EPA, Region III, from Michael I. Stratton, WV DEP, Re: Fike/Artel OU-4 RI/FS Sampling and Analysis Plan and Work Plan	Michael I. Stratton	WV DEP	Yes
May 1, 1996	Letter to Mr. Michael Stratton, WV DEP, from Eugene P. Wingert, U.S. EPA, Region III, Re: Fike/Artel Superfund Site, CST Plant Removal Action	U.S. EPA, Region III	U.S. EPA, Region III	Yes
May 3, 1996	Letter to John McGahren, Esq., Pitney, Hardin, Kipp & Szuch, from Jim Heenehan, U.S. EPA, Region III, Re: Fike CST UAO	Jim Heenehan	U.S. EPA, Region III	Yes
May 9, 1996	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, April 1996 Monthly Progress Report, #32	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
May 17, 1996	Closure Report for the Removal Action for the Former ACF Industries Site, Red House, West Virginia	Philip Environmental Services Corporation	ACF Industries Incorporated	Yes
May 28, 1996	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, CST Lagoon Closure Proposal	Fike/Artel Site Trust	Fike/Artel Trust	Yes
June 7, 1996	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, May 1996 Monthly Progress Report, #33	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
July 1996	Remediation Work Plan, Scary Creek Lagoon, St. Albans, West Virginia	EnviroPower Inc	West Virginia Division of Environmental Protectio	Yes
July 9, 1996	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, June 1996 Monthly Progress Report, #34	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
July 29, 1996	Letter to Mr. Anthony Meadows, US EPA, from Charles A. Moses, WV DEP, Re: CSI & Biomonitoring of Rhone-Poulenc AG Company, WV/NPDES No. WV0000086	WV DEP	WV DEP	Yes
August, 1996	Groundwater Corrective Action System - Rhone-Poulenc Wastewater Treatment Unit, Progress Report #15	Rhone-Poulenc AG Company	Triad Engineering, Inc	Yes
August 18, 1986	Dioxin Contamination in 1986 Fish Tissue Samples from the Kanawha River, Armour Creek, and the Pocatalico River, WV	Roy L. Smith et al.	WV DNR	Yes
September 9, 1996	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, August 1996 Monthly Progress Report, #36	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
September 24, 1996	Letter to Mr. B.F. "Cap" Smith, WV DEP, from Liz O'Finan, UCC, Re: Emergency Waste Pile Permit - Union Carbide Corporation, South Charleston Plant	Union Carbide Corporation	Union Carbide Corporation	Yes
October 2, 1996	Letter to Mr. Peter J. Ludzia, U.S. EPA, Region III, from Michael I. Stratton, WV DEP, Re: Fike/Artel NPL Site, Operable Unit 4, Third Quarter Report, FY 1995-96: April - June 1996	Michael I. Stratton, Site Remediation Program Mana	WV DEP	Yes
October 9, 1996	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, September 1996 Monthly Progress Report, #37	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
October 21, 1996	Letter to Mr. Mark Slusarski, WV DEP, from Jerry DeMuro, ICF Kaiser, Re: Drawing and Data, Fike Chemical Superfund Site, Nitro, West Virginia	ICF Kaiser	WV DEP	Yes
November 7, 1996	Letter to Mr. Eugene P. Wingert, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Chemical Superfund Site, OU-3, October 1996 Monthly Progress Report, #38	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
November 19, 1996	Letter to Mr. Anthony Meadows, U.S. EPA, from Charles A. Moses, WV DEP, Re: CSI & Biomonitoring of Dana Transport, WV/NPDES No. WV0050130	WV DEP	WV DEP	Yes

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Report Date	*Title of Investigation*	*Prepared By*	*Prepared For*	*Contained Relevant Information**
November 20, 1996	Section 4 of the Phase I RFI Report, Occidental Chemical Corporation, Belle, WV	ERM-Midwest, Inc.	U.S. EPA Region III	Yes
December 10, 1996	Summary of Site Investigation and Remediation Activities, Raleigh Junk Company Sattes Facility	TERRADON Corporation	Raleigh Junk Company	Yes
1997	Summary Report of Remedial Actions at Manila Creek Site, Project No. 127-06	ERM-Midwest	NA	Yes
January 9, 1997	Letter to Ms. Katherine A. Lose, U.S. EPA, Region III, from Warren L. Snull, Fike/Artel Site Trust, Re: Fike/Artel Superfund Site, December 1996 Monthly Progress Report #58	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
February, 1997	RCRA BIF Closure Certification	Dixon Environmental Associates, Inc.	Flexsys America L.P.	Yes
February 10, 1997	Letter to Ms. Katherine Lose, U.S. EPA, Region III, from Jerry DeMuro, ICF Kaiser, Re: Fike Chemical Superfund Site, Data Validation, ICF Kaiser Project No. 92192	Jerry DeMuro	ICF Kaiser	Yes
February 13, 1997	Letter to Mr. Richard Hackney, WV DEP, from D. R. Fewell, Rhone-Poulenc	Rhone-Poulenc	Rhone-Poulenc	Yes
February 18, 1997	Compliance Schedule Evaluation Inspection Report, Occidental Chemical Corporation, Belle, WV	John R. Fredericks, WV DEP	WV DEP	Yes
March, 1997	Biocell Sampling and Analysis Report, Volume II - Laboratory Reports, CTLT Terminal, Institute, WV	WEG Engineering	Chemical Leaman Tank Lines, Inc.	No
March 1997	Biocell Sampling Analysis Report - Volume 1	Chemical Leaman Tank Lines, Inc.	WEG Engineering	No
March 4, 1997	Transmittal to Mark Slusarski, WV DEP, from Kate Lose, U.S. EPA, Region III, Re: Comments to the Sampling and Analysis Plan for Fike Chemical OU-4	Kate Lose	U.S. EPA, Region III	Yes
March 27, 1997	Fax to Mark Kees, WV DNR, from Homer Brumfield, ACF, Re: Analysis from Paint Mix Room	ACF	ACF	Yes
April 9, 1997	Letter to Ms. Katherine A. Lose, U.S. EPA, Region III, from Jerry DeMuro, ICF Kaiser, Re: Fike Chemical Superfund Site, CST Sample Analysis, ICF Kaiser Project No. 92192-422-00	ICF Kaiser	Fike/Artel Trust	Yes
April 18, 1997	Work Plan Ex-situ Bioremediation Chemical Leaman Tank Lines Terminal, Institute, West Virginia	Weavertown Environmental Group	EnviroPower, Inc.	Yes
May 1, 1997	Work Plan for Operable Unit Four - Site-Wide Remedial Investigation and Feasibility Study	ICF Kaiser Engineers, Inc.	Fike Chemical Superfund Site	Yes
May 7, 1997	Memorandum: to Mark Slusarski, WV DEP, from Kate Lose, U.S. EPA, Region III, Re: Fike	Kate Lose	U.S. EPA, Region III	Yes
July 18, 1997	Memorandum: Laboratory Analysis of Soils and Drilling Sludges ACF Soil Vapor Extraction Project	David Beam, WasteTron	WasteTron	Yes
August 11, 1997	Transmittal to Mark Slusarski, WV DEP, from Kate Lose, U.S. EPA, Region III	Kate Lose	U.S. EPA, Region III	Yes
October 3, 1997	Letter to Ms. Kate Lose, U.S. EPA, from Sunil I. Shah, Union Carbide, Re: Analytical Method of Choice for Dioxins Analysis for OU-4 RI/FS	Sunil I. Shah	Union Carbide	Yes
October 8, 1997	Letter to Mr. H. M. Agee, UCC, from B. F. Smith, WV DEP, Re: No. 16 Boiler Closure	B. F. Smith, Chief	WV DEP	Yes
October 16, 1997	Letter to Kate Lose, U.S. EPA, from Jerry DeMuro, ICF Kaiser, Re: Dioxin Analyses Fike Chemical Superfund Site, OU-4 RI/FS	Jerry DeMuro	ICF Kaiser	Yes
October 20, 1997	Letter to Kate Lose, U.S. EPA, from Sunil I. Shah, Union Carbide	Sunil I. Shah	Union Carbide	Yes
October 30, 1997	NPDES Permit for Flexsys America	WV DEP	WV DEP	Yes
October 30, 1997	NPDES Permit for Flexsys America	DEP - Water Resources	Flexsys America LP	Yes
November 19, 1997	NA	WV DEP	USEPA REG III	Yes
1998	Quantification of Dioxin Concentrations in the Ohio River Using High Volume Water Sampling	ORSANCO	ORSANCO	Yes
January 8, 1998	Letter to Ms. Katherine Lose, U.S. EPA, from Jerry DeMuro, ICF, Re: Fike Chemical Superfund Site OU-4 RI/FS Work Plan and Sampling and Analysis Plan	ICF Kaiser	Fike/Artel Site Trust	Yes
January 15, 1998	Site Summary Report - Heizer Creek Site	Roy F. Weston, Inc.	U.S. EPA, Region III	Yes
January 29, 1998	Letter to Ms. Katherine Lose, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Superfund Site, Waste Water Management System Analytical Report	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
February 28, 1998	1997 Groundwater Monitoring Report, Union Carbide Holz Impoundment	Union Carbide	WV DEP	Yes
March 24, 1998	Compliance Evaluation Inspection, Flexsys America, L.P.	WV DEP	WV DEP	Yes
April 15, 1998	Final Work Plan for Operable Unit Four - Site-Wide Remedial Investigation and Feasibility Study	ICF Kaiser Engineers, Inc.	Fike/Artel Site Trust	Yes
May 4, 1998	Complaint Response Report	WV DEP	WV DEP	Yes
May 7, 1998	Letter to Ms. Katherine Lose, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Superfund Site, Waste Water Management System Analytical Report	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
May 14, 1998	Letter from Homer Brumfield, ACF Industries to Mark Kees, WV DEP	Homer Brumfield, ACF Industries	Mark Kees, WV DEP	Yes
May 28, 1998	Memorandum to Tom Fisher, WV DEP, from Jim McCune, Weavertown Environmental Group, Re: Stolen Vehicle Situation	Jim McCune	NA	Yes
June 1, 1998	Phase II Ecological Risk Assessment Work Plan, Glenn Springs Holdings, Inc., Belle, WV	Environmental Resources Management, Inc.	U.S. EPA Region III	No
July, 1998	Union Carbide South Charleston Plant - Holz Impoundment Delisting Petition (Volume I and II)	Union Carbide Corporation	NA	Yes
July 31, 1998	Compliance Evaluation Inspection, Union Carbide Corporation, South Charleston (Plant 514)	WV DEP	WV DEP	Yes
September, 1998	Work Plan for Dioxin Sampling in Groundwater Pump and Treat Wells	Roux Associates, Inc.	Solutia, Inc.	Yes
September 10, 1998	Letter to G. Michael Dorsey, Assistant Chief, WV DEP, from Jim Heenehan, U.S. EPA	Jim Heenehan	U.S. EPA, Region III	Yes

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September 14, 1998	Compliance Evaluation Report - Occidental Chemical	Penny Harris	WV DEP	Yes
September 30, 1998	Letter to J. Roger Hirl, President, Occidental Chemical Corporation: Resource Conservation and Recovery Act Administrative Complaint, Compliance Order and Notice of Opportunity for Hearing, Docket Number RCRA-III-285	John Armstead, U.S. EPA Region III	U.S. EPA Region III	Yes
October 26, 1998	Letter to Ms. Katherine Lose, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Superfund Site, Waste Water Management System Analytical Report	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
November, 1998	Results of Dioxin Sampling in Groundwater and Kerosene, Solutia Inc.	Roux Associates, Inc.	US EPA	Yes
November 30, 1998	Results of Dioxin Sampling in Groundwater and Kerosene, (Volume I of III), Solutia Inc., Nitro, West Virginia	Roux Associates	EPA Region III	Yes
January 29, 1999	Letter to Ms. Katherine Lose, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Superfund Site, Waste Water Management System Analytical Report	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
February 4, 1999	Draft Analytical Summary for Groundwater for Operable Unit Four - Site Wide Remedial Investigation and Feasibility Study	ICF Kaiser Engineers, Inc.	NA	Yes
April, 1999	Information Summary: WWI Era Sewers	The IT Group	NA	Yes
April, 1999	Information Summary: WWI Era Sewers, Fike Chemical Superfund Site, Nitro, WV	The IT Group		Yes
April 14, 1999	Trip Report, Kanawha Valley-Dioxin Site, Nitro, Putnam County, WV	Roy F. Weston, Inc.	US EPA Region III	Yes
April 21, 1999	Letter to Ms. Katherine Lose, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Superfund Site, Waste Water Management System Analytical Report	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
May 5, 1999	Letter to Mr. Wendell L. Barner, IT Group, from Mark I. Slusarski, WV DEP, Re: OU-3 Analytical Data Results	Mark I. Slusarski	WV DEP	Yes
May 6, 1999	Compliance Evaluation Inspection, Union Carbide Corporation, South Charleston, Plant 514	WV DEP	WV DEP	Yes
May 7, 1999	Field Trip Report for AES - Monsanto Site	Roy F. Weston, Inc.	U.S. EPA, Region III	Yes
May 14, 1999	Dioxin TMDL Development for Kanawha River, Pocatalico River, and Armour Creek, West Virginia	Limno-Tech, Inc.	USEPA Region III	Yes
May 25, 1999	Fike/Artel Superfund Site, Analytical Data Request Summary	Fike/Artel Site Trust	U.S. EPA	Yes
July, 1999	Investigative Report - Solutia, Inc. HUB Property, Independence Drive, Nitro, Putnam County, West Virginia	Potesta & Associates	Solutia, Inc.	Yes
July 12, 1999	Meeting Minutes: Fike/Artel Site Trust, Community Liaison Panel Meeting, Nitro Community Center	Mary Lovejoy Rebhan	Fike/Artel Site Trust	Yes
August 29, 1999	Dioxin Contamination of the Ohio and Kanawha Rivers	Lewis A. Baker	WV Citizen Research Group	Yes
September 16, 1999	Sampling Plan - Holmes and Madden Landfill	Roy F. Weston, Inc.	U.S. EPA, Region III	Yes
September 26, 1999	EPA botched OxyChem probe, state says, Hazardous waste illegally stored, DEP official says	Ken Ward Jr.	Charleston Sunday Gazette-Mail	Yes
October 21, 1999	Letter to Mr. Jon McKinney, Flexsys America, from Charles A. Moses, WV DEP, Re: Water Compliance Inspection	WV DEP	WV DEP	Yes
October 21, 1999	Letter to Jon McKinney, Flexsys America, LP, from Charles A. Moses, WV DEP, Re: Water Compliance Inspection Report	WV DEP	WV DEP	Yes
November 12, 1999	Letter to Ms. Katherine Lose, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Superfund Site, Waste Water Management System Analytical Report	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
November 18, 1999	Trip Report - Midwest Steel Site Dioxin Assessment	Roy F. Weston, Inc.	U.S. EPA, Region III	Yes
December 23, 1999	Groundwater Monitoring: Appendix IX Analysis Results	Science Application International Corporation	Quality Distribution, Inc.	Yes
December 30 1999	Health Consultation - Dioxin in Soil in the Vicinity of the Heizer Creek Landfill	U.S. Department of Health and Human Services	NA	Yes
				Yes
February, 2000	1999 Annual Groundwater Assessment Monitoring Report - Union Carbide Corporation, Institute, West Virginia	KEMRON Environmental Services, Inc.	Union Carbide Corporation	
February 16, 2000	Trip Report - Old Avtex Landfill Site	Roy F. Weston, Inc.	U.S. EPA, Region III	Yes
February 18, 2000	Phase II Interim Status Report and Supplemental Data Collection Work Plan, RCRA Facility Investigation, Former OxyChem Facility, Belle, WV	Environmental Resources Management, Inc.	Glenn Springs Holdings, Inc. & Miller Springs Remediation Management, Inc.	Yes
March 1, 2000	Trip Report - South Charleston Municipal Landfill Site	Roy F. Weston, Inc.	U.S. EPA, Region III	Yes
March 24, 2000	Trip Report - DuPont Belle Site	Roy F. Weston, Inc.	U.S. EPA, Region III	Yes
March 30, 2000	Letter to Ms. Katherine Lose, U.S. EPA, Region III, from Wendell Barner, IT Group, Re: Schedule for OU-4 RI/FS, Fike Chemical Superfund Site, Nitro, West Virginia	IT Group	Fike/Artel Site Trust	Yes
March 30, 2000	Letter to Ms. Katherine Lose, U.S. EPA, from Wendell Barner, The IT Group, Re: Schedule for OU-4 RI/FS, Fike Chemical Superfund Site, Nitro, West Virginia	Wendell Barner	Fike/Artel Site Trust	Yes
April 4, 2000	Health Consultation - Dioxin in Soil at the Former Midwest Steel Site, Nitro, Putnam County, West Virginia	U.S. Department of Health and Human Services	NA	Yes
April 17, 2000	Letter to Ms. Katherine Lose, U.S. EPA, from Warren L. Smull, Fike/Artel Site Trust, Re: Fike/Artel Superfund Site, Waste Water Management System Analytical Report	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
April 17, 2000	Sampling Plan Manila Creek Site	Roy F. Weston, Inc.	U.S. EPA, Region III	Yes
May 2, 2000	Letter to Anthony C. Tuk, Solutia, from Allyn G. Turner, Chief, WV DEP, Re: WV SW/NPDES Permit No. WV0077020 Armour Creek Landfill	WV DEP	WV DEP	Yes

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May 2, 2000	Letter to Renae Bonnett, from Allyn G. Turner, Chief, WV DEP	WV DEP	WV DEP	Yes
May 2, 2000	WV/NPDES Permit for Armour Creek Landfill	Division of Water Resources	WV DEP	Yes
May 5, 2000	Trip Report, Kanawha River Valley Site, (Nitro Storm sewer/Outfall Investigation), Kanawha & Putnam Counties, WV	Roy F. Weston, Inc.	US EPA Region III	Yes
May 9, 2000	Letter to Ms. Katherine A. Lose, U.S. EPA, Region III, from Warren L. Snull, Fike/Artel Site Trust, Re: Fike/Artel Superfund Site April 2000 Monthly Progress Report #98	Warren L. Snull, Project Coordinator	Fike/Artel Site Trust	Yes
June 7, 2000	Letter to James J. Burke, Director, U.S. EPA Region III, from B.F. Smith, Chief, WV DEP and attached Memorandum: Impact of Wastewater Treatment Unit Exclusion on Region III's Ability to Protect Human Health and the Environment	B.F. Smith, Chief, WV DEP	WV DEP	No
August, 2000	NPDES Permit Renewal for E.I. DuPont de Nemours & Company	DuPont Engineering Technology	WV DEP	Yes
August 1, 2000	NPDES Permit Renewal for Permit No. WV0002399, E.I. DuPont de Nemours & Company, Inc., Belle, WV	DuPont Engineering Technology (DuET)	WV DEP	Yes
September 1, 2000	Letter to Ms. Katherine Lose, U.S. EPA, from Kirk Kessler, GeoSyntec Consultants, Re: Draft Groundwater Remedial Investigation/Feasibility Study Report, Fike Chemical Superfund Site, Nitro, West Virginia	GeoSyntec Consultants	Fike/Artel Site Trust	Yes
September, 2000	Human Health Risk Assessment for the Former OxyChem Belle Facility, Miller Springs Remediation Management, Inc., Be	Environmental Resources Management, Inc.	U.S. EPA Region III	Yes
September 7, 2000	Engineering Evaluation/ Cost Analysis, Heizer Creek Landfill Site, Putnam County, WV	ARCADIS	Monsanto Company	Yes
September 29, 2000	Health Consultation - South Charleston Municipal Landfill	U.S. Department of Health and Human Services	NA	Yes
November, 2000	RFI Work Plan Facility Lead Program, Union Carbide Corporation - Private Trucking Operations, Nitro West Virginia	Remediation Technology Group	NA	Yes
November 16, 2000	Updated Kanawha River Fish Consumption Advisory	WV BPH	WV BPH	Yes
December 18, 2000	Trip Report, Kanawha River Valley Hi-Vol Water Sampling, Nitro, Kanawha and Putnam Counties, WV	Ecology & Environment, Inc.	US EPA Region III	Yes
January, 2001	Soil Feasibility Study - Fike Chemical Superfund Site	GeoSyntec Consultants	Fike/Artel Site Trust	Yes
January, 2001	Soil Feasibility Study - Fike Chemical Superfund Site, Nitro, West Virginia	Geosyntec Consultants	Fike Artel Trust	Yes
January, 2001	Final Soil Remedial Investigation Report - Appendix A - Health and Ecological Risk Assessments for Soil	GeoSyntec Consultants	Fike/Artel Site Trust	Yes
January 3, 2001	EPA's Comments on Human Health Risk Assessment for the Former OxyChem Belle Facility - September 2000	U.S. EPA, Region III	Glenn Springs Holdings, Inc.	Yes
January 5, 2001	Final Soil Remedial Investigation Report, Volume I of III	IT Corporation	NA	Yes
February 1, 2001	Response Action Plan, CAP Construction, AES Property Site, AOC Docket No. 111-2001-0004-DC, Nitro, West Virginia	Potesta & Associates	Solutia, Inc.	Yes
February, 2001	2000 Annual Groundwater Assessment Monitoring Report - Union Carbide Corporation, Institute, West Virginia	KEMRON Environmental Services, Inc.	Union Carbide Corporation	Yes
March 5, 2001	Health Consultation - Manila Creek Landfill (a.k.a. Poca Drum Dump), Raymond, Putnam County, WV	U.S. Department of Health and Human Services	NA	Yes
April, 2001	Permit Modification Request No. 2 Chemical Leaman Tank Lines, Inc.	Quality Distribution, Inc.	Science Application International Corporation	Yes
April 3, 2001	Meeting Minutes: Fike/Artel Site Trust, Community Liaison Panel Meeting, Nitro Community Center	John McPherson	Fike/Artel Site Trust	Yes
2001	West Virginia Discharge Monitoring Report (May 2001 - November 2001)	Aventis CropScience	Division of Water Resources	Yes
June 12, 2001	Letter to Kate Lose, U.S. EPA, Region III, from Mark L. Slusarski, WV DEP, Re: WVDEP Trip Report - Offsite Sewer System Investigation (May 29, 2001), Fike/Artel Superfund Site, Nitro, West Virginia	WV DEP	WV DEP	Yes
June 26, 2001	Trip Report, Kanawha River Valley Site, Kanawha and Putnam County, WV	Roy F. Weston, Inc.	US EPA Region III	Yes
July 9, 2001	Letter to Mike Chezik, DOI Custom House, from Kate, Lose RPM, U.S. EPA, Region III, Re: Proposed Plan for Fike/Artel Superfund Site, Operable Unit 4	Kate Lose	U.S. EPA, Region III	Yes
2001	West Virginia Discharge Monitoring Report (August 2001 - November 2001 and March 2002)	Aventis CropScience	Division of Water Resources	Yes
August 3, 2001	Letter to Mr. Patrick T. Ragan, Aventis CropScience, from WV DEP	WV DEP	WV DEP	Yes
August 3, 2001	Compliance Inspection Report - Aventis CropScience	WV DEP	Aventis CropScience	Yes
September, 2001	Lagoon 3 Characterization Report, Fike/Artel Superfund Site, Nitro, WV	GeoSyntec Consultants	Fike/Artel Trust	Yes
September, 2001	Report on Phase 1A Activities – Corrective Measures Study	Roux Associates, Inc.	Solutia, Inc.	Yes
September, 2001	Record of Decision - Operable Unit 4 - Fike Artel Superfund Site, Nitro, West Virginia	USEPA Region III Superfund Program	NA	Yes
September 10, 2001	State of West Virginia Discharge Monitoring Report for the month of August 2001	Aventis	WV DEP	Yes
September 26, 2001	Compliance Evaluation Inspection, Flexsys Nitro Plant	WV DEP	WV DEP	Yes
September 28, 2001	Pre-RFI Site Assessment - Union Carbide Corporation South Charleston Facility	Union Carbide Corporation	NA	Yes
October 1, 2001	Report for 3rd Quarter 2001 Groundwater Monitoring - Armour Creek Landfill	Potesta & Associates	Solutia, Inc.	Yes
October 1, 2001	Stormwater Sampling for 2,3,7,8-TCDD - Armour Creek Landfill	Potesta & Associates	Solutia, Inc.	Yes
October 1, 2001	Report for 3rd Quarter 2001 Groundwater Monitoring - Armour Creek Landfill	Potesta & Associates	Solutia, Inc.	Yes
October 12, 2001	State of West Virginia Discharge Monitoring Repot for the month of September 2001	Aventis	WV DEP	Yes

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October 12, 2001	Letter to Ms. Allyn Turner, from Anthony C. Tuk, Solutia, Re: 3rd Quarter, 2001 Report, Armour Creek Landfill - NPDES Permit Requirements, WV 0077020	Anthony Tuk	Solutia	Yes
October 22, 2001	Response to Comments, Phase II Ecological Risk Assessment Report (October 2000), Former Occidental Chemical Corporation Facility, Belle, WV	Glenn Springs Holding, Inc.	U.S. EPA Region III	Yes
October 22, 2001	Human Health Risk Assessment for Surface Water and Sediment - Fish Ingestion Evaluation, Former OxyChem Facility, Belle, WV	Environmental Resources Management, Inc.	Glenn Springs Holdings, Inc.	Yes
October 25, 2001	Letter to Mr. Pravin Sangani, from Gordon T. Smith, Aventis CropScience	Gordon T. Smith	Aventis CropScience	Yes
November 26, 2001	Engineering Evaluation/ Cost Analysis Addendum, Heizer Creek Landfill Site, Putnam County, WV	ARCADIS	Monsanto Company	Yes
2001	West Virginia Discharge Monitoring Report (December 2001 - April 2002)	Bayer CropScience	Division of Water Resources	Yes
December 12, 2001	State of West Virginia Discharge Monitoring Repot for the month of November 2001	Aventis	WV DEP	Yes
December 21, 2001	Evaluation of Environmental Indicators for Migration of Contaminated Groundwater Under Control	Roux Associates, Inc.	U.S. EPA, Region III	Yes
2002	Dioxin seep discovered at Nitro plant	Ken Ward Jr.	The Charleston Gazette	Yes
January 8, 2002	Letter to Mr. Jon W. McKinney, Flexsys, from David B. Wheatcraft, WV DEP, Re: Notice of Violation of the terms and conditions of WV/NPDES Permit No. WV0000868 and the West Virginia Legislative Rules	WV DEP	WV DEP	Yes
April, 2002	Sampling Inspection Report – Solutia, Inc., Nitro West Virginia	WV DEP	NA	Yes
April 5, 2002	Letter to Mr. Jon W. McKinney, Flexsys, from Naresh R. Shah, WV DEP, Re: WV/NPDES Application WV0000868 Review of Information Received on March 14 & 28, 2002	WV DEP	WV DEP	Yes
April 11, 2002	State of West Virginia Discharge Monitoring Report for the Month of March 2002	Aventis	WV DEP	Yes
April 15, 2002	Letter to Ms. Jennifer Shoemaker, U.S. EPA, from D.M. Light, Solutia, Re: Notification of Potential Release	D.M. Light	Solutia	Yes
April 18, 2002	Memorandum: Solutia Sampling, from WV DEP	WV DEP	WV DEP	Yes
April 24, 2002	Sampling Inspection Report - Solutia, Inc.	Christopher M. Gatens	WV DEP	Yes
April 29, 2002	Sampling Inspection Report - Solutia, Inc.	WV DEP	WV DEP	Yes
April 29, 2002	Letter to Mike Light, Solutia, from Thomas A. Fisher, WV DEP, Re: Sampling Inspection Report dated April 24, 2002	WV DEP	WV DEP	Yes
May 3, 2002	Letter to Katherine A. Lose, U.S. EPA, from Mark Slusarski, WV DEP, Re: Fike/Artel Superfund Site, 1st Q. 2002 Waste Water Management System Analytical Report	WV DEP	WV DEP	Yes
June 11, 2002	Building 603 Geoprobe Investigation, DOW South Charleston Facility	KEMRON	Union Carbide Corporation	Yes
July 24, 2002	Letter to Katherine A. Lose, U.S. EPA, from Mark Slusarski, WV DEP, Re: Fike/Artel Superfund Site, 2nd Q. 2002 Waste Water Management System Analytical Report	WV DEP	WV DEP	Yes
August 1, 2002	Interim Measures Work Plan - Final (Kanawha River Bank Stabilization and Residue Cleanup, Flexsys Nitro Plant Facility, MP 42.1, Nitro, West Virginia)	Potesta & Associates, Inc.	Solutia, Inc.	Yes
September 10, 2002	Letter to Michael Light, Solutia, from David Farley, WV DEP	WV DEP	WV DEP	Yes
September 26, 2002	Summary of HUB Drainage Ditch Dye Study, Flexsys America L.P. Nitro Production Facility, Nitro, West Virginia	Potesta & Associates	NA	Yes
March, 2003	Final Report - Multimedia Compliance Investigation, Institute Plant - Union Carbide	National Enforcement Investigations Center	U.S. EPA, Region III	Yes
March 1, 2003	Kanawha River Mile Point 41 to 42.5 and Mile Point 42.5 to 46.5 Site Inspection Report	Region III, START	U.S. EPA	Yes
April, 2003	Quality Assurance Plan - Great Lakes Chemical Corporation and FMC Corporation	Blasland, Bouck & Lee, Inc.	Great Lakes Chemical Corporation	Yes
May, 2003	Interim Remedial Measure Work Plan - Former SSS Area Dupont Plant, Belle, West Virginia	Corporate Remediation Group	NA	Yes
May, 2003	Phase II RFI Investigation Report - Plant Area Dupont Belle Plant, Belle, West Virginia	Corporate Remediation Group	NA	Yes
June 12, 2003	Letter to Jon W. McKinney, Plant Manager, Flexsys, from Belinda Beller, Permitting Section, WV DEP, Re: Permit Application No. WV0000868 Putnam County	WV DEP	WV DEP	Yes
July, 2003	Dupont Belle, Offsite Groundwater Sampling Summary	Corporate Remediation Group	USEPA	Yes
July 9, 2003	Letter to Mr. Charlie Moses, WV DEP, from REIC, Re: CM-CAM-6-23-03-1	REIC	WV DEP	Yes
August 1, 2003	Summary of Analytical Data Results Warehouse Area Groundwater/ Soil Investigation, WVABCA Property, Nitro, West Virginia	Potesta & Associates, Inc.	Solutia, Inc.	Yes
August, 2003	File Review and Information Compilation Report	TRIAD Engineering, Inc.	WV DEP	Yes
August 5, 2003	Letter to Jon W. McKinney, Flexsys America, LP, from Charles A. Moses, WV DEP, Re: Water Compliance Inspection Report	WV DEP	WV DEP	Yes
September 19, 2003	ACF - Huntington (WV D005004866)	WV DEP	WV DEP	Yes
1977	Evaporation Ponds	NEIC	NA	Yes
1988	Fike Chemical Project	Technical Testing Laboratories, Inc.	NA	Yes
2003	Draft NPDES Water Pollution Control Permit No. WV0000868, Flexsys America, LP	WV DEP	WV DEP	Yes

TABLE 3.1

SUMMARY OF PREVIOUS INVESTIGATIONS OF THE KANAWHA RIVER
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Report Date	*Title of Investigation*	*Prepared By*	*Prepared For*	*Contained Relevant Information**
NA	The Fike/Artel Superfund Site Remediation, Operable Unit Three - - What does it involve and who's doing the work?	Fike/Artel Site Trust	Fike/Artel Site Trust	Yes
NA	Memorandum to Thomas P. Eichler, U.S. EPA, from Bruce Potoka, U.S. EPA, Re: Immediate Removal Request for the Fike Chemical Site, Nitro, West Virginia	U.S. EPA, Region III	U.S. EPA, Region III	Yes
NA	Site Information - Volume Four - Kanawha Valley Sites	Roy F. Weston, Inc.	U.S. EPA, Region III	Yes
NA	West Virginia Discharge Monitoring Report (May 2002 - April 2003)	Bayer CropScience	WV DEP, Division of Water Resources	Yes
NA	West Virginia Discharge Monitoring Report (May 2001 - November 2001)	Aventis CropScience	WV DEP, Division of Water Resources	Yes
NA	West Virginia Discharge Monitoring Report (December 2001 - April 2002)	Bayer CropScience	WV DEP, Division of Water Resources	Yes
NA	Occidental Chemical Corporation (WVD005010227)			Yes
NA	State Questions Eleanor Cleanup, Water Contaminated, DEP Letter States	Rusty Marks	NA	Yes
NA	Dioxin worries surface on buried soil in Wetzel	Pat Sanders	Charleston Daily Mail	Yes
NA	Letter to H. William Lichtenberger, President, UCC, from Maria Parisi Vickers, Director, RCRA Programs, U.S. EPA Region III	U.S. EPA, Region III	U.S. EPA, Region III	Yes
NA	West Virginia Discharge Monitoring Report (May 2002 - April 2003)	Bayer CropScience	Division of Water Resources	Yes
NA	Site Information - Volume Four Kanawha River Valley Sites	Roy F. Weston	USEPA Region III	Yes

Notes:
* This item contained information that was determined to be relevant for development of one or all of the following items; the Work Plan, the Site History, and/or the Site database.
NA - Information was not available.

TABLE 3.2

SUMMARY OF KANAWHA RIVER WATER COLUMN 2,3,7,8-TCDD ANALYSES
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sampling Date	*River Mile*	*Charleston Flow (cfs)*	*2,3,7,8-TCDD (pg/L)* Dissolved	*2,3,7,8-TCDD (pg/L)* Particulate	*2,3,7,8-TCDD (pg/L)* Total	*Total Dioxin TEQ (pg/L)* Dissolved	*Total Dioxin TEQ (pg/L)* Particulate	*Total Dioxin TEQ (pg/L)* Total
May-99	"Upstream"	5,100 - 20,800	-	-	0.009	-	-	-
Jun-00	46.0	18,000	0.000	0.007	0.007	0.010	0.179	0.189
Jun-00	42.2	22,900	0.014	0.191	0.205	0.028	0.543	0.571
Jun-00	41.8	23,900	0.009	0.100	0.109	0.034	0.391	0.425
Jun-98	41.3	9,060	0.015	0.115	0.130	0.028	0.220	0.248
Jul-98	41.3	5,100	0.027	0.312	0.339	0.030	0.425	0.455
Jun-98	36.5	9,340	0.024	0.351	0.375	0.032	0.490	0.522
Jul-98	36.5	4,500	0.033	0.202	0.235	0.036	0.290	0.326
Jun-98	29.7	9,320	0.027	0.231	0.258	0.036	0.424	0.460
Jul-98	29.7	3,700	0.023	0.222	0.245	0.027	0.507	0.533
		MEAN VALUE:	0.022	0.216	0.237	0.031	0.411	0.443

Source: EPA, 2000a and 2000b.

TABLE 4.1

SUMMARY OF EOC FIELD ACTIVITIES
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Date	*Activity*	*Comment*
PHASE I EOC ACTIVITIES		
October 4, 2004	Mobilization - CRA	- -
October 5, 2004	Mobilization - Blue Coast	ADCP flooded in inner chamber at approx. 2:30 p.m. Replacement unit shipped to Site.
October 6, 2004	Velocity Profiling - RM 68	Heavy fog delays FedEx, ADCP does not arrive until early afternoon
October 7, 2004	Velocity Profiling - RM 46, 42, 33, 31 / De-Mobilization - Blue Coast	- -
October 8, 2004	De-Mobilization - CRA	- -
October 9, 2004	CRA - Mobilization	- -
October 10, 2004	No Activity	- -
October 11, 2004	Mobilization - Axys, Exponent, CRA (Don Knorr), Normandeau (Fish sampling)	- -
October 12, 2004	SW sampling - RM 46; Fish sampling, seasonal low flow	- -
October 13, 2004	SW sampling - RM 42; Fish sampling, seasonal low flow	SW sampling suspended after 7 of the 8 sections completed due to lightening; fishing suspended
October 14, 2004	SW sampling - RM 33; Fish sampling, seasonal low flow	- -
October 15, 2004	SW sampling - RM 31; Fish sampling, seasonal low flow	Heavy wind causing boat to drift, need to reposition. Lots of barge traffic interrupting sampling (must move from channel). Intake clogged with silt at approx. 4 p.m., suspends sampling as motor must be taken apart to fix.
October 16, 2004	Maintenance (Infiltrex Pump) / Normandeau Crew Change - Crew 1 De-mobilizes	- -
October 17, 2004	Maintenance (Infiltrex Pump)	Submersible pump was plumbed into Infiltrex system, bypassing Infiltrex pump that could not be fixed.
October 18, 2004	SW sampling - RM 68; Re-Mobilization -Normandeau Crew 2, seasonal low flow	Heavy wind causing boat to drift, need to reposition. Heavy barge traffic - requested by lockmaster to move out of channel several times (pumping suspended).
October 19, 2004	SW sampling - RM 31; Fish sampling, seasonal low flow	Complete sampling at RM 31. Requested by lockmaster to move out of channel due to barge traffic (pumping suspended).
October 20, 2004	Demobilization - Exponent & Axys; Fish sampling; Mobilization - Golder	- -
October 21, 2004	Geophysical/Bath Surveying Coal River to Winfield Dam; Fish sampling	- -
October 22, 2004	Geophysical/Bath Surveying Coal River to Winfield Dam; Fish sampling	- -
October 23, 2004	Geophysical/Bath Surveying Coal River to Winfield Dam; Fish sampling; De-Mobilization - Normandeau	- -
October 24, 2004	Prepare Sediment Sampling Equipment	- -
October 25, 2004	Sediment sampling for physical properties	- -
October 26, 2004	Sediment sampling for physical properties	- -
October 27, 2004	Sediment sampling for physical properties	- -
October 28, 2004	Sediment sampling for TCDD	- -
October 29, 2004	Sediment sampling for TCDD/physical properties	Attempted to collect samples for physical properties at locations previously unable to
October 30, 2004	Sediment sampling for TCDD/De-Mobilization - Anchor	- -
October 31, 2004	De-Mobilization - Golder	- -
November 1, 2004	De-Mobilization - CRA	- -
November 2, 2004	De-Mobilization - CRA	- -
April 11, 2005	Re-Mobilization - CRA, Exponent, Axys	- -
April 12, 2005	SW sampling - RM 68, seasonal high flow	- -
April 13, 2005	SW sampling - RM 46, seasonal high flow	- -
April 14, 2005	SW sampling - RM 31, seasonal high flow	- -
April 15, 2005	SW sampling - RM 33, seasonal high flow	- -
April 16, 2005	SW sampling - RM 42, seasonal high flow	- -
April 17, 2005	De-mobilization - Axys, Exponent	- -
April 18, 2005	De-mobilization - CRA	- -
		- -

TABLE 4.1

SUMMARY OF EOC FIELD ACTIVITIES
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Date	*Activity*	*Comment*
PHASE II EOC ACTIVITIES		- -
November 26, 2007	Mobilization: CRA (Dan Deitner), Exponent, and Normandeau (Rich Kling, Andrew Fiscus)	- -
November 27, 2007	Mobilization: CRA (Dan Deitner), Exponent, and Normandeau (Rich Kling, Andrew Fiscus)	- -
November 28, 2007	Sediment sampling - SSD-23, -24, -25, -26, -27, and -28; COR-37, -38, -39, -40, -41, -42, and -43	- -
November 29, 2007	Sediment sampling - SSD-19, -20, -21, and -22; COR-25, -26, -27, -28, -29, -30, -31, -32, -33, -34, -35, and -36	- -
November 30, 2007	Sediment sampling - SSD-10, -11, -12, -13, -14, -15, -16, -17, and -18; COR-19, -20, -21, -22, -23, and -24	- -
December 1, 2007	Sediment sampling - SSD-6, -7, and -9; COR-4, -5, -6, -7, -8, -9, -10, -11, -12, -13, -14, -15, -16, -17, and -18	- -
December 2, 2007	Sediment sampling - SSD-1, -2, -3, -4, and -5; COR-1, -2, and -3	- -
December 3, 2007	Sediment sampling - COR-42, and -43	- -
December 4, 2007	Sediment sampling - COR-38, -39, -40, and -41	- -
December 5, 2007	Sediment sampling - COR-35, and -36; NRC-08	- -
December 6, 2007	Sediment Sampling - COR-33; NRC-07	- -
December 7, 2007	Sediment Sampling - COR-30	- -
December 8, 2007	Sediment Sampling - COR-23, -25, and -28	- -
December 9, 2007	No Activity	- -
December 10, 2007	Sediment Sampling - COR-21, -22; NRC-05	- -
December 11, 2007	Sediment Sampling - COR-18, -19, and -20	- -
December 12, 2007	Sediment Sampling - COR-04; NRC-02	- -
December 13, 2007	Sediment Sampling - COR-03, -4, and -8	- -
December 14, 2007	Sediment Sampling - COR-07; NRC-03	- -
December 15, 2007	Sediment Sampling - COR-09, -11, and -12	- -
December 16, 2007	No Activity	- -
December 17, 2007	No Activity	- -
December 18, 2007	No Activity	- -
December 19, 2007	Demobilization: CRA (Dan Deitner), Exponent, and Normandeau (Rich Kling, Andrew	- -
February 18, 2008	Mobilization: CRA (Dan Deitner), Exponent, and Normandeau (Rich Kling, Andrew Fiscus)	- -
February 19, 2008	Sediment coring - NRC-04, and -05	Locations cored late in the day processed next day.
February 20, 2008	Sediment processing - NRC-04, and -05; attempted coring at COR-01, 02; NRC-01	Five attempts at each coring locations resulting in refusals.
February 21, 2008	sediment coring - COR-05,-06,-13,-14	Total of five (5) attempts at each coring location resulting in refusals.
February 22, 2008	No activity	Cancelled sampling activities for the day due to freezing rain.
February 23, 2008	Sediment Sampling - COR-15, and -16	- -
February 24, 2008	Sediment Sampling - NRC-08; Black Carbon samples BC-COR-10A, BC-COR-10B, BC-COR-13A, BC-COR-13B, BC-COR-37A, BC-COR-37B, BC-SSD-26A, BC-SSD-26B ; Waste Characterization samples	- -
February 25, 2008	Demobilization: CRA, Exponent, and Normandeau (Rich Kling, Andrew Fiscus)	- -
February 26, 2008	Demobilization: CRA, Exponent, and Normandeau (Rich Kling, Andrew Fiscus)	- -
December 8, 2008	Mobilization: CRA (Shelly Gould and Rebecca Bentley) and Normandeau (Rich Kling, Andrew Fiscus, Helen Sharp)	- -
December 9, 2008	Sediment sampling - COR-40; COR-42	Attempted to collect sample at COR-36A, however lost tube.
December 10, 2008	Sediment sampling - COR-36A; COR-36; COR-36B; COR-36C; and COR-32A	Refusal at COR-32A.
December 11, 2008	Sediment sampling - COR-32B; COR-31; COR-28A; COR-32A	Re-sample location COR-32A at EPA's request; refusal at COR-31.
December 12, 2008	Demobilization: CRA (Shelly Gould, Rebecca Bentley) and Normandeau (Helen Sharp); Normandeau (Rich Kling, Andrew Fiscus) begins electrofishing	Turbid water and rain making electrofishing difficult.
December 13, 2008	Electrofishing; Demobilization: CRA (Shelly Gould, Rebecca Bentley)	- -
December 14, 2008	Electrofishing; Mobilization: CRA (Don Knorr, Christine Potts)	- -

TABLE 4.1

SUMMARY OF EOC FIELD ACTIVITIES
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Date	*Activity*	*Comment*
December 15, 2008	Electrofishing	- -
December 16, 2008	Electrofishing at RM 33	Weather is poor, river is high and muddy making electrofishing difficult. Have bass from RM 42, and about half the catfish sample from RM 42. Set more trot lines for catfish in the evening. Attempted to electrofish at RM 33 in the afternoon and evening, however there are less fish than observed at RM 42.
December 17, 2008	Electrofishing at RM 33 for gizzard shad and bass; Electrofishing at RM 68	Set trot lines for catfish at RM 75-95. Electrofished at RM 68 and caught a few bass and a few saugers. More productive electrofishing is in the morning.
December 18, 2008	Electrofishing at RM 68 in the morning, completed bass sampling at RM 68	Checked trot lines at RM 75-95.
December 19, 2008	Electrofishing	- -
December 20, 2008	Electrofishing	- -
December 21, 2008	Electrofishing	- -
December 22, 2008	Demobilization: CRA (Don Knorr, Christine Potts), Normandeau (Rich Kling, Andrew	- -
January 12, 2009	Mobilization: Normandeau	- -
January 13, 2009	Electrofishing	- -
January 14, 2009	Electrofishing	- -
January 15, 2009	Electrofishing	- -
January 16, 2009	Electrofishing	- -
January 17, 2009	Electrofishing	- -
January 18, 2009	Electrofishing	- -
January 19, 2009	Electrofishing	- -
January 20, 2009	Demobilization: Normandeau	- -
July 26, 2009	Mobilization: CRA (Dan Deitner), Normandeau (Mike Mettler), Sea Engineering (Frank	- -
July 27, 2009	Sediment sampling for SedFlume testing - KRSD-24, - 25, and -28	- -
July 28, 2009	Sediment sampling for SedFlume testing - COR-42, -40, -39, -35, -36, -32B, -30, -25, KRSD-14 and -20	Five (5) attempts each at locations COR-32B and COR-25 resulted in no recovery.
July 29, 2009	Sediment sampling for SedFlume testing - KRSD-48, -10, and COR-20	Rain and lightening reduced sampling activities.
July 30, 2009	Sediment sampling for SedFlume testing - KRSD-1, -4, -5 and COR-7	- -
July 31, 2009	Demobilization: CRA (Dan Deitner), Normandeau (Mike Mettler), Sea Engineering (Frank Spada)	- -

TABLE 4.2

SUMMARY OF FLOW MEASUREMENT DATA
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

		Total Flow (m^3/s)				*Average Velocity (cm/s)*			
	Date	*Transect 1*	*Transect 2*	*Transect 3*	*Transect 4*	*Transect 1*	*Transect 2*	*Transect 3*	*Transect 4*
RM 31	10/7/2004	283.25	265.67	-	-	10.93	10.60	-	-
RM 33	10/7/2004	260.16	208.92	-	-	12.80	9.85	-	-
RM 42	10/7/2004	196.41	159.21	-	-	12.55	10.28	-	-
RM 46	10/7/2004	225.79	235.81	244.11	-	17.17	17.45	17.71	-
RM 68	10/6/2004	251.18	249.24	212.58	205.29	14.71	16.18	12.42	13.28

Notes:

1) RM - River mile, distance upstream of the concluence of the Kanawha River with the Ohio River.
2) Velocity measurements used to calculate flow were taken using RD Instruments 1200 kHz ADCP.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 31*	*RM 31*	*RM 31*	*RM 31*
Sample ID:		*SW-31884-DL-10/19/04-003A/B*	*SW-31884-DL-10/15/04-001*	*SW-31884-DL-10/19/04-001*	*SW-31884-DL-10/19/04-002*
Sample Date:		*10/19/04*	*10/15/2004*	*10/19/2004*	*10/19/2004*
Flow Type:		*Low Flow*	*Low Flow*	*Low Flow*	*Low Flow*
	Units				
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	14,200	18,800	14,200	14,200
Sample Volume Filtered	L	1,000	-	-	-
Dioxins and Furans					
2,3,7,8-TCDD (Dissolved)	pg/sample	5.96 J	-	-	-
2,3,7,8-TCDD (Dissolved)	pg/L	0.00596 J	-	-	-
2,3,7,8-TCDD (Particulate)	pg/sample	46.3	-	-	-
2,3,7,8-TCDD (Particulate)	pg/L	0.04630	-	-	-
General Chemistry					
Dissolved Organic Carbon (DOC)	mg/L	-	2	2	3
Total Organic Carbon (TOC)	mg/L	-	2	3	2
Total Suspended Solids (TSS)	mg/L	-	11	8.0	6.0

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***RM 33***	***RM 33***	***RM 33***	***RM 33***
Sample ID:		***SW-37884-DL-10/14/04-004A/B***	***SW-31884-DL-10/14/04-001***	***SW-31884-DL-10/14/04-002***	***SW-31884-DL-10/14/04-003***
Sample Date:		***10/14/04***	***10/14/2004***	***10/14/2004***	***10/14/2004***
Flow Type:		***Low Flow***	***Low Flow***	***Low Flow***	***Low Flow***
	Units				
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	10,700	10,700	10,700	10,700
Sample Volume Filtered	L	1,000	-	-	-
Dioxins and Furans					
2,3,7,8-TCDD (Dissolved)	pg/sample	10.9	-	-	-
2,3,7,8-TCDD (Dissolved)	pg/L	0.01090	-	-	-
2,3,7,8-TCDD (Particulate)	pg/sample	15.6	-	-	-
2,3,7,8-TCDD (Particulate)	pg/L	0.01560	-	-	-
General Chemistry					
Dissolved Organic Carbon (DOC)	mg/L	-	2	2	2
Total Organic Carbon (TOC)	mg/L	-	2	1	2
Total Suspended Solids (TSS)	mg/L	-	9.0 J	8.0 J	7.0 J

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***RM 42***	***RM 42***	***RM 42***	***RM 42***
Sample ID:		***SW-31884-DL-10/13/04-004A/B***	***SW-31884-DL-10/13/04-005A***	***SW-31884-DL-10/13/04-001***	***SW-31884-DL-10/13/04-002***
Sample Date:		***10/13/04***	***10/13/04***	***10/13/2004***	***10/13/2004***
Flow Type:		***Low Flow***	***Low Flow***	***Low Flow***	***Low Flow***
	Units				
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	6,820	6,820	6,820	6,820
Sample Volume Filtered	L	756	756	-	-
Dioxins and Furans					
2,3,7,8-TCDD (Dissolved)	pg/sample	5.33 J	5.36 J	-	-
2,3,7,8-TCDD (Dissolved)	pg/L	0.00705 J	0.00709 J	-	-
2,3,7,8-TCDD (Particulate)	pg/sample	3.78 J	-	-	-
2,3,7,8-TCDD (Particulate)	pg/L	0.00500 J	-	-	-
General Chemistry					
Dissolved Organic Carbon (DOC)	mg/L	-	-	2	2
Total Organic Carbon (TOC)	mg/L	-	-	2	2
Total Suspended Solids (TSS)	mg/L	-	-	8.0 J	5.0 J

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 42*	*RM 46*	*RM 46*	*RM 46*
Sample ID:		*SW-31884-DL-10/13/04-003*	*SW-31884-DL-10/12/04-001A/B*	*SW-31884-DL-10/12/04-002*	*SW-31884-DL-10/12/04-003*
Sample Date:		*10/13/2004*	*10/12/04*	*10/12/2004*	*10/12/2004*
Flow Type:		*Low Flow*	*Low Flow*	*Low Flow*	*Low Flow*
	Units				
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	6,820	6,840	6,840	6,840
Sample Volume Filtered	L	-	1,000	-	-
Dioxins and Furans					
2,3,7,8-TCDD (Dissolved)	pg/sample	-	0.874 J	-	-
2,3,7,8-TCDD (Dissolved)	pg/L	-	0.000874 J	-	-
2,3,7,8-TCDD (Particulate)	pg/sample	-	ND (1.27) U	-	-
2,3,7,8-TCDD (Particulate)	pg/L	-	ND (0.00127) U	-	-
General Chemistry					
Dissolved Organic Carbon (DOC)	mg/L	2	-	2	2
Total Organic Carbon (TOC)	mg/L	2	-	2	2
Total Suspended Solids (TSS)	mg/L	5.0 J	-	ND(2.8)	5.0 J

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***RM 46***	***RM 68***	***RM 68***	***RM 68***
Sample ID:		***SW-31884-DL-10/12/04-001A***	***SW-31884-DL-10/18/04-004 A/B***	***SW-31884-DL-10/18/04-001***	***SW-31884-DL-10/18/04-002***
Sample Date:		***10/12/2004***	***10/18/04***	***10/18/2004***	***10/18/2004***
Flow Type:		***Low Flow***	***Low Flow***	***Low Flow***	***Low Flow***
	Units				
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	6,840	10,400	10,400	10,400
Sample Volume Filtered	L	-	1,000	-	-
Dioxins and Furans					
2,3,7,8-TCDD (Dissolved)	pg/sample	-	1.12 J	-	-
2,3,7,8-TCDD (Dissolved)	pg/L	-	0.00112 J	-	-
2,3,7,8-TCDD (Particulate)	pg/sample	-	ND (0.753) U	-	-
2,3,7,8-TCDD (Particulate)	pg/L	-	ND (0.000753) U	-	-
General Chemistry					
Dissolved Organic Carbon (DOC)	mg/L	--	-	2	2
Total Organic Carbon (TOC)	mg/L	--	-	2	2
Total Suspended Solids (TSS)	mg/L	--	-	5.0	7.0

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***RM 68***	***RM 31***	***RM 31***	***RM 31***
Sample ID:		***SW-31884-DL-10/18/04-003***	***SW-31884-DL-4/14/05-004A/B***	***SW-31884-DL-04/14/05-001***	***SW-31884-DL-04/14/05-002***
Sample Date:		***10/18/2004***	***04/14/05***	***4/14/2005***	***4/14/2005***
Flow Type:		***Low Flow***	***High Flow***	***High Flow***	***High Flow***
	Units				
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	10,400	15,400	15,400	15,400
Sample Volume Filtered	L	-	1,000	-	-
Dioxins and Furans					
2,3,7,8-TCDD (Dissolved)	pg/sample	-	14.0	-	-
2,3,7,8-TCDD (Dissolved)	pg/L	-	0.01400	-	-
2,3,7,8-TCDD (Particulate)	pg/sample	-	48.9	-	-
2,3,7,8-TCDD (Particulate)	pg/L	-	0.04890	-	-
General Chemistry					
Dissolved Organic Carbon (DOC)	mg/L	2	-	1	2
Total Organic Carbon (TOC)	mg/L	2	-	1	2
Total Suspended Solids (TSS)	mg/L	8.0	-	12	7.0

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 31*	*RM 33*	*RM 33*	*RM 33*
Sample ID:		*SW-31884-DL-04/14/05-003*	*SW-31884-DL-4/15/05-004A/B*	*SW-31884-DL-4/15/05-001*	*SW-31884-DL-4/15/05-002*
Sample Date:		*4/14/2005*	*04/15/05*	*4/15/2005*	*4/15/2005*
Flow Type:		*High Flow*	*High Flow*	*High Flow*	*High Flow*
	Units				
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	15,400	15,300	15,300	15,300
Sample Volume Filtered	L	-	997	-	-
Dioxins and Furans					
2,3,7,8-TCDD (Dissolved)	pg/sample	-	10.3	-	-
2,3,7,8-TCDD (Dissolved)	pg/L	-	0.01033	-	-
2,3,7,8-TCDD (Particulate)	pg/sample	-	33.5	-	-
2,3,7,8-TCDD (Particulate)	pg/L	-	0.03360	-	-
General Chemistry					
Dissolved Organic Carbon (DOC)	mg/L	2	-	1	ND(0.08)
Total Organic Carbon (TOC)	mg/L	1	-	1	1
Total Suspended Solids (TSS)	mg/L	9.0	-	10	10

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 33*	*RM 42*	*RM 42*	*RM 42*
Sample ID:		*SW-31884-DL-4/15/05-003*	*SW-31884-DL-4/16/05-005A/B*	*SW-31884-DL-4/16/05-006A/B*	*SW-31884-DL-4/16/05-001*
Sample Date:		*4/15/2005*	*04/16/05*	*04/16/05*	*4/16/2005*
Flow Type:		*High Flow*	*High Flow*	*High Flow*	*High Flow*
	Units				
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	15,300	15,400	15,400	15,400
Sample Volume Filtered	L	-	1,003	1,003	-
Dioxins and Furans					
2,3,7,8-TCDD (Dissolved)	pg/sample	-	9.67 J	9.69 J	-
2,3,7,8-TCDD (Dissolved)	pg/L	-	0.00964 J	0.00966 J	-
2,3,7,8-TCDD (Particulate)	pg/sample	-	7.98 J	119	-
2,3,7,8-TCDD (Particulate)	pg/L	-	0.00796 J	0.11864	-
General Chemistry					
Dissolved Organic Carbon (DOC)	mg/L	1	-	-	1
Total Organic Carbon (TOC)	mg/L	2	-	-	1
Total Suspended Solids (TSS)	mg/L	19	-	-	14

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 42*	*RM 42*	*RM 42*	*RM 46*
Sample ID:		*SW-31884-DL-4/16/05-002*	*SW-31884-DL-4/16/05-003*	*SW-31884-DL-4/16/05-004*	*SW-31884-DL-4/13/05-004A/B*
Sample Date:		*4/16/2005*	*4/16/2005*	*4/16/2005*	*04/13/05*
Flow Type:		*High Flow*	*High Flow*	*High Flow*	*High Flow*
	Units				
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	15,400	15,400	15,400	15,600
Sample Volume Filtered	L	-	-	-	994
Dioxins and Furans					
2,3,7,8-TCDD (Dissolved)	pg/sample	-	-	-	ND (2.20)
2,3,7,8-TCDD (Dissolved)	pg/L	-	-	-	ND (0.00221)
2,3,7,8-TCDD (Particulate)	pg/sample	-	-	-	8.48 J
2,3,7,8-TCDD (Particulate)	pg/L	-	-	-	0.00853 J
General Chemistry					
Dissolved Organic Carbon (DOC)	mg/L	1	2	2	-
Total Organic Carbon (TOC)	mg/L	1	1	1	-
Total Suspended Solids (TSS)	mg/L	11	9.0	6.0	-

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***RM 46***	***RM 46***	***RM 46***	***RM 68***
Sample ID:		***SW-31884-DL-4/13/05-001***	***SW-31884-DL-4/13/05-002***	***SW-31884-DL-4/13/05-003***	***SW-31884-DL-4/12/05-004A/B***
Sample Date:		***4/13/2005***	***4/13/2005***	***4/13/2005***	***04/12/05***
Flow Type:		***High Flow***	***High Flow***	***High Flow***	***High Flow***
	Units				
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	15,600	15,600	15,600	15,100
Sample Volume Filtered	L	-	-	-	1,008
Dioxins and Furans					
2,3,7,8-TCDD (Dissolved)	pg/sample	-	-	-	ND (1.90)
2,3,7,8-TCDD (Dissolved)	pg/L	-	-	-	ND (0.00188)
2,3,7,8-TCDD (Particulate)	pg/sample	-	-	-	6.40 J
2,3,7,8-TCDD (Particulate)	pg/L	-	-	-	0.00635 J
General Chemistry					
Dissolved Organic Carbon (DOC)	mg/L	1	2	2	-
Total Organic Carbon (TOC)	mg/L	1	1	2	-
Total Suspended Solids (TSS)	mg/L	ND (2.8)	13	11	-

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.3

SURFACE WATER ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***RM 68***	***RM 68***	***RM 68***
Sample ID:		***SW-31884-DL-4/12/05-001***	***SW-31884-DL-4/12/05-002***	***SW-31884-DL-4/12/05-003***
Sample Date:		***4/12/2005***	***4/12/2005***	***4/12/2005***
Flow Type:		***High Flow***	***High Flow***	***High Flow***
	Units			
Mean Flow at Charleston Gauge (USGS 03198000)	ft^3/s	15,100	15,100	15,100
Sample Volume Filtered	L	-	-	-
Dioxins and Furans				
2,3,7,8-TCDD (Dissolved)	pg/sample	-	-	-
2,3,7,8-TCDD (Dissolved)	pg/L	-	-	-
2,3,7,8-TCDD (Particulate)	pg/sample	-	-	-
2,3,7,8-TCDD (Particulate)	pg/L	-	-	-
General Chemistry				
Dissolved Organic Carbon (DOC)	mg/L	2	2	2
Total Organic Carbon (TOC)	mg/L	ND (0.08)	1	1
Total Suspended Solids (TSS)	mg/L	4.0	9.0	9.0

Notes:

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
ft^3/s - Cubic feet per second
L - liter
ND - Not detected at or above the associated value.
pg - picogram
J - Estimated Concentration
U - Not present at or above the associated value
"-" - Parameter not analyzed.

TABLE 4.4

SUMMARY OF FISH TISSUE SAMPLING (PHASE I AND PHASE II EOC ACTIVITIES)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

River Mile	*Species*	*Replicate 1 (No. of Fish)*	*Sample ID*	*Replicate 2 (No. of Fish)*	*Sample ID*	*Replicate 3 (No. of Fish)*	*Sample ID*	*Replicate 4 (No. of Fish)*	*Sample ID*	*Replicate 5 (No. of Fish)*	*Sample ID*	*Duplicate (No. of Fish)*	*Sample ID*	*MS/MSD (No. of Fish)*	*Sample ID*
75-95	Channel Catfish	5	TISS-031884-012104-DK-046	5	TISS-031884-102104-DK-047	5	TISS-031884-102204-DK-048	5	TISS-031884-102204-DK-049	3	TISS-031884-111704-DFK-050 (2)	0	--	0	--
75-95	Sauger	5	TISS-031884-121808-DFK-036	5	TISS-031884-121808-DFK-037	2	TISS-031884-010809-DFK-038 (2)	15	TISS-031884-111704-DFK-051	15	TISS-031884-111704-DFK-052	0	--	0	--
68	Bass	5	TISS-031884-101604-DK-041	5	TISS-031884-101604-DK-042	5	TISS-031884-101604-DK-043	5	TISS-031884-101804-DK-044	5	TISS-031884-101804-DK-045	0	--	0	--
68	Bass	5	TISS-031884-121808-DFK-026	5	TISS-031884-121808-DFK-027	5	TISS-031884-121808-DFK-028	5	TISS-031884-121808-DFK-029	5	TISS-031884-121808-DFK-030	0	--	0	--
68	Forage (Gizzard Shad)	15	TISS-031884-101604-DK-036	15	TISS-031884-101804-DK-037	15	TISS-031884-101804-DK-038	6 (1)	TISS-031884-102104-DK-039	0	TISS-031884-101604-040 (2)	0	--	0	--
68	Forage (Gizzard Shad)	5	TISS-031884-121808-DFK-031	5	TISS-031884-121808-DFK-032	5	TISS-031884-122208-DFK-033	5	TISS-031884-122208-DFK-034	5	TISS-031884-122208-DFK-035	0	--	0	--
42	Bass	5	TISS-031884-101204-DK-001	5	TISS-031884-101304-DK-011	5	TISS-031884-101304-DK-012	5	TISS-031884-101504-DK-033	5	TISS-031884-101504-DK-034	0	--	0	--
42	Bass	5	TISS-031884-121708-DFK-001	5	TISS-031884-121708-DFK-002	5	TISS-031884-121708-DFK-009	5	TISS-031884-121708-DFK-010	0	--	0	--	0	--
42	Forage (Gizzard Shad)	15	TISS-031884-101304-DK-003	15	TISS-031884-101304-DK-004	15	TISS-031884-101304-DK-005	15	TISS-031884-101304-DK-006	15	TISS-031884-101304-DK-007	0	--	0	--
42	Forage (Gizzard Shad)	10	TISS-031884-121608-DFK-003	10	TISS-031884-121608-DFK-004	10	TISS-031884-121608-DFK-005	10	TISS-031884-121608-DFK-006	10	TISS-031884-121608-DFK-007	0	--	0	--
33-45	Channel Catfish	5	TISS-031884-101204-DK-002	5	TISS-031884-101304-DK-008	5	TISS-031884-101304-DK-009	5	TISS-031884-101304-DK-010	5	TISS-031884-101504-DK-035	0	--	0	--
33-45	Channel Catfish	5	TISS-031884-121708-DFK-011	5	TISS-031884-121708-DFK-012	5	TISS-031884-121708-DFK-013	5	TISS-031884-121708-DFK-014	5	TISS-031884-121708-DFK-015	0	--	0	--
33	Bass	5	TISS-031884-101404-DK-023	5	TISS-031884-101404-DK-024	5	TISS-031884-101404-DK-025	5	TISS-031884-101504-DK-026	5	TISS-031884-101504-DK-027	0	--	0	--
33	Bass	5	TISS-031884-121708-DFK-021	5	TISS-031884-121708-DFK-022	5	TISS-031884-121708-DFK-023	5	TISS-031884-121708-DFK-024	5	TISS-031884-121708-DK-025	0	--	0	--
33	Forage (Gizzard Shad)	15	TISS-031884-101404-DK-013	15	TISS-031884-101404-DK-014	15	TISS-031884-101404-DK-015	15	TISS-031884-101404-DK-016	15	TISS-031884-101404-DK-017	75 (5 sets of 15)	TISS-031884-101404-DK--018 to TISS-031884-101504-DK-022 (3)	50 (5 sets of 10)	TISS-031884-101504-DK-028 to TISS-031884-101504-DK-032
33	Forage (Gizzard Shad)	10	TISS-031884-121708-DFK-016	10	TISS-031884-121708-DFK-017	10	TISS-031884-121708-DFK-018	10	TISS-031884-121708-DFK-019	10	TISS-031884-121708-DFK-020	0	--	0	--

Notes:

(1) Sample consisted of 6 large gizzard shad.

(2) An insufficient number of target species was obtained to collect the sample.

(3) Samples TISS-031884-101404-DK-018 through -022 are duplicate samples of Gizzard Shad at RM33. Samples -018, -021, and -022 were put on hold and were not analyzed since the 1/20 duplicate frequency requirement had already been met.

TABLE 4.5a

PHASE I EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*
Sample ID:		*TISS-031884-101404-DK-013*	*TISS-031884-101404-DK-014*	*TISS-031884-101404-DK-015*	*TISS-031884-101404-DK-016*	*TISS-031884-101404-DK-017*	*TISS-031884-101404-DK-019*	*TISS-031884-101404-DK-020*
Sample Date:		*10/14/2004*	*10/14/2004*	*10/14/2004*	*10/14/2004*	*10/14/2004*	*10/14/2004*	*10/14/2004*
Sample Type:							*Field Duplicate*	*Field Duplicate*
Sample Species:		*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*
	Units							
Dioxins and Furans								
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	4.50	3.69	7.53	3.40	3.35	5.72	5.99
Lipids	%	2.39	2.07	2.61	1.97	2.63	2.56	2.54

Notes:

pg/g - picograms per gram
J- Estimated concentration.
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.

TABLE 4.5a

PHASE I EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33-45*	*RM 33-45*
Sample ID:		*TISS-031884-101404-DK-023*	*TISS-031884-101404-DK-024*	*TISS-031884-101404-DK-025*	*TISS-031884-101504-DK-026*	*TISS-031884-101504-DK-027*	*TISS-031884-101204-DK 002*	*TISS-031884-101304-DK-008*
Sample Date:		*10/14/2004*	*10/14/2004*	*10/14/2004*	*10/15/2004*	*10/15/2004*	*10/12/2004*	*10/13/2004*
Sample Type:								
Sample Species:		*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Channel Catfish (skin off fillets)*	*5 fish per composite Channel Catfish (skin off fillets)*
	Units							
Dioxins and Furans								
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	4.46	2.83	2.72	1.37	1.74	19.5	3.34
Lipids	%	0.52	0.51	0.50	0.76	0.45	3.05	1.20

Notes:

pg/g - picograms per gram
J- Estimated concentration.
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.

TABLE 4.5a

PHASE I EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 33-45*	*RM 33-45*	*RM 33-45*	*RM 42*	*RM 42*	*RM 42*	*RM 42*
Sample ID:		*TISS-031884-101304-DK-009*	*TISS-031884-101304-DK-010*	*TISS-031884-101504-DK-035*	*TISS-031884-101304-DK-003*	*TISS-031884-101304-DK-004*	*TISS-031884-101304-DK-005*	*TISS-031884-101304-DK-006*
Sample Date:		*10/13/2004*	*10/13/2004*	*10/15/2004*	*10/13/2004*	*10/13/2004*	*10/13/2004*	*10/13/2004*
Sample Type:								
Sample Species:		*5 fish per composite Channel Catfish (skin off fillets)*	*5 fish per composite Channel Catfish (skin off fillets)*	*5 fish per composite Channel Catfish (skin off fillets)*	*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*
	Units							
Dioxins and Furans								
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	1.33	6.07	4.02	1.50	6.70	0.877 J	1.59
Lipids	%	2.26	2.51	0.77	1.80	2.15	2.14	1.94

Notes:

pg/g - picograms per gram
J- Estimated concentration.
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.

TABLE 4.5a

PHASE I EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 68*
Sample ID:		*TISS-031884-101304-DK-007*	*TISS-031884-101204-DK 001*	*TISS-031884-101304-DK-011*	*TISS-031884-101304-DK-012*	*TISS-031884-101504-DK-033*	*TISS-031884-101504-DK-034*	*TISS-031884-101604-DK-036*
Sample Date:		*10/13/2004*	*10/12/2004*	*10/13/2004*	*10/13/2004*	*10/15/2004*	*10/15/2004*	*10/16/2004*
Sample Type:								
Sample Species:		*15 fish per composite Gizzard Shad (whole fish)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*15 fish per composite Gizzard Shad (whole fish)*
	Units							
Dioxins and Furans								
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	5.98	3.58	4.02	3.52	1.79	2.04	1.44
Lipids	%	2.49	0.28	0.39	0.42	0.53	0.48	3.73

Notes:

pg/g - picograms per gram
J- Estimated concentration.
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.

TABLE 4.5a

PHASE I EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*
Sample ID:		*TISS-031884-101804-DK-037*	*TISS-031884-101804-DK-038*	*TISS-031884-102104-DK-039*	*TISS-031884-111704-DFK-051*	*TISS-031884-111704-DFK-052*	*TISS-031884-101604-DK-041*
Sample Date:		*10/18/2004*	*10/18/2004*	*10/21/2004*	*11/17/2004*	*11/17/2004*	*10/16/2004*
Sample Type:							
Sample Species:		*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*	*6 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*	*15 fish per composite Gizzard Shad (whole fish)*	*5 fish per composite Bass (skin on fillets)*
	Units						
Dioxins and Furans							
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	2.10	0.511 J	0.222 J	0.936 J	0.307 J	ND (0.221) U
Lipids	%	3.19	3.13	4.56	4.60	5.02	0.38

Notes:

pg/g - picograms per gram
J- Estimated concentration.
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.

TABLE 4.5a

PHASE I EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 75-95*	*RM 75-95*
Sample ID:		*TISS-031884-101604-DK-042*	*TISS-031884-101604-DK-043*	*TISS-031884-101804-DK-044*	*TISS-031884-101804-DK-045*	*TISS-031884-102104-DK-046*	*TISS-031884-102104-DK-047*
Sample Date:		*10/16/2004*	*10/16/2004*	*10/18/2004*	*10/18/2004*	*10/21/2004*	*10/21/2004*
Sample Type:							
Sample Species:		*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Channel Catfish (skin off fillets)*	*5 fish per composite Channel Catfish (skin off fillets)*
	Units						
Dioxins and Furans							
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	0.469 J	ND (0.178) U	0.365 J	ND (0.077) U	0.635 J	0.251 J
Lipids	%	0.30	0.26	0.65	0.31	2.13	4.85

Notes:

pg/g - picograms per gram
J- Estimated concentration.
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.

TABLE 4.5a

PHASE I EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 75-95*	*RM 95*	*RM 95*
Sample ID:		*TISS-031884-111704-DFK-050*	*TISS-031884-102204-DK-048*	*TISS-031884-102204-DK-049*
Sample Date:		*11/17/2004*	*10/22/2004*	*10/22/2004*
Sample Type:				
Sample Species:		*3 fish per composite Channel Catfish (skin off fillets)*	*5 fish per composite Channel Catfish (skin off fillets)*	*5 fish per composite Channel Catfish (skin off fillets)*
	Units			
Dioxins and Furans				
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	0.300 J	0.736 J	0.462 J
Lipids	%	2.91	2.24	2.20

Notes:

pg/g - picograms per gram
J- Estimated concentration.
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.

TABLE 4.5b

PHASE II EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*
Sample ID:		*TISS031884-121708-DFK-016*	*TISS031884-121708-DFK-017*	*TISS031884-121708-DFK-018*	*TISS031884-121708-DFK-019*	*TISS031884-121708-DFK-020*
Sample Date:		*12/17/2008*	*12/17/2008*	*12/17/2008*	*12/17/2008*	*12/17/2008*
Sample Species:		*10 fish per composite Gizzard Shad (whole fish)*	*10 fish per composite Gizzard Shad (whole fish)*	*10 fish per composite Gizzard Shad (whole fish)*	*10 fish per composite Gizzard Shad (whole fish)*	*10 fish per composite Gizzard Shad (whole fish)*
	Units					
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	15.8	7.07	13.7	16.1	16.1
Lipids	%	7.39	6.9	8.15	6.35	6.76

Notes:

pg/g - picograms per gram
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
UJ- Estimated reporting limit.

TABLE 4.5b

PHASE II EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*
Sample ID:		*TISS031884-121708-DFK-021*	*TISS031884-121708-DFK-022*	*TISS031884-121708-DFK-023*	*TISS031884-121708-DFK-024*	*TISS031884-121708-DFK-025*
Sample Date:		*12/17/2008*	*12/17/2008*	*12/17/2008*	*12/17/2008*	*12/17/2008*
Sample Species:		*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*
	Units					
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	1.44	2.14	1.7	1.22	1.28
Lipids	%	0.34	0.31	0.29	0.26	0.3

Notes:

pg/g - picograms per gram
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
UJ- Estimated reporting limit.

TABLE 4.5b

PHASE II EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

	Units					
Sample Location:		*RM 33-45*	*RM 33-45*	*RM 33-45*	*RM 33-45*	*RM 33-45*
Sample ID:		*TISS031884-121708-DFK-011*	*TISS031884-121708-DFK-012*	*TISS031884-121708-DFK-013*	*TISS031884-121708-DFK-014*	*TISS031884-121708-DFK-015*
Sample Date:		*12/17/2008*	*12/17/2008*	*12/17/2008*	*12/17/2008*	*12/17/2008*
Sample Species:		*5 fish per composite Channel Catfish (skin off fillets)*	*5 fish per composite Channel Catfish (skin off fillets)*	*5 fish per composite Channel Catfish & Sauger (skin off fillets)*	*5 fish per composite Channel Catfish & Sauger (skin off fillets)*	*5 fish per composite Sauger (skin off fillets)*
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	8.58	2.09	36.2	2.53	0.975 J
Lipids	%	1.08	0.94	1.18	1.07	1.31

Notes:

pg/g - picograms per gram
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
UJ- Estimated reporting limit.

TABLE 4.5b

PHASE II EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*
Sample ID:		*TISS031884-121608-DFK-003*	*TISS031884-121608-DFK-004*	*TISS031884-121608-DFK-005*	*TISS031884-121608-DFK-006*	*TISS031884-121608-DFK-007*
Sample Date:		*12/16/2008*	*12/16/2008*	*12/16/2008*	*12/16/2008*	*12/16/2008*
Sample Species:		*10 fish per composite Gizzard Shad (whole fish)*	*10 fish per composite Gizzard Shad (whole fish)*	*10 fish per composite Gizzard Shad (whole fish)*	*10 fish per composite Gizzard Shad (whole fish)*	*10 fish per composite Gizzard Shad (whole fish)*
	Units					
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	9.05	7.1	4.22	5.2	7.93
Lipids	%	6.31	6.13	6.05	6.45	5.32

Notes:

pg/g - picograms per gram
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
UJ- Estimated reporting limit.

TABLE 4.5b

PHASE II EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*
Sample ID:		*TISS031884-121708-DFK-001*	*TISS031884-121708-DFK-002*	*TISS031884-121708-DFK-008*	*TISS031884-121708-DFK-009*	*TISS031884-121708-DFK-010*
Sample Date:		*12/17/2008*	*12/17/2008*	*12/17/2008*	*12/17/2008*	*12/17/2008*
Sample Species:		*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*
	Units					
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	1.71	5.68	4.77	7.17	12.6
Lipids	%	0.4	0.54	0.67	0.49	0.78

Notes:

pg/g - picograms per gram
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
UJ- Estimated reporting limit.

TABLE 4.5b

PHASE II EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*
Sample ID:		*TISS031884-121808-DFK-031*	*TISS031884-121808-DFK-032*	*TISS031884-122208-DFK-033*	*TISS031884-122208-DFK-034*	*TISS031884-122208-DFK-035*
Sample Date:		*12/18/2008*	*12/18/2008*	*1/8/2009*	*1/8/2009*	*1/8/2009*
Sample Species:		*5 fish per composite Gizzard Shad (whole fish)*	*5 fish per composite Gizzard Shad (whole fish)*	*5 fish per composite Gizzard Shad (whole fish)*	*5 fish per composite Gizzard Shad (whole fish)*	*5 fish per composite Gizzard Shad (whole fish)*
	Units					
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	ND (1.22) U	0.191 J	0.185 J	0.387 J	0.195 J
Lipids	%	10.9	9.65	9.48	7.22	10.5

Notes:

pg/g - picograms per gram
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
UJ- Estimated reporting limit.

TABLE 4.5b

PHASE II EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*
Sample ID:		*TISS031884-121808-DFK-026*	*TISS031884-121808-DFK-027*	*TISS031884-121808-DFK-028*	*TISS031884-121808-DFK-029*	*TISS031884-121808-DFK-030*
Sample Date:		*12/18/2008*	*12/18/2008*	*12/18/2008*	*12/18/2008*	*12/18/2008*
Sample Species:		*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*	*5 fish per composite Bass (skin on fillets)*
	Units					
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	ND (0.989) U	ND (1.13) U	ND (0.970) U	ND (1.13) U	ND (1.14) U
Lipids	%	0.21	0.21	0.15	0.12	0.81

Notes:

pg/g - picograms per gram
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
UJ- Estimated reporting limit.

TABLE 4.5b

PHASE II EOC FISH TISSUE SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***RM 75-95***	***RM 75-95***
Sample ID:		***TISS031884-121808-DFK-036***	***TISS031884-121808-DFK-037***
Sample Date:		***12/18/2008***	***12/18/2008***
Sample Species:		***5 fish per composite Sauger (skin off fillets)***	***5 fish per composite Sauger (skin off fillets)***
	Units		
Dioxins and Furans			
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	ND (1.15) U	ND (1.11) U
Lipids	%	0.49	0.39

Notes:

pg/g - picograms per gram
ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
UJ- Estimated reporting limit.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 32*	*RM 32*	*RM 34.5*	*RM 34.5*	*RM 34.5*	*RM 34.5*	*RM 36*	*RM 36*	*RM 37.5*	*RM 38.5*	*RM 39*	*RM 39*	*RM 39*	*RM 40.5*	*RM 41*	*RM 41*	*RM 41*	*RM 42*	*RM 42.5*	*RM 42.5*
Sample Identification:		*KR-GT-28*	*KR-GT-25*	*KR-GT-21*	*KR-GT-22*	*KR-GT-24*	*KR-GT-23*	*KR-GT-18*	*KR-GT-19*	*KR-GT-16*	*KR-GT-15*	*KR-GT-08*	*KR-GT-11*	*KR-GT-12*	*KR-GT-09*	*KR-GT-06*	*KR-GT-07*	*KR-GT-06*	*KR-GT-04*	*KR-GT-03*	*KR-GT-03*
Sample Date:		*10/26/2004*	*10/29/2004*	*10/26/2004*	*10/26/2004*	*10/26/2004*	*10/29/2004*	*10/26/2004*	*10/27/2004*	*10/27/2004*	*10/29/2004*	*10/27/2004*	*10/27/2004*	*10/27/2004*	*10/29/2004*	*10/25/2004*	*10/25/2004*	*10/29/2004*	*10/25/2004*	*10/25/2004*	*10/29/2004*
Sample Depth:		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type:																					
	Units																				
Dioxins and Furans																					
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
General Chemistry																					
Total Organic Carbon (TOC)	%	--	--	--	--	--	--	--	2.59	--	2.98	7.52	--	--	--	--	--	--	2.58	--	--
Total Organic Carbon (TOC)	µg/kg	71,000	60,000	17,000	22,000	26,000	43,000	69,000	46,000 Dup 34,000	55,000	37,000 Dup 18,000	45,000 Dup 25,000	27,000	49,000	20,000	15,000	25,000	--	ND (1000) Dup 17,000	40,000	--
Total Solids	%	44.9	59.1	72.7	70.9	71	55.2	43.6	52.8	42	58.2	57.3	71.3	56.7	71.7	74.6	74.5	--	71.1	60.9	--

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[(1)] Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 43.5*	*RM 43.5*	*KD-200*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*KD-201*	*RM 33*
Sample Identification:		*KR-GT-01*	*KR-GT-02*	*SD-31884-10282004-KD-200* [1]	*SD-31884-10282004-KD-001* [1]	*SD-31884-10282004-KD-002* [1]	*SD-31884-10282004-KD-003* [1]	*SD-31884-10282004-KD-004* [1]	*SD-31884-10282004-KD-005* [1]	*SD-31884-10282004-KD-201* [1]	*SD-31884-10282004-KD-006* [1]
Sample Date:		*10/25/2004*	*10/29/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*
Sample Depth:		-	-	-	-	-	-	-	-	-	-
Sample Type:				*Composite (KD-001 to KD005)*	*Composite 2 (KRM433-B-2)*	*Composite 3 (KRM33-B-3)*	*Composite 1 (KRM33-B-1)*	*Composite 4 (KRM33-B-4)*	*Composite 5 (KRM33-B-5)*	*Composite (KD-006 to KD010)*	*Composite 2 (KRM433-A-2)*
	Units										
Dioxins and Furans											
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	--	--	0.015	--	--	--	--	--	0.28	--
General Chemistry											
Total Organic Carbon (TOC)	%	--	--	--	3.87	1.75	2.83	1.27	2.01	--	2.01
Total Organic Carbon (TOC)	µg/kg	30,000	21,000	--	37,000	ND (1000)	ND (1000)	ND (1000)	ND (1000)	--	ND (1000)
Total Solids	%	67.7	52.9	--	45.1	70.9	54.7	69.5	71.2	--	71.2

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[1] Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 33*	*RM 33*	*RM 33*	*RM 33*	*KD-202*	*RM 42*	*RM 42*	*RM 42*	*RM 42*
Sample Identification:		*SD-31884-10282004-KD-007* [1]	*SD-31884-10282004-KD-008* [1]	*SD-31884-10282004-KD-009* [1]	*SD-31884-10282004-KD-010* [1]	*SD-31884-10282004-KD-202* [1]	*SD-31884-10282004-KD-011* [1]	*SD-31884-10282004-KD-012* [1]	*SD-31884-10282004-KD-013* [1]	*SD-31884-10282004-KD-014* [1]
Sample Date:		*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*
Sample Depth:		-	-	-	-	-	-	-	-	-
Sample Type:		*Composite 5 (KRM33-A-5)*	*Composite 1 (KRM33-A-1)*	*Composite 3 (KRM33-A-3)*	*Composite 4 (KRM33-A-4)*	*Composite (KD-011 to KD015)*	*Composite 2 (KRM42-B-2)*	*Composite 5 (KRM42-B-5)*	*Composite 3 (KRM42-B-3)*	*Composite 1 (KRM42-B-1)*
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	--	--	--	--	0.071	--	--	--	--
General Chemistry										
Total Organic Carbon (TOC)	%	2.21	3.14	3.24	0.95	5.94	--	0.98	--	4.29
Total Organic Carbon (TOC)	µg/kg	ND (1000)	ND (2000)	ND (1000)	ND (1000)	ND (1000)	ND (1000)	ND (1000)	ND (1000)	ND (1000)
Total Solids	%	58.7	52	62.9	77	54.6 Dup 58.9	64.4	70.7	78.9	55.6

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[1] Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 42*	*KD-203*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*KD-204*	*RM 68*
Sample Identification:		*SD-31884-10282004-KD-015* [(1)]	*SD-31884-10292004-KD-203* [(1)]	*SD-31884-10282004-KD-016* [(1)]	*SD-31884-10282004-KD-017* [(1)]	*SD-31884-10292004-KD-018* [(1)]	*SD-31884-10292004-KD-019* [(1)]	*SD-31884-10292004-KD-020* [(1)]	*SD-31884-10302004-KD-204* [(1)]	*SD-31884-10302004-KD-021* [(1)]
Sample Date:		*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/29/2004*	*10/29/2004*	*10/29/2004*	*10/30/2004*	*10/30/2004*
Sample Depth:		-	-	-	-	-	-	-	-	-
Sample Type:		*Composite 4 (KRM42-B-4)*	*Composite (KD-016 to KD020)*	*Composite 5 (KRM42-A-5)*	*Composite 2 (KRM42-A-2)*	*Composite 1 (KRM42-A-1)*	*Composite 4 (KRM42-A-4)*	*Composite 3 (KRM42-A-3)*	*Composite (KD-021 to KD025)*	*Composite 2 (KRM68-A-2)*
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	--	0.024	--	--	--	--	--	ND (0.00036)	--
General Chemistry										
Total Organic Carbon (TOC)	%	--	--	2.1	--	--	--	14.9	--	--
Total Organic Carbon (TOC)	µg/kg	ND (1000)	--	ND (1000)	ND (1000)	ND (1000)	ND (2000)	ND (1000)	--	ND (2000)
Total Solids	%	64.4	--	64.2	65.3	61.4	45.5	79.5	--	53.7

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[(1)] Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 68*	*RM 68*	*RM 68*	*RM 68*	*KD-205*	*RM 68*	*RM 68*	*RM 68*	*RM 68*
Sample Identification:		*SD-31884-10302004-KD-022* [1]	*SD-31884-10302004-KD-023* [1]	*SD-31884-10302004-KD-024* [1]	*SD-31884-10302004-KD-025* [1]	*SD-31884-10302004-KD-205* [1]	*SD-31884-10302004-KD-026* [1]	*SD-31884-10302004-KD-027* [1]	*SD-31884-10302004-KD-028* [1]	*SD-31884-10302004-KD-029* [1]
Sample Date:		*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*
Sample Depth:		-	-	-	-	-	-	-	-	-
Sample Type:		*Composite 1 (KRM68-A-1)*	*Composite 3 (KRM68-A-3)*	*Composite 5 (KRM68-A-5)*	*Composite 4 (KRM68-A-4)*	*Composite (KD-026 to KD030)*	*Composite 4 (KRM68-B-4)*	*Composite 5 (KRM68-B-5)*	*Composite 3 (KRM68-B-3)*	*Composite 1 (KRM68-B-1)*
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	--	--	--	--	ND (0.00031)	--	--	--	--
General Chemistry										
Total Organic Carbon (TOC)	%	--	--	3.1	--	--	--	5.29	--	--
Total Organic Carbon (TOC)	µg/kg	21,000	ND (1000)	ND (1000)	ND (1000)	--	ND (1000)	ND (1000)	ND (1000)	ND (1000)
Total Solids	%	53.8	79.2	62.7	73.5	--	75.6	56.4	74.4	68.1

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[1] Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 68*	*COR-01*	*COR-02*	*COR-03*	*COR-04*	*COR-05*	*COR-05*	*COR-06*	*COR-07*	*COR-08*
Sample Identification:		*SD-31884-10302004-KD-030* [(1)]	*SE-031884-120207-DD-071*	*SE-031884-120207-DD-070*	*SE-031884-120207-DD-068* [(1)]	*SE-031884-120107-DD-067*	*SE-031884-120107-DD-065*	*SE-031884-120107-DD-066*	*SE-031884-120107-DD-062*	*SE-031884-120107-DD-063* [(1)]	*SE-031884-120107-DD-061*
Sample Date:		*10/30/2004*	*12/2/2007*	*12/2/2007*	*12/2/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*
Sample Depth:		*-*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:		*Composite 2 (KRM68-B-2)*						*Duplicate*			
	Units										
Dioxins and Furans											
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	--	0.014	0.048	0.01	0.0073	0.02	0.0057	0.0031	0.048	0.0041
General Chemistry											
Total Organic Carbon (TOC)	%	3.99	--	--	--	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	ND (1000)	30,600,000	16,000,000	33,400,000	40,000,000	2,300,000	2,300,000	1,400,000	31,800,000	31,100,000
Total Solids	%	78.2	42.4	78.8	65.6	64	75.8	78	74.5	56.1	44.8

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[(1)] Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-09*	*COR-10*	*COR-11*	*COR-12*	*COR-13*	*COR-14*	*COR-15*	*COR-16*	*COR-17*	*COR-18*
Sample Identification:		*SE-031884-120107-DD-059*	*SE-031884-120107-DD-058*	*SE-031884-120107-DD-057*	*SE-031884-120107-DD-056*	*SE-031884-120107-DD-055* [1]	*SE-031884-120107-DD-054*	*SE-031884-120107-DD-053*	*SE-031884-120107-DD-052*	*SE-031884-120107-DD-051*	*SE-031884-120107-DD-049*
Sample Date:		*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:								*MS/MSD*			
	Units										
Dioxins and Furans											
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.014	ND (0.0038)U	0.01	0.023	0.01	0.012	ND (0.0069)U	ND (0.0052)U	ND (0.0028)U	ND (0.0072)U
General Chemistry											
Total Organic Carbon (TOC)	%	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	39,100,000	7,000,000	32,000,000	30,400,000	12,700,000	26,500,000	30,300,000	27,900,000	4,100,000	19,700,000
Total Solids	%	55.4	78.8	55	55.1	71.2	48	47.1	62.1	81.4	56.5

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[1] Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-19*	*COR-20*	*COR-20*	*COR-21*	*COR-22*	*COR-23*	*COR-24*	*COR-25*	*COR-25*	*COR-26*
Sample Identification:		*SE-031884-113007-DD-044*	*SE-031884-113007-DD-042* (1)	*SE-031884-113007-DD-043* (1)	*SE-031884-113007-DD-041*	*SE-031884-113007-DD-040*	*SE-031884-113007-DD-039*	*SE-031884-113007-DD-037*	*SE-031884-112907-DD-031*	*SE-031884-112907-DD-032*	*SE-031884-112907-DD-030*
Sample Date:		*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:				*Duplicate*						*Duplicate*	
	Units										
Dioxins and Furans											
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.012	0.009	0.0094	0.023	0.056	0.066	0.0043	0.0011	0.002	0.0026
General Chemistry											
Total Organic Carbon (TOC)	%	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	29,900,000	33,500,000	31,400,000	32,800,000	19,100,000	15,900,000	3,300,000	10,800,000	9,900,000	2,100,000
Total Solids	%	61.2	45.7	44.5	48.6	63	56.1	71	63.2	60.6	74.2

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
(1) Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-27*	*COR-28*	*COR-29*	*COR-30*	*COR-31*	*COR-32*	*COR-33*	*COR-34*	*COR-35*	*COR-36*
Sample Identification:		*SE-031884-112907-DD-028*	*SE-031884-112907-DD-027*	*SE-031884-112907-DD-025*	*SE-031884-112907-DD-024*	*SE-031884-112907-DD-023*	*SE-031884-112907-DD-021*	*SE-031884-112907-DD-019*	*SE-031884-112907-DD-018*	*SE-031884-112907-DD-017*	*SE-031884-112907-DD-016*
Sample Date:		*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:											
	Units										
Dioxins and Furans											
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.013	0.0088	0.0013	0.013	0.0039	0.012	0.015	0.021	0.055	0.0056
General Chemistry											
Total Organic Carbon (TOC)	%	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	3,800,000	14,400,000	9,700,000	13,900,000	7,600,000	23,900,000	24,200,000	10,800,000	27,300,000	31,900,000
Total Solids	%	72.8	66.3	80.5	64.8	69.7	62.2	47.4	33.1	58.9	60.5

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
(1) Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-37*	*COR-38*	*COR-39*	*COR-40*	*COR-41*	*COR-42*	*COR-43*	*SSD-01*	*SSD-02*	*SSD-03*
Sample Identification:		*SE-031884-112807-DD-015*	*SE-031884-112807-DD-012*	*SE-031884-112807-DD-011*	*SE-031884-112807-DD-010*	*SE-031884-112807-DD-009*	*SE-031884-112807-DD-007*	*SE-031884-112807-DD-006*	*SE-031884-120207-DD-075*	*SE-031884-120207-DD-074*	*SE-031884-120207-DD-073*
Sample Date:		*11/28/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*	*12/2/2007*	*12/2/2007*	*12/2/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:							*MS/MSD*				
	Units										
Dioxins and Furans											
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.0031	0.25	3.4 J	0.059	ND (0.0006)	ND (0.0017)U	ND (0.00082)	0.0026	0.0065	0.0046
General Chemistry											
Total Organic Carbon (TOC)	%	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	101,000,000	14,200,000	16,000,000	27,000,000	2,400,000	28,000,000	9,100,000	2,100,000	32,100,000	24,700,000
Total Solids	%	73.1	60.4	65.5	59	78.4	58.4	69.7	71.6	52.7	55.4

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
(1) Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*SSD-04*	*SSD-05*	*SSD-06*	*SSD-07*	*SSD-09*	*SSD-10*	*SSD-11*	*SSD-12*	*SSD-13*	*SSD-14*
Sample Identification:		*SE-031884-120207-DD-072*	*SE-031884-120207-DD-069*	*SE-031884-120107-DD-064*	*SE-031884-120107-DD-060*	*SE-031884-120107-DD-050*	*SE-031884-113007-DD-048*	*SE-031884-113007-DD-047*	*SE-031884-113007-DD-046*	*SE-031884-113007-DD-045*	*SE-031884-113007-DD-038*
Sample Date:		*12/2/2007*	*12/2/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:			*MS/MSD*								
	Units										
Dioxins and Furans											
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.0041	0.024	0.038	0.017	ND (0.025)U	0.0038	0.0052	0.015	0.038	0.023
General Chemistry											
Total Organic Carbon (TOC)	%	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	23,700,000	59,300,000	30,300,000	4,600,000	20,000,000	22,600,000	35,700,000	27,500,000	33,200,000	10,400,000
Total Solids	%	62.6	51.2	40.3	77.2	49.3	59.4	41.6	62.1	49.7	65.3

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
(1) Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		SSD-15	SSD-16	SSD-17	SSD-18	SSD-19	SSD-20	SSD-21	SSD-22	SSD-23	SSD-24
Sample Identification:		SE-031884-113007-DD-036	SE-031884-113007-DD-035	SE-031884-113007-DD-034	SE-031884-113007-DD-033 (1)	SE-031884-112907-DD-029	SE-031884-112907-DD-026 (1)	SE-031884-112907-DD-022	SE-031884-112907-DD-020	SE-031884-112807-DD-014	SE-031884-112807-DD-013
Sample Date:		11/30/2007	11/30/2007	11/30/2007	11/30/2007	11/29/2007	11/29/2007	11/29/2007	11/29/2007	11/28/2007	11/28/2007
Sample Depth:		(0-0) IN	(0-0) IN	(0-0) IN	(0-0) IN	(0-0) IN	(0-0) IN	(0-0) IN	(0-0) IN	(0-0) IN	(0-0) IN
Sample Type:							MS/MSD				
	Units										
Dioxins and Furans											
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.012	0.0055	0.035	0.052	0.0018	0.017	0.01	0.015	0.074	ND (0.0017)U
General Chemistry											
Total Organic Carbon (TOC)	%	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	16,500,000	31,100,000	22,000,000	23,800,000	1,300,000	21,800,000	8,250,000	12,900,000	31,500,000	3,100,000
Total Solids	%	60.3	55.9	55.1	39.3	79	33.1	66.2	72.7	43.4	69

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
(1) Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6a

SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*SSD-25*	*SSD-26*	*SSD-26*	*SSD-27*	*SSD-28*	*SSD-29*
Sample Identification:		*SE-031884-112807-DD-008* [1]	*SE-031884-112807-DD-004*	*SE-031884-112807-DD-005*	*SE-031884-112807-DD-003* [1]	*SE-031884-112807-DD-002*	*SE-031884-112807-DD-001*
Sample Date:		*11/28/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:				*Duplicate*			
	Units						
Dioxins and Furans							
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	ND (0.00098)	0.0029	0.0014	ND (0.00087)	ND (0.00079)	ND (0.00062)
General Chemistry							
Total Organic Carbon (TOC)	%	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	27,500,000	25,600,000	21,800,000	24,700,000	29,500,000	21,000,000
Total Solids	%	46.8	58.8	60.7	54.1	55.4	72.2

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[1] Sample was also analyzed for additional parameters; results are presented in Table 4.10a.

TABLE 4.6b

SUBSURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-03*	*COR-03*	*COR-03*	*COR-04*	*COR-04*	*COR-04*	*COR-07*	*COR-07*	*COR-08*
Sample Identification:		*SE-031884-121307-DD-274*	*SE-031884-121307-DD-275*	*SE-031884-121307-DD-276*	*SE-031884-121207-DD-269*	*SE-031884-121207-DD-270*	*SE-031884-121207-DD-271*	*SE-031884-121407-DD-282*	*SE-031884-121407-DD-283*	*SE-031884-121307-DD-279*
Sample Date:		*12/13/2007*	*12/13/2007*	*12/13/2007*	*12/12/2007*	*12/12/2007*	*12/12/2007*	*12/14/2007*	*12/14/2007*	*12/13/2007*
Sample Depth:		*(0-24) IN*	*(24-48) IN*	*(48-81.6) IN*	*(0-24) IN*	*(24-48) IN*	*(48-72) IN*	*(0-24) IN*	*(24-36) IN*	*(0-24) IN*
Sample Type:										
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.0083	0.011	0.019	0.013	0.0098	0.0086	ND (0.00031)	ND (0.00027)	0.0093
General Chemistry										
Total Organic Carbon (TOC)	µg/kg	27,300,000	40,500,000	45,900,000	34,700,000	43,100,000	50,400,000	8,000,000	7,400,000	24,700,000
Total Solids	%	64.4	57	59.8	67.4	58.8	63.1	70.8	73.6	65.2

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
(1) - Sample was also analyzed for additional parameters; results are presented in Table 4.10b.

TABLE 4.6b

SUBSURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-08*	*COR-09*	*COR-09*	*COR-11*	*COR-12*	*COR-15*	*COR-15*	*COR-15*	*COR-16*
Sample Identification:		*SE-031884-121307-DD-280* [1]	*SE-031884-121507-DD-332*	*SE-031884-121507-DD-333*	*SE-031884-121507-DD-331*	*SE-031884-121507-DD-334*	*S-031884-022308-DD-406 (A)*	*S-031884-022308-DD-406 (B)*	*S-031884-022308-DD-406 (C)*	*S-031884-022308-DD-407 (A)*
Sample Date:		*12/13/2007*	*12/15/2007*	*12/15/2007*	*12/15/2007*	*12/15/2007*	*3/31/2008*	*3/31/2008*	*3/31/2008*	*3/31/2008*
Sample Depth:		*(24-48) IN*	*(0-24) IN*	*(24-34) IN*	*(0-24) IN*	*(0-22) IN*	*(0-19) IN*	*(0-19) IN*	*(0-19) IN*	*(0-16) IN*
Sample Type:										
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	1.4 J	0.0086	ND (0.00055)	0.15	0.002	0.013	0.0042	0.0049	0.00076 J
General Chemistry										
Total Organic Carbon (TOC)	µg/kg	72,200,000	36,700,000	42,900,000	31,700,000	10,800,000	33,600,000	10,600,000	14,600,000	20,800,000
Total Solids	%	60.6	63.9	65.9	59.6	69.2	99.2	99.6	99.7	99.8

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[1] - Sample was also analyzed for additional parameters; results are presented in Table 4.10b.

TABLE 4.6b

SUBSURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-16*	*COR-16*	*COR-18*	*COR-20*	*COR-20*	*COR-21*	*COR-21*	*COR-21*	*COR-21*
Sample Identification:		*S-031884-022308-DD-407 (B)*	*S-031884-022308-DD-407 (C)*	*SE-031884-121107-DD-221*	*SE-031884-121107-DD-218*	*SE-031884-121107-DD-219*	*SE-031884-121007-DD-213*	*SE-031884-121007-DD-214*	*SE-031884-121007-DD-215*	*SE-031884-121007-DD-216*
Sample Date:		*3/31/2008*	*3/31/2008*	*12/11/2007*	*12/11/2007*	*12/11/2007*	*12/10/2007*	*12/10/2007*	*12/10/2007*	*12/10/2007*
Sample Depth:		*(0-16) IN*	*(0-16) IN*	*(0-24) IN*	*(0-24) IN*	*(24-31.6) IN*	*(0-24) IN*	*(0-24) IN*	*(24-48) IN*	*(48-78) IN*
Sample Type:								*Duplicate*		
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.00076 J	0.00077 J	ND (0.00047)	0.014	0.052	2.7 J	2.3 J	0.088	0.0018
General Chemistry										
Total Organic Carbon (TOC)	µg/kg	23,100,000	49,500,000	5,700,000	30,600,000	32,900,000	63,800,000	65,000,000	55,600,000	40,900,000
Total Solids	%	100	100	76.4	56.2	60.9	58.2	55.2	64.6	64.3

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[(1)] - Sample was also analyzed for additional parameters; results are presented in Table 4.10b.

TABLE 4.6b

SUBSURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-22*	*COR-22*	*COR-23*	*COR-25*	*COR-28*	*COR-28A*	*COR-30*	*COR-30*	*COR-32A*
Sample Identification:		*SE-031884-121007-DD-180*	*SE-031884-121007-DD-181* [1]	*SE-031884-120807-DD-179*	*SE-031884-120807-DD-178*	*SE-031884-120807-DD-176* [1]	*SE-031884-121108-SG-020*	*SE-031884-120707-DD-175*	*SE-031884-120707-DD-174*	*SE-031884-121108-SG-021*
Sample Date:		*12/10/2007*	*12/10/2007*	*12/8/2007*	*12/8/2007*	*12/8/2007*	*12/11/2008*	*12/7/2007*	*12/7/2007*	*12/11/2008*
Sample Depth:		*(0-24) IN*	*(24-49) IN*	*(0-27) IN*	*(0-14) IN*	*(0-24) IN*	*(0-6) IN*	*(0-24) IN*	*(24-30) IN*	*(0-18.5) IN*
Sample Type:										
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	3 J	1.1 J	ND (0.00052)	ND (0.00045)	ND (0.0004)	ND (0.0004)	ND (0.00036)	0.0021	ND (0.00055)
General Chemistry										
Total Organic Carbon (TOC)	µg/kg	110,000,000	102,000,000	28,600,000	14,400,000	5,400,000	5,500,000	1,800,000	4,900,000	4,700,000
Total Solids	%	58.8	59.2	64.9	68.9	74.2	75.5	78.1	80.3	78

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[1] - Sample was also analyzed for additional parameters; results are presented in Table 4.10b.

TABLE 4.6b

SUBSURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-32B*	*COR-32B*	*COR-32B*	*COR-32B*	*COR-33*	*COR-35*	*COR-35*	*COR-35*	*COR-35*
Sample Identification:		*SE-031884-121108-SG-016*	*SE-031884-121108-SG-017*	*SE-031884-121108-SG-018*	*SE-031884-121108-SG-019*	*SE-031884-120607-DD-128* (1)	*SE-031884-120507-DD-086*	*SE-031884-120507-DD-087*	*SE-031884-120507-DD-088*	*SE-031884-120507-DD-089*
Sample Date:		*12/11/2008*	*12/11/2008*	*12/11/2008*	*12/11/2008*	*12/6/2007*	*12/5/2007*	*12/5/2007*	*12/5/2007*	*12/5/2007*
Sample Depth:		*(0-24) IN*	*(24-48) IN*	*(48-72) IN*	*(72-92) IN*	*(0-21) IN*	*(0-24) IN*	*(0-24) IN*	*(24-48) IN*	*(48-54) IN*
Sample Type:								*Duplicate*		
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	ND (0.00025)	ND (0.00042)	ND (0.00036)	ND (0.00039)	0.19	0.0036	0.003	ND(0.00034)	ND (0.00038)
General Chemistry										
Total Organic Carbon (TOC)	µg/kg	3,000,000	2,800,000	3,200,000	3,500,000	27,900,000	31,400,000	30,900,000	12,600,000	20,800,000
Total Solids	%	78.7	78	78.4	80.1	68.8	67.2	66.5	70.1	69.3

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
(1) - Sample was also analyzed for additional parameters; results are presented in Table 4.10b.

TABLE 4.6b

SUBSURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-36*	*COR-36*	*COR-36*	*COR-36*	*COR-36*	*COR-36*	*COR-36*	*COR-36*	*COR-36*
Sample Identification:		*SE-031884-120507-DD-123*	*SE-031884-120507-DD-124* (1)	*SE-031884-120507-DD-125* (1)	*SE-031884-121008-SG-007*	*SE-031884-121008-SG-008*	*SE-031884-121008-SG-009*	*SE-031884-121008-SG-010*	*SE-031884-121008-SG-011*	*SE-031884-121008-SG-012*
Sample Date:		*12/5/2007*	*12/5/2007*	*12/5/2007*	*12/10/2008*	*12/10/2008*	*12/10/2008*	*12/10/2008*	*12/10/2008*	*12/10/2008*
Sample Depth:		*(0-24) IN*	*(24-48) IN*	*(48-72) IN*	*(0-24) IN*	*(24-48) IN*	*(24-48) IN*	*(48-72) IN*	*(72-96) IN*	*(96-108) IN*
Sample Type:							*Duplicate*			
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.027	3.3 J	18 J	0.15	2.3 J	1.6 J	25 J	3.8 J	0.21
General Chemistry										
Total Organic Carbon (TOC)	µg/kg	42,700,000	69,500,000	80,200,000	43,000,000	78,000,000	70,000,000	82,000,000	43,000,000	27,000,000
Total Solids	%	65.3	60.4	58.5	64.5	63.9	63.4	61	69.6	73.1

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
(1) - Sample was also analyzed for additional parameters; results are presented in Table 4.10b.

TABLE 4.6b

SUBSURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-36A*	*COR-36B*	*COR-36C*	*COR-36C*	*COR-38*	*COR-39*	*COR-39*	*COR-40*	*COR-40*
Sample Identification:		*SE-031884-121008-SG-006*	*SE-031884-121008-SG-013*	*SE-031884-121008-SG-014*	*SE-031884-121008-SG-015*	*SE-031884-120407-DD-085*	*SE-031884-120407-DD-083* [1]	*SE-031884-120407-DD-084* [1]	*SE-031884-120407-DD-079*	*SE-031884-120407-DD-080*
Sample Date:		*12/10/2008*	*12/10/2008*	*12/10/2008*	*12/10/2008*	*12/4/2007*	*12/4/2007*	*12/4/2007*	*12/4/2007*	*12/4/2007*
Sample Depth:		*(0-10.5) IN*	*(0-12) IN*	*(0-24) IN*	*(24-40) IN*	*(0-24) IN*	*(0-17) IN*	*(17-33.5) IN*	*(0-24) IN*	*(24-40) IN*
Sample Type:										
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	ND(0.00065)	0.025	0.46 J	0.16	0.0087	22 J	33 J	0.01	0.0081
General Chemistry										
Total Organic Carbon (TOC)	µg/kg	5,400,000	17,000,000	22,000,000	27,000,000	8,100,000	83,900,000	79,200,000	68,700,000	84,300,000
Total Solids	%	76.3	68.3	70.5	71.6	73.5	49.2	61.4(49.2)	62.4	67.1

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
[1] - Sample was also analyzed for additional parameters; results are presented in Table 4.10b.

TABLE 4.6b

SUBSURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-40*	*COR-40*	*COR-40*	*COR-41*	*COR-41*	*COR-42*	*COR-42*	*COR-42*	*COR-43*
Sample Identification:		*SE-031884-120908-SG-003*	*SE-031884-120908-SG-004*	*SE-031884-120908-SG-005*	*SE-031884-120407-DD-081*	*SE-031884-120407-DD-082*	*SE-031884-120307-DD-078*	*SE-031884-120908-SG-001*	*SE-031884-120908-SG-002*	*SE-031884-120307-DD-077*
Sample Date:		*12/9/2008*	*12/9/2008*	*12/9/2008*	*12/4/2007*	*12/4/2007*	*12/3/2007*	*12/9/2008*	*12/9/2008*	*12/3/2007*
Sample Depth:		*(0-24) IN*	*(24-48) IN*	*(48-66) IN*	*(0-12) IN*	*(12-25) IN*	*(0-29) IN*	*(0-16.5) IN*	*(0-16.5) IN*	*(0-22) IN*
Sample Type:									*Duplicate*	
	Units									
Dioxins and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.049	ND (0.00074)U	ND (0.0003)	ND (0.0016)U	ND (0.00049)	ND (0.00026)	ND (0.0011)U	0.0018	ND (0.00022)
General Chemistry										
Total Organic Carbon (TOC)	µg/kg	42,000,000	38,000,000	26,000,000	17,900,000	9,400,000	17,500,000	14,000,000	16,000,000	4,480,000
Total Solids	%	67	67.3	73.1	74.6	75.2	69.4	68.4	68.6	76.8

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
(1) - Sample was also analyzed for additional parameters; results are presented in Table 4.10b.

TABLE 4.7

ADDITIONAL SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*KD-200*	*KD-201*	*KD-202*	*KD-203*	*KD-205*	*KD-204*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*
Sample Identification:		*SD-31884-10282004-KD-200*	*SD-31884-10282004-KD-201*	*SD-31884-10282004-KD-202*	*SD-31884-10292004-KD-203*	*SD-31884-10302004-KD-205*	*SD-31884-10302004-KD-204*	*SD-31884-10282004-KD-001*	*SD-31884-10282004-KD-002*	*SD-31884-10282004-KD-003*	*SD-31884-10282004-KD-004*	*SD-31884-10282004-KD-005*	*SD-31884-10282004-KD-006*	*SD-31884-10282004-KD-007*	*SD-31884-10282004-KD-008*
Sample Date:		*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/30/2004*	*10/30/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*
	Units														
Dioxin and Furans															
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	µg/kg	0.013 J	0.12	0.043	0.016 J	0.022	0.014 J	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	µg/kg	0.74	1.2	0.65	0.65	0.46	0.57	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	µg/kg	ND(0.0058)U	ND(0.014)U	0.026	ND(0.0072)U	0.014	ND(0.0049)U	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	µg/kg	0.021	0.044	0.044	0.024	0.027	0.024	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDD (TEQ) (ND*0.5)	µg/kg	0.00021	0.00044	0.00044	0.00024	0.00027	0.00024	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDD (TEQ) (ND=0)	µg/kg	0.00021	0.00044	0.00044	0.00024	0.00027	0.00024	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDF (TEQ) (ND*0.5)	µg/kg	0.000041	0.00014	0.00026	0.000041	0.00014	0.000039	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDF (TEQ) (ND=0)	µg/kg	0	0.00014	0.00026	0	0.00014	0	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	µg/kg	ND(0.00041)	ND(0.0013)	ND(0.00091)	ND(0.00043)	ND(0.00069)	ND(0.00026)	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HPCDF (TEQ) (ND*0.5)	µg/kg	0.00000205	0.0000065	0.00000455	0.00000215	0.00000345	0.0000013	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HPCDF (TEQ) (ND=0)	µg/kg	0	0	0	0	0	0	--	--	--	--	--	--	--	--
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	ND(0.002)	0.0053 J	ND(0.0032)	ND(0.002)	ND(0.0024)	ND(0.0013)	--	--	--	--	--	--	--	--
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	ND(0.00039)	ND(0.00089)	ND(0.00037)	ND(0.00043)	ND(0.00063)	ND(0.0004)	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDD (TEQ) (ND*0.5)	µg/kg	0.0000195	0.0000445	0.0000185	0.0000215	0.0000315	0.00002	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDD (TEQ) (ND=0)	µg/kg	0	0	0	0	0	0	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDF (TEQ) (ND*0.5)	µg/kg	0.0001	0.00053	0.00016	0.0001	0.00012	0.000065	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDF (TEQ) (ND=0)	µg/kg	0	0.00053	0	0	0	0	--	--	--	--	--	--	--	--
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	ND(0.00067)	ND(0.0017)	ND(0.0013)	ND(0.00086)	ND(0.002)	ND(0.00034)	--	--	--	--	--	--	--	--
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	ND(0.00072)	ND(0.0017)	ND(0.0026)	ND(0.00076)	ND(0.0017)	ND(0.00067)	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDD (TEQ) (ND*0.5)	µg/kg	0.000036	0.000085	0.00013	0.000038	0.000085	0.0000335	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDD (TEQ) (ND=0)	µg/kg	0	0	0	0	0	0	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDF (TEQ) (ND*0.5)	µg/kg	0.0000335	0.000085	0.000065	0.000043	0.0001	0.000017	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDF (TEQ) (ND=0)	µg/kg	0	0	0	0	0	0	--	--	--	--	--	--	--	--
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	µg/kg	ND(0.00035)	ND(0.0004)	ND(0.00045)	ND(0.00033)	ND(0.00025)	ND(0.00023)	--	--	--	--	--	--	--	--
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	ND(0.00071)	ND(0.0015)	ND(0.00085)	ND(0.00061)	ND(0.0016)	ND(0.0007)	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDD (TEQ) (ND*0.5)	µg/kg	0.0000355	0.000075	0.0000425	0.0000305	0.00008	0.000035	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDD (TEQ) (ND=0)	µg/kg	0	0	0	0	0	0	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDF (TEQ) (ND*0.5)	µg/kg	0.0000175	0.00002	0.0000225	0.0000165	0.0000125	0.0000115	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDF (TEQ) (ND=0)	µg/kg	0	0	0	0	0	0	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDD (TEQ) (ND*0.5)	µg/kg	0.00024	0.000455	0.000295	0.000335	0.00024	0.0002	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDD (TEQ) (ND=0)	µg/kg	0	0	0	0	0	0	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDF (TEQ) (ND*0.5)	µg/kg	0.00001275	0.0000375	0.00003	0.00001775	0.00002175	0.00000725	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDF (TEQ) (ND=0)	µg/kg	0	0	0	0	0	0	--	--	--	--	--	--	--	--
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	µg/kg	ND(0.00051)	ND(0.0015)	ND(0.0012)	ND(0.00071)	ND(0.00087)	ND(0.00029)	--	--	--	--	--	--	--	--
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	µg/kg	ND(0.00048)	ND(0.00091)	ND(0.00059)	ND(0.00067)	ND(0.00048)	ND(0.0004)	--	--	--	--	--	--	--	--
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	ND(0.00038)	ND(0.00067)	ND(0.00052)	ND(0.00028)	ND(0.0028)	ND(0.00023)	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HXCDF (TEQ) (ND*0.5)	µg/kg	0.000019	0.0000335	0.000026	0.000014	0.00014	0.0000115	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HXCDF (TEQ) (ND=0)	µg/kg	0	0	0	0	0	0	--	--	--	--	--	--	--	--
2,3,4,7,8-PECDF (TEQ) (ND*0.5)	µg/kg	0.000115	0.00045	0.0001725	0.0001725	0.0005	0.0000775	--	--	--	--	--	--	--	--
2,3,4,7,8-PECDF (TEQ) (ND=0)	µg/kg	0	0	0	0	0	0	--	--	--	--	--	--	--	--
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	µg/kg	ND(0.00046)	ND(0.0018)	ND(0.00069)	ND(0.00069)	ND(0.002)	ND(0.00031)	--	--	--	--	--	--	--	--
2,3,7,8-TCDD (TEQ) (ND*0.5)	µg/kg	0.015	0.28	0.071	0.024	0.000155	0.00018	--	--	--	--	--	--	--	--
2,3,7,8-TCDD (TEQ) (ND=0)	µg/kg	0.015	0.28	0.071	0.024	0	0	--	--	--	--	--	--	--	--
2,3,7,8-TCDF (TEQ) (ND*0.5)	µg/kg	0.000094	0.00051	0.000093	0.00012	0.000076	0.000028	--	--	--	--	--	--	--	--
2,3,7,8-TCDF (TEQ) (ND=0)	µg/kg	0.000094	0.00051	0.000093	0.00012	0.000076	0	--	--	--	--	--	--	--	--
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	µg/kg	0.00094 J	0.0051	0.00093 J	0.0012 J	0.00076 J	ND(0.00056)	--	--	--	--	--	--	--	--
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.015	0.28	0.071	0.024	ND(0.00031)	ND(0.00036)	--	--	--	--	--	--	--	--
OCDD (TEQ) (ND*0.5)	µg/kg	0.000074	0.00012	0.000065	0.000065	0.000046	0.000057	--	--	--	--	--	--	--	--
OCDD (TEQ) (ND=0)	µg/kg	0.000074	0.00012	0.000065	0.000065	0.000046	0.000057	--	--	--	--	--	--	--	--
OCDF (TEQ) (ND*0.5)	µg/kg	0.0000013	0.000012	0.0000043	0.0000016	0.0000022	0.0000014	--	--	--	--	--	--	--	--
OCDF (TEQ) (ND=0)	µg/kg	0.0000013	0.000012	0.0000043	0.0000016	0.0000022	0.0000014	--	--	--	--	--	--	--	--
Total Heptachlorodibenzofuran (HpCDF)	µg/kg	0.013 J	0.036 J	0.07 J	0.016 J	0.027 J	0.012 J	--	--	--	--	--	--	--	--
Total Heptachlorodibenzo-p-dioxin (HpCDD)	µg/kg	0.049 J	0.12 J	0.091 J	0.058 J	0.058 J	0.06 J	--	--	--	--	--	--	--	--
Total Hexachlorodibenzofuran (HxCDF)	µg/kg	ND(0.0028)	0.017 J	0.017 J	ND(0.0036)	0.0053 J	ND(0.0019)	--	--	--	--	--	--	--	--
Total Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	ND(0.0031)	0.022 J	0.0047 J	ND(0.0041)	0.027 J	ND(0.0027)	--	--	--	--	--	--	--	--
Total Pentachlorodibenzofuran (PeCDF)	µg/kg	ND(0.0027)	0.031 J	ND(0.0037)	ND(0.0033)	0.0043 J	ND(0.0014)	--	--	--	--	--	--	--	--
Total Pentachlorodibenzo-p-dioxin (PeCDD)	µg/kg	ND(0.001)	ND(0.0026)	ND(0.0014)	ND(0.0018)	0.0098 J	ND(0.00065)	--	--	--	--	--	--	--	--
Total TEQ (ND=0.5)	µg/kg	0.0160511	0.283044	0.07282885	0.0252585	0.0020234	0.00102495	--	--	--	--	--	--	--	--
Total Tetrachlorodibenzofuran (TCDF)	µg/kg	0.0031 J	0.05 J	0.0032 J	0.0027 J	0.01 J	0.0012 J	--	--	--	--	--	--	--	--
Total Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.018 J	0.3 J	0.075 J	0.027 J	0.0062 J	0.0012 J	--	--	--	--	--	--	--	--
Metals															
Aluminum	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs															
Aroclor-1016 (PCB-1016)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1221 (PCB-1221)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1232 (PCB-1232)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1242 (PCB-1242)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1248 (PCB-1248)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1254 (PCB-1254)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1260 (PCB-1260)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 4.7

ADDITIONAL SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*KD-200*	*KD-201*	*KD-202*	*KD-203*	*KD-205*	*KD-204*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*
Sample Identification:		*SD-31884-10282004-KD-200*	*SD-31884-10282004-KD-201*	*SD-31884-10282004-KD-202*	*SD-31884-10292004-KD-203*	*SD-31884-10302004-KD-205*	*SD-31884-10302004-KD-204*	*SD-31884-10282004-KD-001*	*SD-31884-10282004-KD-002*	*SD-31884-10282004-KD-003*	*SD-31884-10282004-KD-004*	*SD-31884-10282004-KD-005*	*SD-31884-10282004-KD-006*	*SD-31884-10282004-KD-007*	*SD-31884-10282004-KD-008*
Sample Date:		*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/30/2004*	*10/30/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*
Pesticides															
4,4'-DDD	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDE	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDT	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aldrin	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
alpha-BHC	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
alpha-Chlordane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
beta-BHC	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
delta-BHC	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dieldrin	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Endosulfan I	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Endosulfan II	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Endosulfan sulfate	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Endrin	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Endrin aldehyde	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Endrin ketone	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
gamma-BHC (Lindane)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
gamma-Chlordane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Heptachlor	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Heptachlor epoxide	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methoxychlor	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toxaphene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semi-Volatile Organic Compounds															
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnaphthalene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitroaniline	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl phenyl ether	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chlorophenyl phenyl ether	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acetophenone	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Atrazine	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzaldehyde	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (1,1-Biphenyl)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethyl)ether	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Butyl benzylphthalate	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Caprolactam	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diethyl phthalate	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethyl phthalate	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Isophorone	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-Nitrosodi-n-propylamine	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-Nitrosodiphenylamine	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenol	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 4.7

ADDITIONAL SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*KD-200*	*KD-201*	*KD-202*	*KD-203*	*KD-205*	*KD-204*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*	*RM 33*
Sample Identification:		*SD-31884-10282004-KD-200*	*SD-31884-10282004-KD-201*	*SD-31884-10282004-KD-202*	*SD-31884-10292004-KD-203*	*SD-31884-10302004-KD-205*	*SD-31884-10302004-KD-204*	*SD-31884-10282004-KD-001*	*SD-31884-10282004-KD-002*	*SD-31884-10282004-KD-003*	*SD-31884-10282004-KD-004*	*SD-31884-10282004-KD-005*	*SD-31884-10282004-KD-006*	*SD-31884-10282004-KD-007*	*SD-31884-10282004-KD-008*
Sample Date:		*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/30/2004*	*10/30/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*
Volatile Organic Compounds															
1,1,1-Trichloroethane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1,2,2-Tetrachloroethane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1,2-Trichloroethane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloropropane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Butanone (Methyl Ethyl Ketone)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Hexanone	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acetone	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bromodichloromethane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bromoform	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bromomethane (Methyl Bromide)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon disulfide	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroethane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform (Trichloromethane)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloromethane (Methyl Chloride)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyclohexane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibromochloromethane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dichlorodifluoromethane (CFC-12)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Isopropylbenzene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methyl acetate	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methyl cyclohexane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methyl Tert Butyl Ether	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methylene chloride	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Styrene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tetrachloroethene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
trans-1,2-Dichloroethene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichlorofluoromethane (CFC-11)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trifluorotrichloroethane (Freon 113)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl chloride	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylene (total)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
General Chemistry															
Oil and Grease	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	--	--	--	--	--	--	37000	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(2000)	ND(1000)
Total Organic Carbon (TOC)	%	--	--	--	--	--	--	3.87	1.75	2.83	1.27	2.01	2.21	3.14	3.24
Total Organic Carbon (2)	%	--	--	--	--	--	--	3.7	1.71	2.69	1.22	1.91	2.55	3.23	3.42
Total Organic Carbon (3)	%	--	--	--	--	--	--	3.71	1.8	2.92	1.08	1.96	2.23	3.09	3.21
Total Organic Carbon (4)	%	--	--	--	--	--	--	3.75	1.57	3.1	1.22	1.86	2.31	3.21	3.12
Total Solids	%	--	--	--	--	--	--	45.1	70.9	54.7	69.5	71.2	58.7	52	62.9
Percent Moisture	%	39.2	45.1	35.1	39.2	33.2	35.5	--	--	--	--	--	--	--	--

Notes:

U - Not present at or above the associated value.
J - Estimated concentration.
ND ( ) - Not present at or above the associated value.
UJ - Estimated reporting limit.

TABLE 4.7

ADDITIONAL SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location: Sample Identification: Sample Date:	Units	*RM 33* *SD-31884-10282004-KD-009* *10/28/2004*	*RM 33* *SD-31884-10282004-KD-010* *10/28/2004*	*RM 36* *SD-31884-10282004-KD-118* *10/28/2004*	*RM 42* *SD-31884-10282004-KD-011* *10/28/2004*	*RM 42* *SD-31884-10282004-KD-012* *10/28/2004*	*RM 42* *SD-31884-10282004-KD-013* *10/28/2004*	*RM 42* *SD-31884-10282004-KD-014* *10/28/2004*	*RM 42* *SD-31884-10282004-KD-015* *10/28/2004*	*RM 42* *SD-31884-10282004-KD-016* *10/28/2004*	*RM 42* *SD-31884-10282004-KD-017* *10/28/2004*	*RM 42* *SD-31884-10292004-KD-018* *10/29/2004*	*RM 42* *SD-31884-10292004-KD-019* *10/29/2004*	*RM 42* *SD-31884-10292004-KD-020* *10/29/2004*	*RM 68* *SD-31884-10302004-KD-021* *10/30/2004*
Dioxin and Furans															
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HPCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HPCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HXCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HXCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,7,8-PECDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,7,8-PECDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Heptachlorodibenzofuran (HpCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Heptachlorodibenzo-p-dioxin (HpCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Hexachlorodibenzofuran (HxCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Pentachlorodibenzofuran (PeCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Pentachlorodibenzo-p-dioxin (PeCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total TEQ (ND=0.5)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Tetrachlorodibenzofuran (TCDF)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Metals															
Aluminum	µg/kg	--	8750000	9110000	--	--	--	--	--	--	--	--	--	--	--
Antimony	µg/kg	--	ND(420)	ND(460)	--	--	--	--	--	--	--	--	--	--	--
Arsenic	µg/kg	--	6300	9400	--	--	--	--	--	--	--	--	--	--	--
Barium	µg/kg	--	436000	456000	--	--	--	--	--	--	--	--	--	--	--
Beryllium	µg/kg	--	1000	1200	--	--	--	--	--	--	--	--	--	--	--
Cadmium	µg/kg	--	510 J	85 J	--	--	--	--	--	--	--	--	--	--	--
Calcium	µg/kg	--	1750000	2120000	--	--	--	--	--	--	--	--	--	--	--
Chromium	µg/kg	--	20200	19700	--	--	--	--	--	--	--	--	--	--	--
Cobalt	µg/kg	--	15600	16000	--	--	--	--	--	--	--	--	--	--	--
Copper	µg/kg	--	32900	34300	--	--	--	--	--	--	--	--	--	--	--
Iron	µg/kg	--	22300000	22500000	--	--	--	--	--	--	--	--	--	--	--
Lead	µg/kg	--	26700	32800	--	--	--	--	--	--	--	--	--	--	--
Magnesium	µg/kg	--	2250000	2180000	--	--	--	--	--	--	--	--	--	--	--
Manganese	µg/kg	--	435000	863000	--	--	--	--	--	--	--	--	--	--	--
Mercury	µg/kg	--	140 J	120 J	--	--	--	--	--	--	--	--	--	--	--
Nickel	µg/kg	--	31400	34000	--	--	--	--	--	--	--	--	--	--	--
Potassium	µg/kg	--	1190000	1180000	--	--	--	--	--	--	--	--	--	--	--
Selenium	µg/kg	--	600 J	590 J	--	--	--	--	--	--	--	--	--	--	--
Silver	µg/kg	--	430 J	300 J	--	--	--	--	--	--	--	--	--	--	--
Sodium	µg/kg	--	ND(128000)	ND(141000)	--	--	--	--	--	--	--	--	--	--	--
Thallium	µg/kg	--	ND(640)	ND(910)U	--	--	--	--	--	--	--	--	--	--	--
Vanadium	µg/kg	--	18400	19500	--	--	--	--	--	--	--	--	--	--	--
Zinc	µg/kg	--	161000	304000	--	--	--	--	--	--	--	--	--	--	--
PCBs															
Aroclor-1016 (PCB-1016)	µg/kg	--	ND(12)	ND(13)	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1221 (PCB-1221)	µg/kg	--	ND(18)	ND(20)	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1232 (PCB-1232)	µg/kg	--	ND(9.5)	ND(10)	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1242 (PCB-1242)	µg/kg	--	ND(18)	ND(20)	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1248 (PCB-1248)	µg/kg	--	140	ND(9.7)	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1254 (PCB-1254)	µg/kg	--	ND(7.9)	ND(8.6)	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1260 (PCB-1260)	µg/kg	--	46 J	ND(16)	--	--	--	--	--	--	--	--	--	--	--

TABLE 4.7

ADDITIONAL SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 33*	*RM 33*	*RM 36*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 68*
Sample Identification:		*SD-31884-10282004-KD-009*	*SD-31884-10282004-KD-010*	*SD-31884-10282004-KD-118*	*SD-31884-10282004-KD-011*	*SD-31884-10282004-KD-012*	*SD-31884-10282004-KD-013*	*SD-31884-10282004-KD-014*	*SD-31884-10282004-KD-015*	*SD-31884-10282004-KD-016*	*SD-31884-10282004-KD-017*	*SD-31884-10292004-KD-018*	*SD-31884-10292004-KD-019*	*SD-31884-10292004-KD-020*	*SD-31884-10302004-KD-021*
Sample Date:		*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/29/2004*	*10/29/2004*	*10/29/2004*	*10/30/2004*
Pesticides															
4,4'-DDD	µg/kg	--	ND(4.6)	ND(1)	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDE	µg/kg	--	ND(3.2)	ND(0.7)	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDT	µg/kg	--	ND(3.7)	ND(0.8)UJ	--	--	--	--	--	--	--	--	--	--	--
Aldrin	µg/kg	--	ND(2.7)	ND(0.6)	--	--	--	--	--	--	--	--	--	--	--
alpha-BHC	µg/kg	--	ND(2.7)	ND(0.6)	--	--	--	--	--	--	--	--	--	--	--
alpha-Chlordane	µg/kg	--	ND(3.2)	ND(0.7)	--	--	--	--	--	--	--	--	--	--	--
beta-BHC	µg/kg	--	13 J	2.8 J	--	--	--	--	--	--	--	--	--	--	--
delta-BHC	µg/kg	--	ND(3.4)	ND(0.74)	--	--	--	--	--	--	--	--	--	--	--
Dieldrin	µg/kg	--	ND(3.1)	ND(0.68)	--	--	--	--	--	--	--	--	--	--	--
Endosulfan I	µg/kg	--	ND(3)	ND(0.66)	--	--	--	--	--	--	--	--	--	--	--
Endosulfan II	µg/kg	--	ND(3.8)	ND(0.84)	--	--	--	--	--	--	--	--	--	--	--
Endosulfan sulfate	µg/kg	--	ND(3.5)	ND(0.76)	--	--	--	--	--	--	--	--	--	--	--
Endrin	µg/kg	--	ND(3.1)	ND(0.68)	--	--	--	--	--	--	--	--	--	--	--
Endrin aldehyde	µg/kg	--	ND(8.1)	ND(1.8)	--	--	--	--	--	--	--	--	--	--	--
Endrin ketone	µg/kg	--	ND(6.4)	ND(1.4)	--	--	--	--	--	--	--	--	--	--	--
gamma-BHC (Lindane)	µg/kg	--	ND(3.1)	ND(0.68)	--	--	--	--	--	--	--	--	--	--	--
gamma-Chlordane	µg/kg	--	ND(2.8)	ND(0.62)	--	--	--	--	--	--	--	--	--	--	--
Heptachlor	µg/kg	--	ND(2.7)	ND(0.58)	--	--	--	--	--	--	--	--	--	--	--
Heptachlor epoxide	µg/kg	--	ND(3.8)	ND(0.84)	--	--	--	--	--	--	--	--	--	--	--
Methoxychlor	µg/kg	--	8.9 J	ND(1)	--	--	--	--	--	--	--	--	--	--	--
Toxaphene	µg/kg	--	ND(110)	ND(24)	--	--	--	--	--	--	--	--	--	--	--
Semi-Volatile Organic Compounds															
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	µg/kg	--	ND(240)	ND(21)	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	µg/kg	--	ND(220)	ND(20)	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	µg/kg	--	ND(310)	ND(27)	--	--	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	µg/kg	--	ND(240)	ND(21)	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	µg/kg	--	ND(310)	ND(27)	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	µg/kg	--	ND(1900)	ND(160)UJ	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	µg/kg	--	ND(260)	ND(23)	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	µg/kg	--	ND(270)	ND(23)	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	µg/kg	--	ND(290)	ND(25)	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	µg/kg	--	ND(160)	ND(14)	--	--	--	--	--	--	--	--	--	--	--
2-Methylnaphthalene	µg/kg	--	ND(45)	ND(4)	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	µg/kg	--	ND(310)	ND(27)	--	--	--	--	--	--	--	--	--	--	--
2-Nitroaniline	µg/kg	--	ND(230)	ND(21)	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	µg/kg	--	ND(160)	ND(14)	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	µg/kg	--	ND(220)	ND(20)	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	µg/kg	--	ND(150)	ND(13)	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	µg/kg	--	ND(2200)	ND(190)UJ	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl phenyl ether	µg/kg	--	ND(220)	ND(19)	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	µg/kg	--	ND(2300)	ND(210)	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	µg/kg	--	ND(240)	ND(21)	--	--	--	--	--	--	--	--	--	--	--
4-Chlorophenyl phenyl ether	µg/kg	--	ND(160)	ND(14)	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	µg/kg	--	ND(270)	250 J	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	µg/kg	--	ND(160)	ND(14)	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	µg/kg	--	ND(3700)	ND(330)	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	µg/kg	--	ND(42)	ND(3.7)	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	µg/kg	--	ND(64)	ND(5.6)	--	--	--	--	--	--	--	--	--	--	--
Acetophenone	µg/kg	--	ND(250)	ND(22)	--	--	--	--	--	--	--	--	--	--	--
Anthracene	µg/kg	--	610 J	83 J	--	--	--	--	--	--	--	--	--	--	--
Atrazine	µg/kg	--	ND(500)	ND(44)	--	--	--	--	--	--	--	--	--	--	--
Benzaldehyde	µg/kg	--	ND(320)	ND(28)	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	µg/kg	--	650 J	180 J	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	µg/kg	--	ND(110)	43 J	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	µg/kg	--	ND(110)	59 J	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	µg/kg	--	ND(82)	ND(7.2)	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	µg/kg	--	ND(110)	59 J	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (1,1-Biphenyl)	µg/kg	--	920 J	160 J	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	µg/kg	--	ND(730)	ND(64)	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethyl)ether	µg/kg	--	ND(190)	ND(16)	--	--	--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	µg/kg	--	35000	2700	--	--	--	--	--	--	--	--	--	--	--
Butyl benzylphthalate	µg/kg	--	ND(170)	ND(15)	--	--	--	--	--	--	--	--	--	--	--
Caprolactam	µg/kg	--	ND(360)	ND(31)	--	--	--	--	--	--	--	--	--	--	--
Carbazole	µg/kg	--	ND(430)	ND(37)	--	--	--	--	--	--	--	--	--	--	--
Chrysene	µg/kg	--	930 J	200 J	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	µg/kg	--	ND(69)	ND(6)	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	µg/kg	--	ND(38)	ND(3.3)	--	--	--	--	--	--	--	--	--	--	--
Diethyl phthalate	µg/kg	--	ND(280)	ND(25)	--	--	--	--	--	--	--	--	--	--	--
Dimethyl phthalate	µg/kg	--	ND(290)	ND(26)	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	µg/kg	--	ND(230)	ND(20)	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	µg/kg	--	ND(500)	ND(44)	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	µg/kg	--	1300 J	380 J	--	--	--	--	--	--	--	--	--	--	--
Fluorene	µg/kg	--	650 J	ND(5.2)	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	µg/kg	--	ND(64)	ND(5.6)	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	µg/kg	--	ND(110)	ND(10)	--	--	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	µg/kg	--	ND(130)	ND(12)	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	µg/kg	--	ND(220)	ND(20)	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	µg/kg	--	ND(92)	ND(8)	--	--	--	--	--	--	--	--	--	--	--
Isophorone	µg/kg	--	ND(160)	ND(14)	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	µg/kg	--	ND(41)	ND(3.6)	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	µg/kg	--	ND(290)	ND(26)	--	--	--	--	--	--	--	--	--	--	--
N-Nitrosodi-n-propylamine	µg/kg	--	ND(350)	ND(31)	--	--	--	--	--	--	--	--	--	--	--
N-Nitrosodiphenylamine	µg/kg	--	ND(190)	ND(16)	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	µg/kg	--	ND(2100)	ND(180)	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	µg/kg	--	1600 J	340 J	--	--	--	--	--	--	--	--	--	--	--
Phenol	µg/kg	--	ND(260)	ND(23)	--	--	--	--	--	--	--	--	--	--	--
Pyrene	µg/kg	--	1500 J	410 J	--	--	--	--	--	--	--	--	--	--	--

TABLE 4.7

ADDITIONAL SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 33*	*RM 33*	*RM 36*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 42*	*RM 68*
Sample Identification:		*SD-31884-10282004-KD-009*	*SD-31884-10282004-KD-010*	*SD-31884-10282004-KD-118*	*SD-31884-10282004-KD-011*	*SD-31884-10282004-KD-012*	*SD-31884-10282004-KD-013*	*SD-31884-10282004-KD-014*	*SD-31884-10282004-KD-015*	*SD-31884-10282004-KD-016*	*SD-31884-10282004-KD-017*	*SD-31884-10292004-KD-018*	*SD-31884-10292004-KD-019*	*SD-31884-10292004-KD-020*	*SD-31884-10302004-KD-021*
Sample Date:		*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/28/2004*	*10/29/2004*	*10/29/2004*	*10/29/2004*	*10/30/2004*
Volatile Organic Compounds															
1,1,1-Trichloroethane	µg/kg	--	ND(1.4)	ND(1.5)	--	--	--	--	--	--	--	--	--	--	--
1,1,2,2-Tetrachloroethane	µg/kg	--	ND(0.84)	ND(0.93)	--	--	--	--	--	--	--	--	--	--	--
1,1,2-Trichloroethane	µg/kg	--	ND(0.75)	ND(0.82)	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	µg/kg	--	ND(0.59)	ND(0.64)	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethene	µg/kg	--	ND(1.1)	ND(1.2)	--	--	--	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	µg/kg	--	ND(0.59)UJ	ND(0.64)	--	--	--	--	--	--	--	--	--	--	--
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	--	ND(2.6)	ND(2.8)	--	--	--	--	--	--	--	--	--	--	--
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	--	ND(0.68)	ND(0.74)	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	µg/kg	--	ND(0.4)UJ	ND(0.44)	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	µg/kg	--	ND(0.88)	ND(0.97)	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloropropane	µg/kg	--	ND(0.64)	ND(0.7)	--	--	--	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	µg/kg	--	ND(0.48)UJ	ND(0.52)	--	--	--	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	µg/kg	--	ND(0.62)UJ	ND(0.68)	--	--	--	--	--	--	--	--	--	--	--
2-Butanone (Methyl Ethyl Ketone)	µg/kg	--	ND(5.5)U	5.4 J	--	--	--	--	--	--	--	--	--	--	--
2-Hexanone	µg/kg	--	ND(1.5)	ND(1.7)	--	--	--	--	--	--	--	--	--	--	--
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	--	ND(0.99)	ND(1.1)	--	--	--	--	--	--	--	--	--	--	--
Acetone	µg/kg	--	ND(26)UJ	23 J	--	--	--	--	--	--	--	--	--	--	--
Benzene	µg/kg	--	ND(0.42)	ND(0.46)	--	--	--	--	--	--	--	--	--	--	--
Bromodichloromethane	µg/kg	--	ND(0.88)	ND(0.97)	--	--	--	--	--	--	--	--	--	--	--
Bromoform	µg/kg	--	ND(1.2)	ND(1.3)	--	--	--	--	--	--	--	--	--	--	--
Bromomethane (Methyl Bromide)	µg/kg	--	ND(1.1)	ND(1.2)	--	--	--	--	--	--	--	--	--	--	--
Carbon disulfide	µg/kg	--	ND(0.37)	ND(0.4)	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	µg/kg	--	ND(0.82)	ND(0.91)	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	µg/kg	--	ND(0.51)	ND(0.56)	--	--	--	--	--	--	--	--	--	--	--
Chloroethane	µg/kg	--	ND(0.99)	ND(1.1)	--	--	--	--	--	--	--	--	--	--	--
Chloroform (Trichloromethane)	µg/kg	--	ND(0.73)	ND(0.8)	--	--	--	--	--	--	--	--	--	--	--
Chloromethane (Methyl Chloride)	µg/kg	--	ND(0.46)	ND(0.5)	--	--	--	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	µg/kg	--	ND(0.75)	ND(0.82)	--	--	--	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	µg/kg	--	ND(0.64)	ND(0.7)	--	--	--	--	--	--	--	--	--	--	--
Cyclohexane	µg/kg	--	ND(0.9)	ND(0.99)	--	--	--	--	--	--	--	--	--	--	--
Dibromochloromethane	µg/kg	--	ND(0.66)	ND(0.72)	--	--	--	--	--	--	--	--	--	--	--
Dichlorodifluoromethane (CFC-12)	µg/kg	--	ND(0.73)	ND(0.8)	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	µg/kg	--	ND(0.97)	ND(1.1)	--	--	--	--	--	--	--	--	--	--	--
Isopropylbenzene	µg/kg	--	ND(0.38)	ND(0.42)	--	--	--	--	--	--	--	--	--	--	--
Methyl acetate	µg/kg	--	ND(1.4)	ND(1.5)	--	--	--	--	--	--	--	--	--	--	--
Methyl cyclohexane	µg/kg	--	ND(0.84)	1 J	--	--	--	--	--	--	--	--	--	--	--
Methyl Tert Butyl Ether	µg/kg	--	ND(0.51)	ND(0.56)	--	--	--	--	--	--	--	--	--	--	--
Methylene chloride	µg/kg	--	ND(2.4)	ND(2.6)	--	--	--	--	--	--	--	--	--	--	--
Styrene	µg/kg	--	ND(0.37)	ND(0.4)	--	--	--	--	--	--	--	--	--	--	--
Tetrachloroethene	µg/kg	--	ND(1.5)	ND(1.7)	--	--	--	--	--	--	--	--	--	--	--
Toluene	µg/kg	--	0.93 J	0.96 J	--	--	--	--	--	--	--	--	--	--	--
trans-1,2-Dichloroethene	µg/kg	--	ND(1)	ND(1.1)	--	--	--	--	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	µg/kg	--	ND(0.64)	ND(0.7)	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	µg/kg	--	ND(0.75)	ND(0.82)	--	--	--	--	--	--	--	--	--	--	--
Trichlorofluoromethane (CFC-11)	µg/kg	--	ND(0.75)	ND(0.82)	--	--	--	--	--	--	--	--	--	--	--
Trifluorotrichloroethane (Freon 113)	µg/kg	--	ND(1.5)	ND(1.6)	--	--	--	--	--	--	--	--	--	--	--
Vinyl chloride	µg/kg	--	ND(0.81)	ND(0.88)	--	--	--	--	--	--	--	--	--	--	--
Xylene (total)	µg/kg	--	ND(1.4)	ND(1.5)	--	--	--	--	--	--	--	--	--	--	--
General Chemistry															
Oil and Grease	µg/kg	--	196000 J	ND(53400)U	--	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	ND(1000)	ND(1000)	25000	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(2000)	ND(1000)	ND(2000)
Total Organic Carbon (TOC)	%	0.95	5.94	--	2.86	0.98	0.9	4.29	3.06	2.1	2.92	3.99	3.81	14.9	4.12
Total Organic Carbon (2)	%	0.85	6.27	--	2.86	0.97	0.85	3.95	2.95	2.56	3.1	3.72	3.78	16	4.05
Total Organic Carbon (3)	%	0.83	5.95	--	2.98	0.97	0.75	3.96	2.95	2.13	2.99	3.49	3.85	15.8	4.14
Total Organic Carbon (4)	%	0.97	6.07	--	3.06	0.99	0.79	3.82	2.77	2.3	2.87	3.83	3.77	14.9	3.85
Total Solids	%	77	54.6 Dup 58.9	49.7 Dup 49.7	64.4	70.7	78.9	55.6	64.4	64.2	65.3	61.4	45.5	79.5	53.7
Percent Moisture	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

U - Not present at or above the associated value.
J - Estimated concentration.
ND ( ) - Not present at or above the associated value.
UJ - Estimated reporting limit.

TABLE 4.7

ADDITIONAL SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*
Sample Identification:		*SD-31884-10302004-KD-022*	*SD-31884-10302004-KD-023*	*SD-31884-10302004-KD-024*	*SD-31884-10302004-KD-025*	*SD-31884-10302004-KD-026*	*SD-31884-10302004-KD-027*	*SD-31884-10302004-KD-028*	*SD-31884-10302004-KD-029*	*SD-31884-10302004-KD-030*
Sample Date:		*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*
	Units									
Dioxin and Furans										
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HPCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HPCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HPCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HXCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HXCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HXCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PECDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	µg/kg	--	--	--	--	--	--	--	--	--
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HXCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HXCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,4,7,8-PECDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,4,7,8-PECDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	µg/kg	--	--	--	--	--	--	--	--	--
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	--	--	--	--	--	--	--	--	--
OCDD (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
OCDD (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
OCDF (TEQ) (ND*0.5)	µg/kg	--	--	--	--	--	--	--	--	--
OCDF (TEQ) (ND=0)	µg/kg	--	--	--	--	--	--	--	--	--
Total Heptachlorodibenzofuran (HpCDF)	µg/kg	--	--	--	--	--	--	--	--	--
Total Heptachlorodibenzo-p-dioxin (HpCDD)	µg/kg	--	--	--	--	--	--	--	--	--
Total Hexachlorodibenzofuran (HxCDF)	µg/kg	--	--	--	--	--	--	--	--	--
Total Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	--	--	--	--	--	--	--	--	--
Total Pentachlorodibenzofuran (PeCDF)	µg/kg	--	--	--	--	--	--	--	--	--
Total Pentachlorodibenzo-p-dioxin (PeCDD)	µg/kg	--	--	--	--	--	--	--	--	--
Total TEQ (ND=0.5)	µg/kg	--	--	--	--	--	--	--	--	--
Total Tetrachlorodibenzofuran (TCDF)	µg/kg	--	--	--	--	--	--	--	--	--
Total Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	--	--	--	--	--	--	--	--	--
Metals										
Aluminum	µg/kg	--	--	--	--	--	--	--	--	--
Antimony	µg/kg	--	--	--	--	--	--	--	--	--
Arsenic	µg/kg	--	--	--	--	--	--	--	--	--
Barium	µg/kg	--	--	--	--	--	--	--	--	--
Beryllium	µg/kg	--	--	--	--	--	--	--	--	--
Cadmium	µg/kg	--	--	--	--	--	--	--	--	--
Calcium	µg/kg	--	--	--	--	--	--	--	--	--
Chromium	µg/kg	--	--	--	--	--	--	--	--	--
Cobalt	µg/kg	--	--	--	--	--	--	--	--	--
Copper	µg/kg	--	--	--	--	--	--	--	--	--
Iron	µg/kg	--	--	--	--	--	--	--	--	--
Lead	µg/kg	--	--	--	--	--	--	--	--	--
Magnesium	µg/kg	--	--	--	--	--	--	--	--	--
Manganese	µg/kg	--	--	--	--	--	--	--	--	--
Mercury	µg/kg	--	--	--	--	--	--	--	--	--
Nickel	µg/kg	--	--	--	--	--	--	--	--	--
Potassium	µg/kg	--	--	--	--	--	--	--	--	--
Selenium	µg/kg	--	--	--	--	--	--	--	--	--
Silver	µg/kg	--	--	--	--	--	--	--	--	--
Sodium	µg/kg	--	--	--	--	--	--	--	--	--
Thallium	µg/kg	--	--	--	--	--	--	--	--	--
Vanadium	µg/kg	--	--	--	--	--	--	--	--	--
Zinc	µg/kg	--	--	--	--	--	--	--	--	--
PCBs										
Aroclor-1016 (PCB-1016)	µg/kg	--	--	--	--	--	--	--	--	--
Aroclor-1221 (PCB-1221)	µg/kg	--	--	--	--	--	--	--	--	--
Aroclor-1232 (PCB-1232)	µg/kg	--	--	--	--	--	--	--	--	--
Aroclor-1242 (PCB-1242)	µg/kg	--	--	--	--	--	--	--	--	--
Aroclor-1248 (PCB-1248)	µg/kg	--	--	--	--	--	--	--	--	--
Aroclor-1254 (PCB-1254)	µg/kg	--	--	--	--	--	--	--	--	--
Aroclor-1260 (PCB-1260)	µg/kg	--	--	--	--	--	--	--	--	--

TABLE 4.7

ADDITIONAL SURFACE SEDIMENT SAMPLING ANALYTICAL RESULTS SUMMARY (PHASE I EOC ACTIVITY)
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*
Sample Identification:		*SD-31884-10302004-KD-022*	*SD-31884-10302004-KD-023*	*SD-31884-10302004-KD-024*	*SD-31884-10302004-KD-025*	*SD-31884-10302004-KD-026*	*SD-31884-10302004-KD-027*	*SD-31884-10302004-KD-028*	*SD-31884-10302004-KD-029*	*SD-31884-10302004-KD-030*
Sample Date:		*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*
Pesticides										
4,4'-DDD	µg/kg	--	--	--	--	--	--	--	--	--
4,4'-DDE	µg/kg	--	--	--	--	--	--	--	--	--
4,4'-DDT	µg/kg	--	--	--	--	--	--	--	--	--
Aldrin	µg/kg	--	--	--	--	--	--	--	--	--
alpha-BHC	µg/kg	--	--	--	--	--	--	--	--	--
alpha-Chlordane	µg/kg	--	--	--	--	--	--	--	--	--
beta-BHC	µg/kg	--	--	--	--	--	--	--	--	--
delta-BHC	µg/kg	--	--	--	--	--	--	--	--	--
Dieldrin	µg/kg	--	--	--	--	--	--	--	--	--
Endosulfan I	µg/kg	--	--	--	--	--	--	--	--	--
Endosulfan II	µg/kg	--	--	--	--	--	--	--	--	--
Endosulfan sulfate	µg/kg	--	--	--	--	--	--	--	--	--
Endrin	µg/kg	--	--	--	--	--	--	--	--	--
Endrin aldehyde	µg/kg	--	--	--	--	--	--	--	--	--
Endrin ketone	µg/kg	--	--	--	--	--	--	--	--	--
gamma-BHC (Lindane)	µg/kg	--	--	--	--	--	--	--	--	--
gamma-Chlordane	µg/kg	--	--	--	--	--	--	--	--	--
Heptachlor	µg/kg	--	--	--	--	--	--	--	--	--
Heptachlor epoxide	µg/kg	--	--	--	--	--	--	--	--	--
Methoxychlor	µg/kg	--	--	--	--	--	--	--	--	--
Toxaphene	µg/kg	--	--	--	--	--	--	--	--	--
Semi-Volatile Organic Compounds										
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	µg/kg	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	µg/kg	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	µg/kg	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	µg/kg	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	µg/kg	--	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	µg/kg	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	µg/kg	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	µg/kg	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	µg/kg	--	--	--	--	--	--	--	--	--
2-Chlorophenol	µg/kg	--	--	--	--	--	--	--	--	--
2-Methylnaphthalene	µg/kg	--	--	--	--	--	--	--	--	--
2-Methylphenol	µg/kg	--	--	--	--	--	--	--	--	--
2-Nitroaniline	µg/kg	--	--	--	--	--	--	--	--	--
2-Nitrophenol	µg/kg	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	µg/kg	--	--	--	--	--	--	--	--	--
3-Nitroaniline	µg/kg	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	µg/kg	--	--	--	--	--	--	--	--	--
4-Bromophenyl phenyl ether	µg/kg	--	--	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	µg/kg	--	--	--	--	--	--	--	--	--
4-Chloroaniline	µg/kg	--	--	--	--	--	--	--	--	--
4-Chlorophenyl phenyl ether	µg/kg	--	--	--	--	--	--	--	--	--
4-Methylphenol	µg/kg	--	--	--	--	--	--	--	--	--
4-Nitroaniline	µg/kg	--	--	--	--	--	--	--	--	--
4-Nitrophenol	µg/kg	--	--	--	--	--	--	--	--	--
Acenaphthene	µg/kg	--	--	--	--	--	--	--	--	--
Acenaphthylene	µg/kg	--	--	--	--	--	--	--	--	--
Acetophenone	µg/kg	--	--	--	--	--	--	--	--	--
Anthracene	µg/kg	--	--	--	--	--	--	--	--	--
Atrazine	µg/kg	--	--	--	--	--	--	--	--	--
Benzaldehyde	µg/kg	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	µg/kg	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	µg/kg	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	µg/kg	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	µg/kg	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	µg/kg	--	--	--	--	--	--	--	--	--
Biphenyl (1,1-Biphenyl)	µg/kg	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	µg/kg	--	--	--	--	--	--	--	--	--
bis(2-Chloroethyl)ether	µg/kg	--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	µg/kg	--	--	--	--	--	--	--	--	--
Butyl benzylphthalate	µg/kg	--	--	--	--	--	--	--	--	--
Caprolactam	µg/kg	--	--	--	--	--	--	--	--	--
Carbazole	µg/kg	--	--	--	--	--	--	--	--	--
Chrysene	µg/kg	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	µg/kg	--	--	--	--	--	--	--	--	--
Dibenzofuran	µg/kg	--	--	--	--	--	--	--	--	--
Diethyl phthalate	µg/kg	--	--	--	--	--	--	--	--	--
Dimethyl phthalate	µg/kg	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	µg/kg	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	µg/kg	--	--	--	--	--	--	--	--	--
Fluoranthene	µg/kg	--	--	--	--	--	--	--	--	--
Fluorene	µg/kg	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	µg/kg	--	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	µg/kg	--	--	--	--	--	--	--	--	--
Hexachloroethane	µg/kg	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	µg/kg	--	--	--	--	--	--	--	--	--
Isophorone	µg/kg	--	--	--	--	--	--	--	--	--
Naphthalene	µg/kg	--	--	--	--	--	--	--	--	--
Nitrobenzene	µg/kg	--	--	--	--	--	--	--	--	--
N-Nitrosodi-n-propylamine	µg/kg	--	--	--	--	--	--	--	--	--
N-Nitrosodiphenylamine	µg/kg	--	--	--	--	--	--	--	--	--
Pentachlorophenol	µg/kg	--	--	--	--	--	--	--	--	--
Phenanthrene	µg/kg	--	--	--	--	--	--	--	--	--
Phenol	µg/kg	--	--	--	--	--	--	--	--	--
Pyrene	µg/kg	--	--	--	--	--	--	--	--	--

TABLE 4.7

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EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*	*RM 68*
Sample Identification:		*SD-31884-10302004-KD-022*	*SD-31884-10302004-KD-023*	*SD-31884-10302004-KD-024*	*SD-31884-10302004-KD-025*	*SD-31884-10302004-KD-026*	*SD-31884-10302004-KD-027*	*SD-31884-10302004-KD-028*	*SD-31884-10302004-KD-029*	*SD-31884-10302004-KD-030*
Sample Date:		*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*	*10/30/2004*
Volatile Organic Compounds										
1,1,1-Trichloroethane	µg/kg	--	--	--	--	--	--	--	--	--
1,1,2,2-Tetrachloroethane	µg/kg	--	--	--	--	--	--	--	--	--
1,1,2-Trichloroethane	µg/kg	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	µg/kg	--	--	--	--	--	--	--	--	--
1,1-Dichloroethene	µg/kg	--	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	--	--	--	--	--	--	--	--	--
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	µg/kg	--	--	--	--	--	--	--	--	--
1,2-Dichloropropane	µg/kg	--	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--
2-Butanone (Methyl Ethyl Ketone)	µg/kg	--	--	--	--	--	--	--	--	--
2-Hexanone	µg/kg	--	--	--	--	--	--	--	--	--
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	--	--	--	--	--	--	--	--	--
Acetone	µg/kg	--	--	--	--	--	--	--	--	--
Benzene	µg/kg	--	--	--	--	--	--	--	--	--
Bromodichloromethane	µg/kg	--	--	--	--	--	--	--	--	--
Bromoform	µg/kg	--	--	--	--	--	--	--	--	--
Bromomethane (Methyl Bromide)	µg/kg	--	--	--	--	--	--	--	--	--
Carbon disulfide	µg/kg	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	µg/kg	--	--	--	--	--	--	--	--	--
Chlorobenzene	µg/kg	--	--	--	--	--	--	--	--	--
Chloroethane	µg/kg	--	--	--	--	--	--	--	--	--
Chloroform (Trichloromethane)	µg/kg	--	--	--	--	--	--	--	--	--
Chloromethane (Methyl Chloride)	µg/kg	--	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	µg/kg	--	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	µg/kg	--	--	--	--	--	--	--	--	--
Cyclohexane	µg/kg	--	--	--	--	--	--	--	--	--
Dibromochloromethane	µg/kg	--	--	--	--	--	--	--	--	--
Dichlorodifluoromethane (CFC-12)	µg/kg	--	--	--	--	--	--	--	--	--
Ethylbenzene	µg/kg	--	--	--	--	--	--	--	--	--
Isopropylbenzene	µg/kg	--	--	--	--	--	--	--	--	--
Methyl acetate	µg/kg	--	--	--	--	--	--	--	--	--
Methyl cyclohexane	µg/kg	--	--	--	--	--	--	--	--	--
Methyl Tert Butyl Ether	µg/kg	--	--	--	--	--	--	--	--	--
Methylene chloride	µg/kg	--	--	--	--	--	--	--	--	--
Styrene	µg/kg	--	--	--	--	--	--	--	--	--
Tetrachloroethene	µg/kg	--	--	--	--	--	--	--	--	--
Toluene	µg/kg	--	--	--	--	--	--	--	--	--
trans-1,2-Dichloroethene	µg/kg	--	--	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	µg/kg	--	--	--	--	--	--	--	--	--
Trichloroethene	µg/kg	--	--	--	--	--	--	--	--	--
Trichlorofluoromethane (CFC-11)	µg/kg	--	--	--	--	--	--	--	--	--
Trifluorotrichloroethane (Freon 113)	µg/kg	--	--	--	--	--	--	--	--	--
Vinyl chloride	µg/kg	--	--	--	--	--	--	--	--	--
Xylene (total)	µg/kg	--	--	--	--	--	--	--	--	--
General Chemistry										
Oil and Grease	µg/kg	--	--	--	--	--	--	--	--	--
Total Organic Carbon (TOC)	µg/kg	21000	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(1000)	ND(1000)
Total Organic Carbon (TOC)	%	3.66	34.9	3.1	2.09	0.14	5.29	12.8	4.47	3.99
Total Organic Carbon (2)	%	3.72	31.4	3.09	2.14	0.13	4.24	12.1	4.72	3.74
Total Organic Carbon (3)	%	3.66	32.2	3.29	1.83	0.12	4.34	11.1	4.29	4.1
Total Organic Carbon (4)	%	3.72	37.5	3.11	2.06	0.17	4.59	10.4	4.56	4.47
Total Solids	%	53.8	79.2	62.7	73.5	75.6	56.4	74.4	68.1	78.2
Percent Moisture	%	--	--	--	--	--	--	--	--	--

Notes:

U - Not present at or above the associated value.
J - Estimated concentration.
ND ( ) - Not present at or above the associated value.
UJ - Estimated reporting limit.

TABLE 4.8a

SUMMARY OF SURFACE SEDIMENT SAMPLE FIELD OBSERVATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Station ID	*River Mile*	*Sample Date*	*Water Depth (feet)*	*Sample Depth (inches below top of sediment)*	*Field Description*
GT-01	43.5	10/25/2004	23.9 - 26.9	4	brown GRAVEL and fine SAND (2 refusals before success)
GT-02	43.0	10/25/2004	22.1 - 26.5	not sampled, no sediment	chunks of clay in sandy SILT
GT-02	43.0	10/29/2004	17.0 - 24.0	3	chunks of clay in sandy SILT
GT-03	42.5	10/25/2004	22.9	6	brown clayey SILT
GT-04	42.0	10/25/2004	23.8 - 24.0	3	brown to black med SAND
GT-05	41.0	10/25/2004	22.0 - 28.4	not sampled, grabs were all water or clay	small amount of stiff CLAY, anthropogenic debris
GT-06	41.0	10/25/2004	26.1	3	brown to black med-coarse SAND and GRAVEL
GT-07	41.0	10/25/2004	28.0 - 28.5	4	brown to black med-coarse SAND and GRAVEL
GT-08	41.0	10/27/2004	23.2	3	olive gray silty CLAY, slight sheen, organic matter
GT-09	40.5	10/27/2004	24.7 - 27.1	not sampled	brown silty SAND w/ GRAVEL and COBBLE
GT-09	40.5	10/29/2004	24.1	grab	brown silty SAND w/ GRAVEL and COBBLE
GT-10	40.0	10/27/2004	21.9 - 26.7	not sampled	silty CLAY w/ coarse SAND, GRAVEL, COBBLE
GT-10	40.0	10/29/2004	not measured	1	silty CLAY w/ coarse SAND, GRAVEL, COBBLE
GT-11	39.0	10/27/2004	22.4	3	olive-brown silty fine-coarse SAND w/ CLAY
GT-12	39.0	10/27/2004	28.5 - 28.8	3	brown to olive gray gravelly CLAY w/ SILT
GT-13	39.0	10/27/2004	44.0 - 44.8	not sediment, no sediment	COBBLE and GRAVEL, traces of SILT and SAND
GT-13	39.0	10/29/2004	not measured	not sampled, no sediment	COBBLE and GRAVEL, traces of SILT and SAND
GT-14	39.0	10/27/2004	34.4 - 35.0	not sampled, cobble	COBBLE and debris, all attempts
GT-15	38.5	10/27/2004	23.8 - 25.7	not sampled, cobble and silt	sandy SILT surf. over silty SAND with shells
GT-15	38.5	10/29/2004	24 - 28.2	3	sandy SILT surf. over silty SAND with shells
GT-16	37.5	10/27/2004	22.6	3	loose brown SILT over olive clayey SILT
GT-17	37.5	10/27/2004	28.3 - 30.6	not sampled, no sediment	SILT, abundant leafy debris
GT-18	36.0	10/26/2004	32.4	3	brown, olive gray to black, clayey SILT w/ sheen, petro odor
GT-18	36.0	10/28/2004	30.8	5	brown, olive gray to black, clayey SILT w/ sheen, petro odor
GT-19	36.0	10/27/2004	23.4	3	brown SILT surf., olive gray clayey SILT
GT-20	34.5	10/26/2004	31.7 - 35.0	not sampled, no sediment	COBBLE in 2 grabs, silty CLAY in one
GT-21	34.5	10/26/2004	36.7	3	brown to black, med-coarse SAND, organic debris
GT-22	34.5	10/26/2004	36.4	3	brown sandy SILT w/ organic matter on surface
GT-23	34.5	10/26/2004	29.5	3	SILT over CLAY, shallow penetration
GT-24	34.5	10/26/2004	35.1	3	red-brown to olive-gray, clayey SILT w/ fine SAND
GT-25	32.0	10/26/2004	28.0 - 28.8	3	soft SILT over hard consolidated SAND and CLAY
GT-26	32.0	10/26/2004	32.8 - 33.8	not sampled, no sediment	trace silty CLAY
GT-27	32.0	10/26/2004	28.5 - 30.3	not sampled, not enough sediment	silty GRAVEL; winnowed samples
GT-28	32.0	10/26/2004	19.1	6	soft SILT and SAND
KD-001	33.0	10/28/2004	23.1	3	sandy SILT, sl. sheen
KD-002	33.0	10/28/2004	35.4 - 35.9	3	brown fine-med SAND w/ coal
KD-003	33.0	10/28/2004	17.2	3	brn SILT surf., olive gray silty fine SAND, sl. sheen
KD-004	33.0	10/28/2004	23.9	3	brn SILT surf., olive gray fine-coarse SAND/SILT, sl. sheen, leafs
KD-005	33.0	10/28/2004	6.1 - 27.2	3	brn SILT surf., olive-gray fine-med SAND
KD-006	33.5	10/28/2004	21.5	3	brn SILT surf., olive-gray v. clayey fine-med SAND, sl. sheen
KD-007	33.5	10/28/2004	25	3	brn SILT surf., olive-gray clayey fine SAND
KD-008	33.5	10/28/2004	18.5	3	brn SILT surf., olive gray silty SAND w/ coal, leaves
KD-009	33.5	10/28/2004	36.2	3	brn SAND w/ organic matter (decomposing leaves)
KD-010	33.5	10/28/2004	32.8	3	brn SILT surf., dk gray to black clayey fine SAND, spotty sheen
KD-011	41.5	10/28/2004	24.1 - 33.6	2	brown sandy SILT, leafy debris, gravel on bottom
KD-012	41.5	10/28/2004	17.3 - 24.2	3	brn SILT surf. over brown fine SAND
KD-013	41.5	10/28/2004	27.2 - 27.6	3	brown fine-med SAND w/ coal
KD-014	41.5	10/28/2004	12.3 - 28.8	3	clayey SILT w/ fine SAND and organic debris
KD-015	41.5	10/28/2004	15.7 - 17.4	3	fine SAND w/ gravel and cobble, sheen
KD-016	42.0	10/28/2004	10	3	brown silty SAND w/ sl. sheen
KD-017	42.0	10/28/2004	18.3 - 32.5	3	brn SILT surf., dk gray clayey SAND w/ gravel, sl. sheen

TABLE 4.8a

SUMMARY OF SURFACE SEDIMENT SAMPLE FIELD OBSERVATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Station ID	River Mile	Sample Date	Water Depth (feet)	Sample Depth (inches below top of sediment)	Field Description
KD-018	42.0	10/29/2004	23.6 - 26.7	3	brn SILT surf., gray silty SAND w/ clay & organics; shale on bottom
KD-019	42.0	10/29/2004	14.7	3	olive-gray to brown sandy SILT, sulfide odor, sheen, methane bubbles
KD-020	42.0	10/29/2004	24	3	brown fine SAND w/ trace GRAVEL and coal
KD-021	68.0	10/30/2004	12.6 - 20.0	3	brown sandy SILT w/ organic matter, sheen, clay on bottom
KD-022	68.0	10/30/2004	23	3	brown sandy SILT w/ shells, clay chunks, organic matter
KD-023	68.0	10/30/2004	29.8 - 31.0	3	brown SAND w/ abundant coal
KD-024	68.0	10/30/2004	25.9 - 27.0	3	brn SILT surf., clayey SAND w/ gravel and shells
KD-025	68.0	10/30/2004	9.5 - 23.0	3	brown fine-med SAND w/ gravel and shells
KD-026	68.0	10/30/2004	5.0 - 7.0	3	brown SAND
KD-027	68.0	10/30/2004	21.0 - 30.1	3	brown sandy SILT w/ gravel and clay, sheen
KD-028	68.0	10/30/2004	31	3	brown SAND w/ abundant coal
KD-029	68.0	10/30/2004	6.0 25.5	3	brown to gray silty SAND w/ shells and organic matter
KD-030	68.0	10/30/2004	21	3	brown fine-med SAND w/ gravel, sl. sheen
COR-01	31.3	12/2/2007	33	6	--
COR-02	31.5	12/2/2007	34	3	--
COR-03	32.0	12/2/2007	34	4	--
COR-04	32.1	12/1/2007	1	4	Coal fragments
COR-05	32.3	12/1/2007	44	2	--
COR-06	32.6	12/1/2007	35	2	--
COR-07	32.6	12/1/2007	26	5	--
COR-08	32.9	12/1/2007	18	5	--
COR-09	33.4	12/1/2007	20	4	--
COR-10	33.4	12/1/2007	36	2	Coal (small gravel size to trace amounts)
COR-11	33.8	12/1/2007	24	5	--
COR-12	34.0	12/1/2007	30	5	--
COR-13	34.3	12/1/2007	32	4	Coal (small gravel size to trace amounts)
COR-14	34.5	12/1/2007	30	2	--
COR-15	34.8	12/1/2007	26	6	--
COR-16	35.0	12/1/2007	22	2	--
COR-17	35.0	12/1/2007	38	3	Trace coal
COR-18	35.9	12/1/2007	32	2	--
COR-19	37.2	11/30/2007	18	4	--
COR-20	37.5	11/30/2007	17	4	--
COR-21	37.7	11/30/2007	6	2	--
COR-22	37.9	11/30/2007	26	4	--
COR-23	38.1	11/30/2007	24	2.5	Trace coal
COR-24	38.6	11/30/2007	25	4	Trace coal
COR-25	39.5	11/29/2007	21	3	--
COR-26	39.7	11/29/2007	30	3.5	--
COR-27	40.0	11/29/2007	25	3	--
COR-28	40.1	11/29/2007	20	1	--
COR-29	40.3	11/29/2007	28	3	Trace coal
COR-30	40.4	11/29/2007	7	1.5	Some material is eroded bank soil.
COR-31	40.8	11/29/2007	28	4	Trace coal
COR-32	40.9	11/29/2007	33	4	Trace coal
COR-33	41.4	11/29/2007	28	3	Coal fragments. Sheen visible.
COR-34	41.4	11/29/2007	24	4	--
COR-35	41.6	11/29/2007	17	1	*Corbicula* sp. Shells
COR-36	41.6	11/29/2007	0.67	4	Organic odor
COR-37	41.8	11/28/2007	24	3	15% of sample is coal
COR-38	41.9	11/28/2007	16	3	--

TABLE 4.8a

SUMMARY OF SURFACE SEDIMENT SAMPLE FIELD OBSERVATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Station ID	*River Mile*	*Sample Date*	*Water Depth (feet)*	*Sample Depth (inches below top of sediment)*	*Field Description*
COR-39	42.0	11/28/2007	21	3	Sheen
COR-40	42.1	12/1/2007	7	0	Unknown chemical odor
COR-41	42.3	12/1/2007	19	2.5	--
COR-42	42.3	12/1/2007	1	3.5	--
COR-43	42.5	12/1/2007	18	3	--
SSD-01	31	12/2/2007	33	2	Trace coal
SSD-02	31	12/2/2007	8	3	*Dreissena polymorpha* shells
SSD-03	31.1	12/2/2007	17	4	Shell fragments visible
SSD-04	31.2	12/2/2007	12	4	--
SSD-05	31.9	12/2/2007	2	4	--
SSD-06	32.6	12/1/2007	4	6	--
SSD-07	33	12/1/2007	35	3	Trace coal and gravel
SSD-09	35.5	12/1/2007	2	2	--
SSD-10	36.4	11/30/2007	8	4	--
SSD-11	36.7	11/30/2007	3	4	--
SSD-12	36.7	11/30/2007	23	3	--
SSD-13	37.1	11/30/2007	21	4	--
SSD-14	38.3	11/30/2007	2	3	--
SSD-15	38.8	11/30/2007	26	2	--
SSD-16	38.9	11/30/2007	17	4	--
SSD-17	39.2	11/30/2007	20	3	Slight sheen visible
SSD-18	39.3	11/30/2007	3	4	--
SSD-19	39.8	11/29/2007	29	0.5	Trace coal
SSD-20	40.3	11/29/2007	6	6	--
SSD-21	40.5	11/29/2007	17	1	Trace coal
SSD-22	41	11/29/2007	18	4	--
SSD-23	41.8	11/28/2007	14	1	--
SSD-24	41.9	11/28/2007	8	2	--
SSD-25	42.3	11/28/2007	9	4	--
SSD-26	42.7	11/28/2007	19	3.5	Large coal fragments
SSD-26	42.7	11/28/2007	19	3.5	Duplicate of Sample #4
SSD-27	42.8	11/28/2007	19	2	*Dreissena polymorpha* shells
SSD-28	44	11/28/2007	10	2	--
SSD-29	44.7	11/28/2007	6.2	2	Sheen visible

TABLE 4.8b

SUMMARY OF SEDIMENT CORING FIELD OBSERVATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Core ID	River Mile	Core Date	Water Depth (ft)	Penetrated Depth (ft)	Recovered Depth (ft)	% Recovery	# of Attempts	Comments	Comparison to US EPA May 2000 Sampling Event
COR-01	31.3	20-Feb-08	30.5	REFUSAL	--	--	5	Bits of coal and brown sand in fingers of core catcher.	KRSD-01, approx. 1000 ft away, had a depth of 60 inches (5 ft).
COR-02	31.5	20-Feb-08	33	REFUSAL	--	--	5	Bits of coal and brown sand in fingers of core catcher.	KRSD-02, approx. 1500 ft away, had a depth of 115" (9.5 ft).
COR-03	32.0	12-Dec-07	0.8	10	8.9	89%	1	--	KRSD-02, approx. 1000 ft away, had a depth of 115" (9.5 ft).
COR-04	32.1	12-Dec-07	0.9	10	8.2	82%	1	--	KRSD-02, approx. 1000 ft away, had a depth of 115" (9.5 ft).
COR-05	32.3	21-Feb-08	43	0.7	0.7	100%	1	8" recovery on one attempt. Brown sand and coal in core catcher. Sample was profiled but not submitted for analysis.	KRSD-02, approx 2000 ft away, had a depth of 115" (9.5 ft).
COR-06	32.6	21-Feb-08	36	REFUSAL	--	--	5	Black coal bits and brown sand in core catcher.	KRSD-02, approx 4000 ft away, had a depth of 115" (9.5ft).
COR-07	32.6	14-Dec-07	29	3	3	100%	1		KRSD-02, approx 4500 ft away, had a depth of 115" (9.5 ft).
COR-07 (Sedflume)	32.6	30-Jul-09	20	1.3	1.3	100%	6	Attempt 6 was at a location 5' ahead of proposed location. Silty mud.	KRSD-02, approx 4500 ft away, had a depth of 115" (9.5 ft).
COR-08	32.9	12-Dec-07	20.8	4	4	100%	1		KRSD-02, approx 5000 ft away, had a depth of 115" (9.5 ft).
COR-09	33.4	14-Dec-07	19	3.3	2.8	85%	2		KRSD-04, approx 3500 ft away, had a depth of 4 ft.
COR-11	33.8	14-Dec-07	24.5	2.5	2	80%	2		KRSD-04, approx 1500 ft away, had a depth of 4 ft.
COR-12	34.0	15-Dec-07	29.5	2.5	1.8	72%	3		KRSD-04, approx 500 ft away, had a depth of 4 ft.
COR-13	34.3	15-Dec-07	not measured	REFUSAL	--	--	3	3 attempts, appears to be refusal. Sandy gravel with coal.	KRSD-04, less than 500 ft away, had a depth of 4 ft.
COR-13 (Resampled)	34.3	21-Feb-08	31.7	REFUSAL	--	--	2	3-4cm pieces of coal and gravel in core catcher.	KRSD-04, less than 500 ft away, had a depth of 4 ft.
COR-14	34.5	23-Feb-08	29	REFUSAL	--	--	5	First 4 attempts with 4" barrel and vibracore. 5th attempt with 3" aluminum barrel and cement vibrator. 5" penetration on 5th attempt.	KRSD-04, approx 750 ft away, had a depth of 4 ft.
COR-15	34.8	23-Feb-08	26.9	2.8	1.6	57%	1		KRSD-04, approx 2000 ft away, had a depth of 4 ft.
COR-16	35.0	17-Dec-07	19.8	REFUSAL	--	--	2	2 attempts failed due to current.	KRSD-05, approx 1500 ft away, had a depth of 8 ft.
COR-16 (Resampled)	35.0	23-Feb-08	16.2	2	1.3	65%	1		KRSD-05, approx 1500 ft away, had a depth of 8 ft.
COR-17	35.0	23-Feb-08	32	REFUSAL	--	--	4		KRSD-05, approx 1500 ft away, had a depth of 8 ft.
COR-18	35.9	11-Dec-07	28.2	10	0	0%	4	4 attempts with poor core quality in first 2 attempts and no recovery in last 2 attempts.	KRSD-05, approx 1500 ft away, had a depth of 8 ft.
COR-19	37.2	10-Dec-07	16.2	0.6	0.6	100%	5		KRSD-09, approx 1500 ft away, had a depth of 4 ft.
COR-20	37.5	10-Dec-07	19.1	2.6	2.6	100%	3		KRSD-09, less than 500 ft away, had a depth of 4 ft.
COR-20 (Sedflume)	37.5	29-Jul-09	1	1.7	1.7	100%	1	Silty mud.	KRSD-09, less than 500 ft away, had a depth of 4 ft.
COR-21	37.7	10-Dec-07	3.2	10	6.5	65%	1	Low recovery likely to do material in core pushing sediment down and not compression of material in core.	KRSD-08, less than 500 ft away, had a depth of 6 ft.
COR-22	37.9	10-Dec-07	5.7	7.9	4.1	52%	1		KRSD-08, less than 500 ft away, had a depth of 6 ft.
COR-23	38.1	8-Dec-07	12	3	2.3	77%	2		KRSD-08, approx 1000 ft away, had a depth of 6 ft.
COR-24	38.6	8-Dec-07	not measured	REFUSAL	--	--	5	5 failed cores. Thin layer of silt/leaves over brown sand.	KRSD-48, less than 500 ft away, had a depth of 40" (3.3 ft).
COR-25	39.5	8-Dec-07	23.5	1.2	1.2	100%	1		No suitable comparison
COR-25 (Sedflume)	39.5	28-Jul-09	22	1	0	0%	5	Very loose sand overlying 1" to 2" gravel; unable to recover sample.	No suitable comparison
COR-26	39.7	8-Dec-07	30	REFUSAL	--	--	5	Brown sand and coal in core catcher. Tried a 2' core barrel on 5th attempt.	No suitable comparison
COR-27	40.0	7-Dec-07	24.5	REFUSAL	--	--	5	Brown sand, gravel, and coal in core catcher.	KRSD-14, approx 1250 ft away, had a depth of 6 ft.

TABLE 4.8b

SUMMARY OF SEDIMENT CORING FIELD OBSERVATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Core ID	*River Mile*	*Core Date*	*Water Depth (ft)*	*Penetrated Depth (ft)*	*Recovered Depth (ft)*	*% Recovery*	*# of Attempts*	*Comments*	*Comparison to US EPA May 2000 Sampling Event*
COR-28	40.1	7-Dec-07	9.5	2.3	2	87%	1	Chironomids in surface sediment. Odd metallic/copper odor from 11" to 24".	KRSD-15, approx 500 ft away had a depth of 8 ft.
COR-28A	40.2	11-Dec-08	15.8	0.5	0.5	100%	1		KRSD-15, approx 500 ft away had a depth of 8 ft.
COR-29	40.3	7-Dec-07	29.5	REFUSAL			5	Black silt with mostly sand and gravel in core catcher.	KRSD-14, approx 250 ft away, had a depth of 6 ft.
COR-30	40.4	7-Dec-07	5.5	2.9	2.5	86%	1		KRSD-15, approx 250 ft away, had a depth of 8 ft.
COR-30 (Sedflume)	40.4	28-Jul-09	6	1	1	100%	4	Offset location to achieve sample. Silt with mud.	KRSD-15, approx 250 ft away, had a depth of 8 ft.
COR-31	40.8	6-Dec-07	not measured	REFUSAL	--	--	5		KRSD-16, approx 250 ft away, had a depth of 4 ft.
COR-32	40.9	6-Dec-07	25.5	REFUSAL	--	--	5		KRSD-16, approx 750 ft away, had a depth of 4 ft.
COR-32A	41.1	11-Dec-08	9.6	1.5	1.5	100%	1		KRSD-16, approx 750 ft away, had a depth of 4 ft.
COR-32B	40.7	11-Dec-08	13.2	9	7.8	87%	1		KRSD-16, approx 750 ft away, had a depth of 4 ft.
COR-32B (Sedflume)	40.7	28-Jul-09	8	1.7	0	0%	5	Several inches of sand overlying dense clay - soil type caused seal to break while retrieving core.	KRSD-16, approx 750 ft away, had a depth of 4 ft.
COR-33	41.4	6-Dec-07	24.5	2.7	1.75	65%	4	Diesel odor 11-12"	KRSD-19, approx 500 ft away, had a depth of 6 ft.
COR-34	41.4	6-Dec-07	24.6	REFUSAL	--	--	5	Station abandoned.	KRSD-18, approx 250 ft away, had a depth of 4 ft.
COR-35	41.6	4-Dec-07	7	5	4.5	90%	1		KRSD-18, approx 500 ft away, had a depth of 4 ft.
COR-35 (Sedflume)	41.6	28-Jul-09	5	1.7	1.7	100%	1	Sandy silt.	KRSD-18, approx 500 ft away, had a depth of 4 ft.
COR-36	41.6	5-Dec-07	4.3	10	9.1	91%	1		KRSD-18, approx 500 ft away, had a depth of 4 ft.
COR-36 (Resampled)	41.6	10-Dec-08	15.25	9.2	9.2	100%	1		KRSD-19, overlaps COR-36 sample site and had a depth of 6 ft.
COR-36 (Sedflume)	41.6	28-Jul-09	3	1.7	1.7	100%	1	Fine sands/silts.	KRSD-19, overlaps COR-36 sample site and had a depth of 6 ft.
COR-36A	41.7	10-Dec-08	18	0.8	0.8	100%	1		KRSD-19, approx 250 ft away, had a depth of 6 ft.
COR-36B	41.5	10-Dec-08	25.2	1.2	1.2	100%	1		KRSD-19, approx 250 ft away, had a depth of 6 ft.
COR-36C	41.5	10-Dec-08	24.1	3.5	3.3	94%	1		KRSD-19, approx 500 ft away, had a depth of 6 ft.
COR-37	41.8	4-Dec-07	25.5	REFUSAL	--	--	5	Clean sand and gravel in core catcher.	KRSD-20, less than 500 ft away, had a depth of 8 ft.
COR-38	41.9	4-Dec-07	15	2.7	2	74%	1		KRSD-20, approx 250 ft away, had a depth of 8 ft.
COR-39	42.0	4-Dec-07	16	3.7	2.75	74%	1	Entire core has a strong hydrocarbon odor and dark staining. Possibly diesel.	KRSD-21, approx 250 ft away, had a depth of 6 ft.
COR-39 (Sedflume)	42.0	28-Jul-09	5	1.75	1.75	100%	1	Offset location due to nearby piezometers. Sand with silt.	KRSD-21, approx 250 ft away, had a depth of 6 ft.
COR-40	42.1	3-Dec-07	8	3.3	3.3	100%	1		KRSD-21 overlaps COR-40, and had a depth of 6 ft.
COR-40 (Resampled)	42.1	9-Dec-08	5.75	5.5	5.5	100%	1		KRSD-21 overlaps COR-40, and had a depth of 6 ft.
COR-40 (Sedflume)	42.1	28-Jul-09	2	1.5	1.5	100%	1	Poor satellite reception on GPS. Muddy sand.	KRSD-21 overlaps COR-40, and had a depth of 6 ft.
COR-41	42.3	4-Dec-07	13	3.5	2.1	60%	1		KRSD-22, approx 250 ft away, had a depth of 2 ft.
COR-42	42.3	3-Dec-07	12	2.4	2.4	100%	1		KRSD-22, approx 750 ft away, had a depth of 2 ft.
COR-42 (Resampled)	42.3	9-Dec-08	3.25	1.5	1.5	100%	1		KRSD-22, approx 750 ft away, had a depth of 2 ft.
COR-42 (Sedflume)	42.3	28-Jul-09	3	1.3	1.3	100%	1	Location may be off due to GPS. Mud with clay.	KRSD-22, approx 750 ft away, had a depth of 2 ft.
COR-43	42.5	3-Dec-07	11	1.8	1.8	100%	1		KRSD-22, approx 500 ft away, had a depth of 2 ft.
NRC-01	31.5	13-Dec-07	not measured	0.3	0.3	100%	1	Coring not attempted due to close proximity to Winfield Dam, no core or subsurface sample collected.	KRSD-02, approx 1500 ft away, had a depth of 115" (9.5 ft).
NRC-01 (Resampled)	31.5	20-Feb-08	33.5	0.5	0.5	100%	5	No sample collected. Only 6" recovery on 3rd attempt.	KRSD-02, approx 1500 ft away, had a depth of 115" (9.5 ft).

TABLE 4.8b

SUMMARY OF SEDIMENT CORING FIELD OBSERVATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Core ID	River Mile	Core Date	Water Depth (ft)	Penetrated Depth (ft)	Recovered Depth (ft)	% Recovery	# of Attempts	Comments	Comparison to US EPA May 2000 Sampling Event
NRC-02	32.1	12-Dec-07	1.2	8	7.7	96%	1	0-50cm sampled at 2.5cm intervals. 50cm and below sampled at 5cm intervals. Chunks of wood 95cm-120cm.	KRSD-02, approx 500 ft away, had a depth of 115" (9.5 ft).
NRC-03	33.3	14-Dec-07	not measured	10	8.2	82%	1	0-50cm sampled at 2.5cm intervals. 50cm and below sampled at 5cm intervals. Sample collected but put on hold.	KRSD-03, overlaps NRC-03 and had a depth of 8 ft.
NRC-04	35.4	11-Dec-07	24.4	REFUSAL	--	--	2	No sample collected. Low recovery.	KRSD-05, overlaps NRC-04 and had a depth of 8 ft.
NRC-04 (Resampled)	35.4	19-Feb-08	23.7	3.5	3.5	100%	1	0-50cm sampled at 2.5cm intervals. 50cm and below sampled at 5cm intervals. Strong diesel odor from 1-2.5 ft.	KRSD-05, overlaps NRC-04 and had a depth of 8 ft.
NRC-05	37.6	10-Dec-07	8.2	6	3.5	58%	1	0-50cm sampled at 2.5cm intervals. 50cm and below sampled at 5cm intervals. Woody chunks from 1.3-1.4 ft and black staining/hydrocarbon odor from 1.8-3.1 ft.	KRSD-09, overlaps NRC-05 and had a depth of 4 ft.
NRC-05 (Resampled)	37.6	19-Feb-08	3.1	9	5	56%	2	Location re-sampled. Sample "bulleted". Large chunks of coal from 0.4-2.6 ft.	KRSD-09, overlaps NRC-05 and had a depth of 4 ft.
NRC-06	40.8	7-Dec-07	27.2	REFUSAL	--	--	5	No sample collected. Traces of brown sand and bits of coal in core catcher.	KRSD-16, approx 250 ft away, had a depth of 4 ft.
NRC-07	41.6	5-Dec-07	1	6	5.9	98%	1	0-50cm sampled at 2.5cm intervals. 50cm and below sampled at 5cm intervals. Diesel odor from 3-5.7 ft. Leaves at bottom of core, barely decomposed. Sample collected but put on hold.	KRSD-19 overlaps NRC-07 and had a depth of 6 ft.
NRC-08	42.1	4-Dec-07	8	4.5	3.9	87%	1	0-50cm sampled at 2.5cm intervals. 50cm and below sampled at 5cm intervals. Plastic strip observed from 2.6-2.9 ft. Visible coal.	KRSD-21 overlaps NRC-08 and had a depth of 6 ft.
NRC-08 (Resampled)	42.1	23-Feb-08	1.6	7.5	7.4	99%	1	Location re-sampled.	KRSD-21 overlaps NRC-08 and had a depth of 6 ft.
KRSD-01 (Sedflume)	31	30-Jul-09	8	1.7	1.7	100%	5	Offset location closer to shore to achieve sample recovery. Silty mud.	--
KRSD-04 (Sedflume)	34.3	30-Jul-09	6	1.7	1.7	100%	1	Silty mud.	--
KRSD-05 (Sedflume)	35.4	30-Jul-09	10	1.7	1.7	100%	3	Silty mud/clay/sand lenses.	--
KRSD-10 (Sedflume)	38.3	29-Jul-09	5	1.3	1.3	100%	5	Soft silty mud.	--
KRSD-14 (Sedflume)	40.2	28-Jul-09	6	1.7	1.7	100%	1	Silty mud.	--
KRSD-20 (Sedflume)	41.8	28-Jul-09	15	1.3	1.3	100%	5	Mud with organic debris.	--
KRSD-24 (Sedflume)	43.2	27-Jul-09	2	1.5	1.5	100%	3	Sandy mud.	--
KRSD-25 (Sedflume)	43.8	27-Jul-09	9	1.3	1.3	100%	2	Thin sand overlying silt.	--
KRSD-28 (Sedflume)	45	27-Jul-09	5	1.7	1.7	100%	1	Sand overlying silt.	--
KRSD-48 (Sedflume)	38.6	29-Jul-09	3	1.3	1.3	100%	1	Soft silty mud.	--

Notes:

Cores with multiple collection dates may not be collected from the exact same coordinates.

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 32*	*RM 32*	*RM 34.5*	*RM 34.5*	*RM 34.5*	*RM 34.5*	*RM 36*	*RM 36*	*RM 37.5*	*RM 38.5*	*RM 39*	*RM 39*	*RM 39*	*RM 40.5*	*RM 41*	*RM 41*
Sample Identification:		*KR-GT-28*	*KR-GT-25*	*KR-GT-21*	*KR-GT-22*	*KR-GT-24*	*KR-GT-23*	*KR-GT-18*	*KR-GT-19*	*KR-GT-16*	*KR-GT-15*	*KR-GT-08*	*KR-GT-11*	*KR-GT-12*	*KR-GT-09*	*KR-GT-07*	*KR-GT-06*
Sample Date:		*10/26/2004*	*10/29/2004*	*10/26/2004*	*10/26/2004*	*10/26/2004*	*10/29/2004*	*10/26/2004*	*10/27/2004*	*10/27/2004*	*10/29/2004*	*10/27/2004*	*10/27/2004*	*10/27/2004*	*10/29/2004*	*10/25/2004*	*10/29/2004*
Sample Depth:		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type:																	
	Units																
Geotech																	
#10 sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
#100 sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
#20 sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
#200 sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
#4 sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
#40 sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
#60 sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
#80 sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0.375 inch sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0.75 inch sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1 inch sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1.5 inch sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2 inch sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3 inch sieve	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Clay	%	20.9	12.5	2.2	3.4	12.4	14.1	21.6	16.7	23.8	9.3	15.2	10.5	13.5	6.5	1.3	1.8
Coarse Sand	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine Sand	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gravel	%	0	0	0	0	0	0	0	0	0.3	1.3	1	0.2	10.6	18.8	2.7	14.1
Hydrometer 1 for Particle size Distribution	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrometer 2 for Particle size Distribution	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrometer 3 for Particle size Distribution	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrometer 4 for Particle size Distribution	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrometer 5 for Particle size Distribution	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrometer 6 for Particle size Distribution	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrometer 7 for Particle size Distribution	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Medium Sand	%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sand	%	21.1	70.3	95.6	93.8	60.7	47.3	10.3	30.1	9	62.7	46.9	67.5	39.6	61.6	94.9	83.1
Silt	%	58	17.2	2.2	2.8	26.9	38.6	68.1	53.2	66.9	26.7	36.9	21.8	36.3	13.1	1.1	1
Fines (Clay and Sand)	%	78.9	29.7	4.4	6.2	39.3	52.7	89.7	69.9	90.7	36.0	52.1	32.3	49.8	19.6	2.4	2.8

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*RM 42*	*RM 42.5*	*RM 43.5*	*RM 43.5*	*COR-01*	*COR-02*	*COR-03*	*COR-04*	*COR-05*
Sample Identification:		*KR-GT-04*	*KR-GT-03*	*KR-GT-01*	*KR-GT-02*	*SE-031884-120207-DD-071*	*SE-031884-120207-DD-070*	*SE-031884-120207-DD-068*	*SE-031884-120107-DD-067*	*SE-031884-120107-DD-065*
Sample Date:		*10/25/2004*	*10/29/2004*	*10/25/2004*	*10/29/2004*	*12/2/2007*	*12/2/2007*	*12/2/2007*	*12/1/2007*	*12/1/2007*
Sample Depth:		-	-	-	-	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:										
	Units									
Geotech										
#10 sieve	%	--	--	--	--	99.8	99.1	100	100	96.1
#100 sieve	%	--	--	--	--	71.5	6.5	87.8	74.3	8.5
#20 sieve	%	--	--	--	--	99	92.2	99.9	99.9	93.5
#200 sieve	%	--	--	--	--	69	5.8	35.8	23.4	8.3
#4 sieve	%	--	--	--	--	100	99.9	100	100	98
#40 sieve	%	--	--	--	--	98.1	85	99.8	98.6	70.5
#60 sieve	%	--	--	--	--	78	15.1	99	95.9	12
#80 sieve	%	--	--	--	--	71.9	6.9	93.5	86.4	8.7
0.375 inch sieve	%	--	--	--	--	100	100	100	100	100
0.75 inch sieve	%	--	--	--	--	100	100	100	100	100
1 inch sieve	%	--	--	--	--	100	100	100	100	100
1.5 inch sieve	%	--	--	--	--	100	100	100	100	100
2 inch sieve	%	--	--	--	--	100	100	100	100	100
3 inch sieve	%	--	--	--	--	100	100	100	100	100
Clay	%	2.9	14.2	10.7	16	23.4	2.4	5.2	2.4	2.3
Coarse Sand	%	--	--	--	--	0.2	0.8	0	0	1.9
Fine Sand	%	--	--	--	--	29	79.2	64	75.2	62.1
Gravel	%	0.5	1.2	10.6	10	0	0.1	0	0	2
Hydrometer 1 for Particle size Distribution	%	--	--	--	--	56.1	4.5	12.7	7	3.5
Hydrometer 2 for Particle size Distribution	%	--	--	--	--	46.4	4	10.7	5.7	3.5
Hydrometer 3 for Particle size Distribution	%	--	--	--	--	34.3	3.4	8.6	4.4	2.9
Hydrometer 4 for Particle size Distribution	%	--	--	--	--	28.3	2.4	6.6	3.1	2.3
Hydrometer 5 for Particle size Distribution	%	--	--	--	--	23.4	2.4	5.2	2.4	2.3
Hydrometer 6 for Particle size Distribution	%	--	--	--	--	16	1.2	3.1	1	1
Hydrometer 7 for Particle size Distribution	%	--	--	--	--	9.7	0.5	2.4	0.4	0.4
Medium Sand	%	--	--	--	--	1.8	14.1	0.2	1.4	25.6
Sand	%	92.8	44.2	49.9	32.8	--	--	--	--	--
Silt	%	3.8	40.4	28.8	41.2	45.6	3.4	30.6	21	6
Fines (Clay and Sand)	%	6.7	54.6	39.5	57.2					

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-06*	*COR-07*	*COR-08*	*COR-09*	*COR-10*	*COR-11*	*COR-12*
Sample Identification:		*SE-031884-120107-DD-062*	*SE-031884-120107-DD-063*	*SE-031884-120107-DD-061*	*SE-031884-120107-DD-059*	*SE-031884-120107-DD-058*	*SE-031884-120107-DD-057*	*SE-031884-120107-DD-056*
Sample Date:		*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:								
	Units							
Geotech								
#10 sieve	%	99.6	98	99.9	99.7	99	99.7	99.4
#100 sieve	%	1.8	86.9	86	92.7	4.5	87.4	73.9
#20 sieve	%	99.2	97.7	99.9	99.4	97.2	99.2	99
#200 sieve	%	1.7	64.7	68.4	69.8	4.3	68.5	55.7
#4 sieve	%	100	99.1	100	99.8	99.8	100	99.5
#40 sieve	%	91.6	96.7	99.6	99	86.7	98.8	98.2
#60 sieve	%	7.9	93.8	98.5	98	14.5	96.7	92.4
#80 sieve	%	2	89.5	91.8	94.9	4.9	90.4	80
0.375 inch sieve	%	100	100	100	100	100	100	100
0.75 inch sieve	%	100	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100	100
Clay	%	1	14.3	26.9	19.5	0.1	20.3	10.9
Coarse Sand	%	0.4	1.1	0.1	0.1	0.8	0.3	0.1
Fine Sand	%	89.9	32	31.3	29.2	82.4	30.3	42.5
Gravel	%	0	0.9	0	0.2	0.2	0	0.5
Hydrometer 1 for Particle size Distribution	%	1.1	34.5	51.9	40.3	0.7	47.8	32.4
Hydrometer 2 for Particle size Distribution	%	1.1	29	45.4	35.9	0.7	41.4	28.1
Hydrometer 3 for Particle size Distribution	%	1.1	20.8	37.8	28.2	0.7	31.9	17.4
Hydrometer 4 for Particle size Distribution	%	1	16.2	31.3	23.9	0.1	24.5	14.2
Hydrometer 5 for Particle size Distribution	%	1	14.3	26.9	19.5	0.1	20.3	10.9
Hydrometer 6 for Particle size Distribution	%	0.4	9.7	18.1	12.8	0	13.9	7.5
Hydrometer 7 for Particle size Distribution	%	0.4	6.9	10.5	8.3	0	9.7	4.5
Medium Sand	%	8	1.4	0.3	0.7	12.3	0.9	1.1
Sand	%	--	--	--	--	--	--	--
Silt	%	0.7	50.3	41.5	50.4	4.2	48.2	44.8
Fines (Clay and Sand)	%							

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-13*	*COR-14*	*COR-15*	*COR-16*	*COR-17*	*COR-18*	*COR-19*
Sample Identification:		*SE-031884-120107-DD-055*	*SE-031884-120107-DD-054*	*SE-031884-120107-DD-053*	*SE-031884-120107-DD-052*	*SE-031884-120107-DD-051*	*SE-031884-120107-DD-049*	*SE-031884-113007-DD-044*
Sample Date:		*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*11/30/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:				*MS/MSD*				
	Units							
Geotech								
#10 sieve	%	99.1	62.1	99.8	98.9	97.3	97.7	99.8
#100 sieve	%	3.5	39.2	75.2	80.1	5.9	69	83.6
#20 sieve	%	96.3	60.7	99.2	98.6	96.2	97.2	99.4
#200 sieve	%	3.3	32.6	69	51.7	5.9	44.8	57
#4 sieve	%	99.7	68.3	100	99.2	98.5	98.1	100
#40 sieve	%	88.7	57.1	98.9	97.5	81.7	96.6	98.7
#60 sieve	%	14.6	47	96	93.5	10.4	86.6	96
#80 sieve	%	3.7	40.7	78.9	86.2	6.1	75.3	88.2
0.375 inch sieve	%	100	80.4	100	100	100	100	100
0.75 inch sieve	%	100	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100	100
Clay	%	0.1	11.3	13.2	12.5	0.8	14.5	11
Coarse Sand	%	0.6	6.2	0.2	0.3	1.2	0.4	0.2
Fine Sand	%	85.4	24.4	29.9	45.8	75.8	51.8	41.7
Gravel	%	0.3	31.7	0	0.8	1.5	1.9	0
Hydrometer 1 for Particle size Distribution	%	0.2	32	44.6	28.1	1.9	31.6	30.1
Hydrometer 2 for Particle size Distribution	%	0.2	26.6	36.5	23.2	1.9	27.8	24.4
Hydrometer 3 for Particle size Distribution	%	0.2	18.9	22.5	18.3	1.3	23	17.7
Hydrometer 4 for Particle size Distribution	%	0.1	14.6	15.5	15	1.3	17.4	13.9
Hydrometer 5 for Particle size Distribution	%	0.1	11.3	13.2	12.5	0.8	14.5	11
Hydrometer 6 for Particle size Distribution	%	0.1	7.8	8.3	9.1	0.7	10.6	7.2
Hydrometer 7 for Particle size Distribution	%	0.1	4.5	6	5	0.1	5.8	4.4
Medium Sand	%	10.3	5.1	0.9	1.4	15.6	1.1	1.2
Sand	%	--	--	--	--	--	--	--
Silt	%	3.2	21.3	55.8	39.2	5.1	30.3	45.9
Fines (Clay and Sand)	%							

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-20*	*COR-21*	*COR-22*	*COR-23*	*COR-24*	*COR-25*	*COR-25*
Sample Identification:		*SE-031884-113007-DD-042*	*SE-031884-113007-DD-041*	*SE-031884-113007-DD-040*	*SE-031884-113007-DD-039*	*SE-031884-113007-DD-037*	*SE-031884-112907-DD-031*	*SE-031884-112907-DD-032*
Sample Date:		*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/29/2007*	*11/29/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:								*Duplicate*
	Units							
Geotech								
#10 sieve	%	99.8	99.3	99.6	96.3	99.5	97.1	93.6
#100 sieve	%	87.6	90.7	83.9	72.1	11.8	75.8	73.4
#20 sieve	%	99.2	98.8	99	95.2	98.6	96.1	93
#200 sieve	%	75	61.9	40.9	24.8	9.6	56.3	53.5
#4 sieve	%	99.9	99.6	99.9	97.8	99.9	98.1	94.5
#40 sieve	%	98.7	98.3	98.1	94	82.5	93	90.7
#60 sieve	%	97.5	97.4	96.2	91.3	21.8	87.3	85.4
#80 sieve	%	91.1	94	89.6	80.7	12.5	79.7	77.5
0.375 inch sieve	%	100	99.7	100	100	100	100	97.8
0.75 inch sieve	%	100	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100	100
Clay	%	15.6	12.7	9.6	5.2	3.5	19.2	20.2
Coarse Sand	%	0.1	0.3	0.3	1.5	0.4	0.9	0.9
Fine Sand	%	23.7	36.4	57.2	69.2	72.9	36.7	37.2
Gravel	%	0.1	0.4	0.1	2.2	0.1	1.9	5.5
Hydrometer 1 for Particle size Distribution	%	49.1	35	22.9	10.8	7.2	40.6	38.9
Hydrometer 2 for Particle size Distribution	%	41	28	19.6	9.2	6.6	35.2	33.3
Hydrometer 3 for Particle size Distribution	%	29.5	19.9	14.6	8.5	6	28.1	27.7
Hydrometer 4 for Particle size Distribution	%	20.2	15.8	11.3	6.9	4.7	23.7	23.9
Hydrometer 5 for Particle size Distribution	%	15.6	12.7	9.6	5.2	3.5	19.2	20.2
Hydrometer 6 for Particle size Distribution	%	9.9	8.7	6.3	2.8	2.2	13.8	14.6
Hydrometer 7 for Particle size Distribution	%	6.4	5.6	3.8	2	1.6	8.5	8.9
Medium Sand	%	1.1	1	1.5	2.2	17	4.1	2.9
Sand	%	--	--	--	--	--	--	--
Silt	%	59.4	49.2	31.3	19.6	6.1	37.1	33.3
Fines (Clay and Sand)	%							

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-26*	*COR-27*	*COR-28*	*COR-29*	*COR-30*	*COR-31*	*COR-32*
Sample Identification:		*SE-031884-112907-DD-030*	*SE-031884-112907-DD-028*	*SE-031884-112907-DD-027*	*SE-031884-112907-DD-025*	*SE-031884-112907-DD-024*	*SE-031884-112907-DD-023*	*SE-031884-112907-DD-021*
Sample Date:		*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:								
	Units							
Geotech								
#10 sieve	%	95.7	98.7	99.6	99.2	95.8	99.7	98.6
#100 sieve	%	1.4	2.8	74.7	5.2	49.8	8.5	15.3
#20 sieve	%	94.6	96.1	98.8	98.6	95.4	99.5	95.8
#200 sieve	%	1.1	2.4	36.1	4.8	15.9	8	14.6
#4 sieve	%	96.4	99.5	99.9	99.7	96.3	99.8	99.7
#40 sieve	%	80.8	67.4	96	82.9	91	90.5	78.9
#60 sieve	%	10.4	5.9	90.2	10.1	75.9	19.1	23.5
#80 sieve	%	1.7	2.9	81	5.3	58.8	9	15.8
0.375 inch sieve	%	97.6	100	100	100	97.2	100	100
0.75 inch sieve	%	100	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100	100
Clay	%	1	1	13.2	2.8	4.1	2	5.5
Coarse Sand	%	0.7	0.7	0.2	0.5	0.4	0.1	1.1
Fine Sand	%	79.8	65	59.8	78.1	75.1	82.6	64.3
Gravel	%	3.6	0.5	0.1	0.3	3.7	0.2	0.3
Hydrometer 1 for Particle size Distribution	%	1	2.3	25.2	4.6	10.2	6.9	13.1
Hydrometer 2 for Particle size Distribution	%	1	2.3	20.7	4	8.2	5.6	11.6
Hydrometer 3 for Particle size Distribution	%	1	2.3	17	3.4	6.1	3.7	8.9
Hydrometer 4 for Particle size Distribution	%	1	1.7	14.7	2.8	4.8	3.1	6.9
Hydrometer 5 for Particle size Distribution	%	1	1	13.2	2.8	4.1	2	5.5
Hydrometer 6 for Particle size Distribution	%	1	0.4	9.5	1.6	2.7	0.6	2.8
Hydrometer 7 for Particle size Distribution	%	0.4	0.4	6.5	1	1.4	0	1.4
Medium Sand	%	14.8	31.3	3.7	16.3	4.8	9.2	19.7
Sand	%	--	--	--	--	--	--	--
Silt	%	0.1	1.4	22.9	2	11.8	6	9.1
Fines (Clay and Sand)	%							

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-33*	*COR-34*	*COR-35*	*COR-36*	*COR-37*	*COR-38*	*COR-39*
Sample Identification:		*SE-031884-112907-DD-019*	*SE-031884-112907-DD-018*	*SE-031884-112907-DD-017*	*SE-031884-112907-DD-016*	*SE-031884-112807-DD-015*	*SE-031884-112807-DD-012*	*SE-031884-112807-DD-011*
Sample Date:		*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:								
	Units							
Geotech								
#10 sieve	%	77.9	99.7	95.6	99.8	85.6	99.2	95.8
#100 sieve	%	52.5	10.3	56.1	73	2.9	38.1	29.5
#20 sieve	%	74.3	98.9	94.3	99.3	76.7	99	94.6
#200 sieve	%	45.5	9.5	33.3	25.9	2.3	25.9	15.5
#4 sieve	%	86.9	100	96.8	100	96.6	99.6	96.7
#40 sieve	%	70.5	77.5	92.4	98.7	53.4	97.8	92.4
#60 sieve	%	62.6	14.8	85.1	96	6.4	75.5	66.9
#80 sieve	%	54.8	10.4	65.1	83.4	3	46.6	38.3
0.375 inch sieve	%	98.7	100	98.6	100	100	99.8	97.8
0.75 inch sieve	%	100	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100	100
Clay	%	12.7	3.6	9.1	5.3	0.6	8	6.4
Coarse Sand	%	9	0.3	1.2	0.2	11	0.4	0.9
Fine Sand	%	25	68	59.2	72.8	51.2	71.9	76.9
Gravel	%	13.1	0	3.2	0	3.4	0.4	3.3
Hydrometer 1 for Particle size Distribution	%	31.5	8.4	22.8	12.8	1.7	17.2	12
Hydrometer 2 for Particle size Distribution	%	26.1	7.2	18.7	9.8	1.7	15.1	11.3
Hydrometer 3 for Particle size Distribution	%	18.9	6	14.6	7.5	1.2	12.2	9.2
Hydrometer 4 for Particle size Distribution	%	15.4	4.9	11.4	6	0.6	9.4	7.8
Hydrometer 5 for Particle size Distribution	%	12.7	3.6	9.1	5.3	0.6	8	6.4
Hydrometer 6 for Particle size Distribution	%	8.2	2.4	4.9	3	0	5.1	4.4
Hydrometer 7 for Particle size Distribution	%	4.6	0.6	1.8	1.5	-0.6	2.8	2.8
Medium Sand	%	7.4	22.3	3.2	1.1	32.2	1.4	3.4
Sand	%	--	--	--	--	--	--	--
Silt	%	32.8	5.9	24.2	20.6	1.7	17.9	9.1
Fines (Clay and Sand)	%							

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-40*	*COR-41*	*COR-42*	*COR-43*	*SSD-01*	*SSD-02*	*SSD-03*
Sample Identification:		*SE-031884-112807-DD-010*	*SE-031884-112807-DD-009*	*SE-031884-112807-DD-007*	*SE-031884-112807-DD-006*	*SE-031884-120207-DD-075*	*SE-031884-120207-DD-074*	*SE-031884-120207-DD-073*
Sample Date:		*11/28/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*	*12/2/2007*	*12/2/2007*	*12/2/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:				*MS/MSD*				
	Units							
Geotech								
#10 sieve	%	99.8	99.8	99.8	98.7	100	99.2	98.9
#100 sieve	%	73.3	9.5	82.4	13.9	7.5	92.4	88.5
#20 sieve	%	99.4	99.4	99.6	98.2	100	98.8	98.6
#200 sieve	%	54.5	2	34.4	7.6	7	62.2	61.9
#4 sieve	%	100	100	100	99.2	100	99.5	99.5
#40 sieve	%	98.7	94	99.3	95.5	99.7	98.6	98.3
#60 sieve	%	91	43.3	98.1	48.3	30.5	97.8	96.4
#80 sieve	%	80	16.7	91.4	19.2	8.1	95.4	92.2
0.375 inch sieve	%	100	100	100	99.4	100	100	100
0.75 inch sieve	%	100	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100	100
Clay	%	14.5	0.7	6.3	2	1.4	16	19.1
Coarse Sand	%	0.2	0.2	0.2	0.5	0	0.3	0.6
Fine Sand	%	44.2	92	65	87.9	92.7	36.4	36.4
Gravel	%	0	0	0	0.8	0	0.5	0.5
Hydrometer 1 for Particle size Distribution	%	41.2	1.3	16	4.6	3.1	32.8	37.1
Hydrometer 2 for Particle size Distribution	%	35.5	1.3	13.3	3.9	3.1	27.9	33.3
Hydrometer 3 for Particle size Distribution	%	26	1.3	9.8	3.3	3.1	24	26.6
Hydrometer 4 for Particle size Distribution	%	19.3	0.7	7.2	2	2	18.9	21.9
Hydrometer 5 for Particle size Distribution	%	14.5	0.7	6.3	2	1.4	16	19.1
Hydrometer 6 for Particle size Distribution	%	9.7	0.1	3.7	0.7	1.3	10.9	13.3
Hydrometer 7 for Particle size Distribution	%	4.8	-0.6	1.8	0	0.1	7	8.6
Medium Sand	%	1.2	5.8	0.5	3.2	0.3	0.6	0.6
Sand	%	--	--	--	--	--	--	--
Silt	%	40	1.2	28.1	5.5	5.6	46.2	42.8
Fines (Clay and Sand)	%							

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*SSD-04*	*SSD-05*	*SSD-06*	*SSD-07*	*SSD-09*	*SSD-10*	*SSD-11*
Sample Identification:		*SE-031884-120207-DD-072*	*SE-031884-120207-DD-069*	*SE-031884-120107-DD-064*	*SE-031884-120107-DD-060*	*SE-031884-120107-DD-050*	*SE-031884-113007-DD-048*	*SE-031884-113007-DD-047*
Sample Date:		*12/2/2007*	*12/2/2007*	*12/1/2007*	*12/1/2007*	*12/1/2007*	*11/30/2007*	*11/30/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:			*MS/MSD*					
	Units							
Geotech								
#10 sieve	%	99.8	99.5	99.8	95.9	98.5	99.7	98.2
#100 sieve	%	85.9	94	99.1	5.3	83.8	84.6	92.9
#20 sieve	%	99.4	99.3	99.8	93.8	98	99.4	97.7
#200 sieve	%	54.3	69.7	98	4.9	52.9	43.3	86.4
#4 sieve	%	99.9	99.8	100	97.9	99.1	100	100
#40 sieve	%	98.9	98.8	99.8	85.4	97.4	98.8	96.9
#60 sieve	%	95.8	97.3	99.5	15.4	96.3	97.2	95.9
#80 sieve	%	90.5	95	99.2	5.9	90.3	90.8	93.9
0.375 inch sieve	%	100	100	100	99	99.9	100	100
0.75 inch sieve	%	100	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100	100
Clay	%	17.2	17.3	27.6	1.6	10	8.5	14.2
Coarse Sand	%	0.1	0.3	0.2	2.1	0.7	0.3	1.8
Fine Sand	%	44.6	29.1	1.8	80.5	44.5	55.5	10.5
Gravel	%	0.1	0.2	0	2.1	0.9	0	0
Hydrometer 1 for Particle size Distribution	%	33.4	40.4	79.7	3.4	24.4	23.6	54.5
Hydrometer 2 for Particle size Distribution	%	29.6	32.7	69.5	3.4	20.5	20	41.1
Hydrometer 3 for Particle size Distribution	%	22.9	26.1	50.4	2.2	15.7	15.6	26.4
Hydrometer 4 for Particle size Distribution	%	20.1	19.5	36.5	2.2	11.9	11.2	17.8
Hydrometer 5 for Particle size Distribution	%	17.2	17.3	27.6	1.6	10	8.5	14.2
Hydrometer 6 for Particle size Distribution	%	12.5	10.6	17.3	0.4	6.9	5.8	8
Hydrometer 7 for Particle size Distribution	%	7.7	6.2	9.6	0.3	3	3.1	5.5
Medium Sand	%	0.9	0.7	0.1	10.5	1	0.9	1.3
Sand	%	--	--	--	--	--	--	--
Silt	%	37	52.4	70.4	3.3	43	34.8	72.2
Fines (Clay and Sand)	%							

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*SSD-12*	*SSD-13*	*SSD-14*	*SSD-15*	*SSD-16*	*SSD-17*	*SSD-18*
Sample Identification:		*SE-031884-113007-DD-046*	*SE-031884-113007-DD-045*	*SE-031884-113007-DD-038*	*SE-031884-113007-DD-036*	*SE-031884-113007-DD-035*	*SE-031884-113007-DD-034*	*SE-031884-113007-DD-033*
Sample Date:		*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:								
	Units							
Geotech								
#10 sieve	%	97.3	99.3	95.2	73.3	99.7	94.4	99.8
#100 sieve	%	82.1	90.4	59.7	28.6	63.2	57.4	98.3
#20 sieve	%	97	98.9	94.1	69	98.9	93.7	99.6
#200 sieve	%	63.8	74.1	21	20.3	51.5	20.1	92.1
#4 sieve	%	97.4	99.6	96.5	79.6	99.9	95.8	100
#40 sieve	%	96.4	98.2	89.3	53.7	96.8	91.6	99.4
#60 sieve	%	93.3	95.9	82	39.9	82.6	80.3	99.2
#80 sieve	%	85.7	92.2	68.9	31.4	69.6	65.4	98.7
0.375 inch sieve	%	98.3	100	98.9	91.5	100	98.1	100
0.75 inch sieve	%	100	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100	100
Clay	%	15.5	18.7	3.5	7.6	17	5.8	21.6
Coarse Sand	%	0.1	0.4	1.3	6.2	0.3	1.3	0.2
Fine Sand	%	32.6	24.1	68.3	33.4	45.3	71.5	7.3
Gravel	%	2.6	0.4	3.5	20.4	0.1	4.2	0
Hydrometer 1 for Particle size Distribution	%	46.5	54.7	8.3	17.2	45.4	10.3	71.5
Hydrometer 2 for Particle size Distribution	%	39.5	47.5	7.1	14.8	37.8	9.6	60.4
Hydrometer 3 for Particle size Distribution	%	33.5	41.5	5.9	11.6	28	8.8	42.4
Hydrometer 4 for Particle size Distribution	%	21.5	23.5	4.7	9.2	22.5	7.3	29.9
Hydrometer 5 for Particle size Distribution	%	15.5	18.7	3.5	7.6	17	5.8	21.6
Hydrometer 6 for Particle size Distribution	%	9.6	11.5	2.2	6	12.6	4.2	15.9
Hydrometer 7 for Particle size Distribution	%	6.6	9.1	1.6	2.8	8.2	2.7	10.4
Medium Sand	%	0.9	1	5.9	19.7	2.8	2.9	0.4
Sand	%	--	--	--	--	--	--	--
Silt	%	48.3	55.4	17.5	12.7	34.5	14.3	70.5
Fines (Clay and Sand)	%							

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*SSD-19*	*SSD-20*	*SSD-21*	*SSD-22*	*SSD-23*	*SSD-24*	*SSD-25*
Sample Identification:		*SE-031884-112907-DD-029*	*SE-031884-112907-DD-026*	*SE-031884-112907-DD-022*	*SE-031884-112907-DD-020*	*SE-031884-112807-DD-014*	*SE-031884-112807-DD-013*	*SE-031884-112807-DD-008*
Sample Date:		*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/29/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:			*MS/MSD*					
	Units							
Geotech								
#10 sieve	%	87.4	99.8	95.8	99.9	86.3	99.4	90.7
#100 sieve	%	8.3	99.5	32.9	23.1	70.6	39.5	67
#20 sieve	%	85.7	99.8	94.8	99.3	85.3	98.4	89.7
#200 sieve	%	2.5	99.4	10.9	9.2	49.5	7.4	34.8
#4 sieve	%	91.3	99.9	98.1	100	88	99.6	96.6
#40 sieve	%	75.2	99.8	87.1	78.2	84.2	93.4	88
#60 sieve	%	32	99.6	63.9	36.6	81.2	78.9	84.6
#80 sieve	%	12	99.5	40.5	26	74.5	53.4	75
0.375 inch sieve	%	96.5	100	100	100	92	100	99
0.75 inch sieve	%	100	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100	100
Clay	%	0.9	52.8	1.8	1.5	11.7	0.7	4.8
Coarse Sand	%	3.9	0	2.3	0.1	1.7	0.2	5.9
Fine Sand	%	72.7	0.4	76.2	68.9	34.7	86	53.2
Gravel	%	8.7	0.1	1.9	0	12	0.4	3.4
Hydrometer 1 for Particle size Distribution	%	2.1	91.3	4.3	5.2	26.2	3.3	14.1
Hydrometer 2 for Particle size Distribution	%	2.1	85.4	3.6	5.2	23.5	2.7	12.2
Hydrometer 3 for Particle size Distribution	%	2.1	72	2.4	3	17.1	2.1	9.4
Hydrometer 4 for Particle size Distribution	%	1.5	60.2	1.8	2.3	14.4	1.3	6.7
Hydrometer 5 for Particle size Distribution	%	0.9	52.8	1.8	1.5	11.7	0.7	4.8
Hydrometer 6 for Particle size Distribution	%	0.9	37.9	0.6	0.9	8.1	0	2.9
Hydrometer 7 for Particle size Distribution	%	0.3	26.1	0	0	4.5	-0.7	0.9
Medium Sand	%	12.2	0.1	8.7	21.7	2.1	6	2.7
Sand	%	--	--	--	--	--	--	--
Silt	%	1.6	46.6	9.1	7.8	37.7	6.7	30
Fines (Clay and Sand)	%							

TABLE 4.9a

SURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*SSD-26*	*SSD-26*	*SSD-27*	*SSD-28*	*SSD-29*
Sample Identification:		*SE-031884-112807-DD-004*	*SE-031884-112807-DD-005*	*SE-031884-112807-DD-003*	*SE-031884-112807-DD-002*	*SE-031884-112807-DD-001*
Sample Date:		*11/28/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*	*11/28/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:			*Duplicate*			
	Units					
Geotech						
#10 sieve	%	71.7	81.9	97.4	98.7	99.4
#100 sieve	%	45.1	49.2	59.9	73.8	41.4
#20 sieve	%	68.1	77.5	97.1	98.5	99.1
#200 sieve	%	35.3	38.9	17.8	30.9	11.8
#4 sieve	%	75	86.6	98.3	100	100
#40 sieve	%	64.9	74.1	95.8	97.7	98.1
#60 sieve	%	57.8	65.1	88.8	95.2	88.7
#80 sieve	%	48.7	53.6	71.5	83.9	56.3
0.375 inch sieve	%	84.1	94.1	98.6	100	100
0.75 inch sieve	%	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100
Clay	%	9.4	8.9	3	5	1.6
Coarse Sand	%	3.3	4.7	0.9	1.3	0.6
Fine Sand	%	29.7	35.2	78.1	66.9	86.3
Gravel	%	25	13.4	1.7	0	0
Hydrometer 1 for Particle size Distribution	%	24.5	21.6	6.7	12.8	4.5
Hydrometer 2 for Particle size Distribution	%	20.3	18.4	5.9	10.9	3.8
Hydrometer 3 for Particle size Distribution	%	15.2	13.7	5.2	8.9	2.3
Hydrometer 4 for Particle size Distribution	%	11.9	10.5	3.8	7	2.3
Hydrometer 5 for Particle size Distribution	%	9.4	8.9	3	5	1.6
Hydrometer 6 for Particle size Distribution	%	6	8.9	2.3	3.1	0.9
Hydrometer 7 for Particle size Distribution	%	3.5	1.7	0.7	1.1	0
Medium Sand	%	6.7	7.8	1.5	1	1.2
Sand	%	--	--	--	--	--
Silt	%	25.9	30	14.7	25.9	10.2
Fines (Clay and Sand)	%					

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-03*	*COR-03*	*COR-03*	*COR-04*	*COR-04*	*COR-04*
Sample Identification:		*SE-031884-121307-DD-274*	*SE-031884-121307-DD-275*	*SE-031884-121307-DD-276*	*SE-031884-121207-DD-269*	*SE-031884-121207-DD-270*	*SE-031884-121207-DD-271*
Sample Date:		*12/13/2007*	*12/13/2007*	*12/13/2007*	*12/12/2007*	*12/12/2007*	*12/12/2007*
Sample Depth:		*(0-24) In*	*(24-48) In*	*(48-81.6) In*	*(0-24) In*	*(24-48) In*	*(48-72) In*
Sample Type:							
	Units						
Geotech							
#10 sieve	%	100	100	100	99.9	100	100
#100 sieve	%	86.9	97.1	97.9	80.5	94	95.4
#20 sieve	%	99.7	99.8	99.9	98.6	99.1	99.2
#200 sieve	%	48.8	75.8	85.6	41.7	70.4	77.5
#4 sieve	%	100	100	100	100	100	100
#40 sieve	%	99.6	99.7	99.8	97.4	98.7	98.9
#60 sieve	%	98.6	99.3	99.4	94.8	97.7	98.2
#80 sieve	%	93.4	98.1	98.5	89	96	96.4
0.375 inch sieve	%	100	100	100	100	100	100
0.75 inch sieve	%	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100
Clay	%	16.1	25.5	33.1	6.1	16.4	23.6
Coarse Sand	%	0	0	0	0.1	0	0
Fine Sand	%	50.8	23.9	14.2	55.7	28.3	21.4
Gravel	%	0	0	0	0	0	0
Hydrometer 1 for Particle size Distribution	%	33.1	50.8	65.3	23	41.7	49.6
Hydrometer 2 for Particle size Distribution	%	28.4	44	57	19	33.6	41.8
Hydrometer 3 for Particle size Distribution	%	22.7	35.2	45.5	11.1	24.5	32.7
Hydrometer 4 for Particle size Distribution	%	19	29.4	39.3	8.1	19.4	27.5
Hydrometer 5 for Particle size Distribution	%	16.1	25.5	33.1	6.1	16.4	23.6
Hydrometer 6 for Particle size Distribution	%	11.3	18.5	23.8	4	11.1	15.6
Hydrometer 7 for Particle size Distribution	%	7.5	11.7	15.5	1	7.3	9.3
Medium Sand	%	0.4	0.3	0.2	2.5	1.2	1.1
Silt	%	32.7	50.3	52.5	35.6	54.1	53.9

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-07*	*COR-07*	*COR-08*	*COR-08*	*COR-09*	*COR-09*
Sample Identification:		*SE-031884-121407-DD-282*	*SE-031884-121407-DD-283*	*SE-031884-121307-DD-279*	*SE-031884-121307-DD-280*	*SE-031884-121507-DD-332*	*SE-031884-121507-DD-333*
Sample Date:		*12/14/2007*	*12/14/2007*	*12/13/2007*	*12/13/2007*	*12/15/2007*	*12/15/2007*
Sample Depth:		*(0-24) In*	*(24-36) In*	*(0-24) In*	*(24-48) In*	*(0-24) In*	*(24-34) In*
Sample Type:							
	Units						
Geotech							
#10 sieve	%	99.8	99.8	100	99.9	100	99.8
#100 sieve	%	95.4	97.4	63.4	78.4	88.9	91.4
#20 sieve	%	99.8	99.8	99.8	99.9	99.8	99.7
#200 sieve	%	75.1	81.4	46.3	67.2	64.6	70.5
#4 sieve	%	100	99.8	100	100	100	100
#40 sieve	%	99.7	99.8	99.6	99.7	99.5	99.4
#60 sieve	%	99.4	99.6	96.9	98	98.2	98.4
#80 sieve	%	97.4	98.5	78.8	87.3	92.7	94.4
0.375 inch sieve	%	100	100	100	100	100	100
0.75 inch sieve	%	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100
Clay	%	28.2	31.9	16.9	29.3	23.4	27.5
Coarse Sand	%	0.2	0	0	0.1	0	0.2
Fine Sand	%	24.6	18.4	53.3	32.5	34.9	28.9
Gravel	%	0	0.2	0	0	0	0
Hydrometer 1 for Particle size Distribution	%	50.9	55.1	35.7	56.8	45.8	51.4
Hydrometer 2 for Particle size Distribution	%	43.9	48.6	30.4	50.7	40.7	45.4
Hydrometer 3 for Particle size Distribution	%	36.1	40.2	24.2	40.4	32.6	38.6
Hydrometer 4 for Particle size Distribution	%	31.7	35.6	20.4	34.4	26.6	32.6
Hydrometer 5 for Particle size Distribution	%	28.2	31.9	16.9	29.3	23.4	27.5
Hydrometer 6 for Particle size Distribution	%	22	24.3	11.6	21.2	16.3	19.8
Hydrometer 7 for Particle size Distribution	%	15.7	18.6	7.1	13.1	11.3	12.9
Medium Sand	%	0.1	0	0.4	0.3	0.5	0.5
Silt	%	46.9	49.5	29.4	37.9	41.2	43

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-11*	*COR-12*	*COR-18*	*COR-20*	*COR-20*	*COR-21*
Sample Identification:		*SE-031884-121507-DD-331*	*SE-031884-121507-DD-334*	*SE-031884-121107-DD-221*	*SE-031884-121107-DD-218*	*SE-031884-121107-DD-219*	*SE-031884-121007-DD-213*
Sample Date:		*12/15/2007*	*12/15/2007*	*12/11/2007*	*12/11/2007*	*12/11/2007*	*12/10/2007*
Sample Depth:		*(0-24) In*	*(0-22) In*	*(0-24) In*	*(0-24) In*	*(24-31.6) In*	*(0-24) In*
Sample Type:							
	Units						
Geotech							
#10 sieve	%	96.3	100	99.8	99.8	99.8	82.7
#100 sieve	%	63.4	73.8	76.2	91.9	88.2	74.6
#20 sieve	%	95	100	99.7	99.2	99.5	81.4
#200 sieve	%	45.3	42.1	43.2	74.9	65.5	56.7
#4 sieve	%	98.2	100	100	100	100	85.6
#40 sieve	%	91.8	99.8	99.5	98.9	99	80.2
#60 sieve	%	81.9	95.9	96.4	98	97.3	78.9
#80 sieve	%	68.7	82.1	85.2	94.5	91.7	76.3
0.375 inch sieve	%	100	100	100	100	100	87.3
0.75 inch sieve	%	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100
Clay	%	16.9	18.9	14.5	18.8	21.7	14.4
Coarse Sand	%	1.9	0	0.2	0.2	0.2	2.9
Fine Sand	%	46.5	57.7	56.3	24.1	33.5	23.5
Gravel	%	1.8	0	0	0	0	14.4
Hydrometer 1 for Particle size Distribution	%	33	36.8	28.3	51.1	44.1	37.9
Hydrometer 2 for Particle size Distribution	%	28.7	30.8	24.9	45.6	38.3	30.7
Hydrometer 3 for Particle size Distribution	%	23.8	25.7	20.6	32.3	31.4	22.6
Hydrometer 4 for Particle size Distribution	%	19.4	21.5	18.1	23.4	26.5	17.2
Hydrometer 5 for Particle size Distribution	%	16.9	18.9	14.5	18.8	21.7	14.4
Hydrometer 6 for Particle size Distribution	%	11.7	14.6	11.1	13.3	14.8	9.9
Hydrometer 7 for Particle size Distribution	%	7.6	10.4	7.7	8.9	9	6.3
Medium Sand	%	4.5	0.2	0.3	0.8	0.9	2.5
Silt	%	28.3	23.2	28.7	56	43.9	42.3

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-21*	*COR-21*	*COR-22*	*COR-22*	*COR-23*	*COR-25*
Sample Identification:		*SE-031884-121007-DD-215*	*SE-031884-121007-DD-216*	*SE-031884-121007-DD-180*	*SE-031884-121007-DD-181*	*SE-031884-120807-DD-179*	*SE-031884-120807-DD-178*
Sample Date:		*12/10/2007*	*12/10/2007*	*12/10/2007*	*12/10/2007*	*12/8/2007*	*12/8/2007*
Sample Depth:		*(24-48) In*	*(48-78) In*	*(0-24) In*	*(24-49) In*	*(0-27) In*	*(0-14) In*
Sample Type:							
	Units						
Geotech							
#10 sieve	%	98.1	99.2	98.9	99	92.2	99.2
#100 sieve	%	85.7	93.4	86.7	88.5	88.6	90.5
#20 sieve	%	97.5	99.1	98.6	98.6	91.9	99
#200 sieve	%	61.6	77.7	63.8	68.1	79	69.8
#4 sieve	%	99.3	99.8	100	99.6	93.3	100
#40 sieve	%	96.6	98.8	98	97.6	91.6	98.3
#60 sieve	%	94.6	98.1	96.1	95.7	91.1	96.9
#80 sieve	%	89.5	95.3	90.3	91.2	89.6	92.8
0.375 inch sieve	%	100	100	100	100	93.7	100
0.75 inch sieve	%	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100
Clay	%	20	26.3	24.5	27.4	31.7	19.9
Coarse Sand	%	1.2	0.6	1.1	0.6	1	0.8
Fine Sand	%	35	21.2	34.2	29.6	12.6	28.5
Gravel	%	0.7	0.2	0	0.4	6.7	0
Hydrometer 1 for Particle size Distribution	%	43.6	55.4	50	51.2	62.3	42.7
Hydrometer 2 for Particle size Distribution	%	36.6	47.3	43.4	45.9	54.9	34.4
Hydrometer 3 for Particle size Distribution	%	28.8	39.3	34.5	37.1	45.4	27.1
Hydrometer 4 for Particle size Distribution	%	24.3	32.3	29	31.8	39.1	24
Hydrometer 5 for Particle size Distribution	%	20	26.3	24.5	27.4	31.7	19.9
Hydrometer 6 for Particle size Distribution	%	14.8	18.1	17.9	19.3	23.3	13.7
Hydrometer 7 for Particle size Distribution	%	8.7	11	11.3	12.3	14.7	9.3
Medium Sand	%	1.5	0.4	0.9	1.4	0.6	0.9
Silt	%	41.6	51.4	39.2	40.7	47.3	49.9

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-28*	*COR-28A*	*COR-30*	*COR-30*	*COR-32A*	*COR-32B*
Sample Identification:		*SE-031884-120807-DD-176*	*SE-031884-121108-SG-020*	*SE-031884-120707-DD-174*	*SE-031884-120707-DD-175*	*SE-031884-121108-SG-021*	*SE-031884-121108-SG-016*
Sample Date:		*12/8/2007*	*12/11/2008*	*12/7/2007*	*12/7/2007*	*12/11/2008*	*12/11/2008*
Sample Depth:		*(0-24) In*	*(0-6) In*	*(24-30) In*	*(0-24) In*	*(0-18.5) In*	*(0-24) In*
Sample Type:							
	Units						
Geotech							
#10 sieve	%	98.1	100	97	99.7	95.8	100
#100 sieve	%	91.3	91.9	15.8	14.6	74	58
#20 sieve	%	97.8	99.1	96.7	99.4	95.5	99.6
#200 sieve	%	72.7	72.6	7.8	7.3	45.6	32.5
#4 sieve	%	98.9	100	97.5	100	95.8	100
#40 sieve	%	97.3	98.6	84.7	86.9	95.1	99.1
#60 sieve	%	96.5	97.7	36.5	49.2	90.8	88.7
#80 sieve	%	93.3	95.1	18.7	19.7	81.5	69.6
0.375 inch sieve	%	100	100	98.6	100	95.8	100
0.75 inch sieve	%	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100
Clay	%	26.6	28.1	5.1	3.1	16.2	12.7
Coarse Sand	%	0.8	0	0.5	0.3	0	0
Fine Sand	%	24.7	26	77	79.6	49.5	66.6
Gravel	%	1.1	0	2.5	0	4.2	0
Hydrometer 1 for Particle size Distribution	%	51.1	50.6	7.6	6.7	28.8	22.1
Hydrometer 2 for Particle size Distribution	%	43.3	44.2	7	6.1	24.6	18.1
Hydrometer 3 for Particle size Distribution	%	35.4	36.1	6.4	4.9	20.4	15.4
Hydrometer 4 for Particle size Distribution	%	31.5	32.9	5.7	4.2	17.6	14.1
Hydrometer 5 for Particle size Distribution	%	26.6	28.1	5.1	3.1	16.2	12.7
Hydrometer 6 for Particle size Distribution	%	19.6	21.7	3.2	1.9	11.9	10
Hydrometer 7 for Particle size Distribution	%	13.7	18.5	2.5	1.2	9.1	8.7
Medium Sand	%	0.8	1.4	12.2	12.7	0.7	0.9
Silt	%	46.1	44.5	2.6	4.2	29.4	19.8

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-32B*	*COR-32B*	*COR-32B*	*COR-33*	*COR-35*	*COR-35*
Sample Identification:		*SE-031884-121108-SG-017*	*SE-031884-121108-SG-018*	*SE-031884-121108-SG-019*	*SE-031884-120607-DD-128*	*SE-031884-120507-DD-086*	*SE-031884-120507-DD-088*
Sample Date:		*12/11/2008*	*12/11/2008*	*12/11/2008*	*12/6/2007*	*12/5/2007*	*12/5/2007*
Sample Depth:		*(24-48) In*	*(48-72) In*	*(72-92) In*	*(0-21) In*	*(0-24) In*	*(24-48) In*
Sample Type:							
	Units						
Geotech							
#10 sieve	%	100	100	100	96.1	99.7	100
#100 sieve	%	51.2	55.6	64.2	81.9	75.8	63.5
#20 sieve	%	99.9	100	100	94.7	99.1	99.6
#200 sieve	%	27.1	29.8	37.2	61.6	53.8	36.8
#4 sieve	%	100	100	100	97.3	100	100
#40 sieve	%	99.7	99.8	99.9	92.5	97.7	98.5
#60 sieve	%	86.6	88.1	91.3	90	94.9	91.2
#80 sieve	%	63.9	67.6	74.6	85	83.6	74
0.375 inch sieve	%	100	100	100	100	100	100
0.75 inch sieve	%	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100
Clay	%	10.6	9.3	11.8	22.4	17.1	13.8
Coarse Sand	%	0	0	0	1.2	0.2	0
Fine Sand	%	72.6	70	62.8	30.8	43.8	61.7
Gravel	%	0	0	0	2.7	0	0
Hydrometer 1 for Particle size Distribution	%	17.7	16.8	22.7	45	35.9	26.9
Hydrometer 2 for Particle size Distribution	%	16.3	15.6	19.6	37.7	30.5	22.7
Hydrometer 3 for Particle size Distribution	%	13.4	11.8	16.5	30.5	24.3	18.7
Hydrometer 4 for Particle size Distribution	%	12	9.3	14.9	25.6	20.7	16.3
Hydrometer 5 for Particle size Distribution	%	10.6	9.3	11.8	22.4	17.1	13.8
Hydrometer 6 for Particle size Distribution	%	7.8	6.8	10.2	15.9	10.7	8.9
Hydrometer 7 for Particle size Distribution	%	7.8	4.4	8.6	10.1	7.1	5.6
Medium Sand	%	0.3	0.2	0.1	3.6	2.1	1.5
Silt	%	16.5	20.5	25.4	39.3	36.7	23

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-35*	*COR-36*	*COR-36*	*COR-36*	*COR-36*	*COR-36*
Sample Identification:		*SE-031884-120507-DD-089*	*SE-031884-120507-DD-123*	*SE-031884-120507-DD-124*	*SE-031884-120507-DD-125*	*SE-031884-121008-SG-007*	*SE-031884-121008-SG-008*
Sample Date:		*12/5/2007*	*12/5/2007*	*12/5/2007*	*12/5/2007*	*12/10/2008*	*12/10/2008*
Sample Depth:		*(48-54) In*	*(0-24) In*	*(24-48) In*	*(48-72) In*	*(0-24) In*	*(24-48) In*
Sample Type:							
	Units						
Geotech							
#10 sieve	%	99.9	100	99.9	99.9	100	100
#100 sieve	%	82.8	90.5	91	92.8	90.1	90.7
#20 sieve	%	99.8	99.9	99.9	99.8	99.8	99.7
#200 sieve	%	66.9	60.1	62.7	79.8	60.1	66.1
#4 sieve	%	100	100	100	100	100	100
#40 sieve	%	99.5	99.7	99.6	99.2	99.7	99.3
#60 sieve	%	95.7	98.7	98	97.4	98.6	97.2
#80 sieve	%	87.4	94.8	94.3	94.6	95	93.9
0.375 inch sieve	%	100	100	100	100	100	100
0.75 inch sieve	%	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100
Clay	%	32.7	18.9	16.3	31.9	23.2	17
Coarse Sand	%	0.1	0	0.1	0.1	0	0
Fine Sand	%	32.5	39.6	36.9	19.5	39.6	33.2
Gravel	%	0	0	0	0	0	0
Hydrometer 1 for Particle size Distribution	%	55.4	39.7	36.1	60.5	45.7	37.5
Hydrometer 2 for Particle size Distribution	%	50.5	34.1	29.8	53.1	39.3	30.7
Hydrometer 3 for Particle size Distribution	%	42.6	27.5	23.6	43.5	32.8	25.8
Hydrometer 4 for Particle size Distribution	%	38.6	22.6	19.8	36.1	26.4	22
Hydrometer 5 for Particle size Distribution	%	32.7	18.9	16.3	31.9	23.2	17
Hydrometer 6 for Particle size Distribution	%	23.7	14.1	11.6	21.1	16.6	13.1
Hydrometer 7 for Particle size Distribution	%	15.8	9.4	7.2	13.7	10.2	9.2
Medium Sand	%	0.5	0.3	0.3	0.7	0.3	0.7
Silt	%	34.2	41.2	46.5	47.9	36.9	49.1

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-36*	*COR-36*	*COR-36*	*COR-36*	*COR-36A*	*COR-36B*
Sample Identification:		*SE-031884-121008-SG-009*	*SE-031884-121008-SG-010*	*SE-031884-121008-SG-011*	*SE-031884-121008-SG-012*	*SE-031884-121008-SG-006*	*SE-031884-121008-SG-013*
Sample Date:		*12/10/2008*	*12/10/2008*	*12/10/2008*	*12/10/2008*	*12/10/2008*	*12/10/2008*
Sample Depth:		*(24-48) In*	*(48-72) In*	*(72-96) In*	*(96-108) In*	*(0-10.5) In*	*(0-12) In*
Sample Type:		*Duplicate*					
	Units						
Geotech							
#10 sieve	%	100	100	100	100	99.4	100
#100 sieve	%	90.1	90.6	91	92.9	98.1	82.6
#20 sieve	%	99.8	99.9	99.9	99.9	99.3	99.8
#200 sieve	%	64.4	76.7	70.9	70.1	92.2	50.6
#4 sieve	%	100	100	100	100	99.4	100
#40 sieve	%	99.4	99	99.5	99.7	99.1	99.6
#60 sieve	%	97.1	96.1	97.9	98.8	98.7	97.4
#80 sieve	%	93.5	93	94.5	96.1	98.4	89.7
0.375 inch sieve	%	100	100	100	100	100	100
0.75 inch sieve	%	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100
Clay	%	18.2	32.3	24.7	21.1	42.5	16.6
Coarse Sand	%	0	0	0	0	0	0
Fine Sand	%	34.9	22.4	28.5	29.6	6.9	48.9
Gravel	%	0	0	0	0	0.6	0
Hydrometer 1 for Particle size Distribution	%	38.7	66.3	52	51.4	72.3	39.4
Hydrometer 2 for Particle size Distribution	%	31.8	58	43.9	39.6	63.4	28.9
Hydrometer 3 for Particle size Distribution	%	26	47.5	33.9	29.5	51.5	21.9
Hydrometer 4 for Particle size Distribution	%	22.1	40.5	28.8	24.4	47	20.1
Hydrometer 5 for Particle size Distribution	%	18.2	32.3	24.7	21.1	42.5	16.6
Hydrometer 6 for Particle size Distribution	%	12.2	22.8	17.6	14.3	32	13.1
Hydrometer 7 for Particle size Distribution	%	8.3	14.6	11.6	11	24.6	9.6
Medium Sand	%	0.6	1	0.5	0.3	0.3	0.4
Silt	%	46.3	44.4	46.2	49	49.7	34

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-36C*	*COR-36C*	*COR-38*	*COR-39*	*COR-39*	*COR-40*
Sample Identification:		*SE-031884-121008-SG-014*	*SE-031884-121008-SG-015*	*SE-031884-120407-DD-085*	*SE-031884-120407-DD-083*	*SE-031884-120407-DD-084*	*SE-031884-120407-DD-079*
Sample Date:		*12/10/2008*	*12/10/2008*	*12/4/2007*	*12/4/2007*	*12/4/2007*	*12/4/2007*
Sample Depth:		*(0-24) In*	*(24-40) In*	*(0-24) In*	*(0-17) In*	*(17-33.5) In*	*(0-24) In*
Sample Type:							
	Units						
Geotech							
#10 sieve	%	100	100	100	94.3	99.9	99.6
#100 sieve	%	83.6	94	80.1	65.6	58	69.6
#20 sieve	%	98	99.9	99.8	92.9	99	99
#200 sieve	%	59.9	75.3	50.6	50.5	36.6	48.4
#4 sieve	%	100	100	100	96.2	99.9	99.9
#40 sieve	%	96.4	99.7	99.7	90.2	96.7	95.6
#60 sieve	%	93.6	98.9	96.9	83.7	85.3	87.7
#80 sieve	%	88.4	96.6	87.2	70.7	65.6	75.4
0.375 inch sieve	%	100	100	100	100	100	100
0.75 inch sieve	%	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100
Clay	%	19.4	24.8	16.8	3.7	0.9	14
Coarse Sand	%	0	0	0	2	0	0.2
Fine Sand	%	36.4	24.4	49	39.8	60.1	47.2
Gravel	%	0	0	0	3.8	0.1	0.1
Hydrometer 1 for Particle size Distribution	%	39.7	54.2	31.9	40.7	21.1	35.7
Hydrometer 2 for Particle size Distribution	%	33	45	26.8	31.5	15.9	30.5
Hydrometer 3 for Particle size Distribution	%	26.2	35.8	21.8	7.1	6.3	22.7
Hydrometer 4 for Particle size Distribution	%	22.8	28.5	20.1	4.8	1	18.3
Hydrometer 5 for Particle size Distribution	%	19.4	24.8	16.8	3.7	0.9	14
Hydrometer 6 for Particle size Distribution	%	14.4	17.5	13.3	2.3	0	9.5
Hydrometer 7 for Particle size Distribution	%	11	11.9	9.2	1.2	0	6.2
Medium Sand	%	3.6	0.3	0.3	4.1	3.1	4.1
Silt	%	40.5	50.5	33.9	46.8	35.8	34.3

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***COR-40***	***COR-40***	***COR-40***	***COR-40***	***COR-41***	***COR-41***
Sample Identification:		***SE-031884-120407-DD-080***	***SE-031884-120908-SG-003***	***SE-031884-120908-SG-004***	***SE-031884-120908-SG-005***	***SE-031884-120407-DD-081***	***SE-031884-120407-DD-082***
Sample Date:		***12/4/2007***	***12/9/2008***	***12/9/2008***	***12/9/2008***	***12/4/2007***	***12/4/2007***
Sample Depth:		***(24-40) In***	***(0-24) In***	***(24-48) In***	***(48-66) In***	***(0-12) In***	***(12-25) In***
Sample Type:							
	Units						
Geotech							
#10 sieve	%	99.7	100	100	100	99.9	100
#100 sieve	%	76.4	74	88.2	80.7	67.4	66.6
#20 sieve	%	98.8	99.7	99.8	99.9	99.8	100
#200 sieve	%	48.7	51.1	66.8	57.8	36.5	31.3
#4 sieve	%	99.8	100	100	100	100	100
#40 sieve	%	95.7	98.4	99.3	99.3	98.6	99.7
#60 sieve	%	91.5	92.4	97.4	95.4	92.8	95.3
#80 sieve	%	82	81.6	93	87	76.6	77
0.375 inch sieve	%	100	100	100	100	100	100
0.75 inch sieve	%	100	100	100	100	100	100
1 inch sieve	%	100	100	100	100	100	100
1.5 inch sieve	%	100	100	100	100	100	100
2 inch sieve	%	100	100	100	100	100	100
3 inch sieve	%	100	100	100	100	100	100
Clay	%	15.4	17.8	23.4	20.3	14.2	12.2
Coarse Sand	%	0.2	0	0	0	0.1	0
Fine Sand	%	47	47.4	32.5	41.5	62.1	68.4
Gravel	%	0.2	0	0	0	0	0
Hydrometer 1 for Particle size Distribution	%	32.3	37	47.2	40.1	27.6	22.1
Hydrometer 2 for Particle size Distribution	%	27.9	32.2	41	34.3	22.9	19.2
Hydrometer 3 for Particle size Distribution	%	21.6	26.4	33.7	27.7	17.4	15
Hydrometer 4 for Particle size Distribution	%	18	21.7	27.5	24.4	16.6	13.6
Hydrometer 5 for Particle size Distribution	%	15.4	17.8	23.4	20.3	14.2	12.2
Hydrometer 6 for Particle size Distribution	%	10.7	13	16	14.4	10.2	8.5
Hydrometer 7 for Particle size Distribution	%	6.4	8.2	9.8	8.7	7.1	5.7
Medium Sand	%	4	1.6	0.7	0.7	1.3	0.3
Silt	%	33.3	33.2	43.4	37.6	22.2	19.1

TABLE 4.9b

SUBSURFACE SEDIMENT GEOTECHNICAL ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-42*	*COR-42*	*COR-42*	*COR-43*
Sample Identification:		*SE-031884-120307-DD-078*	*SE-031884-120908-SG-001*	*SE-031884-120908-SG-002*	*SE-031884-120307-DD-077*
Sample Date:		*12/3/2007*	*12/9/2008*	*12/9/2008*	*12/3/2007*
Sample Depth:		*(0-29) In*	*(0-16.5) In*	*(0-16.5) In*	*(0-22) In*
Sample Type:				*Duplicate*	
	Units				
Geotech					
#10 sieve	%	99.9	100	100	99.8
#100 sieve	%	96.6	96.3	96.5	76.6
#20 sieve	%	99.6	99.9	99.9	99.7
#200 sieve	%	75.6	83.5	83.5	47.7
#4 sieve	%	100	100	100	99.9
#40 sieve	%	99.3	99.7	99.6	99.3
#60 sieve	%	99	99.2	99.3	95.1
#80 sieve	%	98	98	98.1	84.6
0.375 inch sieve	%	100	100	100	100
0.75 inch sieve	%	100	100	100	100
1 inch sieve	%	100	100	100	100
1.5 inch sieve	%	100	100	100	100
2 inch sieve	%	100	100	100	100
3 inch sieve	%	100	100	100	100
Clay	%	25.8	33.7	35.4	16.8
Coarse Sand	%	0.1	0	0	0.1
Fine Sand	%	23.8	16.2	16.1	51.6
Gravel	%	0	0	0	0.1
Hydrometer 1 for Particle size Distribution	%	52.2	62.7	65.9	31
Hydrometer 2 for Particle size Distribution	%	44.4	54.7	57.5	27.3
Hydrometer 3 for Particle size Distribution	%	36.6	44.7	46.9	22
Hydrometer 4 for Particle size Distribution	%	29.7	39.7	40.6	19.8
Hydrometer 5 for Particle size Distribution	%	25.8	33.7	35.4	16.8
Hydrometer 6 for Particle size Distribution	%	18.8	25.6	26.8	12.1
Hydrometer 7 for Particle size Distribution	%	12.9	17.5	18.4	8.4
Medium Sand	%	0.5	0.3	0.4	0.5
Silt	%	49.8	49.8	48.1	30.9

TABLE 4.10a

SURFACE SEDIMENT SAMPLING EXPANDED ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-03*	*COR-07*	*COR-13*	*COR-20*	*COR-20*	*SSD-18*	*SSD-20*	*SSD-25*	*SSD-27*
Sample Identification:		*SE-031884-120207-DD-068*	*SE-031884-120107-DD-063*	*SE-031884-120107-DD-055*	*SE-031884-113007-DD-042*	*SE-031884-113007-DD-043*	*SE-031884-113007-DD-033*	*SE-031884-112907-DD-026*	*SE-031884-112807-DD-008*	*SE-031884-112807-DD-003*
Sample Date:		*12/2/2007*	*12/1/2007*	*12/1/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/29/2007*	*11/28/2007*	*11/28/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:						*Duplicate*				
	Units									
Dioxins and Furans										
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	µg/kg	0.013 J	0.042	0.016	0.041	0.05	0.092	0.12	0.018 J	0.013 J
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	µg/kg	0.39	1.2	0.059	1.8	2	2	2.9 J	0.51	0.44
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	µg/kg	ND(0.0076)U	0.025	ND(0.0027)	ND(0.018)U	ND(0.019)U	0.041	0.058	ND(0.012)U	ND(0.0093)U
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	µg/kg	0.018	0.032	ND(0.003)	0.064	0.069	0.082	0.15	0.027	0.018
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	µg/kg	ND(0.00043)	ND(0.0019)	ND(0.00011)	ND(0.001)	ND(0.0013)	ND(0.0019)	ND(0.0027)	ND(0.0009)	ND(0.0011)
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	ND(0.0012)	0.0054 J	ND(0.00031)	ND(0.0016)	ND(0.0017)	ND(0.0039)	ND(0.0065)	ND(0.0044)	ND(0.0015)
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	ND(0.00023)	ND(0.00053)	ND(0.000098)	ND(0.0011)UJ	ND(0.0013)UJ	ND(0.0015)UJ	ND(0.0027)UJ	ND(0.0011)UJ	ND(0.0013)UJ
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	ND(0.00066)	ND(0.0029)	ND(0.00007)	ND(0.00092)	ND(0.00083)	ND(0.00097)	ND(0.0042)	ND(0.0013)	ND(0.00083)
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	ND(0.00066)	ND(0.0014)	ND(0.00027)	ND(0.0019)	ND(0.0028)	ND(0.0035)	ND(0.0066)	ND(0.0016)	ND(0.0014)
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	µg/kg	ND(0.00026)	ND(0.00032)	ND(0.000084)	ND(0.00096)	ND(0.00088)	ND(0.001)	ND(0.0019)	ND(0.00088)	ND(0.00089)
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	ND(0.00061)	ND(0.0011)	ND(0.00018)	ND(0.0022)	ND(0.002)	ND(0.0026)	ND(0.0047)	ND(0.0014)	ND(0.0011)
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	µg/kg	ND(0.001)	ND(0.0026)	ND(0.00013)	ND(0.0016)	ND(0.0012)	ND(0.0019)	ND(0.0017)	ND(0.0012)	ND(0.001)
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	µg/kg	ND(0.00059)	ND(0.00066)	ND(0.00015)	ND(0.0018)	ND(0.0019)	ND(0.002)	ND(0.003)	ND(0.0022)	ND(0.0018)
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	µg/kg	ND(0.00059)	ND(0.0011)	ND(0.00013)	ND(0.00096)	ND(0.00088)	ND(0.001)	ND(0.0023)	ND(0.0011)	ND(0.00089)
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	µg/kg	ND(0.0011)	ND(0.0017)	ND(0.00013)	ND(0.0013)	ND(0.001)	ND(0.0013)	ND(0.0018)	ND(0.0011)	ND(0.0011)
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	µg/kg	0.0021	0.0033	ND(0.00025)	0.0013 J	0.0011 J	ND(0.0025)U	0.0019 J	ND(0.00079)	ND(0.00068)
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.01	0.048	0.01	0.009	0.0094	0.052	0.017	ND(0.00098)	ND(0.00087)
Total Heptachlorodibenzofuran (HpCDF)	µg/kg	0.012 J	0.034 J	ND(0.0027)	0.039 J	0.039 J	0.063 J	0.12 J	0.023 J	0.019 J
Total Heptachlorodibenzo-p-dioxin (HpCDD)	µg/kg	0.045 J	0.072 J	ND(0.0032)	0.14 J	0.15 J	0.17 J	0.31 J	0.055 J	0.041 J
Total Hexachlorodibenzofuran (HxCDF)	µg/kg	ND(0.0025)	0.011 J	ND(0.00058)	0.0074 J	0.0071 J	ND(0.0084)	0.032 J	ND(0.0053)	ND(0.0032)
Total Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg	ND(0.0022)	ND(0.0044)	ND(0.00072)	0.0066 J	0.013 J	0.017 J	0.027 J	ND(0.0044)	ND(0.0026)
Total Pentachlorodibenzofuran (PeCDF)	µg/kg	ND(0.0033)	0.0059 J	ND(0.00062)	ND(0.0048)	ND(0.0046)	0.0081 J	0.011 J	ND(0.0047)	ND(0.0032)
Total Pentachlorodibenzo-p-dioxin (PeCDD)	µg/kg	ND(0.00087)	ND(0.00091)	ND(0.00015)	ND(0.0018)	ND(0.0019)	ND(0.0022)	ND(0.0044)	ND(0.0026)	ND(0.0018)
Total TEQ (ND=0.5)	µg/kg	0.012	0.052	0.01	0.013	0.014	0.057	0.025	0.0029	0.0023
Total Tetrachlorodibenzofuran (TCDF)	µg/kg	0.022 J	0.014 J	ND(0.00014)	0.0065 J	0.0085 J	0.011 J	0.012 J	0.0095 J	0.0052 J
Total Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.012 J	0.053 J	0.01 J	0.015 J	0.017 J	0.06 J	0.022 J	0.0042 J	ND(0.0022)
Metals										
Antimony	µg/kg	ND(1500)UJ	ND(1800)UJ	ND(1400)UJ	ND(2200)UJ	ND(2200)UJ	ND(2500)UJ	ND(3000)UJ	ND(2100)UJ	ND(1800)UJ
Arsenic	µg/kg	3400	3100	3100	4300	5400	4800	5800	3600	2900
Cadmium	µg/kg	ND(310)U	ND(360)U	ND(280)	ND(440)U	390 J	ND(510)U	ND(600)U	ND(430)U	380
Copper	µg/kg	10600	12000	3900	19800	23200	25600	24300	10000	10000
Lead	µg/kg	11300	18000	6600	19800	22000	30600	22100	9300	16600
Mercury	µg/kg	1100	ND(180)U	ND(140)U	ND(220)U	ND(220)U	ND(250)U	ND(300)U	ND(210)	ND(180)
Nickel	µg/kg	16500	12400	10800	39700	28000	22100	27500	15000	16200
Silver	µg/kg	1500	ND(890)	ND(700)	ND(1100)	ND(1100)	ND(1300)	ND(1500)	ND(1100)	ND(920)
Zinc	µg/kg	67800	77000	31700	108000	126000	165000	142000	68000	91200
PCBs										
Aroclor-1016 (PCB-1016)	µg/kg	ND(50)	ND(59)	ND(46)	ND(72)	ND(74)	ND(84)	ND(100)	ND(71)	ND(61)
Aroclor-1221 (PCB-1221)	µg/kg	ND(50)	ND(59)	ND(46)	ND(72)	ND(74)	ND(84)	ND(100)	ND(71)	ND(61)
Aroclor-1232 (PCB-1232)	µg/kg	ND(50)	ND(59)	ND(46)	ND(72)	ND(74)	ND(84)	ND(100)	ND(71)	ND(61)
Aroclor-1242 (PCB-1242)	µg/kg	ND(50)	ND(59)	ND(46)	ND(72)	ND(74)	ND(84)	ND(100)	ND(71)	ND(61)
Aroclor-1248 (PCB-1248)	µg/kg	ND(50)	ND(59)	ND(46)	ND(72)	ND(74)	ND(84)	ND(100)	ND(71)	ND(61)
Aroclor-1254 (PCB-1254)	µg/kg	ND(50)	ND(59)	ND(46)	ND(72)	ND(74)	ND(84)	ND(100)	ND(71)	ND(61)
Aroclor-1260 (PCB-1260)	µg/kg	ND(50)	ND(59)	ND(46)	ND(72)	ND(74)	ND(84)	ND(100)	ND(71)	ND(61)

TABLE 4.10a

SURFACE SEDIMENT SAMPLING EXPANDED ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-03*	*COR-07*	*COR-13*	*COR-20*	*COR-20*	*SSD-18*	*SSD-20*	*SSD-25*	*SSD-27*
Sample Identification:		*SE-031884-120207-DD-068*	*SE-031884-120107-DD-063*	*SE-031884-120107-DD-055*	*SE-031884-113007-DD-042*	*SE-031884-113007-DD-043*	*SE-031884-113007-DD-033*	*SE-031884-112907-DD-026*	*SE-031884-112807-DD-008*	*SE-031884-112807-DD-003*
Sample Date:		*12/2/2007*	*12/1/2007*	*12/1/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/29/2007*	*11/28/2007*	*11/28/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:						*Duplicate*				
	Units									
Dioxins and Furans										
Pesticides										
4,4'-DDD	µg/kg	ND(5.2)UJ	ND(6.1)UJ	2 J	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	2.9 J
4,4'-DDE	µg/kg	ND(5.2)	ND(6.1)	ND(4.8)	ND(7.4)	ND(7.6)	ND(4.3)	ND(10)	ND(7.3)	ND(6.3)
4,4'-DDT	µg/kg	ND(5.2)	ND(6.1)	3.5 J	ND(7.4)	ND(7.6)	ND(4.3)	ND(10)	ND(7.3)	ND(6.3)
Aldrin	µg/kg	ND(5.2)UJ	ND(6.1)UJ	ND(4.8)	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
alpha-BHC	µg/kg	ND(5.2)UJ	ND(6.1)UJ	7.1	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
alpha-Chlordane	µg/kg	ND(5.2)UJ	ND(6.1)UJ	ND(4.8)	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
beta-BHC	µg/kg	5 J	ND(6.1)UJ	52 J	3.6 J	3.1 J	ND(4.3)UJ	3.2 J	ND(7.3)UJ	ND(6.3)UJ
delta-BHC	µg/kg	ND(5.2)UJ	ND(6.1)UJ	ND(4.8)	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
Dieldrin	µg/kg	ND(5.2)UJ	ND(6.1)UJ	ND(4.8)	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
Endosulfan I	µg/kg	ND(5.2)UJ	ND(6.1)UJ	ND(4.8)	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
Endosulfan II	µg/kg	ND(5.2)UJ	2.2 J	ND(4.8)	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	2.8 J	3.9 J
Endosulfan sulfate	µg/kg	ND(5.2)UJ	ND(6.1)UJ	ND(4.8)	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
Endrin	µg/kg	ND(5.2)UJ	ND(6.1)UJ	ND(4.8)	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
Endrin aldehyde	µg/kg	ND(5.2)	ND(6.1)	ND(4.8)	ND(7.4)	ND(7.6)	ND(4.3)	ND(10)	ND(7.3)	ND(6.3)
Endrin ketone	µg/kg	2.2 J	3.4 J	5.7	ND(7.4)	ND(7.6)	ND(4.3)	ND(10)	6.8 J	6.1 J
gamma-BHC (Lindane)	µg/kg	ND(5.2)UJ	ND(6.1)UJ	3.2 J	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
gamma-Chlordane	µg/kg	ND(5.2)UJ	ND(6.1)UJ	ND(4.8)	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
Heptachlor	µg/kg	ND(5.2)	ND(6.1)	ND(4.8)	ND(7.4)	ND(7.6)	ND(4.3)	ND(10)	ND(7.3)	ND(6.3)
Heptachlor epoxide	µg/kg	ND(5.2)UJ	ND(6.1)UJ	ND(4.8)	ND(7.4)UJ	ND(7.6)UJ	ND(4.3)UJ	ND(10)UJ	ND(7.3)UJ	ND(6.3)UJ
Methoxychlor	µg/kg	ND(10)	ND(12)	ND(9.3)	ND(14)	ND(15)	ND(8.4)	ND(20)	ND(14)	ND(12)
Toxaphene	µg/kg	ND(200)	ND(240)	ND(190)	ND(290)	ND(300)	ND(170)	ND(400)	ND(290)	ND(250)
Semi-Volatile Organic Compounds										
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	µg/kg	ND(150)UJ	ND(180)UJ	ND(140)UJ	ND(220)UJ	ND(1100)UJ	ND(640)UJ	ND(760)UJ	ND(210)UJ	ND(180)UJ
2,4,5-Trichlorophenol	µg/kg	ND(230)	ND(270)	ND(210)	ND(330)	ND(1700)	ND(950)	ND(1100)UJ	ND(320)	ND(280)
2,4,6-Trichlorophenol	µg/kg	ND(230)	ND(270)	ND(210)	ND(330)	ND(1700)	ND(950)	ND(1100)UJ	ND(320)	ND(280)
2,4-Dichlorophenol	µg/kg	ND(230)	ND(270)	ND(210)	ND(330)	ND(1700)	ND(950)	ND(1100)UJ	ND(320)	ND(280)
2,4-Dimethylphenol	µg/kg	ND(230)	ND(270)	ND(210)	ND(330)	ND(1700)	ND(950)	ND(1100)UJ	ND(320)	ND(280)
2,4-Dinitrophenol	µg/kg	ND(500)	ND(590)	ND(460)	ND(720)	ND(3700)	ND(2100)	ND(2500)UJ	ND(710)	ND(610)
2,4-Dinitrotoluene	µg/kg	ND(310)	ND(360)	ND(280)	ND(440)	ND(2200)	ND(1300)	ND(1500)UJ	ND(430)	ND(370)
2,6-Dinitrotoluene	µg/kg	ND(310)	ND(360)	ND(280)	ND(440)	ND(2200)	ND(1300)	ND(1500)UJ	ND(430)	ND(370)
2-Chloronaphthalene	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
2-Chlorophenol	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)UJ	ND(92)
2-Methylnaphthalene	µg/kg	280	370	300	310	330	83	56 J	340	310
2-Methylphenol	µg/kg	ND(310)	ND(360)	ND(280)	ND(440)	ND(2200)	ND(1300)	ND(1500)UJ	ND(430)UJ	ND(370)
2-Nitroaniline	µg/kg	ND(310)	ND(360)	ND(280)	ND(440)	ND(2200)	ND(1300)	ND(1500)UJ	ND(430)	ND(370)
2-Nitrophenol	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
3,3'-Dichlorobenzidine	µg/kg	ND(150)UJ	ND(180)UJ	ND(140)UJ	ND(220)UJ	ND(1100)UJ	ND(640)UJ	ND(760)UJ	ND(210)UJ	ND(180)UJ
3-Nitroaniline	µg/kg	ND(310)	ND(360)	ND(280)	ND(440)	ND(2200)	ND(1300)	ND(1500)UJ	ND(430)	ND(370)
4,6-Dinitro-2-methylphenol	µg/kg	ND(230)	ND(270)	ND(210)	ND(330)	ND(1700)	ND(950)	ND(1100)UJ	ND(320)	ND(280)
4-Bromophenyl phenyl ether	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
4-Chloro-3-methylphenol	µg/kg	ND(230)	ND(270)	ND(210)	ND(330)	ND(1700)	ND(950)	ND(1100)UJ	ND(320)	ND(280)
4-Chloroaniline	µg/kg	ND(230)	ND(270)	ND(210)	ND(330)	ND(1700)	ND(950)	ND(1100)UJ	ND(320)	ND(280)
4-Chlorophenyl phenyl ether	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
4-Methylphenol	µg/kg	ND(310)	51 J	ND(280)	ND(440)	ND(2200)	ND(1300)	ND(1500)UJ	ND(430)UJ	ND(370)
4-Nitroaniline	µg/kg	ND(310)	ND(360)	ND(280)	ND(440)	ND(2200)	ND(1300)	ND(1500)UJ	ND(430)	ND(370)
4-Nitrophenol	µg/kg	ND(500)	ND(590)	ND(460)	ND(720)	ND(3700)	ND(2100)	ND(2500)UJ	ND(710)	ND(610)
Acenaphthene	µg/kg	17	47	ND(9.4)	21	ND(75)	ND(42)	ND(50)UJ	20	ND(12)
Acenaphthylene	µg/kg	ND(10)	44	ND(9.4)	26	ND(75)	ND(42)	ND(50)UJ	ND(14)	ND(12)
Acetophenone	µg/kg	ND(150)	ND(180)	ND(140)	ND(220)	ND(1100)	ND(640)	ND(760)UJ	ND(210)UJ	ND(180)
Anthracene	µg/kg	32	130	16	53	ND(75)	25 J	ND(50)UJ	23	31

TABLE 4.10a

SURFACE SEDIMENT SAMPLING EXPANDED ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*COR-03*	*COR-07*	*COR-13*	*COR-20*	*COR-20*	*SSD-18*	*SSD-20*	*SSD-25*	*SSD-27*
Sample Identification:		*SE-031884-120207-DD-068*	*SE-031884-120107-DD-063*	*SE-031884-120107-DD-055*	*SE-031884-113007-DD-042*	*SE-031884-113007-DD-043*	*SE-031884-113007-DD-033*	*SE-031884-112907-DD-026*	*SE-031884-112807-DD-008*	*SE-031884-112807-DD-003*
Sample Date:		*12/2/2007*	*12/1/2007*	*12/1/2007*	*11/30/2007*	*11/30/2007*	*11/30/2007*	*11/29/2007*	*11/28/2007*	*11/28/2007*
Sample Depth:		*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*	*(0-0) IN*
Sample Type:						*Duplicate*				
	Units									
Dioxins and Furans										
Atrazine	µg/kg	ND(310)	ND(360)	ND(280)	ND(440)	ND(2200)	ND(1300)	ND(1500)UJ	ND(430)	ND(370)
Benzaldehyde	µg/kg	ND(150)	ND(180)	ND(140)	ND(220)	ND(1100)	ND(640)	ND(760)UJ	ND(210)UJ	ND(180)
Benzo(a)anthracene	µg/kg	100	200	30	160	200	79	170 J	96	130
Benzo(a)pyrene	µg/kg	98	140	ND(9.4)	150	170	80	250 J	74	100
Benzo(b)fluoranthene	µg/kg	140	220	27	240	240	140	450 J	120	170
Benzo(g,h,i)perylene	µg/kg	70	98	ND(9.4)	130	170	77	270 J	66	73
Benzo(k)fluoranthene	µg/kg	63	86	10	120	140	55	230 J	66	60
Biphenyl (1,1-Biphenyl)	µg/kg	45 J	320	310	51 J	ND(560)	ND(320)	ND(380)UJ	ND(110)	110
bis(2-Chloroethoxy)methane	µg/kg	ND(150)	ND(180)	ND(140)	ND(220)	ND(1100)	ND(640)	ND(760)UJ	ND(210)	ND(180)
bis(2-Chloroethyl)ether	µg/kg	ND(150)	ND(180)	ND(140)	ND(220)	ND(1100)	ND(640)	ND(760)UJ	ND(210)UJ	ND(180)
bis(2-Ethylhexyl)phthalate	µg/kg	150 J	1200 J	73 J	230 J	660 J	240 J	390 J	200 J	560 J
Butyl benzylphthalate	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
Caprolactam	µg/kg	ND(500)	ND(590)	ND(460)	ND(720)	ND(3700)	ND(2100)	ND(2500)UJ	ND(710)	ND(610)
Carbazole	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
Chrysene	µg/kg	150	220	63	230	250	110	300 J	150	150
Dibenz(a,h)anthracene	µg/kg	ND(10)	ND(12)	ND(9.4)	ND(15)	ND(75)	ND(42)	ND(50)UJ	ND(14)	20
Dibenzofuran	µg/kg	76	87 J	73	87 J	ND(560)	ND(320)	ND(380)UJ	92 J	81 J
Diethyl phthalate	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
Dimethyl phthalate	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
Di-n-butylphthalate	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
Di-n-octyl phthalate	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
Fluoranthene	µg/kg	230	360	59	340	420	190	520 J	270	210
Fluorene	µg/kg	31	120	32	40	ND(75)	ND(42)	ND(50)UJ	35	33
Hexachlorobenzene	µg/kg	ND(10)	ND(12)	ND(9.4)	ND(15)	ND(75)	ND(42)	ND(50)UJ	ND(14)	ND(12)
Hexachlorobutadiene	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
Hexachlorocyclopentadiene	µg/kg	ND(500)	ND(590)	ND(460)	ND(720)	ND(3700)	ND(2100)	ND(2500)UJ	ND(710)UJ	ND(610)UJ
Hexachloroethane	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)UJ	ND(92)
Indeno(1,2,3-cd)pyrene	µg/kg	62	74	ND(9.4)	100	120	54	220 J	41	55
Isophorone	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
Naphthalene	µg/kg	170	310	250	180	200	52	ND(50)UJ	190	330
Nitrobenzene	µg/kg	ND(150)	ND(180)	ND(140)	ND(220)	ND(1100)	ND(640)	ND(760)UJ	ND(210)UJ	ND(180)
N-Nitrosodi-n-propylamine	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
N-Nitrosodiphenylamine	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)	ND(92)
Pentachlorophenol	µg/kg	ND(230)	ND(270)	ND(210)	ND(330)	ND(1700)	ND(950)	ND(1100)UJ	ND(320)	ND(280)
Phenanthrene	µg/kg	260	510	190	260	300	98	110 J	330	230
Phenol	µg/kg	ND(76)	ND(89)	ND(70)	ND(110)	ND(560)	ND(320)	ND(380)UJ	ND(110)UJ	ND(92)
Pyrene	µg/kg	170	330	50	240	310	140	350 J	170	160
General Chemistry										
Total Organic Carbon (TOC)	µg/kg	33400000	31800000	12700000	33500000	31400000	23800000	21800000	27500000	24700000
Total Solids	%	65.6	56.1	71.2	45.7	44.5	39.3	33.1	46.8	54.1

Notes:

ND()- Not present at or above the associated value.
U- Not present at or above the associated value.
J- Estimated concentration.
UJ- Estimated reporting limit.
Measured levels exceed benchmark level

TABLE 4.10b

SUBSURFACE SEDIMENT SAMPLING EXPANDED ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:			*COR-08*	*COR-22*	*COR-28*	*COR-33*	*COR-36*	*COR-36*	*COR-39*	*COR-39*
Sample Identification:			*SE-031884-121307-DD-280*	*SE-031884-121007-DD-181*	*SE-031884-120807-DD-176*	*SE-031884-120607-DD-128*	*SE-031884-120507-DD-124*	*SE-031884-120507-DD-125*	*SE-031884-120407-DD-083*	*SE-031884-120407-DD-084*
Sample Date:			*12/13/2007*	*12/10/2007*	*12/8/2007*	*12/6/2007*	*12/5/2007*	*12/5/2007*	*12/4/2007*	*12/4/2007*
Sample Depth:			*(24-48) IN*	*(24-49) IN*	*(0-24) IN*	*(0-21) IN*	*(24-48) IN*	*(48-72) IN*	*(0-17) IN*	*(17-33.5) IN*
Sample Type:										
	Units	*Benchmarks* ug/Kg								
Dioxin and Furans										
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg		1.4 J	1.1 J	ND(0.0004)	0.19	3.3 J	18 J	22 J	33 J
Total Heptachlorodibenzofuran (HpCDF)	µg/kg		0.95 J	0.16 J	ND(0.00057)	0.017 J	0.99 J	6 J	2.7 J	3.3 J
Total Heptachlorodibenzo-p-dioxin (HpCDD)	µg/kg		0.53 J	0.39 J	0.02 J	0.052 J	0.65 J	1.9 J	1.8 J	24 J
Total Hexachlorodibenzofuran (HxCDF)	µg/kg		0.38 J	0.053 J	ND(0.00044)	0.011 J	0.62 J	2.8 J	1.4 J	1.4 J
Total Hexachlorodibenzo-p-dioxin (HxCDD)	µg/kg		0.11 J	0.086 J	0.0092 J	0.0037 J	0.27 J	1.8 J	0.43 J	4.4 J
Total Pentachlorodibenzofuran (PeCDF)	µg/kg		0.24 J	0.1 J	ND(0.00048)	0.014 J	0.45 J	1.9 J	1 J	1.1 J
Total Pentachlorodibenzo-p-dioxin (PeCDD)	µg/kg		0.014 J	0.0073 J	ND(0.0019)	ND(0.0013)	0.11 J	0.26 J	0.13 J	0.13 J
Total TEQ (ND=0.5)	µg/kg		1.4	1.1	0.00094	0.19	3.4	18	22	33
Total Tetrachlorodibenzofuran (TCDF)	µg/kg		0.17 J	0.16 J	ND(0.00024)	0.024 J	0.35 J	1.1 J	0.87 J	1.5 J
Total Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.00085	1.4 J	1.1 J	0.00077 J	0.2 J	3.3 J	18 J	23 J	35 J
Metals										
Antimony	µg/kg	2000	1300 J	760 J	ND(1300)	ND(1500)UJ	ND(1700)UJ	670 J	ND(2000)UJ	730 J
Arsenic	µg/kg	9800	8700	10700	3400	4500	6800	8500	8100	6400
Cadmium	µg/kg	990	330	440	ND(270)U	260 J	470	510	340 J	610
Copper	µg/kg	31600	61800	42700	15400	16900	50400	62600	445000	78400
Lead	µg/kg	35800	39500	37400	15100	36600	36300	52200	50800	41800
Mercury	µg/kg	180	2600	360	21 J	70 J	170	290	1200	230
Nickel	µg/kg	22700	44200	32000	19300	17600	63300	57300	32600	19200
Silver	µg/kg	1000	2100	260 J	ND(670)	ND(730)	1600	4600	690 J	ND(810)
Zinc	µg/kg	121000	409000	163000	60200	137000	195000	235000	274000	156000
PCBs										
Aroclor-1016 (PCB-1016)	µg/kg		ND(54)	ND(56)	ND(44)	ND(48)	ND(55)	ND(56)	ND(3400)	ND(5400)
Aroclor-1221 (PCB-1221)	µg/kg		ND(54)	ND(56)	ND(44)	ND(48)	ND(55)	ND(56)	ND(3400)	ND(5400)
Aroclor-1232 (PCB-1232)	µg/kg		ND(54)	ND(56)	ND(44)	ND(48)	ND(55)	ND(56)	ND(3400)	ND(5400)
Aroclor-1242 (PCB-1242)	µg/kg		ND(54)	ND(56)	ND(44)	ND(48)	46 J	ND(56)	ND(3400)	ND(5400)
Aroclor-1248 (PCB-1248)	µg/kg		89	39 J	ND(44)	ND(48)	ND(55)	530	3000 J	75000
Aroclor-1254 (PCB-1254)	µg/kg		ND(54)	ND(56)	ND(44)	31 J	39 J	ND(56)	ND(3400)	ND(5400)
Aroclor-1260 (PCB-1260)	µg/kg		67	ND(56)	ND(44)	ND(48)	ND(55)	ND(56)	ND(3400)	14000
Pesticides										
4,4'-DDD	µg/kg	4.88	36 J	3.7 J	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	ND(1400)
4,4'-DDE	µg/kg	3.16	12 J	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)UJ	ND(1400)UJ
4,4'-DDT	µg/kg	4.16	ND(56)	ND(5.7)	ND(2.3)	0.62 J	ND(2.8)	ND(29)	ND(1700)UJ	ND(1400)UJ
Aldrin	µg/kg	2	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)UJ	ND(1400)UJ
alpha-BHC	µg/kg	6	ND(56)UJ	4.1 J	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)UJ	ND(1400)UJ
alpha-Chlordane	µg/kg	3.24	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	ND(1400)
beta-BHC	µg/kg	5	ND(56)UJ	8 J	ND(2.3)UJ	ND(2.5)UJ	2.3 J	ND(29)	ND(1700)	ND(1400)
delta-BHC	µg/kg	6400	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	ND(1400)
Dieldrin	µg/kg	1.9	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	ND(1400)
Endosulfan I	µg/kg	2.9	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	0.77 J	ND(29)	ND(1700)	ND(1400)
Endosulfan II	µg/kg	14	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	ND(1400)
Endosulfan sulfate	µg/kg	5.4	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	ND(1400)
Endrin	µg/kg	2.22	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	550 J
Endrin aldehyde	µg/kg		ND(56)UJ	ND(5.7)	ND(2.3)	ND(2.5)	ND(2.8)	ND(29)	ND(1700)	ND(1400)
Endrin ketone	µg/kg		ND(56)UJ	ND(5.7)	ND(2.3)	ND(2.5)	ND(2.8)	ND(29)	ND(1700)	ND(1400)
gamma-BHC (Lindane)	µg/kg	2.37	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	ND(1400)
gamma-Chlordane	µg/kg		ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	ND(1400)
Heptachlor	µg/kg	68	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	ND(1400)
Heptachlor epoxide	µg/kg	2.47	ND(56)UJ	ND(5.7)	ND(2.3)UJ	ND(2.5)UJ	ND(2.8)UJ	ND(29)	ND(1700)	ND(1400)
Methoxychlor	µg/kg	18.7	ND(110)	ND(11)	ND(4.4)	4 J	1.7 J	41 J	1100 J	2300 J
Toxaphene	µg/kg	0.1	ND(2200)	ND(230)UJ	ND(90)	ND(97)	ND(110)	ND(1100)UJ	ND(68000)	ND(55000)

TABLE 4.10b

SUBSURFACE SEDIMENT SAMPLING EXPANDED ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:			*COR-08*	*COR-22*	*COR-28*	*COR-33*	*COR-36*	*COR-36*	*COR-39*	*COR-39*
Sample Identification:			*SE-031884-121307-DD-280*	*SE-031884-121007-DD-181*	*SE-031884-120807-DD-176*	*SE-031884-120607-DD-128*	*SE-031884-120507-DD-124*	*SE-031884-120507-DD-125*	*SE-031884-120407-DD-083*	*SE-031884-120407-DD-084*
Sample Date:			*12/13/2007*	*12/10/2007*	*12/8/2007*	*12/6/2007*	*12/5/2007*	*12/5/2007*	*12/4/2007*	*12/4/2007*
Sample Depth:			*(24-48) IN*	*(24-49) IN*	*(0-24) IN*	*(0-21) IN*	*(24-48) IN*	*(48-72) IN*	*(0-17) IN*	*(17-33.5) IN*
Sample Type:										
	Units	*Benchmarks*								
Semi-Volatile Organic Compounds										
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	µg/kg		ND(16000)UJ	ND(8500)	ND(130)	ND(580)	ND(8300)	ND(17000)	ND(25000)UJ	ND(81000)UJ
2,4,5-Trichlorophenol	µg/kg		ND(25000)	ND(13000)	ND(200)	ND(870)	ND(12000)	ND(26000)	ND(38000)	ND(120000)
2,4,6-Trichlorophenol	µg/kg	213	ND(25000)	ND(13000)	ND(200)	ND(870)	ND(12000)	ND(26000)	ND(38000)	ND(120000)
2,4-Dichlorophenol	µg/kg	117	ND(25000)	ND(13000)	ND(200)	ND(870)	ND(12000)	ND(26000)	ND(38000)	ND(120000)
2,4-Dimethylphenol	µg/kg	29	ND(25000)	ND(13000)	ND(200)	ND(870)	ND(12000)	ND(26000)	ND(38000)	ND(120000)
2,4-Dinitrophenol	µg/kg		ND(54000)	ND(28000)	ND(440)	ND(1900)	ND(27000)	ND(56000)	ND(84000)	ND(270000)
2,4-Dinitrotoluene	µg/kg	41.6	ND(33000)	ND(17000)	ND(270)	ND(1200)	ND(17000)	ND(34000)	ND(51000)	ND(160000)
2,6-Dinitrotoluene	µg/kg		ND(33000)	ND(17000)	ND(270)	ND(1200)	ND(17000)	ND(34000)	ND(51000)	ND(160000)
2-Chloronaphthalene	µg/kg		ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
2-Chlorophenol	µg/kg	31.2	ND(8200)UJ	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
2-Methylnaphthalene	µg/kg	20.2	ND(1100)	1700	ND(9)	240	1000	2600	2700	ND(5400)
2-Methylphenol	µg/kg		ND(33000)UJ	ND(17000)	ND(270)	ND(1200)	ND(17000)	ND(34000)	ND(51000)	ND(160000)
2-Nitroaniline	µg/kg		ND(33000)	ND(17000)	ND(270)	ND(1200)	ND(17000)	ND(34000)	ND(51000)	ND(160000)
2-Nitrophenol	µg/kg		ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
3,3'-Dichlorobenzidine	µg/kg	127	ND(16000)	ND(8500)	ND(130)	ND(580)	ND(8300)	ND(17000)	ND(25000)UJ	ND(81000)UJ
3-Nitroaniline	µg/kg		ND(33000)	ND(17000)	ND(270)	ND(1200)	ND(17000)	ND(34000)	ND(51000)	ND(160000)
4,6-Dinitro-2-methylphenol	µg/kg		ND(25000)	ND(13000)	ND(200)	ND(870)	ND(12000)	ND(26000)	ND(38000)	ND(120000)
4-Bromophenyl phenyl ether	µg/kg	1230	ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
4-Chloro-3-methylphenol	µg/kg		ND(25000)	ND(13000)	ND(200)	ND(870)	ND(12000)	ND(26000)	ND(38000)	ND(120000)
4-Chloroaniline	µg/kg		ND(25000)	ND(13000)	ND(200)	ND(870)	ND(12000)	ND(26000)	ND(38000)	ND(120000)
4-Chlorophenyl phenyl ether	µg/kg		ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
4-Methylphenol	µg/kg	670	ND(33000)UJ	ND(17000)	ND(270)	ND(1200)	ND(17000)	ND(34000)	7000 J	ND(160000)
4-Nitroaniline	µg/kg		ND(33000)	ND(17000)	ND(270)	ND(1200)	ND(17000)	ND(34000)	ND(51000)	ND(160000)
4-Nitrophenol	µg/kg		ND(54000)	ND(28000)	ND(440)	ND(1900)	ND(27000)	ND(56000)	ND(84000)	ND(270000)
Acenaphthene	µg/kg	6.7	ND(1100)	ND(560)	ND(9)	58	ND(550)	ND(1100)	ND(1700)	ND(5400)
Acenaphthylene	µg/kg	5.9	ND(1100)	ND(560)	ND(9)	50	ND(550)	ND(1100)	ND(1700)	ND(5400)
Acetophenone	µg/kg		ND(16000)UJ	ND(8500)	ND(130)	ND(580)	ND(8300)	ND(17000)	ND(25000)	ND(81000)
Anthracene	µg/kg	57.2	ND(1100)	ND(560)	ND(9)	140	ND(550)	1600	ND(1700)	ND(5400)
Atrazine	µg/kg	6.62	ND(33000)	ND(17000)	ND(270)	ND(1200)	ND(17000)	ND(34000)	ND(51000)	ND(160000)
Benzaldehyde	µg/kg		ND(16000)UJ	ND(8500)	ND(130)	ND(580)	ND(8300)	ND(17000)	ND(25000)	ND(81000)
Benzo(a)anthracene	µg/kg	108	ND(1100)	ND(560)	ND(9)	180	ND(550)	1400	ND(1700)	ND(5400)
Benzo(a)pyrene	µg/kg	150	ND(1100)	1400	ND(9)	110	ND(550)	ND(1100)	ND(1700)	ND(5400)
Benzo(b)fluoranthene	µg/kg	27.2	ND(1100)	1300	ND(9)	150	ND(550)	ND(1100)	ND(1700)	ND(5400)
Benzo(g,h,i)perylene	µg/kg	170	ND(1100)	1000	ND(9)	ND(39)	ND(550)	ND(1100)	ND(1700)	ND(5400)
Benzo(k)fluoranthene	µg/kg	240	ND(1100)	ND(560)	ND(9)	ND(39)	ND(550)	ND(1100)	ND(1700)	ND(5400)
Biphenyl (1,1-Biphenyl)	µg/kg	1220	5800 J	ND(4200)	ND(67)	300	2200 J	11000	10000 J	ND(41000)
bis(2-Chloroethoxy)methane	µg/kg		ND(16000)	ND(8500)	ND(130)	ND(580)	ND(8300)	ND(17000)	ND(25000)	ND(81000)
bis(2-Chloroethyl)ether	µg/kg		ND(16000)UJ	ND(8500)	ND(130)	ND(580)	ND(8300)	ND(17000)	ND(25000)	ND(81000)
bis(2-Ethylhexyl)phthalate	µg/kg	180	190000	99000	81	4800	210000	290000	1500000 J	1700000 J
Butyl benzylphthalate	µg/kg	10900	ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
Caprolactam	µg/kg		ND(54000)	ND(28000)	ND(440)	ND(1900)	ND(27000)	ND(56000)	ND(84000)	ND(270000)
Carbazole	µg/kg		ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
Chrysene	µg/kg	166	ND(1100)	590	ND(9)	200	710	1400	ND(1700)	ND(5400)
Dibenz(a,h)anthracene	µg/kg	33	ND(1100)	ND(560)	ND(9)	ND(39)	ND(550)	ND(1100)	ND(1700)	ND(5400)
Dibenzofuran	µg/kg	415	ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
Diethyl phthalate	µg/kg	603	ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
Dimethyl phthalate	µg/kg		ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
Di-n-butylphthalate	µg/kg	6470	ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	8500 J	ND(41000)
Di-n-octyl phthalate	µg/kg		ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	36000	24000 J
Fluoranthene	µg/kg	423	5300	1100	ND(9)	330	910	2100	2600	ND(5400)
Fluorene	µg/kg	77.4	3100	ND(560)	ND(9)	130	ND(550)	ND(1100)	ND(1700)	ND(5400)
Hexachlorobenzene	µg/kg	20	ND(1100)	ND(560)	ND(9)	ND(39)	ND(550)	ND(1100)	ND(1700)	ND(5400)
Hexachlorobutadiene	µg/kg		ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
Hexachlorocyclopentadiene	µg/kg		ND(54000)	ND(28000)	ND(440)	ND(1900)	ND(27000)	ND(56000)	ND(84000)	ND(270000)
Hexachloroethane	µg/kg	1027	ND(8200)UJ	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
Indeno(1,2,3-cd)pyrene	µg/kg	17	ND(1100)	1200	ND(9)	ND(39)	ND(550)	ND(1100)	ND(1700)	ND(5400)
Isophorone	µg/kg		ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
Naphthalene	µg/kg	176	ND(1100)	1400	ND(9)	200	870	1500	4800	ND(5400)
Nitrobenzene	µg/kg		ND(16000)UJ	ND(8500)	ND(130)	ND(580)	ND(8300)	ND(17000)	ND(25000)	ND(81000)
N-Nitrosodi-n-propylamine	µg/kg		ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
N-Nitrosodiphenylamine	µg/kg	2680	ND(8200)	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)

TABLE 4.10b

SUBSURFACE SEDIMENT SAMPLING EXPANDED ANALYSIS RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:			*COR-08*	*COR-22*	*COR-28*	*COR-33*	*COR-36*	*COR-36*	*COR-39*	*COR-39*
Sample Identification:			*SE-031884-121307-DD-280*	*SE-031884-121007-DD-181*	*SE-031884-120807-DD-176*	*SE-031884-120607-DD-128*	*SE-031884-120507-DD-124*	*SE-031884-120507-DD-125*	*SE-031884-120407-DD-083*	*SE-031884-120407-DD-084*
Sample Date:			*12/13/2007*	*12/10/2007*	*12/8/2007*	*12/6/2007*	*12/5/2007*	*12/5/2007*	*12/4/2007*	*12/4/2007*
Sample Depth:			*(24-48) IN*	*(24-49) IN*	*(0-24) IN*	*(0-21) IN*	*(24-48) IN*	*(48-72) IN*	*(0-17) IN*	*(17-33.5) IN*
Sample Type:										
	Units	***Benchmarks***								
Pentachlorophenol	µg/kg	504	ND(25000)	ND(13000)	ND(200)	ND(870)	ND(12000)	ND(26000)	ND(38000)	ND(120000)
Phenanthrene	µg/kg	204	5000	1900	ND(9)	590	1800	6600	4100	ND(5400)
Phenol	µg/kg	420	ND(8200)UJ	ND(4200)	ND(67)	ND(290)	ND(4100)	ND(8600)	ND(13000)	ND(41000)
Pyrene	µg/kg	195	4600	1100	ND(9)	460	1100	2600	2500	ND(5400)
General Chemistry										
Total Organic Carbon (TOC)	µg/kg		72200000	102000000	5400000	27900000	69500000	80200000	83900000	79200000
Total Solids	%		60.6	59.2	74.2	68.8	60.4	58.5	49.2	61.4(49.2)

Notes:

ND()- Not present at or above the associated value
U- Not present at or above the associated value
J- Estimated concentration
UJ- Estimated reporting limit
Measured levels exceed benchmark level

TABLE 4.11

BLACK CARBON SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*BC-COR-10A*	*BC-COR-10A*	*BC-COR-10A*	*BC-COR-10B*	*BC-COR-10B*
Sample ID:		*S-031884-022408-DD-455 (A)*	*S-031884-022408-DD-455 (B)*	*S-031884-022408-DD-455 (C)*	*S-031884-022408-DD-456 (A)*	*S-031884-022408-DD-456 (B)*
Sample Date:		*3/28/2008*	*3/28/2008*	*3/28/2008*	*3/28/2008*	*3/28/2008*
Sample Depth:		*(0-6) IN*	*(0-6) IN*	*(0-6) IN*	*(0-2) IN*	*(0-2) IN*
River Marker:		*33.4*	*33.4*	*33.4*	*33.4*	*33.4*
	Units					
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.042	0.0032	0.0036	0.049	0.0014
General Chemistry						
Total Organic Carbon (TOC) - Method 9060 (modified)	µg/kg	--	1300000	1200000	--	1000000
Total Solids	%	--	100	100	--	99.8
TOC - Lloyd Kahn Method	ug/kg	--	831000	3000000	--	874000
Black Carbon - Lloyd Kahn Method	µg/kg	--	648000	500000 U	--	500000 U

Notes:

ND ( ) - Not present at or above the associated value.
U - Not present at or above the associated value.
J - Estimated concentration.
JA - The analyte was positively identified but the quantitation is an estimate
q - Elevated reporting limit. The reporting limit is elevated due to high analyte levels.
B - Estimated result. Result is less than Reporting Limit
UJ - Estimated reporting limit.
BC-COR-XXA - coal sample.
BC-COR-XXB - reduced coal sample.
(A) - Greater than 300 micron material (coarse sand and gravel)
(B) - Between 75 and 300 micron material (fine and medium sands)
(C) - Less than 75 micron material (silts and clays)

TABLE 4.11

BLACK CARBON SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***BC-COR-10B***	***BC-COR-13A***	***BC-COR-13A***	***BC-COR-13A***	***BC-COR-13B***
Sample ID:		***S-031884-022408-DD-456 (C)***	***S-031884-022408-DD-457 (A)***	***S-031884-022408-DD-457 (B)***	***S-031884-022408-DD-457 (C)***	***S-031884-022408-DD-458 (A)***
Sample Date:		***3/28/2008***	***3/28/2008***	***3/28/2008***	***3/28/2008***	***3/28/2008***
Sample Depth:		***(0-2) IN***	***(0-2) IN***	***(0-2) IN***	***(0-2) IN***	***(0-2) IN***
River Marker:		***33.4***	***34.3***	***34.3***	***34.3***	***34.3***
	Units					
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.0078	0.13	0.0046	0.013	0.074
General Chemistry						
Total Organic Carbon (TOC) - Method 9060 (modified)	µg/kg	600000 B	--	4900000	2700000	--
Total Solids	%	100	--	100	99.8	--
TOC - Lloyd Kahn Method	ug/kg	502000	--	4070000	1150000	--
Black Carbon - Lloyd Kahn Method	µg/kg	500000 U	--	500000 U	1440000	--

Notes:

ND ( ) - Not present at or above the associated value.
U - Not present at or above the associated value.
J - Estimated concentration.
JA - The analyte was positively identified but the quantitation is an estimate
q - Elevated reporting limit. The reporting limit is elevated due to high analyte levels.
B - Estimated result. Result is less than Reporting Limit
UJ - Estimated reporting limit.
BC-COR-XXA - coal sample.
BC-COR-XXB - reduced coal sample.
(A) - Greater than 300 micron material (coarse sand and gravel)
(B) - Between 75 and 300 micron material (fine and medium sands)
(C) - Less than 75 micron material (silts and clays)

TABLE 4.11

BLACK CARBON SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***BC-COR-13B***	***BC-COR-13B***	***BC-COR-37A***	***BC-COR-37A***	***BC-COR-37A***
Sample ID:		***S-031884-022408-DD-458 (B)***	***S-031884-022408-DD-458 (C)***	***S-031884-022408-DD-459 (A)***	***S-031884-022408-DD-459 (B)***	***S-031884-022408-DD-459 (C)***
Sample Date:		***3/28/2008***	***3/28/2008***	***3/28/2008***	***3/28/2008***	***3/28/2008***
Sample Depth:		***(0-2) IN***	***(0-2) IN***	***(0-3) IN***	***(0-3) IN***	***(0-3) IN***
River Marker:		***34.3***	***34.3***	***41.8***	***41.8***	***41.8***
	Units					
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	0.0079	ND(0.0012)U	ND(0.0026)	ND(0.00044)	ND(0.00045)
General Chemistry						
Total Organic Carbon (TOC) - Method 9060 (modified)	µg/kg	700000 B	900000 B	--	5100000	3000000
Total Solids	%	100	100	--	100	99.8
TOC - Lloyd Kahn Method	ug/kg	1400000	620,000 JA	--	7470000	2390000
Black Carbon - Lloyd Kahn Method	µg/kg	1080000	500000 U	--	500000 U	500000 U

Notes:

ND ( ) - Not present at or above the associated value.
U - Not present at or above the associated value.
J - Estimated concentration.
JA - The analyte was positively identified but the quantitation is an estimate
q - Elevated reporting limit. The reporting limit is elevated due to high analyte levels.
B - Estimated result. Result is less than Reporting Limit
UJ - Estimated reporting limit.
BC-COR-XXA - coal sample.
BC-COR-XXB - reduced coal sample.
(A) - Greater than 300 micron material (coarse sand and gravel)
(B) - Between 75 and 300 micron material (fine and medium sands)
(C) - Less than 75 micron material (silts and clays)

TABLE 4.11

BLACK CARBON SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*BC-COR-37B*	*BC-COR-37B*	*BC-COR-37B*	*BC-SSD-26A*	*BC-SSD-26A*
Sample ID:		*S-031884-022408-DD-460 (A)*	*S-031884-022408-DD-460 (B)*	*S-031884-022408-DD-460 (C)*	*S-031884-022408-DD-461 (A)*	*S-031884-022408-DD-461 (B)*
Sample Date:		*3/28/2008*	*3/28/2008*	*3/28/2008*	*3/31/2008*	*3/31/2008*
Sample Depth:		*(0-2) IN*	*(0-2) IN*	*(0-2) IN*	*(0-3) IN*	*(0-3) IN*
River Marker:		*41.8*	*41.8*	*41.8*	*39.7*	*39.7*
	Units					
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	μg/kg	0.0044	0.0011	ND(0.001)U	ND(0.00091)	ND(0.00029)
General Chemistry						
Total Organic Carbon (TOC) - Method 9060 (modified)	μg/kg	9920000	2000000	1000000	--	2200000
Total Solids	%	100	99.8	99.8	--	99.8
TOC - Lloyd Kahn Method	ug/kg	8870000	2080000	1410000 J, JA	--	2780000
Black Carbon - Lloyd Kahn Method	μg/kg	1130000	500000 U	500000 U	--	500000 U

Notes:

ND ( ) - Not present at or above the associated value.
U - Not present at or above the associated value.
J - Estimated concentration.
JA - The analyte was positively identified but the quantitation is an estimate
q - Elevated reporting limit. The reporting limit is elevated due to high analyte levels.
B - Estimated result. Result is less than Reporting Limit
UJ - Estimated reporting limit.
BC-COR-XXA - coal sample.
BC-COR-XXB - reduced coal sample.
(A) - Greater than 300 micron material (coarse sand and gravel)
(B) - Between 75 and 300 micron material (fine and medium sands)
(C) - Less than 75 micron material (silts and clays)

TABLE 4.11

BLACK CARBON SAMPLING ANALYTICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***BC-SSD-26A***	***BC-SSD-26B***	***BC-SSD-26B***	***BC-SSD-26B***
Sample ID:		***S-031884-022408-DD-461 (C)***	***S-031884-022408-DD-462 (A)***	***S-031884-022408-DD-462 (B)***	***S-031884-022408-DD-462 (C)***
Sample Date:		***3/31/2008***	***3/31/2008***	***3/31/2008***	***3/31/2008***
Sample Depth:		***(0-3) IN***	***(0-2) IN***	***(0-2) IN***	***(0-2) IN***
River Marker:		***39.7***	***39.7***	***39.7***	***39.7***
	Units				
Dioxins and Furans					
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	µg/kg	ND(0.000069)	ND(0.000089)	ND(0.0001)UJ	ND(0.000067)
General Chemistry					
Total Organic Carbon (TOC) - Method 9060 (modified)	µg/kg	1000000	49000000 q	39300000 q	22000000
Total Solids	%	99.9	99.6	99.8	99.9
TOC - Lloyd Kahn Method	ug/kg	1030000	66300000	61000000	47600000
Black Carbon - Lloyd Kahn Method	µg/kg	500000 U	87200000	73300000	73300000

Notes:

ND ( ) - Not present at or above the associated value.
U - Not present at or above the associated value.
J - Estimated concentration.
JA - The analyte was positively identified but the quantitation is an estimate
q - Elevated reporting limit. The reporting limit is elevated due to high analyte levels.
B - Estimated result. Result is less than Reporting Limit
UJ - Estimated reporting limit.
BC-COR-XXA - coal sample.
BC-COR-XXB - reduced coal sample.
(A) - Greater than 300 micron material (coarse sand and gravel)
(B) - Between 75 and 300 micron material (fine and medium sands)
(C) - Less than 75 micron material (silts and clays)

TABLE 4.12

NATURAL RECOVERY CORE SAMPLING RADIOLOGICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***NRC-02***	***NRC-02***	***NRC-02***	***NRC-02***	***NRC-02***
Sample Identification:		***SE-031884-121207-DD-222***	***SE-031884-121207-DD-223***	***SE-031884-121207-DD-224***	***SE-031884-121207-DD-225***	***SE-031884-121207-DD-234***
Sample Date:		***12/12/2007***	***12/12/2007***	***12/12/2007***	***12/12/2007***	***12/12/2007***
Sample Depth:		***(0-0) cm***	***(2.5-2.5) cm***	***(5-5) cm***	***(7.5-7.5) cm***	***(30-30) cm***
	Units					
Radiology						
Beryllium-7	pci/g	ND(0.32)	ND(0.405)	ND(0.373)	ND(0.32)	ND(0.386)
Cesium-137	pci/g	ND(0.0322)	0.0702 J +/-0.0341	ND(0.034)	0.0485 J +/-0.0204	0.0471 J +/-0.0279
General Chemistry						
Total Solids	%	53.6	68.7	66.2	63.26	70.6

Notes:

ND ( ) - Not present at or above the associated value.
J - Estimated concentration.

TABLE 4.12

NATURAL RECOVERY CORE SAMPLING RADIOLOGICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***NRC-02***	***NRC-02***	***NRC-02***	***NRC-02***	***NRC-02***
Sample Identification:		***SE-031884-121207-DD-244***	***SE-031884-121207-DD-250***	***SE-031884-121207-DD-256***	***SE-031884-121207-DD-262***	***SE-031884-121207-DD-268***
Sample Date:		***12/12/2007***	***12/12/2007***	***12/12/2007***	***12/12/2007***	***12/12/2007***
Sample Depth:		***(60-60) cm***	***(90-90) cm***	***(120-120) cm***	***(150-150) cm***	***(180-180) cm***
	Units					
Radiology						
Beryllium-7	pci/g	ND(0.401)	ND(0.476)	ND(0.535)	ND(0.524)	ND(0.496)
Cesium-137	pci/g	0.074 J +/-0.0283	0.121 J +/-0.0418	0.151 J +/-0.0468	0.103 J +/-0.0425	0.128 J +/-0.0401
General Chemistry						
Total Solids	%	57.9	66.3	53.6	74.9	71.2

Notes:

ND ( ) - Not present at or above the associated value.
J - Estimated concentration.

TABLE 4.12

NATURAL RECOVERY CORE SAMPLING RADIOLOGICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*NRC-04*	*NRC-04*	*NRC-04*	*NRC-04*	*NRC-04*
Sample Identification:		*SE-031884-022008-DD-375*	*SE-031884-022008-DD-376*	*SE-031884-022008-DD-377*	*SE-031884-022008-DD-378*	*SE-031884-022008-DD-385*
Sample Date:		*2/20/2008*	*2/20/2008*	*2/20/2008*	*2/20/2008*	*2/20/2008*
Sample Depth:		*(0-2.5) cm*	*(2.5-5) cm*	*(5-7.5) cm*	*(7.5-10) cm*	*(25-27.5) cm*
	Units					
Radiology						
Beryllium-7	pci/g	ND(0.721)	1.53 +/-0.569	ND(0.663)	ND(0.597)	ND(0.818)
Cesium-137	pci/g	ND(0.0606)	0.136 J +/-0.0552	ND(0.0591)	ND(0.0592)	ND(0.0725)
General Chemistry						
Total Solids	%	5.3	8.5	11.6	15.8	18.5

Notes:

ND ( ) - Not present at or above the associated value.
J - Estimated concentration.

TABLE 4.12

NATURAL RECOVERY CORE SAMPLING RADIOLOGICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***NRC-04***	***NRC-04***	***NRC-04***	***NRC-04***	***NRC-04***
Sample Identification:		***SE-031884-022008-DD-391***	***SE-031884-022008-DD-396***	***SE-031884-022008-DD-399***	***SE-031884-022008-DD-402***	***SE-031884-022008-DD-405***
Sample Date:		***2/20/2008***	***2/20/2008***	***2/20/2008***	***2/20/2008***	***2/20/2008***
Sample Depth:		***(40-42.5) cm***	***(55-60) cm***	***(70-75) cm***	***(85-90) cm***	***(100-105) cm***
	Units					
Radiology						
Beryllium-7	pci/g	ND(0.449)	ND(0.712)	ND(0.646)	ND(0.551)	ND(0.622)
Cesium-137	pci/g	ND(0.0454)	ND(0.0585)	ND(0.0619)	ND(0.0516)	ND(0.052)
General Chemistry						
Total Solids	%	14.1	26.0	25.3	29.0	25.7

Notes:

ND ( ) - Not present at or above the associated value.
J - Estimated concentration.

TABLE 4.12

NATURAL RECOVERY CORE SAMPLING RADIOLOGICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***NRC-05***	***NRC-05***	***NRC-05***	***NRC-05***	***NRC-05***
Sample Identification:		***SE-031884-022008-DD-335***	***SE-031884-022008-DD-336***	***SE-031884-022008-DD-337***	***SE-031884-022008-DD-338***	***SE-031884-022008-DD-344***
Sample Date:		***2/20/2008***	***2/20/2008***	***2/20/2008***	***2/20/2008***	***2/20/2008***
Sample Depth:		***(0-2.5) cm***	***(2.5-5) cm***	***(5-7.5) cm***	***(7.5-10) cm***	***(22.5-25) cm***
	Units					
Radiology						
Beryllium-7	pci/g	ND(0.762)	ND(0.439)	ND(0.511)	ND(0.588)	ND(0.549)
Cesium-137	pci/g	ND(0.0707)	0.11 J +/-0.0405	0.0823 J +/-0.0436	ND(0.0617)	ND(0.0513)
General Chemistry						
Total Solids	%	9.2	15.1	12.0	13.4	18.1

Notes:

ND ( ) - Not present at or above the associated value.
J - Estimated concentration.

TABLE 4.12

NATURAL RECOVERY CORE SAMPLING RADIOLOGICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***NRC-05***	***NRC-05***	***NRC-05***	***NRC-05***	***NRC-05***
Sample Identification:		***SE-031884-022008-DD-354***	***SE-031884-022008-DD-359***	***SE-031884-022008-DD-364***	***SE-031884-022008-DD-369***	***SE-031884-022008-DD-374***
Sample Date:		***2/20/2008***	***2/20/2008***	***2/20/2008***	***2/20/2008***	***2/20/2008***
Sample Depth:		***(47.5-50) cm***	***(70-75) cm***	***(95-100) cm***	***(120-125) cm***	***(145-150) cm***
	Units					
Radiology						
Beryllium-7	pci/g	ND(0.694)	ND(0.708)	ND(0.515)	ND(0.515)	ND(0.572)
Cesium-137	pci/g	ND(0.0623)	ND(0.063)	ND(0.0428)	ND(0.045)	ND(0.0507)
General Chemistry						
Total Solids	%	14.5	33.9	28.6	24.5	38.9

Notes:

ND ( ) - Not present at or above the associated value.
J - Estimated concentration.

TABLE 4.12

NATURAL RECOVERY CORE SAMPLING RADIOLOGICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***NRC-08***	***NRC-08***	***NRC-08***	***NRC-08***	***NRC-08***
Sample Identification:		***SE-031884-120507-DD-090***	***SE-031884-120507-DD-091***	***SE-031884-120507-DD-092***	***SE-031884-120507-DD-093***	***SE-031884-120507-DD-098***
Sample Date:		***12/5/2007***	***12/5/2007***	***12/5/2007***	***12/5/2007***	***12/5/2007***
Sample Depth:		***(0-0) cm***	***(2.5-2.5) cm***	***(5-5) cm***	***(7.5-7.5) cm***	***(20-20) cm***
	Units					
Radiology						
Beryllium-7	pci/g	ND(0.489)	ND(0.428)	ND(0.511)	ND(0.402)	ND(0.36)
Cesium-137	pci/g	ND(0.0565)	ND(0.059)	ND(0.0636)	ND(0.0521)	ND(0.0451)
General Chemistry						
Total Solids	%	59.9	36.6	55.6	64.2	57.0

Notes:

ND ( ) - Not present at or above the associated value.
J - Estimated concentration.

TABLE 4.12

NATURAL RECOVERY CORE SAMPLING RADIOLOGICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***NRC-08***	***NRC-08***	***NRC-08***	***NRC-08***	***NRC-08***
Sample Identification:		***SE-031884-120507-DD-104***	***SE-031884-120507-DD-110***	***SE-031884-120507-DD-114***	***SE-031884-120507-DD-118***	***SE-031884-120507-DD-122***
Sample Date:		***12/5/2007***	***12/5/2007***	***12/5/2007***	***12/5/2007***	***12/5/2007***
Sample Depth:		***(35-35) cm***	***(50-50) cm***	***(70-70) cm***	***(90-90) cm***	***(110-110) cm***
	Units					
Radiology						
Beryllium-7	pci/g	ND(0.502)	ND(0.456)	ND(0.484)	ND(0.66)	ND(0.546)
Cesium-137	pci/g	ND(0.0581)	ND(0.0516)	ND(0.0537)	ND(0.075)	ND(0.064)
General Chemistry						
Total Solids	%	45.4	46.0	48.4	52.2	54.4

Notes:

ND ( ) - Not present at or above the associated value.
J - Estimated concentration.

TABLE 4.12

NATURAL RECOVERY CORE SAMPLING RADIOLOGICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		*NRC-08*	*NRC-08*	*NRC-08*	*NRC-08*	*NRC-08*	*NRC-08*
Sample Identification:		*S-031884-022408-DD-408*	*S-031884-022408-DD-409*	*S-031884-022408-DD-410*	*S-031884-022408-DD-411*	*S-031884-022408-DD-420*	*S-031884-022408-DD-430*
Sample Date:		*2/24/2008*	*2/24/2008*	*2/24/2008*	*2/24/2008*	*2/24/2008*	*2/24/2008*
Sample Depth:		*(0-0) cm*	*(2.5-2.5) cm*	*(5-5) cm*	*(7.5-7.5) cm*	*(30-30) cm*	*(60-60) cm*
	Units						
Radiology							
Beryllium-7	pci/g	1.77 +/-0.554	ND(0.631)	ND(0.493)	ND(0.51)	ND(0.387)	ND(0.354)
Cesium-137	pci/g	0.112 J +/-0.0601	ND(0.0588)	0.0787 J +/-0.0436	0.0835 J +/-0.0422	ND(0.0375)	ND(0.0372)
General Chemistry							
Total Solids	%	8.8	16.7	14.1	13.0	37.3	28.7

Notes:

ND ( ) - Not present at or above the associated value.
J - Estimated concentration.

TABLE 4.12

NATURAL RECOVERY CORE SAMPLING RADIOLOGICAL RESULTS SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample Location:		***NRC-08***	***NRC-08***	***NRC-08***	***NRC-08***
Sample Identification:		***S-031884-022408-DD-436***	***S-031884-022408-DD-442***	***S-031884-022408-DD-448***	***S-031884-022408-DD-454***
Sample Date:		***2/24/2008***	***2/24/2008***	***2/24/2008***	***2/24/2008***
Sample Depth:		***(90-90) cm***	***(120-120) cm***	***(150-150) cm***	***(180-180) cm***
	Units				
Radiology					
Beryllium-7	pci/g	ND(0.588)	ND(0.763)	ND(0.477)	ND(0.507)
Cesium-137	pci/g	ND(0.0593)	ND(0.0682)	ND(0.0455)	ND(0.0474)
General Chemistry					
Total Solids	%	26.9	26.3	40.1	36.1

Notes:

ND ( ) - Not present at or above the associated value.
J - Estimated concentration.

TABLE 4.13

SUMMARY OF BSAF CALCULATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

	Round 1 Fish Tissue Samling (2004)			*Round 2 Fish Tissue Samling (2008)*		
2,3,7,8-TCDD in Fish Tissue	***RM-68***	***RM-42***	***RM-33***	***RM-68***	***RM-42***	***RM-33***
Range TCDD (pg/g-wet)	0.3 - 2.1	0.9 - 6.7	3.4 - 7.5	ND (1.22) - 0.4	4.2 - 9.1	7.1 - 16.1
Geomean TCDD (pg/g-wet)	0.7	2.4	4.7	N/A	6.5	13.2
Average Lipids (%)	4.0	2.1	2.4	9.6	6.1	7.1
Lipid-Norm TCDD (pg/g-lipid)	17	116	196	N/A	107	186
2,3,7,8-TCDD in Sediment						
Range TCDD (pg/g-dry)	ND (0.4)	24 - 71	15 - 280	ND (0.4)	24 - 71	15 - 280
Geomean TCDD (pg/g-dry)	N/A	41	65	N/A	41	65
Average TOC (%)	4.0	3.4	3.5	4.0	3.4	3.5
Carbon-Norm TCDD (pg/g-TOC)	N/A	872	1,754	N/A	872	1,754
BSAF Values:	N/A	0.13	0.11	N/A	0.12	0.11

TABLE 4.14

SUMMARY OF SEDFLUME ANALYSIS RESULTS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Core Location	*Study Area*	*Water Depth at Core Location[1] (m)*	*Mean D50 (µm)*		*Mean Bulk Density, ρb (g/cm³)*	*Mean Power Law Critical Shear Stress, τcr (Pa)*	*Mean Linear Interpolation Critical Shear Stress, τcr (Pa)*
COR-07	4	6.1	31.16	(silt)	1.68	1.05	1.11
COR-20	4	6.1	23.7	(silt)	1.45	1.08	1.10
COR-30	3	1.8	201.99	(sand)	1.77	0.16	0.25
COR-35	2	1.5	69.95	(sand)	1.65	0.67	0.64
COR-36	2	0.9	51.62	(silt)	1.51	0.40	0.51
COR-39	2	1.5	64.5	(sand)	1.57	0.78	0.80
COR-40	2	0.6	110.22	(sand)	1.65	0.34	0.54
COR-42	2	0.9	55.55	(silt)	1.54	0.54	0.63
KRSD-01	4	2.4	51.05	(silt)	1.48	0.25	0.25
KRSD-04	4	1.8	35.83	(silt)	1.68	1.10	1.08
KRSD-05	4	3.0	41.96	(silt)	1.51	1.25	1.32
KRSD-10	4	1.5	85.07	(sand)	1.56	0.31	0.36
KRSD-14	3	1.8	47.93	(silt)	1.66	1.14	1.15
KRSD-20	2	4.6	69.13	(sand)	1.55	0.39	0.34
KRSD-24	1	0.6	69.73	(sand)	1.60	0.36	0.46
KRSD-25	1	2.7	62.57	(sand)	1.55	0.67	0.53
KRSD-28	1	1.5	288.29	(sand)	1.71	0.19	0.24
KRSD-48	3	0.9	33.13	(silt)	1.54	0.64	0.67

Notes:

[1] Water depth measured from the water surface and is not corrected to a vertical datum.

TABLE 4.15

SUMMARY OF KANAWHA RIVER DREDGING PERMITS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

						River Miles			
Applicant	*Permit No.*	*Assign Date*	*Begin Date*	*Expire Date*	*Bank*	*Begin*	*End*	*Dredge Volume (CY)*	*Project*
Construction Projects									
Union Carbide Corp.	KRD-10.089	7/14/70	11/13/70	12/31/73	R	49.41		2,000	Dock Construction
FMC Corp.	KRD-11.032	3/27/72	5/17/72	12/31/75	R	42.7		30	Clear Water Intake Lines
FMC Corp.	KRD-11.040	10/11/74	7/3/75	12/31/85	R	42.7		5,000	Clear Water Intake Lines
Monsanto Industrial Chemicals	KRD-11.041	11/22/74	4/29/75	12/31/85	R	42.3		250	Clear Water Intake Lines
Allied Chemical Corp.	KRD-11.048	1/29/79	2/13/79	12/31/79	R	43.27		30	Clear Water Intake Lines
Union Carbide Corp.	KRD-11.050	5/2/79	10/27/79	12/31/89	R	49.0		60	Clear Water Intake Lines
J.W. McDavid	KRD-10.130	8/8/76	9/26/80	12/31/83	L	36.95		910	Marina Construction
Union Boiler Company	KRD-10.139	5/4/78	9/18/78	12/31/81	R	43.43	43.57	2,500	Loading Dock
Midwest Corp.	KRD-10.170	4/23/82	7/19/82	12/31/85	R	41.1		1,914 Lin. Ft.	Bank Stabilization (Rip Rap)
Dravo Basic Materials Co.		7/30/90	N/P		R	49.0			Structures/Deadman
Rhone Poulenc Ag Co.	KRD-054318	3/7/91	6/17/91	12/31/94	R	49.0		150	Clear Water Intake Lines
Reclamation Projects									
Kanawha Dredging & Minerals Co.		7/8/80	N/P		R	36.97	38.81		
Kanawha Dredging & Minerals Co.	KRD-11.056	11/1/83	3/23/84	12/31/87	R	36.97	38.81	8,000/day	Coal and Sand Reclamation
Kanawha Dredging & Minerals Co.	KRD-11.056	5/1/85	9/16/85	12/31/90	R	36.97	38.81	8,000/day	Coal and Sand Reclamation
Voyager Coal Co.	KRD-11.056	4/1/91	6/6/91	12/31/96	R	36.97	38.81	8,000/day	Coal and Sand Reclamation
Kanawha Dredging & Minerals Co.	KRD-11.060		3/23/84	12/31/87	L	34.87	36.50	8,000/day	Coal and Sand Reclamation
Kanawha Dredging & Minerals Co.	KRD-11.060		9/16/85	12/31/90	L	34.87	36.50	8,000/day	Coal and Sand Reclamation
Voyager Coal Co.	KRD-11.060	4/1/91	6/6/91	12/31/96	L	34.87	36.50	8,000/day	Coal and Sand Reclamation
Kanawha Dredging & Minerals Co.		4/6/79	N/P		L	40.45	41.70		
Kanawha Dredging & Minerals Co.	KRD-11.057	11/1/83	3/23/84	12/31/87	L	40.45	41.70	2,000/day	Coal and Sand Reclamation
Kanawha Dredging & Minerals Co.	KRD-11.064	3/19/87	6/19/87	12/31/92	L	40.45	41.70	2,000/day	Coal and Sand Reclamation
Voyager Coal Co.	KRD-055741	11/3/92	2/18/93	12/31/98	L	40.45	41.70	5,000/day	Coal and Sand Reclamation
Voyager Coal Co.	KRD-055741		D/P	12/31/04	L	40.45	41.70		No Record of Final Authorization
Kanawha Dredging & Minerals Co.	KRD-11.055	5/11/82	1/3/83	12/31/85	L	43.15	43.80		
Kanawha Dredging & Minerals Co.	KRD-11.062	5/1/85	9/16/85	12/31/90	L	43.15	44.10	8,000/day	Coal and Sand Reclamation
Voyager Coal Co.			N/P		L	43.15	45.25	8,000/day	Coal and Sand Reclamation

Notes:

N/P = No Permit on file at USACE Huntington, WV, although Project Number was assigned
D/P = Draft Permit on file, unsigned by USACE or applicant; presumably was never finalized

TABLE 5.1

ANALYTICAL DATA SUMMARY - ALL FISH TISSUE SAMPLES
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Sample ID	*Species*	*Sample Date*	*Location*	*2,3,7,8-TCDD (ng/kg)*	*Lipids (%)*
TISS-031884-101404-DK-023	*bass*	*2004*	*RM 33*	4.46	0.52
TISS-031884-101404-DK-024	*bass*	*2004*	*RM 33*	2.83	0.51
TISS-031884-101404-DK-025	*bass*	*2004*	*RM 33*	2.72	0.50
TISS-031884-101504-DK-026	*bass*	*2004*	*RM 33*	1.37	0.76
TISS-031884-101504-DK-027	*bass*	*2004*	*RM 33*	1.74	0.45
TISS031884-121708-DFK-021	*bass*	*2008*	*RM 33*	1.44	0.34
TISS031884-121708-DFK-022	*bass*	*2008*	*RM 33*	2.14	0.31
TISS031884-121708-DFK-023	*bass*	*2008*	*RM 33*	1.7	0.29
TISS031884-121708-DFK-024	*bass*	*2008*	*RM 33*	1.22	0.26
TISS031884-121708-DFK-025	*bass*	*2008*	*RM 33*	1.28	0.30
TISS-031884-101204-DK 001	*bass*	*2004*	*RM 42*	3.58	0.28
TISS-031884-101304-DK-011	*bass*	*2004*	*RM 42*	4.02	0.39
TISS-031884-101304-DK-012	*bass*	*2004*	*RM 42*	3.52	0.42
TISS-031884-101504-DK-033	*bass*	*2004*	*RM 42*	1.79	0.53
TISS-031884-101504-DK-034	*bass*	*2004*	*RM 42*	2.04	0.48
TISS031884-121708-DFK-001	*bass*	*2008*	*RM 42*	1.71	0.40
TISS031884-121708-DFK-002	*bass*	*2008*	*RM 42*	5.68	0.54
TISS031884-121708-DFK-008	*bass*	*2008*	*RM 42*	4.77	0.67
TISS031884-121708-DFK-009	*bass*	*2008*	*RM 42*	7.17	0.49
TISS031884-121708-DFK-010	*bass*	*2008*	*RM 42*	12.6	0.78
TISS-031884-101604-DK-041	*bass*	*2004*	*RM 68*	ND (0.221)	0.38
TISS-031884-101604-DK-042	*bass*	*2004*	*RM 68*	0.469 J	0.30
TISS-031884-101604-DK-043	*bass*	*2004*	*RM 68*	ND (0.178)	0.26
TISS-031884-101804-DK-044	*bass*	*2004*	*RM 68*	0.365 J	0.65
TISS-031884-101804-DK-045	*bass*	*2004*	*RM 68*	ND (0.077)	0.31
TISS031884-121808-DFK-026	*bass*	*2008*	*RM 68*	ND (0.989)	0.21
TISS031884-121808-DFK-027	*bass*	*2008*	*RM 68*	ND (1.13)	0.21
TISS031884-121808-DFK-028	*bass*	*2008*	*RM 68*	ND (0.97)	0.15
TISS031884-121808-DFK-029	*bass*	*2008*	*RM 68*	ND (1.13)	0.12
TISS031884-121808-DFK-030	*bass*	*2008*	*RM 68*	ND (1.14)	0.81
TISS-031884-101204-DK 002	*catfish*	*2004*	*RM 33-45*	19.5	3.05
TISS-031884-101304-DK-008	*catfish*	*2004*	*RM 33-45*	3.34	1.20
TISS-031884-101304-DK-009	*catfish*	*2004*	*RM 33-45*	1.33	2.26
TISS-031884-101304-DK-010	*catfish*	*2004*	*RM 33-45*	6.07	2.51
TISS-031884-101504-DK-035	*catfish*	*2004*	*RM 33-45*	4.02	0.77
TISS031884-121708-DFK-011	*catfish*	*2008*	*RM 33-45*	8.58	1.08
TISS031884-121708-DFK-012	*catfish*	*2008*	*RM 33-45*	2.09	0.94
TISS-031884-102104-DK-046	*catfish*	*2004*	*RM 75-95*	0.635 J	2.13
TISS-031884-102104-DK-047	*catfish*	*2004*	*RM 75-95*	0.251 J	4.85
TISS-031884-111704-DFK-050	*catfish*	*2004*	*RM 75-95*	0.300 J	2.91
TISS-031884-102204-DK-048	*catfish*	*2004*	*RM 95*	0.736 J	2.24
TISS-031884-102204-DK-049	*catfish*	*2004*	*RM 95*	0.462 J	2.20
TISS031884-121708-DFK-013	*catfish and sauger*	*2008*	*RM 33-45*	36.20	1.18
TISS031884-121708-DFK-014	*catfish and sauger*	*2008*	*RM 33-45*	2.53	1.07
TISS031884-121708-DFK-015	*sauger*	*2008*	*RM 33-45*	0.975 J	1.31
TISS031884-121808-DFK-036	*sauger*	*2008*	*RM 75-95*	ND (1.15)	0.49
TISS031884-121808-DFK-037	*sauger*	*2008*	*RM 75-95*	ND (1.11)	0.39

Notes:
J - Estimated concentration.
ND - Not detected at or above the associated value.

TABLE 5.2

ANALYTICAL DATA SUMMARY - SURFACE WATER
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

RM	*Sample ID*	***Sample Date***	***2,3,7,8 TCDD [(1)] Results (fg/L)***
RM 31	***SW-31884-DL-4/14/05-004B***	***4/14/2005***	48.9
RM 31	***SW-31884-DL-10/19/04-003B***	***10/19/2004***	46.3
RM 33	***SW-31884-DL-4/15/05-004B***	***4/15/2005***	33.5
RM 33	***SW-31884-DL-10/14/04-004B***	***10/14/2004***	15.6
RM 42	***SW-31884-DL-10/13/04-004B***	***10/13/2004***	3.78 J
RM 42	***SW-31884-DL-4/16/05-005B***	***4/16/2005***	7.96 J/118.64
RM 46	***SW-31884-DL-4/13/05-004B***	***4/13/2005***	8.53 J
RM 46	***SW-31884-DL-10/12/04-001B***	***10/12/2004***	ND (1.27) U
RM 68	***SW-31884-DL-4/12/05-004B***	***4/12/2005***	6.35 J
RM 68	***SW-31884-DL-10/18/04-004B***	***10/18/2004***	ND (0.753) U

Notes:

(1) Results represent concentrations of 2,3,7,8-TCDD adsorbed to suspended sediments.
fg/L - femtograms per liter
ND - Not detected at or above the associated value
J - Estimated concentration
U - Not present at or above the associated value.

TABLE 5.3

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN FISH - ALL FISH TISSUE SAMPLES
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Scenario Timeframe: Current
Medium: Fish
Exposure Medium: All Fish

CAS Number	*Chemical*	*Minimum Concentration* (1,2)	*Minimum Qualifier*	*Maximum Concentration* (1,2)	*Maximum Qualifier*	*Units*	*Location of Maximum Concentration*	*Detection Frequency (2)*	*Range of Detection Limits (2)*	*Concentration Used for Screening (3)*	*Screening Toxicity Value*	*Potential ARAR/TBC Value*	*Potential ARAR/TBC Source*	*COPC Flag (Y/N)*	*Rationale for Contaminant Deletion or Selection* (4)
	Dioxins														
1746-01-6	2,3,7,8-TCDD	0.251	J	36.2		ng/kg	RM 33-45 (12/17/08)	37/47	0.077 - 1.15	N/A	N/A C	N/A	N/A	X	AD

Notes:
(1) Minimum/maximum detected concentration.
(2) Based on data collected from sampling locations: RM 33, RM 33-45, RM 42, RM 68, RM 75-95, RM 95.
(3) Maximum concentration is used for screening. However, quantitative rather than screening evaluations were conducted.
(4) Rationale Codes Selection Reason : Analyte Detected (AD)
Deletion Reason : Analyte Not Detected and therefore not present (ND)

Definitions:
C = Carcinogenic
N = Non-Carcinogenic
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
N/A = Not Applicable

TABLE 5.4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE WATER
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

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

CAS Number	*Chemical*	*Minimum Concentration* (1,2)	*Minimum Qualifier*	*Maximum Concentration* (1,2)	*Maximum Qualifier*	*Units*	*Location of Maximum Concentration*	*Detection Frequency (2)*	*Range of Detection Limits (2)*	*Concentration Used for Screening (3)*	*Screening Toxicity Value*	*Potential ARAR/TBC Value*	*Potential ARAR/TBC Source*	*COPC Flag (Y/N)*	*Rationale for Contaminant Deletion or Selection* (4)
	Dioxins														
1746-01-6	2,3,7,8-TCDD (5)	3.78	J	118.64		fg/L	RM 42 (04/16/05)	8/10	0.753 - 1.27	N/A	N/A C	N/A	N/A	X	AD

Notes:
(1) Minimum/maximum detected concentration.
(2) Based on data collected from sampling locations: RM 31, RM 33, RM 42, RM 46, RM 68.
(3) Maximum concentration is used for screening. However, quantitative rather than screening evaluations were conducted.
(4) Rationale Codes — Selection Reason : Analyte Detected (AD)
Deletion Reason : Analyte Not Detected and therefore not present (ND)
(5) Results represent 2,3,7,8-TCDD adsorbed to suspended sediments.

Definitions:
C = Carcinogenic
N = Non-Carcinogenic
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
N/A = Not Applicable
J = Associated value is estimated

TABLE 5.5

SELECTION OF EXPOSURE PATHWAY SCENARIOS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Scenario Timeframe	*Medium*	*Exposure Medium*	*Exposure Point*	*Receptor Population*	*Receptor Age*	*Exposure Route*	*Type of Analysis*	*Rationale for Selection or Exclusion of Exposure Pathway*
Current/ Future:	Fish	Fish	Direct Contact	Recreational Anglers	Child & Adult	Ingestion	Quant	Potential exposure to fish caught in the Kanawha River.
Current/ Future:	Surface Water	Surface Water	Direct Contact	Recreational Swimmers	Adolescent & Adult	Ingestion Dermal	Quant	Potential exposure to surface water while swimming in the Kanawha River.

Note:

Quant = Quantitative

TABLE 5.6

EXPOSURE POINT CONCENTRATION (EPC) SUMMARY FOR CHEMICALS OF POTENTIAL CONCERN IN FISH - ALL FISH TISSUE SAMPLES
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: All Fish Tissue Samples

Chemical of Potential Concern	*Units*	*Arithmetic Mean*	*Statistic Rationale*	*Maximum Detected Concentration*	*Maximum Qualifier*	*EPC Units*	*Reasonable Maximum Exposure*			*Central Tendency*		
							Medium EPC Value	*Medium EPC Statistic*	*Medium EPC Rationale*	*Medium EPC Value*	*Medium EPC Statistic*	*Medium EPC Rationale*
Dioxins												
2,3,7,8-TCDD	ng/kg	3.41E+00	(1)	3.62E+01		ng/kg	7.25E+00	95% UCL-NP	(1), (2)	3.41E+00	Average	(1), (2)

Notes:
Data set evaluated using U.S. EPA's ProUCL 4.00.04
U.S. EPA ProUCL: User Guide EPA/600/R-07/038 February 2009; Software http://www.epa.gov/esd/tsc/TSC_form.htm
For data sets with multiple detection limits, ProUCL recommends use of the Kaplan-Meier method.
Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-L);
95% UCL of Gamma distributed data (95% UCL-G); Non-parametric method used to Determine 95% UCL (95% UCL-NP).
(1) ProUCL calculated or recommended value.
(2) Statistic included in Exposure Factors submitted for regulatory review.

TABLE 5.7

EXPOSURE POINT CONCENTRATION (EPC) SUMMARY FOR CHEMICALS OF POTENTIAL CONCERN IN SURFACE WATER
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

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

Chemical of Potential Concern	*Units*	*Arithmetic Mean*	*Statistic Rationale*	*Maximum Detected Concentration*	*Maximum Qualifier*	*EPC Units*	*Reasonable Maximum Exposure*			*Central Tendency*		
							Medium EPC Value	*Medium EPC Statistic*	*Medium EPC Rationale*	*Medium EPC Value*	*Medium EPC Statistic*	*Medium EPC Rationale*
Dioxins												
2,3,7,8-TCDD (1)	fg/L	2.34E+01	(2)	1.19E+02		fg/L	3.67E+01	95% UCL-NP	(2), (3)	2.34E+01	Average	(2), (3)

Notes:
Data set evaluated using U.S. EPA's ProUCL 4.00.04
U.S. EPA ProUCL: User Guide EPA/600/R-07/038 February 2009; Software http://www.epa.gov/esd/tsc/TSC_form.htm
For data sets with multiple detection limits, ProUCL recommends use of the Kaplan-Meier method.
Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-L);
95% UCL of Gamma distributed data (95% UCL-G); Non-parametric method used to Determine 95% UCL (95% UCL-NP).
(1) Results represent 2,3,7,8-TCDD adsorbed to suspended sediments.
(2) ProUCL calculated or recommended value.
(3) Statistic included in Exposure Factors submitted for regulatory review.

TABLE 5.8

VALUES USED FOR DAILY INTAKE CALCULATIONS FOR FISH INGESTION - RECREATIONAL ANGLER SCENARIO
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: All Fish Tissue Samples
Receptor Population: Recreational Anglers
Receptor Age: Child & Adult

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*RME Value*	*RME Rationale/ Reference*	*Central Tendency Value*	*Central Tendency Rationale/ Reference*	*Intake Equation/ Model Name*
Ingestion	C_{fish}	Chemical Concentration in Fish	mg/kg	(1)	(1)	(1)	(1)	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR - adult	Ingestion Rate of Freshwater Fish	grams/day	25	U.S. EPA, 1997 (2); WV DEP, 1997 (3)	8.0	U.S. EPA, 1997 (2); WV DEP, 1997 (3)	C_{fish} x IR x F_f x PRF x CF x EF x ED x 1/BW x 1/AT
	IR - child	Ingestion Rate of Freshwater Fish	grams/day	5.0	U.S. EPA, 1997 (4); U.S. EPA, 2004	1.9	U.S. EPA, 1997 (4); U.S. EPA, 2004	
	F_f	Fraction of Ingested Fish from Impacted Waterbody	unitless	1.0	Default	0.5	Professional Judgment (5)	
	CF	Conversion Factor	kg/g	0.001	--	0.001	--	
	EF	Exposure Frequency	days/yr	365	WV DEP, 1997 (6)	365	WV DEP, 1997 (6)	
	ED - adult	Exposure Duration	years	24	U.S. EPA, 1989 (7); WV DEP, 1997 (3)	9	U.S. EPA, 1989 (7); WV DEP, 1997 (3)	
	ED - child	Exposure Duration	years	6	WV DEP, 1997 (6)	6	WV DEP, 1997 (6)	
	BW - adult	Body Weight	kg	70	U.S. EPA, 1989 (7); WV DEP, 1997 (3)	70	U.S. EPA, 1989 (7); WV DEP, 1997 (3)	
	BW - child	Body Weight	kg	15	WV DEP, 1997 (6)	15	WV DEP, 1997 (6)	
	AT-C	Averaging Time (cancer)	days	25,550	U.S. EPA, 1989 (7); WV DEP, 1997 (6)	25,550	U.S. EPA, 1989 (7); WV DEP, 1997 (6)	
	AT-N (adult)	Averaging Time (non-cancer)	days	8,760	U.S. EPA, 1989 (7); WV DEP, 1997 (6)	3,285	U.S. EPA, 1989 (7); WV DEP, 1997 (6)	
	AT-N (child)	Averaging Time (non-cancer)	days	2,190	U.S. EPA, 1989 (7); WV DEP, 1997 (6)	2,190	U.S. EPA, 1989 (7); WV DEP, 1997 (6)	

Notes:
(1) For concentrations, refer to Table 5.6.
(2) The recommended fish ingestion rate for recreational freshwater anglers (Section 10.10.3).
(3) Recommended parameter value listed in Table H-1.
(4) Freshwater fish intake rate represents the total fish consumption rate from Exposure Factors Handbook (EFH) Table 10-1 (U.S. EPA, 1997) multiplied by the ratio of freshwater fish to total fish intake from EFH Table 10-81, i.e., 0.3 as per U.S. EPA, 2004.
(5) Professional Judgment; assume half of the default.
(6) Recommended parameter value listed in Table D-2 of WV DEP (1997).
(7) Recommended parameter value listed in Exhibit 6-17 of U.S. EPA (1989).

Sources:
U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
U.S. EPA, 1997: Exposure Factors Handbook, EPA/600/P-95/002F, August 1997.
U.S. EPA, 2004: Example Exposure Scenarios. National Center for Environmental Assessment. April 2004.
WV DEP, 1997: West Virginia Voluntary Remediation and Redevelopment Act Guidance Manual Version 2.1. 1997.
WV DHHR, 2007: West Virginia Sport Fish Consumption Advisory Guide 2nd Edition. Revised: December 12, 2007.

TABLE 5.9

VALUES USED FOR DAILY INTAKE CALCULATIONS FOR SURFACE WATER - CURRENT RECREATIONAL SWIMMING SCENARIC
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Ingestion and Dermal
Receptor Population: Recreational Swimmer
Receptor Age: Youth & Adult

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*RME Value*	*RME Rationale/ Reference*	*CT Value*	*CT Rationale/ Reference*	*Intake Equation/ Model Name*
Ingestion	CW	Chemical Concentration in Surface Water	mg/L	(1)	(1)	(1)	(1)	CDI (mg/kg-day) =
	IR	Ingestion Rate	L/hour	0.05	U.S. EPA, 1989 (2); WV DEP, 1997 (3)	0.03	U.S. EPA, 2004a	CW x IR x ET x EV x EF x ED x 1/BW x 1/AT
	ET	Exposure Time/event	hour/event	3	WV DEP, 1997 (3)	1	U.S. EPA, 1997 (4); WV DEP, 1997 (3)	
	EV	Event Frequency	event/day	1	U.S. EPA, 1997 (5)	1	U.S. EPA, 1997 (5)	
	EF	Exposure Frequency	days/year	100	U.S. EPA, 2009 (6)	5	U.S. EPA, 1997 (5)	
	ED - youth	Exposure Duration	years	6	U.S. EPA, 2004b (7)	6	U.S. EPA, 2004b (7)	
	ED - adult	Exposure Duration	years	24	U.S. EPA, 2004b (7)	9	U.S. EPA, 2004b (7)	
	BW - youth	Body Weight	kg	59	U.S. EPA, 1997 (8)	59	U.S. EPA, 1997 (8)	
	BW - adult	Body Weight	kg	70	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	70	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	
	AT-C	Averaging Time (cancer)	days	25,550	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	25,550	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	
	AT-N (youth)	Averaging Time (non-cancer)	days	2,190	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	2,190	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	
	AT-N (adult)	Averaging Time (non-cancer)	days	8,760	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	3,285	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	
Dermal	CW	Chemical Concentration in Surface Water	mg/L	(1)	(1)	(1)	(1)	CDI (mg/kg-day) =
	SA - youth	Skin Surface Area Available for Contact	cm^2	18,000	U.S. EPA, 2004b (10)	18,000	U.S. EPA, 2004b (10)	DAevent x SA x EF x EV x ED x 1/BW x 1/AT
	SA - adult	Skin Surface Area Available for Contact	cm^2	18,000	U.S. EPA, 2004b (7)	18,000	U.S. EPA, 2004b (7)	DAevent (mg/cm^2-event) - Inorganics=
	CF	Conversion Factor	L/cm^3	0.001	--	0.001	--	PC x CW x CF x ET
	ET	Exposure Time/event	hour/event	3	U.S. EPA, 1997 (4); WV DEP, 1997 (3)	1	U.S. EPA, 1997 (4); WV DEP, 1997 (3)	
	EV	Event Frequency	event/day	1	U.S. EPA, 1997 (5)	1	U.S. EPA, 1997 (5)	
	EF	Exposure Frequency	days/year	100	U.S. EPA, 2009 (6)	5	U.S. EPA, 1997 (5)	DAevent (mg/cm^2-event) - Organics=
	ED - youth	Exposure Duration	years	6	U.S. EPA, 2004b (7)	6	U.S. EPA, 2004b (7)	ET <= t* =
	ED - adult	Exposure Duration	years	24	U.S. EPA, 2004b (7)	9	U.S. EPA, 2004b (7)	2 x FA x PC x CW x CF x SQRT(6 x Tevent x ET / PI)
	BW - youth	Body Weight	kg	59	U.S. EPA, 1997 (8)	59	U.S. EPA, 1997 (8)	ET > t* =
	BW - adult	Body Weight	kg	70	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	70	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	FA x PC x CW x CF x (ET/(1+B)+2 x Tevent x ((1+3B+3B^2)/$(1+B)^2$)
	AT-C	Averaging Time (cancer)	days	25,550	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	25,550	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	t* =2.4 x Tevent
	AT-N (youth)	Averaging Time (non-cancer)	days	2,190	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	2,190	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	
	AT-N (adult)	Averaging Time (non-cancer)	days	8,760	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	3,285	U.S. EPA, 1989 (2); WV DEP, 1997 (9)	
	FA	Fraction Absorbed	unitless	chemical-specific	U.S. EPA, 2004b	chemical-specific	U.S. EPA, 2004b	
	PC	Permeability Constant	cm/hour	chemical-specific	U.S. EPA, 2004b	chemical-specific	U.S. EPA, 2004b	
	Tevent	Lag Time per event	hr/event	chemical specific	U.S. EPA, 2004b	chemical specific	U.S. EPA, 2004b	
	B	Constant	dimensionless	chemical specific	U.S. EPA, 2004b	chemical specific	U.S. EPA, 2004b	

Notes:
(1) For concentration in surface water, refer to Table 5.7.
(2) Recommended parameter value listed in Exhibit 6-17 of U.S. EPA (1989).
(3) Recommended parameter value listed in Table H-1 of WV DEP (1997).
(4) Recommended parameter value listed in Table 15-176 of U.S. EPA (1997).
(5) Recommended parameter value listed in Table 15-18 of U.S. EPA (1997).
(6) Frequency represents value recommended by U.S. EPA Region 3 (U.S. EPA, 2009) for potential swimming every day, all summer (100 days).
(7) Recommended parameter value listed in Exhibit 3-2 of U.S. EPA (2004b).
(8) Average of male and female bodyweights for 13-18 year olds from Exposure Factors Handbook (EFH) Table 7-3 (U.S. EPA, 1997).
(9) Recommended parameter value listed in Table D-2 of WV DEP (1997).
(10) Surface area assumed to be equivalent to that of an adult.

Sources:
U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
U.S. EPA, 1997: Exposure Factors Handbook, EPA/600/P-95/002F, August 1997.
U.S. EPA, 2004a: Example Exposure Scenarios. National Center for Environmental Assessment. April 2004.
U.S. EPA, 2004b: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.
WV DEP, 1997: West Virginia Voluntary Remediation and Redevelopment Act Guidance Manual Version 2.1. 1997.
U.S. EPA, 2009. Comments on Proposed Exposure Factors. Email from Mr. Randy Sturgeon (U.S. EPA Region 3) to Randall Cooper (Monsanto, Inc.) dated May 29, 2009.

TABLE 5.10

NON-CANCER TOXICITY DATA -- ORAL/DERMAL ROUTE OF EXPOSURE
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Oral RfD Value*	*Oral RfD Units*	*Oral to Dermal Adjustment Factor* (1)	*Adjusted Dermal RfD* (2)	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfD: Target Organ*	*Dates of RfD: Target Organ (MM/DD/YY)*
Dioxins 2,3,7,8-TCDD	chronic	1.00E-09	mg/kg-d	100%	1.00E-09	mg/kg-d	developmental effects	90	(3), (4)	(3), (4)

Notes:

(1) U.S. EPA, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

(2) Adjusted Dermal RfD = Oral RfD x Oral to Dermal Adjustment Factor

(3) ATSDR: Agency for Toxic Substances and Disease Registry, Minimum Risk Levels (MRLs), December 2008.

(4) Regional Screening Levels (RSLs) Master Table, April 2009, (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm).

TABLE 5.11

CANCER TOXICITY DATA -- ORAL/DERMAL ROUTE OF EXPOSURE
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Chemical of Potential Concern (COPC)	*Oral Cancer Slope Factor*	*Oral to Dermal Adjustment Factor* (1)	*Adjusted Dermal Cancer Slope Factor* (2)	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (MM/DD/YY)*
Dioxins 2,3,7,8-TCDD	1.30E+05	100%	1.30E+05	$(mg/kg\text{-}day)^{-1}$	B2	(3), (4)	(3), (4)

Notes:

(1) U.S. EPA, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004. U.S. EPA, Technical Guidance Manual Risk Assessment, Assessing Dermal Exposure from Soil, EPA/903-k-95-003, December 1995.

(2) Adjusted Dermal CSF = Oral CSF / Oral to Dermal Adjustment Factor

(3) CalEPA, 2008. Cal EPA Toxicity Criteria Database, Office of Environmental Health Hazard Assessment, December 17, 2008.

(4) Regional Screening Levels (RSLs) Master Table, April 2009, (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm).

U.S. EPA Weight of Evidence Classification:

A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 5.12

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FOR CURRENT/FUTURE RECREATIONAL ANGLER
REASONABLE MAXIMUM EXPOSURE SCENARIO
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Scenario Timeframe: Current/Future
Receptor Population: Recreational Angler
Receptor Age: Child & Adult

Medium	*Exposure Medium*	*Exposure Point*	*Exposure Route*	*Receptor*	*Chemical of Potential Concern*	*EPC Value*	*EPC Units*	*Cancer Risk Calculations [1]: Intake/Exposure Concentration Value*	*Units*	*CSF/Unit Risk Value*	*Units*	*Cancer Risk*	*Non-Cancer Hazard Calculations [2]: Intake/Exposure Concentration Value*	*Units*	*RfD/RfC Value*	*Units*	*Hazard Quotient*
Fish	All Fish	Kanawha River	Ingestion	Child	2,3,7,8-TCDD	7.25E+00	ng/kg	2.07E-10	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	2.7E-05	2.42E-09	mg/kg-d	1.00E-09	mg/kg-d	2.4E+00
			Ingestion	Adult	2,3,7,8-TCDD	7.25E+00	ng/kg	8.88E-10	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	1.2E-04	2.59E-09	mg/kg-d	1.00E-09	mg/kg-d	2.6E+00
			Exp. Route Total									1.4E-04					2.6E+00
		Exposure Point Total										1.4E-04					2.6E+00
	Exposure Medium Total											1.4E-04					2.6E+00
Medium Total												1.4E-04					2.6E+00
								Total of Receptor Risks Across All Media				**1.4E-04**	**Total of Receptor Hazards Across All Media**				**2.6E+00**

Notes:
[1] Total cancer risk estimate reflects the sum of child and adult estimates.
[2] Total hazard index estimate reflects the maximum of child and adult estimates.

TABLE 5.13

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FOR CURRENT/FUTURE RECREATIONAL ANGLER
CENTRAL TENDENCY SCENARIO
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Scenario Timeframe: Current/Future
Receptor Population: Recreational Angler
Receptor Age: Child & Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Receptor	Chemical of Potential Concern	EPC		Cancer Risk Calculations [1]					Non-Cancer Hazard Calculations [2]				
						Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
								Value	Units	Value	Units		Value	Units	Value	Units	
Fish	All Fish	Kanawha River	Ingestion	Child	2,3,7,8-TCDD	3.41E+00	ng/kg	1.85E-11	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	2.4E-06	2.16E-10	mg/kg-d	1.00E-09	mg/kg-d	2.2E-01
			Ingestion	Adult	2,3,7,8-TCDD	3.41E+00	ng/kg	2.50E-11	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	3.3E-06	1.95E-10	mg/kg-d	1.00E-09	mg/kg-d	1.9E-01
			Exp. Route Total									5.7E-06					2.2E-01
		Exposure Point Total										5.7E-06					2.2E-01
	Exposure Medium Total											5.7E-06					2.2E-01
Medium Total												5.7E-06					2.2E-01
								Total of Receptor Risks Across All Media				**5.7E-06**	**Total of Receptor Hazards Across All Media**				**2.2E-01**

Notes:
[1] Total cancer risk estimate reflects the sum of child and adult estimates
[2] Total hazard index estimate reflects the maximum of child and adult estimates

TABLE 5.14

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FOR CURRENT/FUTURE RECREATIONAL SWIMMER
REASONABLE MAXIMUM EXPOSURE SCENARIO
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Scenario Timeframe: Current/Future
Receptor Population: Recreational Swimmer
Receptor Age: Youth & Adult

Medium	*Exposure Medium*	*Exposure Point*	*Exposure Route*	*Receptor*	*Chemical of Potential Concern*	*EPC*		*Cancer Risk Calculations* (1)					*Non-Cancer Hazard Calculations* (2)				
						Value	*Units*	*Intake/Exposure Concentration*		*CSF/Unit Risk*		*Cancer Risk*	*Intake/Exposure Concentration*		*RfD/RfC*		*Hazard Quotient*
								Value	*Units*	*Value*	*Units*		*Value*	*Units*	*Value*	*Units*	
Surface Water	Surface Water	Kanawha River	Ingestion	Youth	2,3,7,8-TCDD	3.67E+01	fg/L	2.19E-15	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	2.8E-10	2.55E-14	mg/kg-d	1.00E-09	mg/kg-d	2.6E-05
			Ingestion	Adult	2,3,7,8-TCDD	3.67E+01	fg/L	7.38E-15	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	9.6E-10	2.15E-14	mg/kg-d	1.00E-09	mg/kg-d	2.2E-05
			Exp. Route Total									1.2E-09					2.6E-05
			Dermal	Youth	2,3,7,8-TCDD	3.67E+01	fg/L	2.63E-12	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	3.4E-07	3.07E-11	mg/kg-d	1.00E-09	mg/kg-d	3.1E-02
			Dermal	Adult	2,3,7,8-TCDD	3.67E+01	fg/L	8.87E-12	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	1.2E-06	2.59E-11	mg/kg-d	1.00E-09	mg/kg-d	2.6E-02
			Exp. Route Total									1.5E-06					3.1E-02
		Exposure Point Total										1.5E-06					3.1E-02
	Exposure Medium Total											1.5E-06					3.1E-02
Medium Total												1.5E-06					3.1E-02
								Total of Receptor Risks Across All Media				**1.5E-06**	**Total of Receptor Hazards Across All Media**				**3.1E-02**

Notes:
(1) Total cancer risk estimate reflects the sum of youth and adult estimates.
(2) Total hazard index estimate reflects the maximum of youth and adult estimates.

TABLE 5.15

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS FOR CURRENT/FUTURE RECREATIONAL SWIMMER
CENTRAL TENDENCY SCENARIO
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Scenario Timeframe: Current/Future
Receptor Population: Recreational Swimmer
Receptor Age: Youth & Adult

Medium	*Exposure Medium*	*Exposure Point*	*Exposure Route*	*Receptor*	*Chemical of Potential Concern*	*EPC*		*Cancer Risk Calculations* [1]					*Non-Cancer Hazard Calculations* [2]				
						Value	*Units*	*Intake/Exposure Concentration*		*CSF/Unit Risk*		*Cancer Risk*	*Intake/Exposure Concentration*		*RfD/RfC*		*Hazard Quotient*
								Value	*Units*	*Value*	*Units*		*Value*	*Units*	*Value*	*Units*	
Surface Water	Surface Water	Kanawha River	Ingestion	Youth	2,3,7,8-TCDD	2.34E+01	fg/L	1.40E-17	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	1.8E-12	1.63E-16	mg/kg-d	1.00E-09	mg/kg-d	1.6E-07
			Ingestion	Adult	2,3,7,8-TCDD	2.34E+01	fg/L	1.76E-17	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	2.3E-12	1.37E-16	mg/kg-d	1.00E-09	mg/kg-d	1.4E-07
			Exp. Route Total									4.1E-12					1.6E-07
			Dermal	Youth	2,3,7,8-TCDD	2.34E+01	fg/L	4.84E-14	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	6.3E-09	5.65E-13	mg/kg-d	1.00E-09	mg/kg-d	5.7E-04
			Dermal	Adult	2,3,7,8-TCDD	2.34E+01	fg/L	6.12E-14	mg/kg-d	1.30E+05	$(mg/kg\text{-}d)^{-1}$	8.0E-09	4.76E-13	mg/kg-d	1.00E-09	mg/kg-d	4.8E-04
			Exp. Route Total									1.4E-08					5.7E-04
		Exposure Point Total										1.4E-08					5.7E-04
	Exposure Medium Total											1.4E-08					5.7E-04
Medium Total												1.4E-08					5.7E-04
								Total of Receptor Risks Across All Media				**1.4E-08**	**Total of Receptor Hazards Across All Media**				**5.7E-04**

Notes:
(1) Total cancer risk estimate reflects the sum of youth and adult estimates.
(2) Total hazard index estimate reflects the maximum of youth and adult estimates.

TABLE 5.16

FISH SPECIES FOUND IN THE KANAWHA RIVER WHILE SAMPLING
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Common Name	*Scientific Name*	*RM 33*	*RM 42*	*RM 33-45*	*RM 68*	*RM 75-95*
American eel	*Anguilla rostrata*					X
Black crappie	*Pomoxis nigromaculatus*	X				
Bluegill	*Lepomis macrochirus*	X	X			
Brown bullhead	*Ictalurus nebulosus*	X	X			
Chain pickerel	*Esox niger*		X			
Channel catfish	*Ictalurus punctatus*	X	X	X	X	X
Common Carp	*Cyprinus carpio*	X	X	X	X	X
Flathead catfish	*Pylodictis olivaris*	X	X	X	X	X
Freshwater drum	*Aplodinotus grunniens*	X	X	X	X	X
Gizzard shad	*Dorosoma cepedianum*	X	X	X	X	X
Golden shiner	*Notemigonus crysoleucas*					X
Green sunfish	*Lepomis cyanellus*	X	X	X	X	X
Largemouth bass	*Micropterus salmoides*	X	X	X	X	X
Longnose gar	*Lepisosteus osseus*	X	X	X	X	X
Muskellunge	*Esox masquinongy*					X
Northern pike	*Esox lucius*		X	X		X
Pumpkinseed	*Lepomis gibbosus*	X				X
Quillback	*Carpiodes cyprinus*			X	X	X
River redhorse	*Moxostoma carinatum*	X			X	X
Sauger	*Stizostedion canadense*	X	X		X	X
Shiner	*Notropis sp.*	X	X	X	X	X
Shorthead redhorse	*Moxostoma macrolepidotum*			X	X	X
Smallmouth bass	*Micropterus dolomieu*	X	X	X	X	X
Smallmouth buffalo	*Ictiobus bubalus*			X	X	
Spotted bass	*Micropterus punctulatus*	X	X	X	X	X
Walleye	*Stizostedion vitreum*	X			X	X
White bass	*Morone chrysops*	X	X	X		
White sucker	*Catostomus commersoni*	X	X	X	X	X

TABLE 5.17

BODY BURDEN EFFECT ENDPOINTS BASED ON 2,3,7,8-TCDD CONCENTRATION IN FISH EGGS EE/CA REPORT KANAWHA RIVER, WEST VIRGINIA

Species	*NOEC* *pg/g ww*	*LOEC* *pg/g ww*	*$LCegg_{50}$* *pg/g ww*
lake trout	35	55	92.6
brook trout	135	185	200
rainbow trout	188.3	279	447.7
lake herring	175	270	902
channel catfish	385	486.4 (1)	644
fathead minnow	235	435	539
medaka	455	949	1110
zebrafish	424	2000	2610
northern pike	1190	1800	2460
white sucker	848	1220	1890

Notes:

(1) This number is an LC_{20}, used because the LC_{50} was lower than the LOEC.

TABLE 5.18

BODY WEIGHTS AND INGESTION RATES FOR SLERA MEASUREMENT RECEPTORS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Measurement Receptor	*Ecological guild*	*Body Weight (kg)*	*Rate (kg WW/kg BW–day)*	*Rate (L/kg BW–day)*	*Rate (kg DW/kg BW-day)*	*Source*
Muskrat	Herbivore	1.09	0.267	0.0982	0.00064	EPA 1999
Canvasback	Herbivore	0.77	0.199	0.0643	0.00182	EPA 1999
Little Brown Bat	Insectivore	0.007	0.33	0.172	0	Baron et al. 1999
Tree Swallow	Insectivore	0.02	0.755	0.2	0	Baron et al. 1999
Raccoon	Omnivore	7	0.1 (1)	0.081	0.0024 (1)	EPA 1993b
Mallard	Omnivore	1.04	0.179	0.0582	0.0032	EPA 1999
Mink	Carnivore	0.974	0.216	0.0993	0.00193	EPA 1999
Great Blue Heron	Carnivore	2.2	0.18	0.0454	0.0036	EPA 1993b

Notes:

WW = wet weight
DW = dry weight
BW = body weight
(1) Food ingestion rate and Incidental ingestion rate for soil, from EPA 1993, both divided by 2 to account for terrestrial half of diet.

TABLE 5.19

EXPOSURE POINT CONCENTRATIONS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Medium	*Study Area*	*Location*	*Number of samples*	*Frequency of detection*	*Mean (pg/L)*	*Max (pg/L)*	*95% UCL (pg/L)*
Surface water:							
Surface Water, Total (1)	Study Area 1	upstream	4	100%	0.005	0.010	-
	Study Area 2	adjacent to site	2	100%	0.041	0.073	-
	Study Area 3 & 4	downstream	4	100%	0.046	0.063	-
Fish/benthic macroinvertebrates:							
Gizzard shad, 2,3,7,8-TCDD not lipid norma	Study Area 1	upstream (RM 68)	11	91%	0.64	2.10	1.46
	Study Area 2	adjacent to site (RM 42)	10	100%	5.01	9.05	6.69
	Study Area 3 & 4	downstream (RM 33)	12	100%	8.58	16.10	12.09
Bass, 2,3,7,8-TCDD lipid normalized (3)	Study Area 1	upstream (RM 68)	10	20%	1.66	4.71	2.55
	Study Area 2	adjacent to site (RM 42)	10	100%	9.18	16.15	11.78
	Study Area 3 & 4	downstream (RM 33)	10	100%	5.12	8.58	6.18
Crayfish (4)	Study Area 1	upstream (RM 68)	-	-	4.15	11.77	6.38
	Study Area 2	adjacent to site (RM 42)	-	-	22.95	40.38	29.45
	Study Area 3 & 4	downstream (RM 33)	-	-	12.80	21.44	15.46
Sediment:							
Surface Sediment	Study Area 1	upstream	8	25%	0.77	2.90	2.06
	Study Area 2	adjacent to site	15	73%	265.35	3400	1257
	Study Area 3 & 4	downstream	55	89%	18.96	280	41.96

Notes:

ppt = parts per trillion.

(1) Concentrations are dissolved plus adsorbed 2,3,7,8-TCDD concentrations.

(2) 2,3,7,8-TCDD concentrations for gizzard shad are used for great blue heron and mink risk calculations.

(3) 2,3,7,8-TCDD concentrations for bass are lipid normalized at 1% lipid.

(4) Crayfish concentrations calculated by multiplying lipid normalized bass concentration by 2.5, the percent lipid of a crayfish. Concentration used in risk calculations for little brown bat, tree swallow, raccoon, and mallard.

TABLE 5.20

SCREENING OF SURFACE WATER FOR IMPACTS ON WATER COLUMN SPECIES (FISH)
EE/CA REPORT
KANAHWA RIVER, WEST VIRGINIA

Medium	*Study Area*	*Location*	*NOEC (pg/L)*	*LOEC (pg/L)*	*Mean (pg/L)*	*Max (pg/L)*	*ESQ NOEC*	*ESQ LOEC*
Surface Water:								
Surface Water, Dissolved								
	Study Area 1	upstream (RM 68)	11	38	0.000	0.001	0.00	0.00
	Study Area 2	adjacent to site (RM 42)	11	38	0.000	0.010	0.00	0.00
	Study Area 3 & 4	downstream (RM 33)	11	38	0.000	0.014	0.00	0.00
Surface Water, Adsorbed								
	Study Area 1	upstream (RM 68)	11	38	0.000	0.008	0.00	0.00
	Study Area 2	adjacent to site (RM 42)	11	38	0.000	0.063	0.00	0.00
	Study Area 3 & 4	downstream (RM 33)	11	38	0.000	0.049	0.00	0.00
Surface Water, Total (1)	Study Area 1	upstream	11	38	0.005	0.010	0.00	0.00
	Study Area 2	adjacent to site	11	38	0.041	0.073	0.00	0.00
	Study Area 3 & 4	downstream	11	38	0.046	0.063	0.00	0.00

Notes:

(1) Concentrations are dissolved plus adsorbed 2,3,7,8-TCDD concentrations.

TABLE 5.21

SCREENING OF RISKS TO FISH USING THE BODY BURDEN METHOD
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Fish species (2,3,7,8-TCDD lipid normalized at 1% lipid)	*Study Area*	*Location*	*Number of samples*	*Frequency of detection*	*Mean (ng/kg)*	*Max (ppt)*	*95% UCL (ng/kg)*	*Test*	*NOEC (ng/kg) = 80 ng/kg at 1% lipid*		*LOEC (ng/kg) = 178 ng/kg at 1% lipid*	
									Mean NOEC ESQ	*95% UCL NOEC ESQ*	*Mean LOEC ESQ*	*95% UCL LOEC ESQ*
Gizzard shad	Study Area 1	upstream (RM 68)	11	91%	0.15	0.66	0.32	95% approx gamma	0.00	0.00	0.00	0.00
	Study Area 2	adjacent to site (RM 42)	10	100%	1.32	3.12	1.81	95% students	0.02	0.02	0.01	0.01
	Study Area 3 & 4	downstream (RM 33)	12	100%	1.99	2.89	2.27	95% students	0.02	0.03	0.01	0.01
									0.00	0.00	0.00	0.00
Bass	Study Area 1	upstream (RM 68)	10	20%	1.66	4.71	2.55	95% students	0.02	0.03	0.01	0.01
	Study Area 2	adjacent to site (RM 42)	10	100%	9.18	16.15	11.78	95% students	0.11	0.15	0.05	0.07
	Study Area 3 & 4	downstream (RM 33)	10	100%	5.12	8.58	6.18	95% students	0.06	0.08	0.03	0.03
									0.00	0.00	0.00	0.00
Catfish and Sauger	Study Area 1	upstream (RM 75-95)	7	71%	0.51	1.42	1.34	95% approx gamma	0.01	0.02	0.00	0.01
	Study Area 2,3,4	adjacent/downstream to site (RM 33-45)	10	100%	6.13	30.68	13.03	95% approx gamma	0.08	0.16	0.03	0.07

TABLE 5.22

SCREENING OF RISK VIA FOOD CHAIN EXPOSURE FOR SEMI-AQUATIC VERTEBRATES FORAGING STUDY AREAS 3 AND 4
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Measurement Receptor	*Aquatic Food Ingestion Rate (kg WW/kg BW–day)* [(1)]	*Water Ingestion Rate (L/kg BW–day)*	*Sediment Ingestion Rate (kg DW/kg BW/day)*	*Food (mean)*	*Food (max)*	*Water (mean)*	*Water (max)*	*Sediment (mean)*	*Sediment (95% UCL)*	*Mean Dose*	*95% UCL Dose*	*NOAEL*	*NOAEL ESQ Mean*	*NOAEL ESQ 95% UCL*	*LOAEL*	*LOAEL ESQ mean*	*LOAEL ESQ 95% UCL*
Muskrat	0.267	0.0982	0.00064	0.02	0.05	0.05	0.06	18.96	41.96	0.0	0.0	1	0.02	0.05	10	0.00	0.00
Canvasback	0.199	0.0643	0.00182	0.02	0.05	0.05	0.06	18.96	41.96	0.0	0.1	10	0.00	0.01	100	0.00	0.00
Little Brown Bat	0.33	0.172	0	12.8	15.45	0.05	0.06	18.96	41.96	4.2	5.1	1	**4.23**	**5.11**	10	0.42	0.51
Tree Swallow	0.755	0.2	0	12.8	15.45	0.05	0.06	18.96	41.96	9.7	11.7	10	0.97	**1.17**	100	0.10	0.12
Raccoon	0.1	0.081	0.0024	12.8	15.45	0.05	0.06	18.96	41.96	1.3	1.7	1	**1.33**	**1.65**	10	0.13	0.17
Mallard	0.179	0.0582	0.0032	12.8	15.45	0.05	0.06	18.96	41.96	1.2	1.5	10	0.12	0.15	100	0.01	0.02
Mink	0.216	0.0993	0.00193	8.58	12.09	0.05	0.06	18.96	41.96	1.9	2.7	3.9	0.49	0.69	16.6	0.11	0.16
Great Blue Heron	0.18	0.0454	0.0036	8.58	12.09	0.05	0.06	18.96	41.96	1.6	2.3	10	0.16	0.23	100	0.02	0.02

Notes:

(1) Ingestion rates for sediment and water are included in the risk calculation but not shown on the table; see Table 5.18.

TABLE 5.23

SCREENING OF RISK VIA FOOD CHAIN EXPOSURE FOR SEMI-AQUATIC VERTEBRATES FORAGING STUDY AREA 2
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Measurement Receptor	***Aquatic Food Ingestion Rate (kg WW/kg BW–day)*** (1)	***Water Ingestion Rate (L/kg BW–day)***	***Sediment Ingestion Rate (kg DW/kg BW/day)***	***Food (mean)***	***Food (max)***	***Water (mean)***	***Water (max)***	***Sediment (mean)***	***Sediment (95% UCL)***	***Mean Dose***	***95% UCL Dose***	***NOAEL***	*NOAEL ESQ Mean*	*NOAEL ESQ 95% UCL*	*LOAEL*	***LOAEL ESQ mean***	***LOAEL ESQ 95% UCL***
Muskrat	0.267	0.0982	0.00064	0.30	1.41	0.04	0.07	265.35	1257	0.3	1.2	1	0.3	**1.2**	10	0.0	0.1
Canvasback	0.199	0.0643	0.00182	0.30	1.41	0.04	0.07	265.35	1257	0.5	2.6	10	0.1	0.3	100	0.0	0.0
Little Brown Bat	0.33	0.172	0	22.95	29.45	0.04	0.07	265.35	1257	7.6	9.7	1	**7.6**	**9.7**	10	0.8	1.0
Tree Swallow	0.755	0.2	0	22.95	29.45	0.04	0.07	265.35	1257	17.3	22.2	10	**1.7**	**2.2**	100	0.2	0.2
Raccoon	0.1	0.081	0.0024	22.95	29.45	0.04	0.07	265.35	1257	2.9	6.0	1	**2.9**	**6.0**	10	0.3	0.6
Mallard	0.179	0.0582	0.0032	22.95	29.45	0.04	0.07	265.35	1257	2.9	7.7	10	0.3	0.8	100	0.0	0.1
Mink	0.216	0.0993	0.00193	5.01	6.69	0.04	0.07	265.35	1257	1.6	3.9	3.9	0.4	1.0	16.6	0.1	0.2
Great Blue Heron	0.18	0.0454	0.0036	5.01	6.69	0.04	0.07	265.35	1257	1.9	5.7	10	0.2	0.6	100	0.0	0.1

Notes:

(1) Ingestion rates for sediment and water are included in the risk calculation but not shown on the table; see Table 5.18.

TABLE 6.1

PRELIMINARY SUMMARY OF IDENTIFIED POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

	Authority	*Citation*	*ARAR Status*	*TBC*	*Comment*
Chemical Specific ARARs					
Federal	Clean Water Act [Federal Water Pollution Control Act, as amended], 33 U.S.C. §§ 1251-1387	40CFR 131.36	Relevant and Appropriate (see below)	TBC for drinking water use	The ambient water criteria for 2,3,7,8-TCDD: 0.013 pg/L for consumption of water and organisms and 0.014 pg/L for consumption of water only.
State	West Virginia Regulations - Requirements Governing Water Standards	WV 47 CSR 02	Relevant and Appropriate for Recreational Contact		Water use designations for streams in state and protective water quality standards. Kanawha River designated for recreational contact; excludes drinking water use. Water Contact Recreational - 0.014 pg/L 2,3,7,8-TCDD (fish consumption)
Chemical Specific TBCs					
Federal	Safe Drinking Water Act, 42 U.S.C. §§ 300f -300j-26	40 CFR § 141.61		TBC - Not used for water supply	The Maximum Contaminant Level (MCL) for 2,3,7,8-TCDD in finished drinking water supplied to consumers of public water supply is 0.00000003 mg/L.
Federal	Clean Water Act - TMDL for Dioxin	Dioxin TMDL Development for Kanawha River, Pocatalico River and Armour Creek, West Virginia, September 14, 2000		TBC	Identified endpoints of dioxin exposures in Kanawha River for Study Areas and sources of dioxin loading, including historical depositions in sediment. Modeled connections between sources and endpoints and performed waste load allocations.
State	West Virginia Division of Health and Human Resources	Fish Consumption Advisory 2009		TBC	Advisory against fish consumption on Lower Kanawha River downstream of I-64: Do Not Eat Flathead and Channel Catfish, Carp, Hybrid Striped Bass and Suckers due to dioxin, mercury and PCB content
Location Specific					
Federal	Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR Part 6, Appendix A			Sets forth EPA policy and guidance for carrying out Executive Orders 11990 and 11988.
			Potentially Applicable if activity at River bank		Executive Order 11988: Floodplain Management requires evaluation of potential effects of actions in a floodplain to avoid or limit adverse effects associated with direct and indirect development of a floodplain.
			Potentially Applicable if activity at wetland area (Armour Creek?)		Executive Order 11990: Protection of Wetlands requires avoidance or limiting adverse impacts associated with the destruction or loss of wetlands.

TABLE 6.1

PRELIMINARY SUMMARY OF IDENTIFIED POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

	Authority	***Citation***	***ARAR Status***	***TBC***	***Comment***
Federal	Endangered Species Act of 1973, as amended	50 CFR Part 17, Subpart I; 50 CFR Part 402	Applicable but not believed present		Requirement to verify that action will not jeopardize the continued existence of any §§ 1531- 1544 endangered species or threatened species or loss of a critical habitat of such species, without appropriate exemptions. No federally listed or proposed threatened or endangered species are known to exist in the Lower Kanawha River.
Federal	Fish and Wildlife Coordination Act, 16 U.S.C. § 662	N/A	Applicable to dredging or capping		Changes to the channel or the stream or otherwise modified for any purpose, requires prior consultation with the United States Fish and Wildlife Service, Department of the Interior and state wildlife resources agency to prevent loss of and damage to such resources.
Federal	National Historic Preservation Act, 16 U.S.C. § 470 et seq.	36 CFR Part 800	Applicable if present		Evaluation required of impacts on properties in or eligible for inclusion in the National Registry of Historic Places. Potential impacts require review and comment by the Advisory Council on Historic Preservation. A Stage 1A cultural resource survey is expected to be necessary for any active remediation.
Federal	EPA Office of Solid Waste and Emergency Response	Policy on Floodplains and Wetland Assessments for CERCLA Actions, August 1985		TBC if wetland and floodplain areas impacted	Describes situations that require preparation of a floodplains or wetlands assessment, and the factors that should be considered in preparing an assessment, for response actions taken pursuant to Section 104 or 106 of CERCLA. For remedial actions, a floodplain/wetlands assessment must be incorporated into the analysis conducted during the planning of the remedial action.
Action Specific					
Dredging, Capping and Discharges					
Federal	Section 404(b) of the Clean Water Act, 33 U.S.C. § 1344(b)	40 CFR Part 230	Applicable for dredging or capping		Guidelines for Specification of Disposal Sites for Dredged or Fill Material. Prohibition or limitation of discharges of dredged or fill material requires demonstration of no practicable alternative. Includes criteria for evaluating whether a particular discharge site may be specified.
Federal	Section 404(c) of the Clean Water Act, 33 U.S.C. § 1344(c)	40 CFR Part 231, 33 CFR Parts 320, 323, and 325	Applicable for dredging or capping		Regulation of disposal sites for discharges of dredged or fill materials (including return water from dredged material disposed of on the upland) into U.S. waters, which include wetlands. Includes special policies, practices, and procedures to be followed by the U.S. Army Corps of Engineers to regulated under Section 404 of the Clean Water Act.

TABLE 6.1

PRELIMINARY SUMMARY OF IDENTIFIED POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS EE/CA REPORT KANAWHA RIVER, WEST VIRGINIA

	Authority	Citation	ARAR Status	TBC	Comment
Federal	Section 10, Rivers and Harbors Act, 33 U.S.C. § 403	33 CFR Part 322	Applicable for capping		U.S. Army Corps of Engineers limits actions to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of the channel of any navigable water of the United States. Construction, excavation, or deposition of materials in, over, or under such waters, or any work which would affect the course, location, condition, or capacity of those waters Note: Federally authorized channel in Kanawha River is 9 feet maintained depth in channel 200 feet wide
State	Public Land Corporation (West Virginia Code Article 11 Chapter 7)			TBC?	All applicants must receive a permit from the Public Lands Corporation of the Division of Natural Resources to work in a stream.
State	Water Pollution Control Act (West Virginia Code Article 22 Chapter 11-7(a))	WV CSR 5A	Certification not Applicable, but may be Relevant and Appropriate to meet Substantive Requirements		Provisions for State to Certify WQ on Federal Permitted Activities apply to Corps permits
Cleanup PCBs					
Federal	Toxic Substances Control Act (TSCA), Title I, 15 U.S.C.§ 2605	40 CFR § 761	Potentially Applicable if PCBs >=50 ppm are cleaned up		Cleanup and disposal options for PCB remediation waste, which includes PCB-contaminated sediments and dredged materials. 40 CFR § 761.61(c) provides an EPA Regional Administrator to approve a risk-based disposal method that will not pose an unreasonable risk of injury to human health or the environment; this provision applies to sediment remediation.
Water Discharges					
Federal	Clean Water Act Effluent Guidelines and Standards	40 CFR 401	Applicable to discharge of waters from on Site dewatering of dredged sediment		Applicable for discharges of wastewaters to surface water bodies. Provides requirements for point source discharges of pollutants.
State	Water Pollution Control Act (WV Code Chapter 22 Article 11)	WV 47 CSR 2	Relevant to the discharge of water from dewatering sediment on Site		Pollutant Discharge Elimination System regulations for known point source discharges to surface water
State	Water Pollution Control Act (WV Code Chapter 22 Article 11)	WV 47 CSR 10	Applicable to discharge of waters from on Site dewatering of dredged sediment		Regulation of discharges containing pollutants from known point sources, including stormwater from construction sites
Federal	Clean Water Act NPDES Stormwater Discharge Requirements	40 CFR 122	Applicable to discharge of stormwaters from Site sediment dewatering, disposal and water treatment		Applicable for point source discharges of stormwater to surface waters. Regulates the discharge of stormwater from industrial activities and those associated with construction activities that are in a land disturbance of equal to or greater than one acre of land.

TABLE 6.1

PRELIMINARY SUMMARY OF IDENTIFIED POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS EE/CA REPORT KANAWHA RIVER, WEST VIRGINIA

	Authority	***Citation***	***ARAR Status***	***TBC***	***Comment***
Waste Management					
Federal	Resource Conservation and Recovery Act - Treatment, Storage and Disposal of Hazardous Waste	40 CFR 260-268	Applicable if RCRA Haz Waste disposed off Site; Relevant and Appropriate if HW disposed on Site		Specifies requirements for the identification and listing of hazardous wastes, the determination of hazardous wastes, the transportation, documentation and operation of hazardous waste treatment, storage and disposal facilities. Applicable for on-site hazardous waste treatment and storage and disposal activities
State	Solid Waste Management Act (WV Code Article 22 Chapter 15)	WV 33 CSR 1	Applicable for disposal of dredged sediments in on Site CDF		Provides regulations for the disposal and management of solid wastes

TABLE 6.1

PRELIMINARY SUMMARY OF IDENTIFIED POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

	Authority	Citation	ARAR Status	TBC	Comment
State	Hazardous Waste Management Act (WV Code Article 22 Chapter 18)	WV 33 CSR 20	Applicable for disposal of dredged sediments in on Site CDF if Haz Waste		Provides regulations on the identification, management, transportation, treatment and disposal of hazardous wastes
Air Emissions					
Federal	Clean Air Act	40 CFR 50	Applicable to on Site construction and operation of sediment dewatering, treatment and disposal facilities		National Ambient Air Quality Standards for particulate matter, etc.
State	Air Pollution Control (WV Code Chapter 22 Article 5)	WV 45 CSR 17	Applicable to on Site construction of sediment dewatering, treatment and disposal facilities		State regulations to prevent and control particulate air pollution from materials handling, preparation, storage and sources of fugitive particulate matter, preparation and storage, disposal areas, roads, haulways and parking lots, vehicles and construction and demolition activities.
Sediment Remediation					
Federal	USEPA	Contaminated Sediment Strategy (EPA-823-R-98-001, April 1998)		TBC	Establishes an Agency-wide strategy for contaminated sediments.
Federal	USEPA Office of Solid Waste and Emergency Response OSWER 9355.0-85	Contaminated Sediment Remediation Guidance for Hazardous Waste Sites EPA-540-R-05-012 December 2005		TBC	Provides integrated strategy and describes process for remediation of contaminated sediments
Federal	USEPA Office of Solid Waste and Emergency Response OSWER Directive 9285.6-08	Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites. February 12, 2002		TBC	Outlines and describes 11 principles EPA should use for managing risks associated with contaminated sediments.

TABLE 6.2

SUMMARY OF SWAC CALCULATIONS FOR ROLLING 3-MILE REACHES
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

River Section (by River Mile) *From*		*To*	*Surface Weighted Average Concentration of 2,3,7,8-TCDD (ug/kg)*
RM 45.0	-	RM 42.0	0.0013
RM 44.5	-	RM 41.5	0.0116
RM 44.0	-	RM 41.0	0.0188
RM 43.5	-	RM 40.5	0.0198
RM 43.0	-	RM 40.0	0.0207
RM 42.5	-	RM 39.5	0.0215
RM 42.0	-	RM 39.0	0.0219
RM 41.5	-	RM 38.5	0.0121
RM 41.0	-	RM 38.0	0.0074
RM 40.5	-	RM 37.5	0.0084
RM 40.0	-	RM 37.0	0.0090
RM 39.5	-	RM 36.5	0.0106
RM 39.0	-	RM 36.0	0.0109
RM 38.5	-	RM 35.5	0.0119
RM 38.0	-	RM 35.0	0.0102
RM 37.5	-	RM 34.5	0.0089
RM 37.0	-	RM 34.0	0.0105
RM 36.5	-	RM 33.5	0.0109
RM 36.0	-	RM 33.0	0.0114
RM 35.5	-	RM 32.5	0.0127
RM 35.0	-	RM 32.0	0.0144
RM 34.5	-	RM 31.5	0.0162
RM 34.0	-	RM 31.0	0.0142
RM 33.5	-	RM 30.5	0.0126
Armour Creek Backwater Area			0.0119
Pocatalico River Backwater Area			0.0009

TABLE 7.1

SCREENING OF REMOVAL ACTION TECHNOLOGIES SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

	Effectiveness		*Implementability*		*Cost*
	Short Term	*Long Term*	*Technical*	*Administrative*	
No Action	**Very Low** - Exposure would continue unabated	**Very Low** - Exposure would continue unabated	**High**	**High**	**Low**
Institutional Controls	**Low to Moderate** - May reduce potential increased exposure due to coal recovery dredging	**Low to Moderate** - Difficult to ensure ICs are maintianed	**High**	**Low to Moderate** - Requires ICs to be placed by entities not directly involved in project (e.g. USACE)	**Low**
Monitored Natural Recovery (MNR)	**Low** - Slow rate of recovery	**Low to Moderate** - Dependant on the stability of the sediment bed and control of contaminant sources	**Moderate** - Dependant on thorough evaluation and understanding of recovery process and rates	**Moderate** - Requires implementation of Institutional Controls and equipment for monitoring alternative effectiveness	**Low to Moderate** - Requires baseline and ongoing monitoring of fish, water, and sediment
In Situ Treatment	**Low to Moderate** -The MNR process is accelerated by the introduction of organic carbon to provide an immediate reduction in contaminant bioavailability within the bioactive zone	**Moderate to High** - The incorporation of enhancements would result in a reduction in the recovery timeframe and improve the effectiveness of the remedy	**Moderate** - Dependant on thorough evaluation and understanding of recovery process and rates	**Moderate** - Relative to Alternative 2, but also requires specialized equipment/operators	**Low to Moderate** - Costs relative to Alternative 2, however, the time for ongoing monitoring may be reduced, but there will be additional costs for the enhancement product/method
Capping	**High** - Immediate covering of contaminated sediment resulting in SWAC reduction	**Moderate to High** - Cap stability susceptible to erosion from propwash and storm events. Ongoing inspection and maintenance is required	**Moderate to High** - Technology established, infrastructure available, can be improved with armoring	**Moderate** - Capping requires U.S. ACE and WV DEP approval	**Moderate to High** - Capital costs vary primarily on cost of cap and armoring materials. Operation, monitoring and maintenance required to verify cap integrity must be included
Dredging	**Low to Moderate** - Provides mass removal, however, release of re-suspended sediment will cause increase in fish tissue concentrations in short term	**Moderate to High** - Success limited due to residuals	**High** - Dredging, dewatering and disposal is proven and equipment is readily available	**Moderate** - Requires specialized equipment/operators and coordination with USACE for approvals	**Very High** -Due to dredging costs and capital costs for land acquisition, siting investigation, design, construction, operation during filling, and closure of Near-Shore CDF

TABLE 8.1

REMOVAL ACTION ALTERNATIVE EVALUATION SUMMARY
EE/CA REPORT
KANAWHA RIVER, WEST VIRGINIA

Alternative		*Effectiveness*	*Implementability*	*Cost*
1	No Action/ Institutional Controls	• Not anticipated to be effective	• Easily implemented	• Capital Cost: $0 • O&M Cost: $0
2	Institutional Controls/ Monitored Natural Recovery	• Gradual reduction in sediment, surface water, an fish tissue concentrations over time (15+ years) • Most reliant on effective source control and ICs • Does not improve stability of existing sediment in areas of elevated surficial sediment 2,3,7,8-TCDD concentrations • Effectiveness of remedy determined over time based on comparisons of monitoring data to anticipated recovery trends • Risk of future active remedial activities (dredging, capping, enhanced MNR) if recovery criteria not met • ICs need to be re-evaluated if additional sources are identified or existing sources are no longer present	• Significant efforts in evaluation, source control and monitoring to support remedy • Ability to establish institutional control against coal recovery dredging unknown	• Capital Cost: $686,000 • O&M Cost: $1,006,000 (Present Worth) - Costs to monitor sediment, surface water, and fish tissue - Potential for significant future costs if recovery timeframe not met
3	Institutional Controls/ Enhanced Monitored Natural Recovery/ In-Situ Treatment	• Same as Alternative 2 except enhancement may accelerate recovery trends • Relies on source control Enhancement (carbon addition) methods include proprietary and non-proprietary alternatives • Does not improve stability of existing sediment in areas of elevated surficial sediment 2,3,7,8-TCDD concentrations	• Agency approval and public acceptance likely more easily obtained (compared to Alternative 2) due to active treatment component. • Significant efforts in evaluation, source control and monitoring to support remedy • Ability to establish institutional control against coal recovery dredging unknown	• Capital Cost: $2,029,000 • O&M Cost: $1,006,000 (Present Worth) - Costs to monitor sediment, surface water, and fish tissue
4	Institutional Controls/ Enhanced Monitored Natural Recovery/ Capping of Selected Areas	• Relies on source control • Immediate reduction in surface-weighted average concentration (SWAC) in capped areas • Proven effectiveness in capped areas • Armoring of capped areas must be designed in accordance with shear stress model • Provides immediate risk reduction and accelerates recovery, however recovery of fish tissue will lag 5-10 years behind dredging. • Habitat considerations need to be evaluated based on selected capping material	• No issues with agency or public acceptance anticipated • Requires coordination with RCRA Closure of former Flexsys Facility (bank stabilization) • Requires coordination with USACE and adjacent landowners to approve cap design (capping limited to non-navigational areas) • Capping can be implemented quickly (vs. dredging & off-Site removal)	• Capital Cost: $7,109,000 • O&M Cost: $1,049,000 (Present Worth) - Costs to monitor cap integrity - Costs to monitor sediment, surface water, and fish tissue
5a	Institutional Controls/ Monitored Natural Recovery/ Dredging of Selected Areas/ Near-Shore Confined Disposal Facility	• Relies on source control and mass removal • Capping of dredged areas likely required to address increased concentrations in dredged areas due to dredge residuals • Results in short-term risk increase but accelerates long-term recovery (if SWAC reduced after dredging or area capped), however recovery of fish tissue will lag 5-10 years behind dredging. • The extent of risk reduction likely to be disproportionately small as compared to cost • Requires increased coordination with Solutia to coordinate consolidation of dredge spoils on former Flexsys Facility • Risk with dispersion/volatilization of contaminated material during dredging which could be transported downstream of Site	• No issues with agency or public acceptance anticipated. • Requires significant coordination with RCRA Closure of former Flexsys Facility (construction of CDF) • Requires coordination with USACE and adjacent landowners to approve cap design (capping limited to non-navigational areas) if capping of residuals is required • Sediment dewatering and water treatment components poses more technical challenges than any other remedy components • Possible schedules delays due to weather if dredging is not feasible • Possible impacts to the community (noise, residential/commercial disruption)	• Capital Cost: $24,582,000 - High cost due to dredging - Higher costs for sediment treatment and dewatering • O&M Cost: $1,438,000 (Present Worth) - Costs to monitor sediment, surface water, and fish tissue - Costs for CDF maintenance and monitoring
5b	Institutional Controls/ Monitored Natural Recovery/ Dredging of Selected Areas/ Off-Site Disposal	• See Alternative 5A	• See Alternative 5A • Difficulty in locating disposal facility to accept waste may exist • Community impacts more significant than 5A due to off-site transportation of large volume of contaminated soil	• Capital Cost: $40,051,000 - Highest cost due to off-Site disposal fees • O&M Cost: $1,049,000 (Present Worth) - Costs to monitor sediment, surface water, and fish tissue

TABLE 8.2

PRELIMINARY COST ESTIMATE - ALTERNATIVE 2
INSTITUTIONAL CONTROLS AND MNR
KANAWHA RIVER, WEST VIRGINIA

Item	*Estimated Quantity*	*Unit*	*Unit Price*	*Total Cost*
Capital Costs				
1. Detailed Design/Permitting and Approvals	--	lump sum	--	$ 150,000
2. Establishment of Institutional Controls	--	lump sum	--	$ 52,500
3. Baseline Sampling				
- Fish Tissue Sampling (5 composite fish tissue samples at 9 stations) including 2,3,7,8-TCDD Analysis	45	each	$ 3,750	$ 168,750
- High-Volume Surface Water Sampling (5 stations) including 2,3,7,8-TCDD Analysis	5	each	$ 27,000	$ 135,000
4. Data Validation and Reporting for Baseline Sampling	--	lump sum	--	$ 42,500
Subtotal - Capital Costs				**$ 548,750**
Contingency (25%)				**$ 137,188**
Total - Capital Costs				**$ 685,938**
Operation, Maintenance, and Monitoring Costs				
5. Ongoing Sampling (1 sampling event every 5 years)				
- Fish Tissue Sampling (5 composite fish tissue samples at 9 stations) including 2,3,7,8-TCDD Analysis	45	each	$ 3,750	$ 168,750
- High-Volume Surface Water Sampling (5 stations) including 2,3,7,8-TCDD Analysis	5	each	$ 27,000	$ 135,000
6. Data Validation and Reporting	--	lump sum	--	$ 42,500
7. 5-Year Review	--	lump sum	--	$ 27,000
Subtotal - OMM Costs				**$ 373,250**
Contingency (25%)				**$ 93,313**
Total - OMM Costs (once every 5 years)				**$ 466,563**
Net Present Worth - OMM Costs (30 years, 5.7% discount rate)				**$ 1,005,565**
TOTAL - ALL ACTIVITIES (Rounded)				**$ 1,692,000**

Notes:

Baseline and ongoing sampling costs are based on the sampling procedures for fish tissue and surface water employed in the EOC Study.

TABLE 8.3

PRELIMINARY COST ESTIMATE - ALTERNATIVE 3
INSTITUTIONAL CONTROLS, IN SITU TREATMENT, AND MNR
KANAWHA RIVER, WEST VIRGINIA

Item	*Estimated Quantity*	*Unit*	*Unit Price*	*Total Cost*
Capital Costs				
1. Pre-Design Investigations (limited sampling to refine cap areas)	--	lump sum	--	$ 120,000
2. Detailed Design/Permitting and Approvals	--	lump sum	--	$ 150,000
3. Establishment of Institutional Controls	--	lump sum	--	$ 52,500
4. Contractor Procurement	--	lump sum	--	$ 27,000
5. Mobilization	--	lump sum	--	$ 145,000
6. Activated Carbon Addition (1)	9.39	acre	$ 53,000	$ 497,670
7. Demobilization	--	lump sum	--	$ 70,000
8. Quality Assurance testing to confirm activated carbon application rate	--	lump sum	--	$ 75,000
9. Oversight During Construction	--	lump sum	--	$ 80,000
10. Final Construction Report	--	lump sum	--	$ 60,000
11. Baseline Sampling				
- Fish Tissue Sampling (5 composite fish tissue samples at 9 stations) including 2,3,7,8-TCDD Analysis	45	each	$ 3,750	$ 168,750
- High-Volume Surface Water Sampling (5 stations) including 2,3,7,8-TCDD Analysis	5	each	$ 27,000	$ 135,000
12. Data Validation and Reporting for Baseline Sampling	--	lump sum	--	$ 42,500
Subtotal - Capital Costs				**$ 1,623,420**
Contingency (25%)				**$ 405,855**
Total - Capital Costs				**$ 2,029,275**
Operation, Maintenance, and Monitoring Costs				
13. Ongoing Sampling (1 sampling event every 5 years)				
- Fish Tissue Sampling (5 composite fish tissue samples at 9 stations) including 2,3,7,8-TCDD Analysis	45	each	$ 3,750	$ 168,750
- High-Volume Surface Water Sampling (5 stations) including 2,3,7,8-TCDD Analysis	5	each	$ 27,000	$ 135,000
14. Data Validation and Reporting	--	lump sum	--	$ 42,500
15. 5-Year Review	--	lump sum	--	$ 27,000
Subtotal - OMM Costs				**$ 373,250**
Contingency (25%)				**$ 93,313**
Total - OMM Costs (once every 5 years)				**$ 466,563**
Net Present Worth - OMM Costs (30 years, 5.7% discount rate)				**$ 1,005,565**
TOTAL - ALL ACTIVITIES (Rounded)				**$ 3,035,000**

Notes:

(1) Quantities are based on areas to be treated as identified on Figure 7.3.
The unit cost assumptions were based on median values from other similar projects, derived from confidential bidding or completed cost information compiled by Anchor QEA and CRA.
Baseline and ongoing sampling costs are based on the sampling procedures for fish tissue and surface water employed in the EOC Study.

TABLE 8.4

PRELIMINARY COST ESTIMATE - ALTERNATIVE 4
INSTITUTIONAL CONTROLS, MNR, AND CAPPING OF SELECTED AREAS
KANAWHA RIVER, WEST VIRGINIA

Item	*Estimated Quantity*	*Unit*	*Unit Price*	*Total Cost*
Capital Costs				
1. Pre-Design Investigations (limited sampling to refine cap areas)	--	lump sum	--	$ 120,000
2. Detailed Design/Permitting and Approvals	--	lump sum	--	$ 150,000
3. Establishment of Institutional Controls	--	lump sum	--	$ 52,500
4. Contractor Procurement	--	lump sum	--	$ 27,000
5. Mobilization	--	lump sum	--	$ 145,000
6. Sand Cap Placement (6-inch minimum thickness) (1)	9.39	acre	$ 160,000	$ 1,502,400
7. Armor Stone Placement (12-inches of rip rap) (1)	9.39	acre	$ 325,000	$ 3,051,750
8. Demobilization	--	lump sum	--	$ 70,000
9. Quality Assurance testing to confirm cap thickness	--	lump sum	--	$ 105,000
10. Oversight During Construction	--	lump sum	--	$ 80,000
11. Final Construction Report	--	lump sum	--	$ 37,500
12. Baseline Sampling				
- Fish Tissue Sampling (5 composite fish tissue samples at 9 stations) including 2,3,7,8-TCDD Analysis	45	each	$ 3,750	$ 168,750
- High-Volume Surface Water Sampling (5 stations) including 2,3,7,8-TCDD Analysis	5	each	$ 27,000	$ 135,000
13. Data Validation and Reporting for Baseline Sampling	--	lump sum	--	$ 42,500
Subtotal - Capital Costs				**$ 5,687,400**
Contingency (25%)				**$ 1,421,850**
Total - Capital Costs				**$ 7,109,250**
Operation, Maintenance, and Monitoring Costs				
14. Ongoing Sampling (1 sampling event every 5 years)				
- Fish Tissue Sampling (5 composite fish tissue samples at 9 stations) including 2,3,7,8-TCDD Analysis	45	each	$ 3,750	$ 168,750
- High-Volume Surface Water Sampling (5 stations) including 2,3,7,8-TCDD Analysis	5	each	$ 27,000	$ 135,000
- Cap Inspection	1	each	$ 16,000	$ 16,000
15. Data Validation and Reporting	--	lump sum	--	$ 42,500
16. 5-Year Review	--	lump sum	--	$ 27,000
Subtotal - OMM Costs				**$ 389,250**
Contingency (25%)				**$ 97,313**
Total - OMM Costs (once every 5 years)				**$ 486,563**
Net Present Worth - OMM Costs (30 years, 5.7% discount rate)				**$ 1,048,670**
TOTAL - ALL ACTIVITIES (Rounded)				**$ 8,158,000**

Notes:

(1) Quantities are based on capping the areas as identified on Figure 7.4.
The unit cost assumptions were based on median values from other similar projects, derived from confidential bidding or completed cost information compiled by Anchor QEA and CRA.
Baseline and ongoing sampling costs are based on the sampling procedures for fish tissue and surface water employed in the EOC Study.
It has been assumed that all capped areas will require armoring to prevent erosion or physical damage to the cap. Actual extent of armoring will be determined during detailed design.

TABLE 8.5

PRELIMINARY COST ESTIMATE - ALTERNATIVE 5A
INSTITUTIONAL CONTROLS, MNR, DREDGING OF SELECTED AREAS, AND NEAR-SHORE CDF
KANAWHA RIVER, WEST VIRGINIA

Item	*Estimated Quantity*	*Unit*	*Unit Price*	*Total Cost*
Capital Costs				
1. Pre-Design Investigations (limited sampling to refine dredge areas)	--	lump sum	--	$ 120,000
2. Detailed Design/Permitting and Approvals	--	lump sum	--	$ 345,000
3. Establishment of Institutional Controls	--	lump sum	--	$ 70,000
4. Contractor Procurement	--	lump sum	--	$ 42,500
5. Mobilization	--	lump sum	--	$ 240,000
6. Excavation and Stockpiling of Soil for Containment Cell Construction	24,200	CY	$ 5.25	$ 127,050
7. Composite Liner System Construction (double FML lined cell with leak detection and leachate collection systems)	2.75	acre	$ 180,000.00	$ 495,000
8. Composite Cap Construction (composite FML/GCL liner system)	2.90	acre	$ 138,000.00	$ 400,200
9. Dredging (1)	83,400	in place CY	$ 70.00	$ 5,838,000
10. Dewatering (Geotubes) (1)	83,400	in place CY	$ 90.00	$ 7,506,000
11. Wastewater Treatment Facility	--	lump sum	--	$ 400,000
12. WWTF Operation	6,570,000	gallons	$ 0.12	$ 788,400
13. Capping of Dredge Residuals (assumed to be 50% of area dredged)	4.70	acre	$ 485,000	$ 2,277,075
14. Demobilization	--	lump sum	--	$ 150,000
15. Quality Assurance Testing for CDF, Dredging and Capping	--	lump sum	--	$ 190,000
16. Oversight During Construction	--	lump sum	--	$ 255,000
17. Final Construction Report	--	lump sum	--	$ 75,000
18. Baseline Sampling				
- Fish Tissue Sampling (5 composite fish tissue samples at 9 stations) including 2,3,7,8-TCDD Analysis	45	each	$ 3,750.00	$ 168,750
- High-Volume Surface Water Sampling (5 stations) including 2,3,7,8-TCDD Analysis	5	each	$ 27,000.00	$ 135,000
19. Data Validation and Reporting for Baseline Sampling	--	lump sum	--	$ 42,500
Subtotal - Capital Costs				**$ 19,665,475**
Contingency (25%)				**$ 4,916,369**
Total - Capital Costs				**$ 24,581,844**

TABLE 8.5

PRELIMINARY COST ESTIMATE - ALTERNATIVE 5A
INSTITUTIONAL CONTROLS, MNR, DREDGING OF SELECTED AREAS, AND NEAR-SHORE CDF
KANAWHA RIVER, WEST VIRGINIA

Item	*Estimated Quantity*	*Unit*	*Unit Price*	*Total Cost*
Operation, Maintenance, and Monitoring Costs				
Annual Monitoring				
21. Leachate Collection/Disposal from CDF (non-hazardous)	150,000	gallons	$ 0.016	$ 2,400
22. Monitoring, Inspection and Maintenance of CDF	--	lump sum	--	$ 10,000
23. Data Validation and Reporting - CDF	--	lump sum	--	$ 5,500
Subtotal - Annual OMM Costs				**$ 17,900**
Contingency (25%)				**$ 4,475**
Total - Annual OMM Costs				**$ 22,375**
Net Present Worth - Annual OMM Costs (30 years, 5.7% discount rate)				**$ 318,133**
Monitoring Every 5 Years				
20. Ongoing Sampling (1 sampling event every 5 years)				
- Fish Tissue Sampling (5 composite fish tissue samples at 9 stations) including 2,3,7,8-TCDD Analysis	45	each	$ 3,750	$ 168,750
- High-Volume Surface Water Sampling (5 stations) including 2,3,7,8-TCDD Analysis	5	each	$ 27,000	$ 135,000
- Cap Inspection	1	each	$ 16,000	$ 16,000
21. Data Validation and Reporting - River Monitoring	--	lump sum	--	$ 42,500
22. 5-Year Review	--	lump sum	--	$ 27,000
Subtotal - OMM Costs (once every 5 years)				**$ 389,250**
Contingency (25%)				**$ 97,313**
Total - OMM Costs (once every 5 years)				**$ 486,563**
Net Present Worth - 5-Year OMM Costs (30 years, 5.7% discount rate)				**$ 1,048,670**
TOTAL - OMM ACTIVITIES (Rounded)				**$ 1,438,000**
TOTAL - ALL ACTIVITIES (Rounded)				**$ 26,020,000**

Notes:

(1) Quantities are based on dredging of material as identified on Figure 7.6
The unit cost assumptions were based on median values from other similar projects, derived from confidential bidding or completed cost information compiled by Anchor QEA and CRA.
Baseline and ongoing sampling costs are based on the sampling procedures for fish tissue and surface water employed in the EOC Study.

TABLE 8.6

PRELIMINARY COST ESTIMATE - ALTERNATIVE 5B
INSTITUTIONAL CONTROLS, MNR, DREDGING OF SELECTED AREAS, AND OFF-SITE DISPOSAL
KANAWHA RIVER, WEST VIRGINIA

Item	*Estimated Quantity*	*Unit*	*Unit Price*	*Total Cost*
Capital Costs				
1. Pre-Design Investigations (limited sampling to refine dredge areas)	--	lump sum	--	$ 120,000
2. Detailed Design/Permitting and Approvals	--	lump sum	--	$ 345,000
3. Establishment of Institutional Controls	--	lump sum	--	$ 70,000
4. Contractor Procurement	--	lump sum	--	$ 42,500
5. Mobilization	--	lump sum	--	$ 240,000
6. Dredging (1)	83,400	in place CY	$ 70.00	$ 5,838,000
7. Dewatering (Geotubes) (1)	83,400	in place CY	$ 90.00	$ 7,506,000
8. Wastewater Treatment Facility	--	lump sum	--	$ 400,000
9. WWTF Operation	6,570,000	gallons	$ 0.12	$ 788,400
10. Capping of Dredge Residuals (assumed to be 50% of area dredged)	4.70	acre	$ 485,000.00	$ 2,277,075
11. Loading, Transportation and Disposal of dewatered sediment to off-Site Landfill (1)	99,246	tons	$ 135.00	$ 13,398,210
12. Demobilization	--	lump sum	--	$ 150,000
13. Quality Assurance Testing for Dredging and Capping	--	lump sum	--	$ 190,000
14. Oversight During Construction	--	lump sum	--	$ 255,000
15. Final Construction Report	--	lump sum	--	$ 75,000
16. Baseline Sampling				
- Fish Tissue Sampling (5 composite fish tissue samples at 9 stations) including 2,3,7,8-TCDD Analysis	45	each	$ 3,750.00	$ 168,750
- High-Volume Surface Water Sampling (5 stations) including 2,3,7,8-TCDD Analysis	5	each	$ 27,000.00	$ 135,000
17. Data Validation and Reporting for Baseline Sampling	--	lump sum	--	$ 42,500
Subtotal - Capital Costs				**$ 32,041,435**
Contingency (25%)				**$ 8,010,359**
Total - Capital Costs				**$ 40,051,794**
Operation, Maintenance, and Monitoring Costs				
18. Ongoing Sampling (1 sampling event every 5 years)				
- Fish Tissue Sampling (5 composite fish tissue samples at 9 stations) including 2,3,7,8-TCDD Analysis	45	each	$ 3,750	$ 168,750
- High-Volume Surface Water Sampling (5 stations) including 2,3,7,8-TCDD Analysis	5	each	$ 27,000	$ 135,000
- Cap Inspection	1	each	$ 16,000	$ 16,000
19. Data Validation and Reporting	--	lump sum	--	$ 42,500
20. 5-Year Review	--	lump sum	--	$ 27,000
Subtotal - OMM Costs				**$ 389,250**
Contingency (25%)				**$ 97,313**
Total - OMM Costs (once every 5 years)				**$ 486,563**
Net Present Worth - OMM Costs (30 years, 5.7% discount rate)				**$ 1,048,670**
TOTAL - ALL ACTIVITIES (Rounded)				**$ 41,100,000**

Notes:

(1) Quantities are based on dredging of material as identified on Figure 7.8
The unit cost assumptions were based on median values from other similar projects, derived from confidential bidding or completed cost information compiled by Anchor QEA and CRA.
Baseline and ongoing sampling costs are based on the sampling procedures for fish tissue and surface water employed in the EOC Study.
Disposal is assumed to be landfill disposal. The inclusion of thermal treatment, if required based on material characteristics, will substantially increase costs