1 of 2

**Addendum to the Phase 2 Sampling and Analysis Plan
for the Clinch River Remedial Investigation**

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Energy Systems Environmental Restoration Program
Clinch River Environmental Restoration Program

**Addendum to the Phase 2 Sampling and Analysis Plan
for the Clinch River Remedial Investigation**

This document is an addendum to the Phase 2 Sampling and Analysis Plan contained in report DOE/OR/01-1111&D3 (ORNL/ER-156&D3).

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ACRONYMS AND ABBREVIATIONS

CLP	Contract Laboratory Program, EPA
CRM	Clinch River mile
CRRI	Clinch River Remedial Investigation
DQO	data quality objective
DOE	U.S. Department of Energy
DOE-ORO	U.S. Department of Energy, Oak Ridge Operations
EFPC	East Fork Poplar Creek
EPA-IV	U.S. Environmental Protection Agency, Region IV
ER-L	effects range—low
ERM	Emory River mile
FFA	Federal Facility Agreement
NAWQC	National Ambient Water Quality Criteria
NPDES	National Pollutant Discharge Elimination System
ORR	Oak Ridge Reservation
OU	operable unit
PCM	Poplar Creek mile
QA	quality assurance
QC	quality control
RI/FS	remedial investigation/feasibility study
S&A	sampling and analysis
TDEC	Tennessee Department of Environment and Conservation
TRM	Tennessee River mile
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife and Resources Agency
WBR	Watts Bar Reservoir
WOC	White Oak Creek

EXECUTIVE SUMMARY

This document is an addendum to the Phase 2 Sampling and Analysis Plan for the Clinch River Remedial Investigation (DOE 1993). The Department of Energy-Oak Ridge Operations (DOE-ORO) is proposing this addendum to the U.S. Environmental Protection Agency, Region IV (EPA-IV), and the Tennessee Department of Environment and Conservation (TDEC) as a reduced sampling program on the Clinch River arm of Watts Bar Reservoir and on Poplar Creek. DOE-ORO is proposing to maximize the use of existing data and minimize the collection of new data for water, sediment, and biota during Phase 2 of the Clinch River Remedial Investigation. The existing data along with the additional data collected in Phase 2 would be used to perform a baseline risk assessment and make remedial decisions. DOE-ORO considers that the existing data, the additional data collected in Phase 2, and on-site remedial investigation data would be sufficient to understand the nature and extent of the contamination problem in the Clinch River, perform a baseline risk assessment, and make remedial decisions.

DOE-ORO is also proposing to partition the Clinch River/Poplar Creek study area into two operable units (OUs): (1) the Clinch River OU and (2) the Poplar Creek OU. The Clinch River OU includes the Clinch River from the Oak Ridge Reservation (ORR) to the confluence of the Clinch and Tennessee rivers. The Poplar Creek OU stretches from the mouth of Poplar Creek up to the confluence with East Fork Poplar Creek (EFPC). Because the OU immediately upstream of Poplar Creek (the Lower EFPC OU) is reaching the final stages of the remedial investigation/feasibility study, DOE-ORO is proposing to delay producing the remedial investigation report on Poplar Creek until remedial actions have been completed on the Lower EFPC OU.

The revisions to the approved Phase 2 Sampling and Analysis Plan, as described in this addendum, would produce data that would be used differently for the Clinch River OU and the Poplar Creek OU. The data collected from the new Clinch River OU would be used immediately to begin production of the Remedial Investigation/Baseline Risk Assessment/Feasibility Study Report. Data collected from the new Poplar Creek OU would be used to first produce a data summary/screening-level risk assessment report for Poplar Creek.

This addendum is organized in three sections. The first section provides background information and describes a rationale for modifying the Phase 2 Sampling and Analysis Plan. Section 2 presents a summary of the existing data for the Clinch River arm of Watts Bar Reservoir and an evaluation of the sufficiency of this data for a baseline human health and ecological risk assessment. Section 3 describes the revised Phase 2 Sampling and Analysis Plan for surface water, sediment, and biota in the Clinch River OU and in the Poplar Creek OU.

1. INTRODUCTION

1.1 PURPOSE OF THIS ADDENDUM

This document is an addendum to the Phase 2 Sampling and Analysis Plan for the Clinch River Remedial Investigation (DOE 1993). The Department of Energy-Oak Ridge Operations (DOE-ORO) is proposing this addendum to the U.S. Environmental Protection Agency, Region IV (EPA-IV), and the Tennessee Department of Environment and Conservation (TDEC) as a reduced sampling program on the Clinch River arm of Watts Bar Reservoir (WBR) and on Poplar Creek. The purpose of this addendum is to present a revised sampling plan that would include the use of historical data. The use of historical data would reduce the number of samples collected below the number originally outlined in the Phase 2 Sampling and Analysis Plan.

This addendum is organized as follows:

- Section 1 provides the rationale for modifying the Phase 2 Sampling and Analysis Plan and describes the approach and contents for the addendum.
- Section 2 presents a summary of the existing data for the Clinch River arm of WBR and an evaluation of the sufficiency of this data for a baseline human health and ecological risk assessment. An appendix to this document contains a summary of the number of observations in the existing data sets for surface water, sediment, and fish in the Clinch River arm of WBR and tabulates the numbers of detected and nondetected analytes.
- Section 3 describes the details of the revised Phase 2 Sampling and Analysis Plan for surface water, sediment, and biota.

This addendum describes changes to the Phase 2 Sampling and Analysis Plan. Where the original plan is unchanged, the Phase 2 Sampling and Analysis Plan (DOE 1993) and the Remedial Investigation Work Plan (DOE 1990) contain the details of the sampling and analysis. The reader is referred to the Phase 2 Sampling and Analysis Plan for the following: background and regulatory basis for the Clinch River Remedial Investigation (CRRRI); an overview of historical and current conditions in the Clinch River/WBR system; a summary of the data quality objectives for the Phase 2 Sampling and Analysis Plan; an analysis plan for performing risk assessments for human health and the ecosystem; the objectives of the Phase 2 Sampling and Analysis Plan; and the sample tracking and records management plan for Phase 2. The Quality Assurance Project Plan and the Environmental Health and Safety Plan may also be found in Energy Systems (1993).

1.2 BACKGROUND FOR MODIFICATION OF THE PHASE 2 SAMPLING AND ANALYSIS PLAN

The Phase 2 Sampling and Analysis Plan for the CRRRI was approved by DOE on August 6, 1993; by EPA-IV on September 15, 1993; and by TDEC on August 31, 1993. At the time the plan was approved, the Clinch River/WBR Operable Unit (OU) included the Clinch River

downstream of the Oak Ridge Reservation (ORR) (Melton Hill Reservoir and the Clinch River arm of WBR), Poplar Creek, and WBR downstream of the mouth of the Clinch River.

Several meetings were held with DOE-ORO, EPA-IV, and TDEC between June 1993 and March 1994 concerning the sufficiency of existing data in lower WBR (the Tennessee River from Watts Bar Dam to the confluence of the Clinch and Tennessee rivers). On November 22, 1993, TDEC approved and on January 18, 1994, EPA-IV approved a DOE-ORO plan to partition the Clinch River/WBR OU into two OUs: Lower WBR OU and the Clinch River OU (the Clinch River arm of WBR, Poplar Creek, and Melton Hill Reservoir downstream of ORR). The rationale for this decision was that data sufficient for making a remedial decision and performing a human health risk assessment in lower WBR existed either in historical data (Hoffman et al. 1991; Blaylock et al. 1994) or in Phase 1 of the remedial investigation (Cook et al. 1992). Furthermore, DOE-ORO, TDEC, and EPA-IV agreed that decisions concerning ecological risk in lower WBR could be deferred until completion of an ecological risk assessment for the Clinch River arm of WBR. This decision resulted in significantly (4-year) shortening the schedule for producing a Record of Decision for the Lower WBR OU. A remedial investigation/baseline risk assessment report on lower WBR is currently being prepared and is scheduled to be submitted to the EPA-IV and TDEC on August 5, 1994.

In a letter dated February 1, 1994, and at a meeting on February 23, 1994, DOE-ORO proposed to EPA-IV and TDEC that a reduced sampling program, in the Clinch River arm of WBR, would provide sufficient data to perform a baseline risk assessment and to make a remedial decision for that portion of the system. Furthermore, because the OU adjacent to and upstream of Poplar Creek (the Lower EFPC OU) is reaching the final stages of the remedial investigation/feasibility study (RI/FS), DOE-ORO is proposing to delay producing the remedial investigation report on Poplar Creek until remedial actions have been completed on the Lower EFPC OU.

Thus, we are proposing to define two additional OUs: (1) the Clinch River OU and (2) Poplar Creek OU. If this latest proposal is accepted, the original Clinch River/WBR OU will be further partitioned into these two new OUs, in addition to the Lower WBR OU. The Clinch River OU includes the Clinch River adjacent to ORR to the confluence of the Clinch and Tennessee rivers (Table 1.1 and Fig. 1.1). The Poplar Creek OU stretches from the mouth of Poplar Creek, up to the confluence with EFPC (Table 1.1 and Fig. 1.1). A description of the study areas and reference reaches associated with the Clinch River arm of WBR and Poplar Creek is presented in Table 1.1.

The revisions to the approved Phase 2 Sampling and Analysis Plan, as described in this addendum, would produce data that would be used differently for the Clinch River OU and the Poplar Creek OU. The data collected from the new Clinch River OU would be used immediately to begin production of the Remedial Investigation/Baseline Risk Assessment/Feasibility Study Report. Data collected from the new Poplar Creek OU would be used to first produce a data summary/screening level risk assessment report for Poplar Creek. The RI/FS report for Poplar Creek would be delayed until after completion of any remedial actions on the Lower EFPC OU.

Table 1.1. Stream and river reaches used in the Clinch River Remedial Investigation (CRRRI) site characterization and screening risk assessment

Reach number	Reach name (description)	River mile^a
1	Melton Hill Reservoir (from Oak Ridge Reservation to Melton Hill Dam)	CRM 43.2–23.1
2	Clinch (Clinch River from Melton Hill Dam to Poplar Creek)	CRM 23.0–12.1
3	Poplar Creek embayment (Poplar Creek below the confluence of the East Fork)	PCM 5.5–0.0
4	Poplar Creek Clinch (the Clinch River from the mouth of Poplar Creek to the confluence with the Tennessee River)	CRM 12.0–0.0
5	Lower WBR (the Tennessee River from the confluence of the Clinch River to Watts Bar Dam)	TRM 567.5–530.0
6	Emory River	ERM 14.0–0.0
10	Norris Reservoir (the Clinch River above Norris Dam)	
13	Poplar Creek (Poplar Creek above the confluence of the East Fork)	PCM 6.8–5.6
15	Chickamauga Reservoir (immediately below Watts Bar Dam)	TRM 529.9–515.0
18	Tennessee River arm of WBR (from Fort Loudoun and Tellico dams to the confluence of the Clinch River)	TRM 602.0–567.0

^aCRM = Clinch River mile; PCM = Poplar Creek mile; TRM = Tennessee River mile; ERM = Emory River mile.

Fig. 1.1. Map of study area with Oak Ridge Reservation and study reaches defined.

1.3 RATIONALE FOR THE REVISED PHASE 2 SAMPLING AND ANALYSIS PROGRAM

DOE-ORO has taken the initiative to streamline the remedial investigation of the Clinch River OU. This approach combines EPA's data quality objective process and the observational approach to reduce the costs of data collection, improve the schedule, and expedite the decision-making process. One of the most important decisions by DOE-ORO resulting from this initiative is to use historical data for site characterization and baseline risk-assessment purposes. Previously, DOE's concerns for data quality required the collection of new data of documented quality and high integrity.

Because of the hydrodynamics, complexity, and size of the Clinch River system, the number of samples needed to characterize this system with a high certainty will be difficult to determine, and collection of these samples will be cost-prohibitive. In addition, while the Clinch River is the ultimate integrator of the contaminant releases from ORR, it is also receiving contaminants from non-DOE sources. These factors complicate the characterization of the river.

Because the Clinch River has been studied for over 30 years, an extensive number of samples are already available to describe qualitatively and in some cases quantitatively the present conditions of the system. DOE-ORO considers that there are enough data to address the human health and to some degree the ecological conditions in the Clinch River. DOE-ORO's approach is to maximize the use of historical and Phase 1 data to reduce the number of samples to be collected during Phase 2. Samples collected in Phase 2 will refine the results obtained in Phase 1 and the historical studies. In addition, DOE-ORO is proposing to use the water, sediment, and biota data from the ORR Monitoring Program in the remedial investigation. DOE-ORO has also initiated a search for the Superfund and non-Superfund facilities that might have been releasing contaminants into the river.

The data quality objective (DQO) process has been implemented for this program with active participation of the parties to the Federal Facility Agreement (FFA). This process has been a key element in helping the three parties understand the contamination problems and define how the information available and new data collected could be used to characterize the risk and make the remedial actions. The data collected in this investigation will not be used to address remedial decisions regarding water and biota; however, it will be used to determine whether the combined inputs of the DOE sources are producing unacceptable risks to human health and the environment. The decisions regarding water and biota remediations will be made at the source operable units level. Currently, these source operable units are gathering increasing amounts of data to determine their contribution to the off-site risk. Unlike data on water and biota, the data collected for sediment during this investigation will be used to make remedial decisions.

This new sampling approach is focused entirely on contaminant releases from DOE. Studies of non-DOE contaminant sources will be eliminated from this investigation. In order to understand the non-DOE contamination in the system, DOE has initiated a search for Superfund and non-Superfund facilities and will be gathering information on the contaminants and concentrations that they have released and monitoring data from their programs.

2. EVALUATION OF EXISTING DATA FOR ASSESSING HUMAN HEALTH AND ECOLOGICAL RISKS

The objectives of the Clinch River Environmental Restoration Program are to characterize the contamination in the Clinch River and Poplar Creek, evaluate the risk those contaminants pose to human health and the ecosystem, and perform preliminary identification and evaluation of potential remedial alternatives to reduce unacceptable risks (DOE 1993). This section presents an evaluation of the sufficiency of the existing data (historical, CRRI Phase 1, and CRRI Phase 2) for producing a technically sound baseline risk assessment. This section discusses methods used for obtaining historical data (Sect. 2.1) and evaluates the sufficiency of existing data for human health and ecological risk assessments (Sects. 2.2 and 2.3) (i.e., historical data, Phase 1 data, and Phase 2 data), including data that have been submitted for analyses. Revised sampling plans for surface water, sediment, and biota are presented in Sect. 3.

2.1 SUMMARY OF EXISTING DATA

2.1.1 Selection of Historical Data for the Baseline Risk Assessment

The initial task of CRRI was to conduct human health and ecological screening risk analyses to determine the important pathways and the potential contaminants of concern in the surface-water environment downstream of ORR (Hoffman et al. 1991; Suter 1991). Data used in the initial screening analyses were assimilated from the following sources: ORR Environmental Surveillance Reports [including National Pollutant Discharge Elimination System (NPDES) and water quality monitoring data (Rogers et al. 1987, 1988)]; the ORNL Biological Monitoring and Abatement Program (Loar et al. 1981); ecological studies (Loar et al. 1981); the Instream Contaminant Study (TVA 1985a, 1985b); the Clinch River sediment study (Oakes et al. 1982); STORET (TVA 1985 a, b); a study of sediment contamination in streams (Ashwood et al. 1986); and the WBR scoping study (Olsen et al. 1990).

Historical data available for conducting a baseline risk assessment in the Clinch River arm of WBR are listed in Table 2.1. This table summarizes the historical and Phase 1 data for which detectable contaminant concentrations are available for conducting a baseline risk assessment. In order for a contaminant to be included in the baseline risk assessment, it must have been detected in at least one sample from a reach and medium. Tables A.1 through A.5 provide summaries of all the contaminants that were analyzed in each reach and medium. These summaries also indicate which contaminants were present at detectable concentrations and which were below detection limits. Samples that were collected after Phase 1 and are in the process of being analyzed are listed as "Analyses pending." To obtain the historical data identified in Table 2.1, data sets used in the initial screening activity (Hoffman et al. 1991) were reexamined. This data search also included another search of the STORET database. In addition, the following individuals were contacted:

Ralph Wallace	Tennessee Valley Authority (TVA) Environmental Radiation Monitoring and Instrumentation, Muscle Shoals
Don Dycus	TVA Water Quality Branch, Chattanooga
Greg Denton	TDEC Division of Water Pollution and Control, Nashville
Doug McCoy	TDEC, DOE-O, Oak Ridge
Dale Rector	TDEC, DOE-O, Oak Ridge

**Table 2.1. Historical, Phase 1, and past Phase 1 data available for a baseline risk assessment for
Reaches 2 and 4 on the Clinch River arm of Watts Bar Reservoir**

Reach 2															
Pathways	Inorganics			Organics	PCBs	Pesticides	Radionuclides			References					
Near shore sediments (summer water depth ≤ 6 ft) ----- 2 samples pending analysis	Ref.	(1)	(2)	(1) Bis(2-ethylhexyl)phthalate (1g)			(1) ⁷ Be (8g)		(1) Ashwood et al. 1986						
	Ag	1g					137Cs (16g)								
	Al		2g	(2) Benzo(a)Anthracene (1g)			60Co (15g)		(2) TVA-PU						
	As		2g	Bis(2-ethylhexyl)phthalate (1g)			238U (3g)		(3) CRR1						
	Ba		2g	Fluoranthene (1g)			235U (3g)								
	Be		1g	Phenanthrene (1g)											
	Bo		2g	Pyrene (1g)			(2) 137Cs (1g)		(4) CRR1+						
	Cn		1g												
	Cr	2g	2g				(3) 60Co (39g)								
	Cu	2g	2g				137Cs (41g)								
	Hg	2g	1g				(4) 60Co (29g)								
	Li		2g				137Cs (40g)								
	Mn		2g				241Am (4g)								
	Ni	2g	2g												
	Pb	2g	2g												
	Sb		1g												
	Se	2g													
	V		2g												
	Zn	2g	2g												
Deep sediments	Ref.	(2)	(3)	(4)	(3) 2-Methylnaphthalene (1c)	(3) Aroclor 1254 (1c)	(3) Toxaphene (1c)	(1) 137Cs (137c)	(1) Oakes et al. 1982						
	As	2c		1c	Benzo(a)anthracene (1c)	Aroclor 1260 (1c)		60Co (137c)							
	Be	2c		1c	Benzo(a)pyrene (1c)			90Sr (64c)							
	Cd	2c		1c	Benzo(b)fluoranthene (1c)			239,240Pu (64c)	(2) Olsen et al. 1992						
	Cr	2c		1c	Bis(2-ethylhexyl)phthalate (2c)			238Pu (64c)							
	Cu	2c		1c	Chrysene (1c)			241Am (64c)	(3) CRR1						
	Pb	1c		1c	Di-n-butylphthalate (2c)										
	Hg	2c	1c	1c	Diethylphthalate (1c)			(2) 137Cs (2c)	(4) ORTF						
	Ni	2c		1c	Fluoranthene (2c)										
	Se	2c		1c	Indeno(1,2,3-cd)pyrene (1c)			(3) 60Co (2c)							
	Ag	2c		1c	Naphthalene (1c)			137Cs (2c)							
	Zn	1c		1c	Phenanthrene (2c)			241Am (2c)							
	U	2c			Pyrene (2c)			243,244Cm (2c)							
					(4) Methylene chloride (1c)			238Pu (2c)							
								239,240Pu (2c)							
								90Sr (2c)							
								234U (2c)							
								235U (2c)							
								238U (2c)							
	Fish	BGL ¹	CHC ²	LMB ¹		CHC ^{1,2}	SAU ²	STB ^{1,2}	CHC ^{1,2}	SAU ²	STB ^{1,2}	BGL ¹	CHC ^{1,2}	LMB ²	(1) CRR1 (2) TVA
		As (11)	As (1)	As (2)		1254(11)	1254 (12)	1254 (20)	4,4'-DDE(14)	Chlor.(12)	4,4'-DDE(10)	¹³⁷ Cs(11)	¹³⁷ Cs(14)	¹³⁷ Cs(2)	
Hg (11)		Cd (1)	Hg (2)		1260(15)	1260 (12)	1260 (20)	4,4'-DDT (14)					⁹⁰ Sr(6)		
Se (11)		Pb (1)	Se (2)		Total (1)		Total (10)	Aldrin (15)	Endrin (10)						
Zn (11)		Hg (1)	Zn (2)					Chlordane (15)	Chlor. (20)	Beta-BHC (10)					
		Se (1)													
		Zn (1)													
Analyses pending for 20 BGL and 12 LMB for As, Hg, Be, and Se					1992-1993 4 species 60 samples pending					1992-1993 4 species 60 samples pending					
										1992-1993 3 species 36 samples pending					
Water		Cu (2g)										137Cs (2g)			CRR1
	Zn (2g)										90Sr (2g)				
	Analyses pending for 2g				Analyses pending for 2g				Analyses pending for 2g				Analyses pending for 2g		

c = core sample; g = grab sample; BGL = Bluegill; CHC = Channel catfish; LMB = Largemouth Bass; SAU = Sauger; STB = Striped Bass

Table 2.1 (continued)

Reach 4																
Pathways	Inorganics				Organics				PCBs		Pesticides		Radionuclides		References	
Near shore sediments	(1) Ag (1g) Cr (2g) Cu (2g) Hg (2g) Ni (2g) Pb (2g) Zn (2g)												(1) ⁷ Be (2g) ¹³⁷ Cs (6g) ⁶⁰ Co (6g) (2) ⁶⁰ Co (90g) ¹³⁷ Cs (90g) (3) ²⁴¹ Am (3g) ⁶⁰ Co (18g) ¹³⁷ Cs (22g)		(1) Ashwood et al. 1986 (2) CRR1 (3) CRR1+	
8 samples pending analysis																
Deep sediments	Ref. (2)	(3)	(4)	(8)	(3) Bis(2-ethylhexyl)phthalate (1c) Fluoranthene (1c) N-Nitroso-di-n-propylamine (1c) Phenanthrene (1c) Pyrene (1c) (4) Fluoranthene (1c) Methyl chloride (1c) Pyrene (1c) (5) Bis(2-ethylhexyl)phthalate (1c) Fluoranthene (1c) Phenanthrene (1c) Pyrene (1c)				(3) Aroclor-1254 (2c)				(1) ¹³⁷ Cs (89c) ⁶⁰ Co (89c) ⁹⁰ Sr (49c) ^{239,240} Pu (49c) ²³⁸ Pu (49c) ²⁴¹ Am (49c) (2) ¹³⁷ Cs (2c & 3g) (3) ⁶⁰ Co (3c) ¹³⁷ Cs (3c) ²⁴¹ Am (1c) ^{243,246} Cm (1c) ²³⁸ Pu (1c) ^{239,240} Pu (1c) ⁹⁰ Sr (1c) ²³⁴ U (1c) ²³⁵ U (1c) ²³⁸ U (1c) (4) ¹³⁷ Cs (2c) ⁹⁹ Tc (1c) (5) ¹³⁷ Cs (1c) ⁶⁰ Co (1c) ²³⁵ U (1c) ²³⁸ U (1c) ²²⁶ Ra (1c)		(1) Oakes et al. 1982 (2) Olsen et al. 1992 (3) CRR1 (4) ORTTF (5) Ashwood et al. 1986	
12 samples pending analysis																
Fish	BGL As (19) Hg (19) Se (19) Zn (19) Analyses pending for 20 samples each of BGL, CHC and LMB for As, Hg, Ba, and Se					CHC 1254 (56) 1260 (56) Total (18) 1992-1993 pending	GSD* 1254 (30) 1260 (30) Total (1) 7 species	LMB 1254 (23) 1260 (23) Total (1) 114 samples	CHC 4,4'-DDD (28) 4,4'-DDE (28) 4,4'-DDT (28) Aldrin (24) Chlordane (56) Dieldrin (10) Endrin (10) Endosulfan (10) Endosulfate (10) 1992-1993 pending	GSD Chlor. (30)	LMB Chlor. (23)	SAU Chlor. (20)	BGL ¹³⁷ Cs (14) ¹³⁷ Cs (18) ⁹⁰ Sr (10)	CHC ¹³⁷ Cs (18) ⁹⁰ Sr (10)	LMB ¹³⁷ Cs (8)	CRR1
Water	Cd (3g) Pb (3g) Analyses pending for 1g													¹³⁷ Cs (2g) ⁹⁰ Sr (1g) Analyses pending for 1g		CRR1

* whole fish; c = core sample; g = grab sample; BGL = Bluegill; CHC = Channel catfish; GSD = Gizzard Shad; LMB = Largemouth Bass; SAU = Sauger;

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Jess Weaver	USGS, Nashville
Tim Gangaware	UT Water Research Institute

These individuals were either sources of other contacts or provided leads to potential sources of data that were investigated.

2.1.2 Criteria for the Use of Historical Data for a Baseline Risk Assessment

Historical surface water data, to be used in the baseline risk assessment, will be limited to the past 5 years because water is rapidly transported through the river/reservoir system. Water concentrations, unlike sediment cores, which can be a historical record of releases of contaminants to the aquatic ecosystem, reflect current conditions and can change as the contaminant sources change. For these reasons, only water data collected from 1988 to 1993 are considered.

For historical sediment data, only data collected from 1977 to the present will be included in the baseline risk assessment. Data derived from the Clinch River sediment study (Oakes et al. 1982) provides the oldest sediment database of any significance in the upper Clinch River, excepting the Clinch River Study (Struxness et al. 1967). Data from the Clinch River Study was not included previously because sediment samples in this study were collected prior to construction of Melton Hill Dam. The operation of this dam for the generation of electricity significantly influences the flow regime in the Clinch River below it (CRM 23-0) and therefore influences the deposition of sediment. Furthermore, analytical procedures used in the Clinch River Study would not meet current standards.

Because fish are good integrators of contaminants in aquatic ecosystems and reflect the recent contaminant history, historical fish data will not be included in the baseline risk assessment. It is felt that the Phase 1 and Phase 2 fish data, along with recent TVA data, should be sufficient for conducting the human health baseline risk assessment.

2.2 EVALUATION OF EXISTING DATA FOR ASSESSING HUMAN HEALTH RISKS

The human health screening risk analysis conducted on the Phase 1 data identified contaminants of concern for the Clinch River arm of WBR (Cook et al. 1992). Contaminants that have cancer screening risks $\geq 10^{-6}$ and hazard quotients ≥ 0.1 for Reach 2 (Melton Hill Dam to the mouth of Poplar Creek, CRM 23.0-12.0) are listed in Table 2.2. Contaminants that have cancer screening risks $\geq 10^{-6}$ and hazard quotients ≥ 0.1 for Reach 4 (mouth of Poplar Creek to the confluence of the Clinch and Tennessee River, CRM 12.0-0.0) are listed in Table 2.3. Based on the historical data given in Table 2.1, the sufficiency of this data for use in conducting a human health baseline risk assessment on the potential exposure pathways for humans is given in Table 2.4. In this situation, sufficiency is based on professional judgment; however, the following criteria were considered:

1. sufficient data are available for statistical analyses;
2. the variability of data within and between different sources is known and is acceptable;
3. the procedures used in taking and analyzing the samples are acceptable;
4. the samples are spatially and temporally representative of the area of concern;

Table 2.2. Cancer risks/hazard quotients associated with existing data from Reach 2

Media/pathway	Inorganics	Organics	PCBs	Pesticides	Radionuclides
Near-shore sediments/ external exposure					Cs-137 (3.0E-05) Co-60 (1.9E-06)
Deep sediments/ dredging (multiple pathway total for sediment ingestion, inhalation, and external exposure as well as ingestion of milk, meat, and vegetables)	Beryllium (3.0E-05) Arsenic (1.9E-05) Zinc (2.1) Cadmium (1.6) Mercury (1.0) Copper (0.24) Selenium (0.19) Nickel (0.15)	Benzo(a)pyrene (1.5E-04) Phenanthrene (9.6E-05) Pyrene (6.6E-05) Fluoranthene (6.4E-05) Indeno(1,2,3-cd)pyrene (4.3E-05) Benzo(b)fluoranthene (1.8E-05) Benzo(a)anthracene (8.5E-06) Chrysene (1.2E-06)	Aroclor-1260 (1.1E-02) Aroclor-1254 (1.1E-03)	Toxaphene (5.1E-04)	Cs-137 (3.8E-04) Sr-90 (9.1E-06) Co-60 (5.3E-06) U-238 (1.1E-06)
Fish/ ingestion	Arsenic (3.3E-05) Mercury (0.41) Arsenic (0.29) Selenium (0.15)		Aroclor-1260 (2.1E-03) Aroclor-1254 (1.1E-03)	Chlordane (1.2) Chlordane (2.0E-05) 4,4'-DDE (1.2E-06)	Cs-137 (5.8E-06)
Water/ ingestion	Cyanide (0.15)	1,2-Dichloropropane (4.2E-06) Tetrachloroethylene (3.1E-06)			H-3 (2.2E-04) Sr-90 (1.8E-04) Cs-137 (3.6E-05) Np-237 (1.5E-05) Th-228 (1.2E-05) Co-60 (2.5E-06) U-234 (1.8E-06) Os-191 (1.3E-06)

Note: E format = cancer risk; decimal quantities = hazard quotient.

Table 2.3. Cancer risks/hazard quotients associated with existing data from Reach 4

Media/pathway	Inorganics	Organics	PCBs	Pesticides	Radionuclides
Near-shore sediments/ external exposure					Cs-137 (3.1E-05) Co-60 (2.3E-06)
Deep sediments/ dredging (multiple pathway total for sediment ingestion, inhalation, and external exposure as well as ingestion of milk, meat, and vegetables)	Beryllium (4.4E-05) Arsenic (3.4E-05) Chromium (1.6E-06) Mercury (67.0) Cadmium (4.8) Zinc (3.6) Silver (0.69) Chromium (0.69) Selenium (0.67) Copper (0.59) Nickel (0.27) Arsenic (0.16)	<i>N</i> -Nitroso- <i>di-n</i> - propylamine (4.2E-02) Phenanthrene (7.1E-04) Pyrene (5.5E-04) Fluoranthene (5.5E-04)	Aroclor-1254 (5.6E-05)		Cs-137 (6.2E-04) Sr-90 (1.0E-05) Co-60 (8.9E-06) U-238 (1.6E-06)
Fish/ ingestion	Arsenic (3.6E-05) Mercury (1.2) Arsenic (0.32) Selenium (0.12)		Aroclor-1260 (4.1E-03) Aroclor-1254 (4.0E-04)	Chlordane (2.4E-05) 4,4'-DDT (1.3E-05) Aldrin (4.4E-06) 4,4'-DDE (1.6E-06) Chlordane (1.5) 4,4'-DDT (0.36)	Cs-137 (1.2E-06)
Water/ ingestion	Cyanide (0.14)				Pa-234 (2.8E-05) Pu-239 (8.8E-06) Pu-238 (6.1E-06) Th-228 (1.7E-06) Th-234 (1.7E-06) Cs-137 (1.2E-06)

Note: E format = cancer risk; decimal quantities = hazard quotient.

Table 2.4. Evaluation of Clinch River data from Reaches 2 and 4 for human health risk analysis

Pathway	Inorganics	Organics	PCBs	Pesticides	Radionuclides
Near-shore sediments	Insufficient number of samples	Insufficient number of samples	Insufficient number of samples	Insufficient number of samples	Sufficient for ¹³⁷ Cs and ⁶⁰ Co
Deep sediments	Insufficient number of samples	Insufficient number of samples	Insufficient number of samples	Insufficient number of samples	Relatively large number of samples; quality of data questionable
Fish (Fish from Brashear Island location have not been collected)	Probably sufficient if Phase 2 data include Brashear Island location (no catfish analyzed for metals)	Sufficient if Phase 2 data include Brashear Island location except for semivolatiles, but some Phase 2 data include semivolatiles	Sufficient if Phase 2 data include Brashear Island location	Sufficient if Phase 2 data include Brashear Island location	Sufficient with historical data and if Phase 2 data include Brashear Island location
Water	Insufficient number of samples	Insufficient number of samples	Insufficient number of samples	Insufficient number of samples	Insufficient number of samples

Note: Sufficiency in this table reflects the professional judgment of the risk assessors as to how well the data meet the following criteria: (1) sufficient data are available for statistical analyses; (2) the variability of data within and between different sources is known and is acceptable; (3) the procedures used in taking and analyzing the samples are acceptable; (4) the samples are spatially and temporally representative of the areas of concern; and (5) the data are representative of contaminants known to have been released from ORR in the past.

5. the data are representative of contaminants known to have been released from ORR in the past; and
6. professional experience and knowledge of the environmental cycling and fate of contaminants released from ORR.

By using historical data in a baseline risk assessment, data represented in Table 2.1 and supplemental data from the revised sampling plan should prove sufficient to conduct a baseline risk assessment that will satisfy the needs of EPA-IV, TDEC, DOE-ORO, and the public.

2.2.1 Exposure Pathways for a Human Health Risk Assessment

Historical and recently collected data are available for concentrations of organic, inorganic, and radiological contaminants in water, sediment, and biota for the Clinch River arm of WBR. Contaminant concentrations in these environmental media will be used in the following human health exposure pathways, as identified in the original Phase 2 Sampling and Analysis Plan:

<i>Fish</i>	<i>Water</i>	<i>Deep sediments</i>	<i>Near-shore sediments</i>
Ingestion	Ingestion Irrigation (associated pathways) Dermal exposure	Dredging (associated pathways) Inadvertent ingestion Inhalation of resuspended sediment	External exposure Dermal exposure Inadvertent ingestion Inhalation of resuspended sediment

2.2.2 Fish Ingestion Pathway for Reaches 2 and 4

Historical, TVA, Phase 1, and Phase 2 data for contaminant concentrations in fish that are currently available or are in the process of being analyzed are listed in Table 2.1. An additional collection of 20 fish near Brashear Island will complete the proposed Phase 2 fish sampling in Reaches 2 and 4. With these additional samples and the ones that are currently being analyzed (Table 2.1), the data for fish should be sufficient for conducting a human health baseline risk assessment for Reaches 2 and 4.

An additional site at Jones Island in Reach 2 has been added to the revised fish sampling plan (Sect. 3.4). Collections from this site are needed primarily for the ecological risk assessment and have not been included in Table 2.1; however, data from this collection will be used in the human health risk assessment. Reference sites for fish collections are also included in the revised fish sampling plan (Sect. 3.4). Contaminant concentrations from reference sites are needed to establish contaminant concentrations in areas not affected by releases from ORR. Fish from reference sites must be collected in such a manner and in sufficient number to provide sufficient data for statistical comparisons with data from reaches that receive effluents from ORR.

2.2.3 Near-Shore Sediment Exposure Pathways in Reaches 2 and 4

Near-shore sediment data—including historical data, Phase 1 data, and data collected since the completion of Phase 1 (CRRI+) sampling—are listed in Table 2.1. A relatively large number of grab samples have been collected and analyzed for ^{137}Cs and ^{60}Co (Table 2.1). The number of samples appears to be sufficient for evaluating the external exposure and ingestion pathways for ^{137}Cs and ^{60}Co for near-shore sediments in Reaches 2 and 4. However, for inorganic and organic contaminants in Reach 2, the data consist of only four grab samples. Data are not available for PCBs and pesticides; however, two near-shore core samples (CRRI+) are pending analysis. Because of the small number of samples, the near-shore sediment data for inorganic, organic, PCB, and pesticide concentrations in Reach 2 are judged to be insufficient for a baseline risk assessment. The revised sampling plan calls for a minimum of three additional near-shore core samples from Reach 2, analyzed for a complete suite of contaminants.

For Reach 4, the historical data are similar to that of Reach 2. The near-shore sediment samples are insufficient for organics and inorganics in Reach 4. Eight additional cores have been collected in the near-shore areas in Reach 4 and are being analyzed. However, because of the greater sediment deposition in Reach 4 and the greater use of the shoreline by the public, three additional cores are needed to sufficiently characterize the risk to human health from near-shore contaminants.

2.2.4 Deep Sediment Exposure Pathways in Reaches 2 and 4

For Reaches 2 and 4, historical data provide a relatively large number of samples for radionuclides in sediment cores. Oakes et al. (1982) collected 137 cores from Reach 2 and 89 cores from Reach 4 and analyzed them for ^{137}Cs and ^{60}Co . However, the data from the Oakes study cannot be used quantitatively in a baseline risk assessment.¹ This data can be used qualitatively to describe the contaminants in the sediments. The available data from both reaches are limited for inorganics, organics, PCBs, and pesticides and are insufficient to support a baseline risk assessment (Table 2.1). In both reaches, two cores collected during Phase 1 provide the only available data for a complete suite of contaminants. In Reach 4, an additional 12 cores have been collected and are being analyzed. A minimum of nine additional sediment cores (23 total) are needed from Reach 4. Because of the limited sediment accumulation in Reach 2, only three additional deep-sediment cores are needed from this reach.

A reference site will be needed in upper Melton Hill Reservoir. Five sediment cores should be collected from this area and analyzed for the complete suite of contaminants.

¹ Only small subsamples from relatively large sections (that were not homogenized) of the cores were analyzed for ^{137}Cs and ^{60}Co by gamma spectroscopy. In many of these cores, ^{137}Cs was not detected at 0.2 to 0.5 pCi/g dry wt detection limits. However, in many cores in which ^{137}Cs was not detected, ^{90}Sr and transuranic radionuclides were detected, often at depths exceeding 24 in. It appears highly unlikely, on the basis of the release records of ^{137}Cs , that cores with ^{137}Cs concentrations below detection limits would have measurable concentrations of ^{90}Sr and transuranic radionuclides at depths of 24 in. For these reasons, the data from Oakes et al. (1982) are questionable.

2.2.5 Water Exposure Pathways in Reaches 2 and 4

The water data currently available are very limited and are insufficient for conducting a baseline risk assessment. Only two grab samples from Reach 2 and three grab samples from Reach 4 were collected during the Phase 1 sampling. Historical data (data for the past 5 years) are limited primarily to NPDES data collected at discharge points and a limited number of surface-water monitoring stations (DOE 1992). The NPDES data cover a limited number of contaminants. The surface-water monitoring data are usually limited in the frequency of collection (2-month intervals), and the suite of analytes is not comprehensive. In addition, many of the samples are composited and held for 6 months before analysis.

2.3 EVALUATION OF EXISTING DATA FOR ASSESSING ECOLOGICAL RISKS

Screening assessments of contaminants in the Clinch River arm of WBR indicate that several contaminants have been detected at concentrations deemed hazardous to ecological receptors (Suter 1991; Cook et al. 1992). Of these contaminants, 13 chemicals have been reported at concentrations exceeding state water quality standards and national water quality criteria, 17 exceed effects range-low (ER-L) values in sediment or proposed sediment criteria based on equilibrium partitioning, and 10 exceed wildlife toxicity thresholds in fish flesh (Table 2.5). Therefore, there is an apparent ecological hazard. In addition, some potential ecological hazards cannot be evaluated with the type of contaminant analyses provided in existing data. Numerous chemicals could not be evaluated in the screening assessments because their detection limits were higher than ecotoxicity benchmarks. Also, some contaminants lack ecotoxicity data from which to derive benchmarks. Media toxicity tests, bioindicators, and biological surveys can integrate the effects of all contaminants—including those that are not detected or do not have sufficient ecological toxicity data—and account for interactive effects of contaminants. For these reasons, it was deemed necessary by DOE and the regulatory agencies to gather data appropriate to ecological risk assessment (DOE 1993).

As explained in the *Risk Assessment Guide for Superfund*, Vol. 2 (EPA 1989b), in the EPA's *Framework for Ecological Risk Assessment* (EPA 1992), and more specifically in Sect. 5 of the Phase 2 Sampling and Analysis Plan (DOE 1993), ecological risk assessments are based on effects on multiple endpoints and multiple lines of evidence. Table 2.6 presents a summary of the sufficiency of data for the Clinch River downstream of Melton Hill Dam (Reaches 2 and 4). This summary is based on reviews of the existing data for those reaches summarized in Tables 2.7 and 2.8. These reviews include historical data, Phase 1 data, and Phase 2 data that are either in hand or are expected to come from samples that have already been collected. Data sets were deemed insufficient if there were no data or too few data of the type required for ecological risk assessment (e.g., dissolved-phase water samples), if there was no replication, or if there were not enough analyses conducted in conjunction with biological samples (e.g., sediment analyses with benthic invertebrate surveys). The sufficiency of detection limits was not considered. Data sets were termed "analysis pending" if the results from samples collected in the partially completed Phase 2 sampling are not yet available. The availability of regulatory standards shows that it is not possible to default to comparison of measured concentrations to standards as a substitute for performing an ecological risk assessment. The only standards are the National Ambient Water Quality Criteria (NAWQC), which are also state water quality standards, and they are not available for all of the detected contaminants.

Table 2.9 summarizes the sampling and testing that is recommended for ecological risk assessment in the revised Phase 2 Sampling and Analysis Plan. These activities are described in more detail in subsequent sections. This presentation is intended to emphasize the relationship of the proposed activities to gaps in the ecological data set. Table 2.10 shows the reference sites and controls that are proposed for the ecological sampling and testing. It has been possible to cut sampling of reference sites back considerably because TVA and Tennessee Wildlife and Resources Agency (TWRA) ecological data for other reservoirs in the region, which previously were not considered to be of sufficient quality, are now considered potentially useful.

Table 2.5. Contaminants of potential concern for ecological risks in the Clinch River arm of Watts Bar Reservoir

In water	In sediment ^a		In fish
Aluminum	Arsenic	Anthracene	Antimony
Arsenic	Chromium	Aroclor-1254	Arsenic
Boron	Copper	Aroclor-1260	Mercury
Cadmium	Lead	Benzo(a)anthracene	Selenium
Chromium	Mercury	Bis(2-ethylhexyl)phthalate	Thallium
Copper	Nickel	Chrysene	Aldrin
Cyanide	Silver	DDT	Aroclor-1254
Iron	Zinc	Phenanthrene	Aroclor-1260
Lead		Pyrene	DDE
Mercury			DDT
Nickel			
Silver			
Zinc			

Note: Does not include undetected contaminants with detection limits above ecologically safe concentrations.

Sources: Suter 1991; Cook et al. 1992.

^aSediment concentrations reported in ORNL/ER-8 (Suter 1991) were rescreened against the EPA Region IV screening benchmarks (NOAA ER-Ls). This eliminated some metals and added some PAHs to the list.

Table 2.6. Evaluation of data for ecological risk assessment in the Clinch River arm of Watts Bar Reservoir

Scenario/endpoint	Biological surveys	Biological indicators	Media toxicity	Media concentrations	Regulatory standards	Overall adequacy
Current Baseline						
Fish	Analysis pending 2 ^{a,b} Insufficient 4 ^{c,d}	Insufficient	Insufficient	Insufficient (water)	NAWQC	Insufficient
Piscivorous wildlife	Analysis pending	Analysis pending	Analysis pending	Insufficient (fish)	None	Insufficient
Benthic invertebrates	Insufficient 2 & 4	—	Analysis pending	Insufficient 2 Analysis pending 4 (sed, inverts)	None	Insufficient 2 Analysis pending 4
Endangered bats	Assume present	—	—	Insufficient (invertebrates)	None	Insufficient
Baseline Dredging						
Fish	—	—	Analysis pending	Insufficient 2	NAWQC	Insufficient 2
Benthic invertebrates	—	—	Analysis pending	Analysis pending 4 (sediment)	None	Analysis pending 4
Terrestrial plants	—	—	—		None	
Soil heterotrophs	—	—	—		None	
Terrestrial herbivores	—	—	—		None	
Terrestrial predators	—	—	—		None	

^aReach 2.

^b"Analysis pending" indicates that samples have been collected but until analyses have been performed, it is not possible to determine whether the number and distribution of samples is sufficient.

^cReach 4.

^d"Insufficient" indicates that data of a particular type do not exist, do not exist in sufficient numbers, or are not sufficiently distributed in space or time.

Table 2.7. Quantity of existing data for ecological risk assessment in Reach 2, Clinch River arm, Watts Bar Reservoir

Scenario/endpoint	Biological surveys	Biological indicators	Media toxicity	Water concentrations	Sediment concentrations	Fish/invert. concentrations
Current Baseline						
Fish	Surveys: 1 CRR, 3 TVA (above WOC)	CRR suite: 32 fish/1 year TVA suite: 15 fish/1 year (above WOC)	1 site: 3 medaka 3 <i>Pimephales</i> 3 <i>Ceriodaphnia</i> (all CRR)	4 filtered water (CRR)	Pore water: 1 each, 2 sites (CRR)	0 Whole fish
Piscivorous wildlife	PCE heron nesting survey 3 years (S. Illinois U.)	PCE heron markers 3 years (S. Illinois U.)	PCE fish feeding test under way (Michigan St.)			(See Health Risk for Fillets)
Benthic invertebrates	3 surveys at 1 site (TVA)	—	1 site: 2 mussel 3 <i>Daphnia</i> 3 <i>Hyaella</i> 2 <i>Ceriodaphnia</i> 3 Microtox® 1 chromo (all CRR)	(See Health Risk for Unfiltered Water)	(See Health Risk for Whole Sediment)	0 invertebrates
Endangered bats	None	—	—			
Baseline Dredging						
Fish	—	—	None	—		—
Benthic invertebrates	—	—	None	—		—
Terrestrial plants	—	—	None	—		—
Soil heterotrophs	—	—	None	—		—
Terrestrial herbivores	—	—	—	—		—
Terrestrial predators	—	—	—	—		—

Table 2.8. Quantity of existing data for ecological risk assessment in Reach 4, Clinch River arm, Watts Bar Reservoir

Scenario/endpoint	Biological surveys	Biological indicators	Media toxicity	Water concentrations	Sediment concentrations	Fish/inverts. concentrations
Current Baseline						
Fish	Surveys: 1 CRR	CRR suite: 43 fish/1 year	1 site: 3 medaka 4 <i>Pimephales</i> 4 <i>Ceriodaphnia</i> (CRR)	4 filtered water (CRR)	Pore water: 1 each 20 sites (CRR)	32 whole shad 2 whole bass (PCBs)
Piscivorous wildlife	PCE heron nesting survey 3 years (S. Illinois U.)	PCE heron markers 3 years (S. Illinois U.)	PCE fish feeding test (Michigan St.)			(See Health Risk for Fillets)
Benthic invertebrates	1 survey at 3 sites (CRR)	—	1 site: 2 mussel 3 <i>Daphnia</i> 3 <i>Hyaella</i> 2 <i>Ceriodaphnia</i> 4 Microtox [•] 1 chromo (all CRR)	(See Health Risk for Unfiltered Water)	(See Health Risk for Whole Sediment)	1 Mayfly collection (CRR)
Endangered bats	None	—	—			
Baseline Dredging						
Fish	—	—	None	—		—
Benthic invertebrates	—	—	None	—		—
Terrestrial plants	—	—	None	—		—
Soil heterotrophs	—	—	None	—		—
Terrestrial herbivores	—	—	—	—		—
Terrestrial predators	—	—	—	—		—

Table 2.9. Proposed data collection to correct inadequacies of existing data for ecological risk assessment in the Clinch River arm of Watts Bar Reservoir. Details concerning numbers of samples and dates are presented in Section 3.

Scenario/endpoint	Biological surveys	Biological indicators	Media toxicity	Media concentrations
Current Baseline				
Fish	Spring surveys, 2 sites each reach; drop other sites	Perform fish indicators in conjunction with fish analyses	Complete planned water toxicity tests with TVA	Dissolved phase water analyses, on human health plan
Piscivorous wildlife	Spring heron rookery survey (S. Illinois U.)	Spring heron indicators (S. Illinois U.)	Complete mink test (Mich. St.)	Bass and catfish carcasses from Brashear Isl., Shad composites from Brashear and Jones Isl.
Benthic invertebrates	Spring survey (TVA)	—	Complete planned sediment toxicity tests with TVA	Complete sediment and pore water, focused based on COE data
Endangered bats	Assume present	—	—	Mayflies in 2 sites each reach, drop odonata
Baseline Dredging				
Fish	—	—	Complete planned sediment toxicity tests with TVA	Complete sediment and pore water, focused based on COE data
Benthic invertebrates	—	—	Complete planned sediment toxicity tests with TVA	
Terrestrial plants	—	—	—	
Soil heterotrophs	—	—	—	
Terrestrial herbivores	—	—	—	
Terrestrial predators	—	—	—	

Table 2.10. Reference sites and controls for sampling and testing performed in support of ecological risk assessment

Scenario/endpoint	Biological surveys	Biological indicators	Media toxicity	Media concentrations
Current Baseline				
Fish	Only CRM 22, Use TVA res. monitoring as appropriate	Only CRM 22, Use TVA res. monitoring as appropriate	CRM 22 and lab. water	Same as human health water sampling
Piscivorous wildlife	Tenn. River and Melton Hill colonies	Tenn. River and Melton Hill colonies	Ocean fish as control	Same as human health fish sampling
Benthic invertebrates	Only CRM 22, Use TVA res. monitoring as appropriate	—	CRM 22	Same as human health sediment sampling
Endangered bats	—	—	—	CRM 22
Baseline Dredging				
Fish	—	—	CRM 22	
Benthic invertebrates	—	—	CRM 22	Same as human health sediment sampling
Terrestrial plants	—	—	—	
Soil heterotrophs	—	—	—	
Terrestrial herbivores	—	—	—	
Terrestrial predators	—	—	—	

2.3.1 Fish Communities

Fish survey data. TVA has conducted fish community surveys at one station above White Oak Creek (CRM 22) for 3 years. One survey has been performed as part of the CRRI in Reach 2 at Jones Island and another in Reach 4 near Kingston. Additional fish community surveys are needed at Brashear Island to cover the end of Reach 4 nearest Poplar Creek and at CRM 22 to establish a reference upstream of White Oak Creek and to examine the similarity of TVA and CRRI results so that TVA results can be considered for use as regional reference data.

Fish biological indicators. TVA has measured some biological indicators in fish collected during the fish community surveys conducted at CRM 22. The CRRI studies have included fish bioindicators analysis for 1 year from Kingston and Jones Island. Additional fish bioindicators are needed at Brashear Island to cover the end of Reach 4 nearest Poplar Creek and at CRM 22 to establish a reference upstream of White Oak Creek and to examine the similarity of TVA and CRRI results so that TVA results can be considered for use as regional reference data.

Aquatic toxicity. Three separate types of ambient water toxicity tests have each been performed three or four times in Reach 2 and in Reach 4. Continuation of the planned testing through the spring and summer would complete an annual cycle, thus permitting the performance of split-sample tests with TVA.

Water contamination. The EPA has indicated that contaminant levels in the dissolved phase rather than total concentrations (dissolved plus suspended particles) should be used to estimate ecological effects of aqueous contaminants (Prothro 1993). Four filtered water samples were taken from each reach during Phase 1. Other existing water analyses are summarized in Sect. 2.2.5. The revised water sampling plan will provide data for two selected incidents for each of two seasons. Inferences from this data will depend on the assumption that they represent the events of interest, since they are purposive rather than frequency samples.

2.3.2 Piscivorous Wildlife

Heron nesting survey. A survey of breeding success has been performed for 2 years at a rookery on Poplar Creek and at a reference rookery on the Tennessee River arm. An additional rookery on Melton Hill Reservoir has been surveyed for 1 year. These studies show the production of eggs and chicks are similar at all colonies and similar to those reported in other studies. The spring 1994 survey should be completed as planned.

Heron biological indicators. Body burdens of mercury and PCBs have declined in heron chicks since 1991 but are still higher at the Poplar Creek colony than at the reference colonies. However, concentrations of mercury and PCBs in heron eggs have not similarly declined. Necropsy and biomarker results appear normal at all colonies, suggesting that the elevated exposures are not causing significant toxic effects. The spring 1994 analyses should be completed as planned.

Mink toxicity test. A reproductive toxicity test, using fish from Poplar Creek to feed mink, is under way. The dose-response relationship established by this test should be applicable to the Clinch River. The test is needed to determine the actual toxicity to mink from the combination of PCBs and mercury found in this system. Both contaminants have been reported at concentrations in fish that are potentially toxic to mink.

Fish contamination. PCB concentrations have been determined in 32 whole shad and 2 whole bass in Reach 4; however, this is representative of the lower end of Reach 4, near Kingston. No whole fish have been analyzed from upper Reach 4 or from Reach 2. Whole fish from Brashear Island and Jones Island should be analyzed for PCBs and selected metals. The results of these analyses would be used not only to estimate risks to piscivorous wildlife but also to help interpret the data concerning risks to fish.

2.3.3 Benthic Invertebrates

Benthic invertebrate surveys. TVA has performed benthic invertebrate surveys for 3 years below Jones Island (Reach 2), but these surveys do not focus on depositional areas and are not associated with contaminant analyses. Benthic invertebrate surveys for CRRRI have been conducted at three sites in Reach 4, but at none in Reach 2. The benthic invertebrate surveys should be completed by TVA as planned, but using the COE hydroacoustic survey results to focus sampling in depositional areas.

Sediment toxicity tests. Toxicity tests have been performed with whole sediment and sediment pore water from one site each in Reaches 2 and 4. Continuation of the planned testing through the spring and summer would complete an annual cycle, thus permitting the performance of split-sample tests with TVA.

Sediment contamination. EPA-IV has indicated that the screening portion of ecological risk assessments on sediments should be performed using ER-L's for whole sediments, although the EPA Office of Water has based its proposed method for deriving sediment quality criteria on estimation of pore water concentrations and comparison of those concentrations to NAWQC. Therefore, both whole sediment and pore water concentrations should be obtained. Whole sediment and pore water analyses have been performed at two sites in Reach 2 and at 19 sites in Reach 4. Additional sediment sampling should focus on previously uncharacterized depositional areas, as explained in the proposed revisions below.

2.3.4 Endangered Bats

Benthic invertebrate contamination. Mayflies have been collected only from lower Reach 4. Mayflies should be collected from upper Reach 4 and from Reach 2 as well, and all samples should be analyzed for metals and semivolatile organics. The results of these analyses would be used to estimate risks to bats and birds that feed on emergent aquatic insects, and also to help interpret the data concerning risks to fish and benthic invertebrates.

2.3.5 Baseline Dredging Scenarios

The whole sediment analyses are needed to estimate risks to terrestrial communities due to unregulated disposal of dredge spoil. The analyses and toxicity testing of pore water are needed to estimate risks to the aquatic community due to resuspension of contaminated sediments resulting from unregulated dredging.

2.3.6 Other Reaches

These reviews and recommendations are limited to Reaches 2 and 4. If sources in Melton Hill Reservoir are included in the assessment, additional data will be needed. In particular, sources in the McCoy Branch watershed have contaminated the McCoy Branch embayment with ash and ash leachate. These materials have been associated with extinction of all fish in upper McCoy Branch, gross deformities in fish in Rogers Quarry, and a depauperate fish community in lower McCoy Branch (Ryon 1992). No ecological studies have been performed in the McCoy Branch embayment to determine whether ecological effects extend into the off-site environment. If the embayment is included, sediment and water from the embayment should be tested for toxicity and whole fish analyses should be performed.

3. CHANGES TO THE PHASE 2 SAMPLING AND ANALYSIS PLAN

3.1 SAMPLING AND ANALYSIS APPROACH

This section describes changes to the Phase 2 Sampling and Analysis Plan, based on the evaluation of the sufficiency of existing data for site characterization/baseline risk assessment presented in Sect. 2. For those combinations of pathways, media, and contaminants for which existing historical or CRR1 (both Phase 1 and Phase 2) data are sufficient for performing a risk assessment and making a remedial decision, DOE-ORO is proposing that no additional sampling and analysis be conducted. Where the data are inadequate, a sampling and analysis plan would be designed to obtain the amount of information required to perform a baseline risk assessment and to make a remedial decision. Changes to the original Phase 2 Sampling and Analysis Plan are described for water in Sect. 3.2, for sediment in Sect. 3.3, and for biota in Sect. 3.4. Where the original plan is unchanged, the Phase 2 Sampling and Analysis Plan (DOE 1993) and the Remedial Investigation Work Plan (DOE 1990) contain the details of the sampling and analysis.

This section addresses primarily the proposed Clinch River OU (Reaches 1, 2, and 4). For some combinations of pathways, media, and contaminants, existing data in the Poplar Creek OU are sufficient for performing a baseline risk assessment or making remedial decisions. Accordingly, DOE-ORO is proposing changes to sampling and analysis in the proposed Poplar Creek OU so that the minimum amount of new data is collected in that OU as well.

The information for the Clinch River OU collected as part of this addendum will be used immediately to prepare an RI/FS report. Data collected from the new Poplar Creek OU would be used to first produce a data summary/screening level risk assessment report for Poplar Creek. The RI/FS report for Poplar Creek would be delayed until after completion of any remedial actions on lower EFPC.

3.2 WATER

3.2.1 Introduction

This section modifies the water characterization tasks described in Chapter 6 of the CRR1 Phase 2 Sampling and Analysis Plan (DOE 1993). The water sampling plan is primarily concerned with current releases from the ORR, as well as sediment flux from past DOE releases may result in unacceptable water quality conditions in the Clinch River. This addendum reflects a shift in the characterization strategy from a probabilistic sampling design intended to characterize average conditions in the Clinch River to a biased design intended to characterize worst-case conditions. The latter will be achieved by (1) restricting sampling to specific combinations of flow regimes for the ORR source streams, ORR groundwater, and the Clinch River; and (2) purposively sampling near ORR source streams. These data will be used to determine if contaminant concentrations resulting from these flow events result in unacceptable water quality or pose an unacceptable risk to human health or the environment. Though the uncertainty around such events may be large, higher uncertainty is acceptable in this investigation because of the limited remedial alternatives for water. Long-term monitoring data in conjunction with past dye-studies and current

aerial investigations of thermal dispersion in the Clinch River will be collected as specified in the ROD to further refine uncertainty estimates by characterizing contamination in the Clinch River over longer time-frames and evaluating any associated impacts.

Specifically, this addendum modifies the following: (1) subtask W1.1 (investigation of current contaminant sources) of Task W1; (2) the TVA Source Area Sampling Task; (3) subtasks W1.2, W1.3 and W1.4 of Task W1; and (4) Task W2 (toxicity testing) as described by DOE (1993). It also adds sample collection for evaluation of contaminant flux from the sediments. These changes are summarized in Table 3.1 and are described in detail below. The other water characterization tasks as specified in the Phase 2 Sampling and Analysis Plan (DOE 1993) remained unchanged.

3.2.2 Modifications to Subtask W1.1

Samples will be collected from the Clinch River at five general areas: (1) McCoy Branch Embayment; (2) the mouth of White Oak Creek; (3) mouth of Poplar Creek; (4) an area downstream of ORR sources; and (5) an upstream reference area in upper Melton Hill Reservoir. A comparison of the original and revised number of samples to be collected by this subtask are included in Table 3.1. Using the observational approach, the contaminant classes to be analyzed for will be tailored to match those known to be released from specific sites. Also, if contaminants are not detected above detection limits, then they may be dropped from further analysis.

McCoy Branch Embayment. Data from the McCoy Branch Embayment (Fig. 3.1) have been reviewed in order to assess the need for additional information to support ecological and human health risk assessments. The conclusions of this review are that water column arsenic concentrations in the McCoy Branch embayment area warrant further, immediate study. Documented seasonal changes in inorganic arsenic concentrations in the MCBE surface waters were related to changes in sediment chemistry, not changes in Rogers Quarry outfall values (Ford et al. 1993). Available evidence suggests that the sediments are serving as the secondary source of arsenic to the surface water. Samples will be collected from five sites: one site in the upper embayment, three from the lower embayment (a transect across the embayment sampled at 25%, 50%, and 75% of the channel), and at one site in the Clinch River far enough downstream to ensure full mixing of McCoy Branch and Clinch River waters (Fig. 3.2; Sect. 6.1.5.4, DOE 1993; Table 3.2).

White Oak Creek. Samples will be collected from five sites: one site in White Oak Creek Embayment, three sites in the Clinch River immediately below the mouth of White Oak Creek (along a transect that transverses Jones Island at 25%, 50% and 75% of the channels), and one midchannel site far enough downstream to ensure full mixing of White Oak Creek and Clinch River waters (Fig 3.3, Table 3.2).

Poplar Creek. Samples for biased sampling will be collected from five sites: one site in Poplar Creek, three sites in the Clinch River immediately below the mouth of Poplar Creek (along a transect as described above), and one midchannel site far enough downstream to ensure full mixing of Poplar Creek and Clinch River waters (Fig. 3.4, Table 3.2).

Table 3.1. Comparison and summary of the original with the revised number of sites and regular samples for water sample collection for Phase 2.

Reach	Reach descriptions	Subtask W1.1			Task W2		
		Original Phase 2 Plan	Proposed	Actual (Mar. 24, 1994)	Original Phase 2 Plan	Proposed	Actual (Mar. 9, 1994)
1	Melton Hill Reservoir ^a	64	11	3	None	2	0
2	Clinch River between White Oak Creek and Poplar Creek	64	15	2	8	8	4
3	Poplar Creek Embayment ^b	64	48	18	12	12	6
4	Clinch River downstream from Poplar Creek	64	18	1	4	4	2
10	Norris Reservoir	64	None	0	None	None	0
13	Poplar Creek Reference ^b	64	48	16	8	8	4
	McCoy Branch Embayment ^c	76	19	0	None	4	0
99	Upper Melton Hill	64	None	0	None	None	0
	Total Number of Samples^d	524	157	40	32	38	16

^aThis site is modified in the revised sampling and analysis plan to include only sites upstream from any active ORR inflows.

^bSampling conducted for winter quarter 1994 is included in these proposals and totals.

^cNumbers listed for the original Phase 2 plan included both W1.1 and W1.4.

^dThese totals do not include QA/QC samples, which add a maximum of 1 QC sample for every regular 17 samples to both the original and proposed addendum.

Fig. 3.1. McCoy Branch embayment area.

Fig. 3.2. Sample locations in McCoy Branch embayment for Task W1.1.

Table 3.2. Sample collection frequency for the DOE-ORO proposed revision to the Phase 2, Task W1.1 (investigation of current contaminant sources), Reaches 1, 2 and 4 only.

Site description	Oak Ridge Reservation flow regime	No. of site visits
White Oak Creek	High surface water, high baseflow	5
	Low surface water, high baseflow	5
	Low surface water, low baseflow	5
Poplar Creek	High surface water, high baseflow	5
	Low surface water, high baseflow	5
	Low surface water, low baseflow	5
McCoy Branch	High surface water, high baseflow	5
	Low surface water, high baseflow	5
	Low surface water, low baseflow	5
Upper Melton Hill	High surface water, high baseflow	3
	Low surface water, high baseflow	3
	Low surface water, low baseflow	3
Kingston City Park	High surface water, high baseflow	1
	Low surface water, high baseflow	1
	Low surface water, low baseflow	<u>1</u>
Total number of visits		57
Total number of samples + QC ^a , 2 quarters		69

Note: One composite sample from each site for each of the specified flow events will be collected between April and September, 1994. All samples will be analyzed for each of the analysis categories discussed in Sect. 6.1.7 (Phase 2 Sampling and Analysis Plan).

^aThe total number of quality control samples includes 1 field blank (FB), either 1 field collection equipment rinse blank (FRB) or 1 laboratory processing equipment rinse blank (LRB), and 1 field duplicate (FR) for every 17 regular or spike samples collected. Trip blanks (TB) and spike (SPK) samples are required with each sample batch by the analytical laboratories.

Fig. 3.3. Sample locations in White Oak Creek area for Task W1.1.

Fig. 3.4. Sample locations in Poplar Creek area for Task W1.1.

The Poplar Creek sampling proposed above is for use in characterizing Clinch River contaminants. It should be noted that the Phase 2 Sampling and Analysis Plan for characterizing Poplar Creek (DOE 1993) is not fundamentally changed by this addendum; only the number of samples has been reduced. A statistical analysis of appropriate existing data was applied to Poplar Creek in order to determine the sample sizes needed to achieve specified levels of power and the number of samples necessary to provide a 90% confidence interval (of acceptable width) of the mean contaminant concentrations. The statistical analysis took into account the heterogeneous nature of surface water in Poplar Creek as a major factor in the design of the water sampling subtask. This analysis indicated that a random collection of 16 samples from each Poplar Creek reach by season should produce results that would be technically defensible in terms of human health and ecological risk assessment (EPA 1989a, 1989b). The number of samples for Poplar Creek sampling in reaches 3 and 13 is included in Table 3.3.

Clinch River Integrator Site. One sample will be collected from the midchannel of the Clinch River downstream of all ORR surface water sources (Table 3.2).

Reference Site. Three samples will be collected from the midchannel of the Clinch River upstream of all ORR surface water sources (Table 3.2).

Each site at each location above will be sampled on three occasions, as determined by specified combinations of flow regimes for ORR surface water, ORR groundwater, and Clinch River water downstream of the Melton Hill Dam. The flow regimes of interest are (1) low flow in the Clinch combined with high ORR surface water and groundwater discharge (high rainfall winter or early spring conditions); (2) low flow in the Clinch combined with low ORR surface water and high ORR groundwater discharge (low rainfall winter or early spring condition); and (3) low flow in the Clinch combined with low ORR surface water and groundwater discharge (low rainfall summer conditions). Close coordination with TVA will be required to ensure that low flows in the Clinch coincide with the specified ORR flows.

A total of 57 samples for the Clinch River will be collected and analyzed for TAL metals, TCP organic contaminants, and selected radionuclides. All sites will be sampled during a single event representative of each specified combined flow regime.

The modified sampling and analysis plan for subtask W1.1 will enable a more efficient characterization of the worst-case conditions in the Clinch River and assessment of the risk associated with these events. This modified plan is the direct result of DOE's application of EPA's Data Quality Objectives (DQO) Process (EPA 1993) to the CRRI. The goal of the DQO process is to optimize environmental data collection such that only those data necessary for environmental decision-making are collected. The data collected through this plan, in conjunction with the existing data identified in Section 2 of this addendum, will be used in a baseline risk assessment to identify and support remedial decisions for the Clinch River OU.

3.2.3 Modifications to Subtask W1.4

This subtask, intended to characterize contaminant associated parameters downstream of known contaminant sources, has been canceled. The modified sampling plan for subtask W1.1 renders this subtask redundant.

Table 3.3. Sample collection frequency for the revised Phase 2 subtask W1.1 (investigation of current contaminant sources), Reaches 3 and 13 only

Type/reach	Site description	No. of site visits
Regular/3	Downstream, East Fork Poplar Creek confluence (PCM 5.1)	4
	Downstream K-1700 confluence (PCM 4.3)	4
	Downstream CNF confluence (PCM 2.9)	4
	Downstream K-1203 confluence (PCM 1.0)	<u>4</u>
	Total/quarter	16
Reference/13	PCM 6	4
	PCM 6.5	4
	PCM 7	4
	PCM 7.5	<u>4</u>
	Total/quarter	16
Total no. of visits/quarter		32
Total number of visits, 3 quarters		96
Total number of samples + QC, 3 quarters		<u>111</u>

Note: Four composite samples from each site will be collected per quarter between January and September 1994. See Sect. 6.1.5.1 of Cook et al. (1993) for details. All samples are to be analyzed for each of the analysis categories discussed in Sect. 6.1.7 of the Phase 2 Sampling and Analysis Plan.

The total number of quality control samples includes 1 field blank, 1 field collection equipment rinse blank or laboratory processing equipment rinse blank, and 1 field duplicate for every 20 regular or spike samples collected. Trip blanks and spike samples are required with each sample batch by the analytical laboratories.

3.2.4 Modifications to the TVA Source Area Sampling Plan

The scope of this sampling effort, intended to identify contaminant sources to the Clinch and Tennessee Rivers, will be reduced from 26 sites (DOE 1993) to 12. Samples will be collected only from the 9 sites previously identified from Reach 1, the two state of Tennessee Superfund sites at Rockwood in lower Watts Bar, and the one Emory River site. DOE is currently examining the records of state and federal agencies for the purpose of identifying known sources of contaminants to these rivers.

3.2.5 Modifications to Task W2

This task, designed to collect samples for water toxicity testing, has been expanded to include McCoy Branch (Table 3.1). Two samples will be collected from upper McCoy Branch Embayment and two from lower McCoy Branch Embayment. Sampling will cover two seasons (one sample per season from each site). No other changes to Task W2 are proposed. Melton Hill Reservoir, upstream from all DOE ORR inputs will serve as a reference site for this task for McCoy Branch Embayment, and will also be sampled twice. Samples described in subtask W1.1 will also be collected from these areas.

3.2.6 Sediment Resuspension or Release of Contaminants

The seasonal release of contaminants from the surface sediments into the surface water is well documented for some contaminants (Ford et al. 1993); mechanical resuspension of sediments and contaminants from sediments to the water column is poorly documented for the Clinch River. To evaluate the extent to which sediments serve as a contaminant source to the Clinch River surface water, a series of three samples per season from each area with high potential for mechanical or chemical remobilization from the sediments will be collected. Initially, the full suite of W1.1 analytes will be requested on samples collected from approximately 1 m above the sediments. Sites will be chosen within the following areas: the McCoy Branch Embayment, the Clinch River between Poplar Creek and the Emory river, the Kingston City Park area, and a reference site upstream from ORR input to the Clinch River for a total of 12 samples per season (Table 3.4). Sampling for each site is planned for spring and summer, reflecting the general understanding of the changes in sediment chemistry and Clinch River flow regimes. Sites will be chosen based on the actual location of sediment, as determined by practical knowledge of the Clinch River system.

3.2.7 Schedule

The task-by-task schedule of Phase 2 water sampling activities with milestones is included below (Table 3.5). Some of these milestones for completion of task- and reach- specific activities are target dates; actual completion of specific activities may vary by 2 to 4 weeks. These estimates will be finalized closer to the actual completion depending upon weather conditions and other sampling activities. The firm milestones for completion of all tasks are also indicated below and in Table 3.5. These milestones have been coordinated with the overall schedule for the CRRI, with the Clinch River OU report due to DOE in January 1995, the Data Summary Report on Poplar Creek due to DOE in June 1995, and the Remedial Effectiveness Monitoring Program Plan due to DOE in September 1995.

Table 3.4. Sample collection frequency for revision to the Phase 2 Water Sampling and Analysis Plan, Investigation of sediment resuspension or release of contaminants in the Clinch River.

Location description	No. of visits	Total no. of samples
Upper Melton Hill, above DOE-ORR influence	3	
McCoy Branch Embayment	3	
Clinch River between Poplar Creek and the Emory River	3	
Clinch River between the Emory and Tennessee Rivers	3	
Total # Visits / quarter	12	
Total number of visits, 2 quarters	24	
Total number of samples + QC*, 2 quarters		30

Note: Three samples from each location per quarter will be collected from approximately 1 m above the sediments between March and September 1994. All samples to be analyzed for each of the analysis categories discussed in Sect. 6.1.7 (Phase 2 Sampling and Analysis Plan).

The total number of quality control samples includes 1 field blank (FB), either 1 field collection equipment rinse blank (FRB) or 1 laboratory processing equipment rinse blank (LRB), and 1 field duplicate (FR) for every 17 regular or spike samples collected. Trip blanks (TB) and spike (SPK) samples are required with each sample batch by the analytical laboratories.

The following lists schedule and milestone dates for subtask W1.1:

1. Completion of January–March quarter sample collection in Poplar Creek (Reaches 3 and 13) scheduled for March 17, 1994, with a milestone date of March 30, 1994;
2. Completion of spring high surface water, high baseflow collection event from the Clinch River (Reaches 1, 2 and 4) by April 14, 1994, with a milestone of April 28, 1994;
3. Completion of spring low surface water, high baseflow collection event from the Clinch River (Reaches 1, 2 and 4) by April 7, with a milestone of April 28, 1994;
4. Completion of summer low surface water, low baseflow collection event from the Clinch River (Reaches 1, 2 and 4) by June 30, 1994, with a milestone of July 30, 1994;
5. Completion of April–June quarter sample collection in Poplar Creek (Reaches 3 and 13) by June 30, 1994, with a milestone of June 30, 1994; and
6. Completion of July–September quarter sample collection in Poplar Creek (Reaches 3 and 13) by September 30, 1994, with a milestone of September 30, 1994.

**Table 3.5. Schedule and milestone dates for the proposed Phase 2
Tasks W1.1 and W2 and sediment resuspension sampling and analysis plan.**

Task	Event	Estimated completion date	Milestone completion date
W1.1	Completion of January–March quarter sample collection in Poplar Creek (Reaches 3 and 13)	March 17, 1994	March 30, 1994
W1.1	Completion of spring high surface water, high baseflow collection event from the Clinch River (Reaches 1, 2, and 4)	April 14, 1994	April 28, 1994
W1.1	Completion of spring low surface water, high baseflow collection event from the Clinch River (Reaches 1, 2, and 4)	April 7, 1994	April 28, 1994
W1.1	Completion of summer low surface water, low baseflow collection event from the Clinch River (Reaches 1, 2, and 4)	June 30, 1994	July 30, 1994
W1.1	Completion of April–June quarter sample collection in Poplar Creek (Reaches 3 and 13)	June 30, 1994	June 30, 1994
W1.1	Completion of first July–September quarter high flow or low flow sample collection event from the Clinch River (Reaches 1, 2, and 4)	August 4, 1994	August 12, 1994
W1.1	Completion of July–September quarter sample collection in Poplar Creek (Reaches 3 and 13)	September 30, 1994	September 30, 1994
W1.1	Completion of April–June quarter sample collection for sediment resuspension (Reaches 1, 2, and 4)	June 30, 1994	June 30, 1994
W1.1	Completion of July–September quarter sample collection for sediment resuspension (Reaches 1, 2, and 4)	September 30, 1994	September 30, 1994
W2	Completion of spring ambient water toxicity testing for McCoy Branch, Poplar Creek, and the Clinch River	April 28, 1994	May 13, 1994
W2	Completion of summer ambient water toxicity testing for McCoy Branch, Poplar Creek, and the Clinch River	July 28, 1994	August 12, 1994

Milestones for sample collection in conjunction with the evaluation of sediment resuspension potential are as follows:

1. Completion of April–June quarter sample collection for sediment resuspension (Reaches 1, 2 and 4), by June 30 with a milestone of June 30, 1994; and
2. Completion of July–September quarter sample collection for sediment resuspension (Reaches 1, 2, and 4), by September 30, 1994, with a milestone of September 30, 1994.

The following lists schedule milestone dates for Task W2:

1. Completion of spring ambient water toxicity testing for Poplar Creek and the Clinch River, by April 28, 1994, with a milestone of May 13, 1994; and
2. Completion of summer ambient water toxicity testing for Poplar Creek and the Clinch River, by July 28, 1994, with a milestone of August 12, 1994.

3.3 SEDIMENT

3.3.1 Introduction

This section describes changes to the Sediment Section (Chapter 7) of the Phase 2 Sampling and Analysis Plan for the CRRI. A large reduction in the number of samples required to sufficiently characterize the sediment contamination in the Clinch River OU is proposed. This is mainly due to DOE-ORO's initiative to streamline the remedial investigation and is based on the initial results from the hydroacoustic survey of the sediments in the OU. Further Phase 2 sampling would be limited to those deposition areas not fully characterized before. In addition, the sampling design has previously been based on "hot spot" delineation, which required large numbers of samples. The hydroacoustic survey results should allow extrapolation of contaminant levels within deposition zones. This proposed change will provide a qualitative measure of certainty as opposed to the original quantitative method.

3.3.2 Changes to the Source Area Sampling Task S1A

The original Phase 2 Sampling and Analysis Plan called for 26 sites to be sampled for source area characterization. This included sites in Reaches 3, 5, and 10. All samples planned in Reach 3 (Poplar Creek) under this task have been eliminated because the same locations are being sampled as part of Task S1B. The three grab samples planned in Reach 5 (lower WBR) near the city of Rockwood will be collected. These samples will provide information on contaminants released to WBR from a state of Tennessee Superfund site. All samples planned to be collected from Reach 10 have been eliminated. These reference samples are not needed, given the number of reference samples being collected for Task S1B. All samples planned in Reach 1 (Melton Hill Reservoir) are still to be collected (a total of nine), and one sample will be collected in the Emory River. In this addendum, DOE-ORO is proposing to reduce the total number of sampling locations for the Source Area Sampling Task from 26 to 10.

3.3.3 Changes to the Delineation and Quantification Task, S1B

3.3.3.1 Background

Two events have occurred since the approval of the Phase 2 Sampling and Analysis Plan. First, a tentative agreement by the TDEC, EPA-IV, and DOE-ORO indicates that a sample design capable of detecting "hot spots" was not necessary and that a much reduced sampling design would suffice for risk assessment purposes. Second, the U.S. Army Corps of Engineers' hydroacoustic survey of the sediment in Reaches 2, 3, and 4 has been completed. Based on preliminary analysis of data collected during the Corps of Engineers Waterways Experiment Station's hydroacoustic survey, we can significantly reduce the number of sites necessary to

sufficiently characterize sediment contaminants and associated human health and ecological risks even further than previously hoped. Also, concerns expressed by DOE regarding the McCoy Branch Embayment in Melton Hill Reservoir have prompted the addition of several sampling locations.

3.3.3.2 Preliminary results of hydroacoustic survey

The hydroacoustic survey of sediment type and thickness was performed by a field crew from the U.S. Army Corps of Engineers from February 8 to February 16, 1994. Preliminary results indicate that sites sampled to date as part of Phase 2 were indeed in major sediment deposition zones. Results also indicate that much of Reach 2 does not have significant deposits of fine particles and the sampling plan can be drastically reduced. Sampling in Reach 4 can also be reduced significantly because of information of deposition patterns that the survey provided. Changes in sampling design resulting from the hydroacoustic survey were expected and described in the original Phase 2 Sampling and Analysis Plan.

Reach 2

There is little evidence of sediment accumulation in Reach 2 from CRM 14.5 to above the Highway 95 bridge (CRM 22). In this area the river bottom is made up of bedrock, hard clay, or rolling sands with some small and isolated areas of fine sediment. Since contaminants in sediment are typically associated with fine particles, no further sediment sampling in this area is warranted.

From the mouth of Poplar Creek (CRM 12) to CRM 14.5, there is some sediment deposition that is a mixture of sandy material and finer particles. Given the proximity of the K-770 facilities to this 2.5-mile stretch of river and known public use of this area, more sampling is warranted (we have one core from CRM 14.5 from Phase 1).

Reach 4

In Reach 4 there is a general trend of deposition of coarse-grained materials mixed with fine particles immediately below the mouth of Poplar Creek (CRM 12) grading down to almost entirely fine sediment starting at CRM 4 (just below the Emory River confluence) and extending all the way to CRM 0.

There is a major fine sediment deposition zone from CRM 0 to CRM 2.5 just below the Kingston Steam Plant outfall. This area has been sampled extensively as part of Phase 1 and early during Phase 2; therefore, no further sampling is required to characterize this area.

There is also sediment deposition between CRM 2.5 (above the Kingston Steam Plant outfall) up to CRM 4 (where the Emory River enters the Clinch). We have no data from this area, and there are several unique features that warrant collecting additional sediment data from this area. One of these is a submerged weir that TVA constructed to divert cold Clinch River water into the Emory River for cooling purposes. Also, there are some anomalies in the old river channel where the Emory River enters the Clinch. The area upstream and downstream of the weir and in the old river channel have accumulated significant volumes of fine sediment. It is possible that high concentrations of contaminants have accumulated in these sediments.

Between CRM 4 and CRM 9 there are many areas of sediment accumulation, the spatial distribution of which depends on the curvature of the river and the underlying geology. Sandy material typically has deposited on the inside of river bends. However, near CRM 7.1 there is a long stretch of finer sediment on an inside bank that has not been characterized for all contaminants. This is also an area with a number of houses along the floodplain with a lot of obvious shoreline activity by the residents. Throughout the 5-mile reach, slanting geologic layers interrupt the bottom of the river in varying angles from perpendicular to parallel to the river flow causing numerous deposition areas which have trapped finer particles. Several samples in these areas are also warranted.

From CRM 9 to CRM 12 (the Brashear Island area) a large amount of soft sandy mud has deposited. We have collected a number of samples in this area that sufficiently characterize it.

Reach 3

There are no preliminary hydroacoustic survey results available for Poplar Creek at this time, but they will be available by April 1994. The survey boat could navigate only to the first bridge crossing the creek, which is about PCM 2.3. Therefore, a little less than half of Reach 3 was surveyed.

3.3.3.3 Revised Phase 2 sediment sampling plan

This revised plan is based on preliminary results of the hydroacoustic sediment survey and the decision that the detection of "hot spots" is unnecessary. Additional analysis of the survey data may indicate further changes that could add to or subtract from the total number of samples recommended below.

Reach 2

As of February 28, 1994, we have collected sediment samples from two locations in Reach 2 as part of the S1B task. Because of the sediment accumulation patterns in the stretch between CRM 12 and CRM 14.5 and the proximity of the K-770 facilities, three additional samples from the deep channel are needed to sufficiently characterize this area. Four near-shore locations will be sampled to ensure that we have not missed a critical area of contamination and to provide data for direct exposure pathways. This would give us a total of nine sample locations from Phase 2 and two from Phase 1, plus historical data.

Reach 4

As of February 28, 1994, we have collected sediment samples from 20 locations in Reach 4 as part of the S1B task. We believe that we need to sample three deep-water locations and four near-shore locations between CRM 2.5 and CRM 4 and six locations (some near-shore and some deep) between CRM 4 and CRM 9 to completely characterize the contamination levels in Reach 4. This would give us a total of 33 sample locations from Phase 2 and two from Phase 1, plus historical data.

Reach 3

Because the preliminary hydroacoustic survey results for Reach 3 are not available at this time, we cannot revise the sampling plan based on distribution of sediment type. However, given the proposed DOE-ORO streamlined approach, we can reduce the original sample numbers. The original plan called for 100 sample locations in order to ensure that a hot spot was not missed. We feel we do not need more than 25 sample locations to sufficiently characterize Reach 3. This is an estimated maximum number pending the availability of survey results.

Reach 1

No sampling was planned as part of task S1B in Reach 1. Several areas are to be sampled by TVA as part of the Source Area Sampling Task S1A. Numerous samples of sediment and water have been collected in McCoy Branch, which is an embayment of Reach 1 that drains Rogers Quarry. These samples were analyzed for arsenic and several other inorganics. Recent DOE concerns for a broader array of contaminant analysis has prompted the need to collect additional sediment samples in the McCoy Branch Embayment. We propose to sample three locations in this area.

Reference reaches

The original plan called for 10 sampling locations from each of three reference reaches (Reach 10, Norris; Reach 13, West Fork Poplar Creek; and "above Reach 1," Upper Melton Hill Reservoir) and three sampling locations from Reach 18, the Tennessee River arm of Watts Bar. We suggest that five sampling locations each in Reach 13 and "above Reach 1" and three locations in Reach 18 are the absolute minimum that can be justified for risk assessment purposes. We also propose that Reach 10, Norris Reservoir, be dropped as a reference site. It is a very different system than the Clinch River/Watts Bar system and not an appropriate reference site. Originally, Norris Reservoir was to serve as a "background" reference reach. In the interest of cost and schedule, the need for a background reach has been reevaluated and dropped.

3.3.3.4 Total sample locations

The original Phase 2 Sampling and Analysis Plan (DOE 1993) called for 289 sample locations. As a result of the changes described above, this revised plan calls for 79 sample locations. Table 3.6 summarizes the number of sample locations from the original plan and the revised plan and provides a status report on the number of locations already sampled. Table 3.7 presents locations of samples already collected as part of the S1B task.

3.3.3.5 Sampling at each site

Sampling at each site will include collection of four cores (five at each of the Poplar Creek locations). One core each will be used for analysis of physical characteristics, another for metals concentrations, the third for organics concentrations, and the last for radionuclide concentrations. The additional Poplar Creek core will be analyzed for additional radionuclide concentrations. Each core will be split into two sections. The top 15 cm will be analyzed separately from the remaining portion of the core length. The top 15 cm of sediment is considered to be a reasonable depth to which aquatic organisms would be exposed. This will provide data relative to ecological

Table 3.6. Summary of original and revised number of planned sediment sample locations for each reach and number of samples already collected as part of Phase 2

Reach	Original Phase 2 plan	Revised Phase 2 plan	Sampled as of 28 Feb. 1994
1 (Melton Hill Reservoir)	0	3	0
2 (upper Clinch)	40	9	2
3 (Poplar Creek)	100	25	2
4 (lower Clinch)	116	33	20
5 (Lower Watts Bar)	85	3	0
10 (Norris)	10	0	0
13 (upper Poplar Cr.)	10	5	0
18 (Tenn. River Arm)	3	3	3
Upper Melton Hill	10	5	1
Total	374	83	28

Table 3.7. River mile locations of samples collected during Phase 2 as of February 28, 1994

Reach	River mile locations
2 (upper Clinch)	CRM 19, 21.5
3 (Poplar Creek)	PCM 0.5, 1.0
4 (lower Clinch)	CRM 0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 9.0 10.0R, 10.0L, 10.1R, 10.1L, 10.8R, 10.8L, 10.9R, 10.9L
13 (Tennessee River Arm)	TRM 570.8, 572.3, 573.8
Upper Melton Hill	CRM 51.5

risk assessment and a baseline with which to compare environmental monitoring data. To obtain information relative to human health risk assessment, data from the two layers will be combined. Additional surface sediment at each site will be collected, and pore-water will be extracted and analyzed for contaminant concentrations. This is to provide additional data relative to ecological risk exposure pathways. Specific contaminants to be analyzed in both sediment and pore-water are defined in the original Phase 2 plan and have not been changed.

3.3.3.6 Sampling schedule

A total of 20 locations remain to be sampled in Reaches 2 and 4. Sampling in Reaches 2 and 4 will commence upon approval of this addendum and be completed within 10 weeks thereafter. Sampling will continue in Reach 3 while this document is reviewed. Upon completion of sampling in Reaches 2 and 4, sampling will continue in Reach 3, Reach 1, and the reference reaches. Assuming this addendum is approved by April 1, the schedule in Table 3.8 can be met.

**Table 3.8. Sediment sampling schedule for Phase 2
Sampling and Analysis Plan addendum**

Location	Start	End
Reaches 2 and 4	April 1, 1994	June 1, 1994
Reach 1 and above	June 6, 1994	June 20, 1994
Reach 3	June 27, 1994	August 8, 1 994
Reach 13	August 15, 1994	August 29, 1994

3.3.4 Changes to Sediment Toxicity Task, S3

Several sites have been added to the sediment toxicity task because of the concern for ecological impacts in the McCoy Branch Embayments. Two samples will be collected from the embayments, one from the upper embayment and one from the lower embayment (Fig. 3.1). Also a sample from the Walker Branch Embayment will be collected to serve as a reference sample. This will occur once in the spring and once in the summer to account for seasonality of anoxic conditions in the sediment and pore water. Both whole sediment and pore-water toxicity tests will be performed on all samples.

3.4 BIOTA

The major components of this revision to the Phase 2 Sampling and Analysis Plan (DOE 1993) that are different from the original Phase 2 plan are (1) complete elimination of three sampling sites, (2) addition of biological (fish community) surveys at some sites, (3) addition of one site for limited contaminant analysis and biological indicator studies in the Clinch River above the confluence of White Oak Creek, and (4) addition of 15 samples for contaminant analysis in Reach 4 and three additional samples in Reach 2 that are needed for the ecological risk assessment.

As of February 25, 1994, we had completed (as a percentage of the number of samples proposed in the addendum to the Phase 2 Sampling and Analysis Plan) 47% of the biological surveys, 76% of the fish body burden collection and analysis, 57% of the bioindicator and reproductive analysis, and 17% of the invertebrate body burden studies. The completion dates for sampling of each subtask are shown in Table 3.9.

Table 3.9. Biota task schedules for the revised Phase 2 Sampling and Analysis Plan

Subtask	Field activities		Sample analysis	
	Start	End	Start	End
Contaminants in fish	End of March	First of May	August	December
Biological surveys	September	October		
Bioindicators	End of March	First of May	Mid-June	December
Reproductive competence	Mid-April	End of June	July	December
Other biota	March	August	April	November
Foodweb analysis	April	August	August	December

3.4.1 Biological Surveys

Biological surveys are one of the four critical components of the Ecological Risk Assessment (see Ecological Risk Assessment section, Sect 2.3, in the addendum to the Phase 2 Sampling and Analysis Plan). The biological surveys consist of conducting six or seven 10-min electrofishing runs at each site and tabulating the species and numbers of individual fish collected. In order to sample a diversity of fish habitats, both shoreline and midchannel sampling runs are conducted. These types of biological surveys are relatively cost-effective because once the field component is completed, no laboratory analyses are required. Information from the biological surveys is used for (1) ecological risk assessment and (2) as a baseline for evaluating long-term trends in the structure and composition of fish communities. In regard to the latter, the fish community survey information will be valuable in evaluating the effect of remedial actions at ORR sites on fish communities in the Poplar Creek, Clinch River, and Watts Bar systems. Sample locations for the fish community surveys are identified in Table 3.10.

3.4.2 Fish Contaminant Analysis

The major changes proposed in the revised Phase 2 Sampling and Analysis Plan compared to the original Phase 2 plan are eliminating those samples planned for (1) upper Chickamauga Reservoir (TRM 518), (2) Emory River (ERM 5), and (3) lower WBR (TRM 531). In addition, no samples will be taken at one of the two reference areas in Norris Reservoir (Powell River mile 30). The only additions to the fish contaminant analysis will be that ten catfish and three

Table 3.10. Proposed sample locations for fish community analysis

Location	Description	Rationale for sampling
CRM 22.0	Clinch River above mouth of White Oak Creek (WOC)	Upstream reference site for WOC effluents
CRM 20.6	Clinch River at Jones Island, below mouth of WOC	1993 survey indicated abnormal community structure
CRM 0.5	Clinch River at Kingston	Effects of upstream effluents to Clinch River are integrated at this site
PCM 5.3	Poplar Creek below mouth of East Fork Poplar Creek (EFPC)	Evaluate effects of East Fork Poplar Creek effluents
PCM 4.6	Poplar Creek below mouth of Mitchell Branch	Evaluate effects of Mitchell Branch effluents
PCM 0.5	Lower Poplar Creek	Effects of upstream effluents to Poplar Creek are integrated at this site
CRM 125	Norris Reservoir	Reference site

composite samples of five gizzard shad each will be collected at Brashear Island (CRM 9.5) for whole-body analysis of PCBs and selected heavy metals. Also, three composite samples of five gizzard shad each will be collected from Jones Island for whole-body analysis of PCBs and selected heavy metals. The shad analyses are needed for the ecological risk assessment.

3.4.3 Bioindicators

For this addendum to the Phase 2 Sampling and Analysis Plan, the major changes are eliminating those samples planned for (1) upper Chickamauga Reservoir (TRM 518), (2) Emory River (ERM 5), and (3) lower WBR (TRM 531). In addition, no samples will be taken at one of the reference areas in Norris Reservoir (Powell River mile 30). The only addition for the bioindicators component relative to the original Phase 2 Sampling and Analysis Plan is that ten largemouth bass and ten bluegill will be collected at CRM 22.0 above the mouth of White Oak Creek. This information is needed for the ecological risk assessment, and as discussed previously, this location serves as a reference site for evaluating the effects of White Oak Creek discharges on the health of fish in Reach 2 of the Clinch River. This information becomes even more relevant to the ecological risk assessment process when we consider that the results of the bioindicators study for fish collected from CRM 20.6 at Jones Island in spring 1993 indicated that these fish had obvious health problems. For example, elevated levels of detoxification enzymes in these fish indicated exposure to contaminants, and the histopathology data indicated damage to some critical organs, including the occurrence of pretumor-type lesions (preneoplastic focus) in liver tissue.

3.4.4 Invertebrate Body Burden Analysis

Two changes in this component of the biota task are (1) mayflies will be substituted for dragonfly larvae collections at CRM 0.5 and PCM 2.0, and (2) three mayfly collections will be added at both CRM 20.6 and CRM 9.5.

3.5 QUALITY ASSURANCE (QA)/QUALITY CONTROL

DOE-ORO is proposing to reduce the QA/QC documentation associated with samples collected during the revised Phase 2 Sampling and Analysis Program (Table 3.11). The revised plan will require laboratories to perform all analyses using methods from the EPA's Contract Laboratory Program (CLP). For those analytes not covered under CLP (e.g., radionuclides), DOE-ORO is proposing CLP-like methods (DOE 1993). In addition, we will decrease the extent of documentation requested from the service analytical laboratories. The laboratories will submit Level 4 documentation for 15% of the samples, and one-third of those samples with Level 4 documentation will be validated. Level 3 documentation will be required for the remaining 85% of the samples.

Table 3.11. Comparison and summary of the original and revised number of samples for each of the biota subtasks

Sampling Plan Status	Reach 2		Reach 4		Reach 3		
	CRM 20.6	CRM 22.0	CRM 9.5	CRM 0.5	PCM 5.3	PCM 4.6	PCM 0.5
<u>Original Phase 2 Plan</u>							
Biological Surveys	0	0	0	0	0	0	0
Fish Body Burdens ^a	87	0	33	105	30	9	72
Bioindicator and Reproductive ^b	40	0	20	60	20	20	40
Invertebrate Body Burden	0	0	0	6	0	0	6
<u>Revised Phase 2 Plan</u>							
Biological Surveys	2	1	2	2	2	2	2
Fish Body Burdens ^a	97	16	46	125	30	27	72
Bioindicator and Reproductive ^b	47	16	20	80	20	20	40
Invertebrate Body Burden	3	0	3	6	0	0	6
<u>Sampled as of 3/1/94</u>							
Biological Surveys	1	0	1	1	1	1	1
Fish Body Burdens ^a	80	0	13	105	10	8	62
Bioindicator and Reproductive ^b	33	0	0	60	0	0	40
Invertebrate Body Burden	0	0	0	3	0	0	0

Table 3.11 (continued)

	Reach 1	Reach 5	Reach 6	Reach 10	Reach 15	
Sampling plan status	CRM 51	CRM531	ERM 5	CRM 125	TRM 518	Total
<u>Original Phase 2 Plan</u>						
Biological Surveys	0	0	0	0	0	0
Fish Body Burdens ^a	18	33	8	105	6	506
Bioindicator and Reproductive ^b	20	20	20	60	20	340
Invertebrate Body Burden	0	0	0	0	0	12
<u>Revised Phase 2 Plan</u>						
Biological Surveys	0	0	0	2	0	15
Fish Body Burdens ^a	0	0	0	105	0	518
Bioindicator and Reproductive ^b	0	0	0	60	0	303
Invertebrate Body Burden	0	0	0	0	0	18
<u>Sampled as of 3/1/94</u>						
Biological Surveys	0	0	0	1	0	7
Fish Body Burdens ^a	18	13	0	85	0	394
Bioindicator and Reproductive ^b	0	0	0	40	0	173
Invertebrate Body Burden	0	0	0	0	0	3

^aIncludes four species: channel catfish, largemouth bass, bluegill, and gizzard shad.

^bIncludes largemouth bass and bluegill.

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APPENDIX

This appendix summarizes the number of detects and total number of observations in the various data sets examined during the revision of the Phase 2 Sampling and Analysis Plan. The data are grouped by category (fish, nearshore sediments, buried sediments, and water) and reach. Contaminants that were not detected in any of the data sets for a given category and reach are summarized in Tables A.1 through A.5. A common set of identifiers is used in all tables to distinguish the data sources (Table A.6). For the fish, the various species found in the data sets are also identified. The species codes used are also given in Table A.6.

Table A.1. Summary of detected (+) and nondetected (-) inorganic contaminants by reach and media. A plus (+) denotes a contaminant detected in at least one sample from a reach and media, while a minus (-) indicates that the contaminant was not detected in any sample from the reach and media. Blanks indicate that analytes were not analyzed.

Analyte	Reach 2				Reach 4			
	NSS ¹	DS ¹	Fish	Water	NSS	DS	Fish	Water
Alkalinity				+				+
Aluminum	+			+				+
Ammonia				+				+
Ammonia nitrogen				-				-
Antimony	+		-	-		+	-	-
Arsenic	+	+	+	+	-	+	+	-
Barium	+			+				+
Beryllium	+	+	-	-		+	-	-
Boron	+							
Cadmium	-	+	+	-	-	+	-	+
Calcium				+				+
Chloride				+				+
Chromium	+	+	-	-	+	+	-	-
Cobalt				-				-
Copper	+	+	-	+	+	+	-	+
Cyanide	+			-				-
Fluoride				+				+
Iron				+				+
Lead	+	+	+	-	+	+	-	+
Lithium	+							
Magnesium				+				+
Manganese	+			+				+
Mercury	+	+	+	-	+	+	+	-
Nickel	+	+	-	-	+	+	-	-
Nitrate				+				+
Nitrate nitrogen				+				+
Nitrate-nitrite				+				-

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Analyte	Reach 2				Reach 4			
	NSS ¹	DS ¹	Fish	Water	NSS	DS	Fish	Water
Phosphorous, total				+				+
Plutonium				+				
Potassium				+				+
Selenium	+	+	+	-	-	+	+	-
Silver	+	+	-	-	+	+	-	-
Sodium				+				+
Strontium				+				+
Sulfate				+				+
Thallium	-	-	-	-		-	-	-
Uranium		+		+				+
Vanadium	+			+				+
Zinc	+	+	+	+	+	+	+	+

¹ NSS: Nearshore sediment DS: Deep sediment

Table A.2. Summary of detected (+) and nondetected (-) organic contaminants by reach and media. A plus (+) denotes a contaminant detected in at least one sample from a reach and media, while a minus (-) indicates that the contaminant was not detected in any sample from the reach and media. Blanks indicate that analytes were not analyzed.

Analyte	Reach 2				Reach 4			
	NSS ¹	DS ¹	Fish	Water	NSS	DS	Fish	Water
1,1,1-Trichloroethane	-			-				
1,1,2,2-Tetrachloroethane	-			-				
1,1,2-Trichloroethane	-			-				
1,1-Dichloroethane	-			-				
1,1-Dichloroethylene	-			-				
1,2,4-Trichlorobenzene	-	-	-	-		-	-	-
1,2-Dichlorobenzene	-	-	-	-		-	-	-
1,2-Dichloroethane	-			-				
1,2-Dichloropropane	-			-				
1,3-Dichlorobenzene	-	-	-	-		-	-	-
1,4-Dichlorobenzene	-	-	-	-		-	-	-
2,4,5-Trichlorophenol		-	-	-		-	-	-
2,4,6-Trichlorophenol	-	-	-	-		-	-	-
2,4-Dichlorophenol	-	-	-	-		-	-	-
2,4-Dimethylphenol	-	-	-	-		-	-	-
2,4-Dinitrophenol	-	-	-	-		-	-	-
2,4-Dinitrotoluene	-	-	-	-		-	-	-
2,6-Dinitrotoluene	-	-	-	-		-	-	-
2-Chloroethyl vinyl ether	-			-				
2-Chloronaphthalene	-	-	-	-		-	-	-
2-Chlorophenol	-	-	-	-		-	-	-
2-Methylnaphthalene		+	-	-		-	-	-
2-Methylphenol		-	-	-		-	-	-
2-Nitroaniline		-	-	-		-	-	-
2-Nitrophenol	-	-	-	-		-	-	-
3,3'-Dichlorobenzidine	-	-	-	-		-	-	-
3-Nitroaniline		-		-		-	-	-

Analyte	Reach 2				Reach 4			
	NSS ¹	DS ¹	Fish	Water	NSS	DS	Fish	Water
4,6-Dinitro-2-methylphenol	-	-	-	-		-	-	-
4-Bromophenyl-phenylether	-	-	-	-		-	-	-
4-Chloro-3-methylphenol	-	-	-	-		-	-	-
4-Chloroaniline		-	-	-		-	-	-
4-Chlorophenyl-phenylether	-	-	-	-		-	-	-
4-Methylphenol		-	-	-		-	-	-
4-Nitroaniline		-	-	-		-	-	-
4-Nitrophenol	-	-	-	-		-	-	-
Acenaphthene	-	-	-	-		-	-	-
Acenaphthylene	-	-	-	-		-	-	-
Acrolein	-							
Acrylonitrile	-							
Anthracene	-	-	-	-	-	-	-	-
Benzene	-			-				
Benzydine	-			-				
Benzo(a)anthracene	+	+	-	-		-	-	-
Benzo(a)pyrene	-	+	-	-		-	-	-
Benzo(b)fluoranthene	-	+	-	-		-	-	-
Benzo(g,h,i)perylene	-	-	-	-		-	-	-
Benzo(k)fluoranthene		-	-	-		-	-	-
Benzoic acid		-	-	-		-	-	-
Benzyl alcohol		-	-	-		-	-	-
Bis(2-chloroethoxy)methane	-	-	-	-		-	-	-
Bis(2-chloroethyl)ether	-	-	-	-		-	-	-
Bis(2-chloroisopropyl)ether	-	-	-	-		-	-	-
Bis(2-ethylhexyl)phthalate	+	+	-	-	-	+	-	-
Bromoform	-			-				
Butylbenzylphthalate	-	-	-	-		-	-	-
Carbon tetrachloride	-			-				
Chlorobenzene	-			-				

Analyte	Reach 2				Reach 4			
	NSS ¹	DS ¹	Fish	Water	NSS	DS	Fish	Water
Chlorodibromomethane	-			-				
Chloroethane	-			+				
Chloroform	-			-				
Chloromethane	-			-				
Chrysene	-	+	-	-	-	-	-	-
Di-n-butylphthalate	-	+	-	+	-	-	-	-
Di-n-octylphthalate	-	-	-	-		-	-	-
Dibenz(a,h)anthracene	-	-	-	-		-	-	-
Dibenzofuran		-	-	-		-	-	-
Dichlorobromomethane	-			-				
Diethylphthalate	-	+	-	-		-	-	-
Dimethylphthalate	-	-	-	-		-	-	-
Ethylbenzene	-			-				
Fluoranthene	+	+	-	-	-	+	-	-
Fluorene	-	-	-	-		-	-	-
Hexachlorobenzene	-	-	-	-		-	-	-
Hexachlorobutadiene	-	-	-	-		-	-	-
Hexachlorocyclopentadiene	-	-	-	-		-	-	-
Hexachloroethane	-	-	-	-		-	-	-
Indeno(1,2,3-cd)pyrene	-	+	-	-		-	-	-
Isophorone	-	-	-	-		-	-	-
Methyl bromide	-			-				
Methylene chloride	-			+				
N-Nitroso-di-n-propylamine	-	-	-	-		+	-	-
N-Nitrosodimethylamine				-				
N-Nitrosodiphenylamine	-	-	-	-		-	-	-
Naphthalene	-	+	-	-		-	-	-
Nitrobenzene	-	-	-	-		-	-	-
Pentachlorophenol	-	-	-	-		-	-	-
Phenanthrene	+	+	-	-	-	+	-	-

Analyte	Reach 2				Reach 4			
	NSS ¹	DS ¹	Fish	Water	NSS	DS	Fish	Water
Phenol	-	-	-	-		-	-	-
Pyrene	+	+	-	-	-	+	-	-
Tetrachloroethylene	-			-				
Toluene	-			-				
Trichloroethylene	-			-				
Trichlorofluoromethane	-			-				
Vinyl chloride	-			-				
Xylene	-							
cis-1,3-Dichloropropene				-				
trans-1,2-Dichloroethylene				-				
trans- 1,2-Dichloropropene				-				

¹ NSS: Nearshore sediment DS: Deep sediment

Table A.3. Summary of detected (+) and nondetected (–) PCP contaminants by reach and media. A plus (+) denotes a contaminant detected in at least one sample from a reach and media, while a minus (–) indicates that the contaminant was not detected in any sample from the reach and media. Blanks indicate that analytes were not analyzed.

Analyte	Reach 2				Reach 4			
	NSS ¹	DS ¹	Fish	Water	NSS	DS	Fish	Water
Aroclor-1016	-	-	-	-		-	-	-
Aroclor-1221	-	-	-	-		-	-	-
Aroclor-1232	-	-	-	-		-	-	-
Aroclor-1242	-	-	-	-		-	-	-
Aroclor-1248	-	-	-	-		-	-	-
Aroclor-1254	-	+	+	-	-	+	+	-
Aroclor-1260	-	+	+	-	-	-	+	-

¹ NSS: Nearshore sediment DS: Deep sediment

Table A.4. Summary of detected (+) and nondetected (–) pesticide contaminants by reach and media. A plus (+) denotes a contaminant detected in at least one sample from a reach and media, while a minus (–) indicates that the contaminant was not detected in any sample from the reach and media. Blanks indicate that analytes were not analyzed.

Analyte	Reach 2				Reach 4			
	NSS ¹	DS ¹	Fish	Water	NSS	DS	Fish	Water
4,4'-DDD	-	-	-	-		-	+	-
4,4'-DDE	-	-	+	-		-	+	-
4,4'-DDT	-	-	+	-		-	+	-
Aldrin	-	-	+	-		-	+	-
Alpha-BHC	-	-	-	-		-	-	-
Alpha-Chlordane		-	+	-		-	+	-
Alpha-Chlordene			+				+	
Beta-BHC	-	-	-	-		-	-	-
Beta-Chlordene			-				+	
Chlordane	-							
Chlordene			-				-	
Delta-BHC	-	-	-	-		-	-	-
Dieldrin	-	-	-	-		-	+	-
Endosulfan I	-	-	-	-		-	+	-
Endosulfan II	-	-	-	-		-	-	-
Endosulfan sulfate	-	-	-	-		-	+	-
Endrin	-	-	-	-		-	+	-
Endrin aldehyde	-							
Endrin ketone		-		-		-		-
Gamma-BHC (Lindane)	-	-	-	-		-	-	-
Gamma-Chlordane		-	+	-		-	+	-
Gamma-Chlordene			+				+	
Heptachlor	-	-	-	-		-	-	-
Heptachlor epoxide	-	-	-	-		-	-	-
Methoxychlor	-	-		-		-		-
Mirex			-				-	
Oxychlordane			+				+	
Toxaphene	-	+	-	-		-	-	-

¹ NSS: Nearshore sediment DS: Deep sediment

Table A.5. Summary of detected (+) and nondetected (-) radionuclide contaminants by reach and media. A plus (+) denotes a contaminant detected in at least one sample from a reach and media, while a minus (-) indicates that the contaminant was not detected in any sample from the reach and media. Blanks indicate analytes were not analyzed.

Analyte	Reach 2				Reach 4			
	NSS ¹	DS ¹	Fish	Water	NSS	DS	Fish	Water
Ac-228		+						
Alpha, gross		+		+		+		+
Am-241	+	+			+	+		
Be-7	+				+			
Beta, gross		+		+		+		+
Bi-214		+						
Cm-242	-							
Cm-243,244	-	+				+		
Cm-244		+				+		
Cm-245,246		+				+		
Cm-248		+				+		
Co-60	+	+	-	+	+	+	-	+
Cs-137	+	+	+	+	+	+	+	+
Eu-152	-				-			
Eu-154	-				-			
Gamma, gross				+				+
H-3				+				+
Np-237				+				+
Pa-234				+				+
Pb-212		+						
Pb-214		+						
Pu-238	-	+		+		+		+
Pu-239		+		+		+		+
Pu-239,240	-	+				+		
Pu-241	-							
Pu-242	-							
Ra-226		+				+		

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Analyte	Reach 2				Reach 4			
	NSS ¹	DS ¹	Fish	Water	NSS	DS	Fish	Water
Sr-89	-	+						
Sr-90	-	+	+	+		+	+	+
Tc-99				+				+
Th-234		+		+				+
Tl-208		+						
U-234	-	+				+		
U-235	+	+			-	+		+
U-238	+	+			-	+		

¹ NSS: Nearshore sediment DS: Deep sediment

Table A.6. Data set and species identifiers

Identifier	Description
Data Sets	
Ashwood	Ashwood, T.L., C.R. Olsen, I.L. Larsen, and P.D. Lowry. 1986. Sediment Concentrations in Streams Surrounding the Oak Ridge Gaseous Diffusion Plant. ORNL/TM-9791
CRR1	CRR1 Phase 1 and Post-Phase 1 programs
Oakes	Oakes, T.W., et al. 1982. Technical Background Information for the Environmental and Safety Report, Vol: 5, The 1977 Clinch River Sediment Survey-Data Presentation. ORNL-5878
Olsen	Olsen, C.R., et al. 1992. Transport and Accumulation of Cesium-137 and Mercury in the Clinch River and Watts Bar Reservoir System. ORNL/ER-7
ORREM	Oak Ridge Reservation Environmental Reports, 1992-1993
ORTF	TVA. 1985. Instream Contaminant Study, Task 2, Sediment Characterization
TVA	TVA Reservoir Monitoring Program, 1989-1992
TVA-PU	TVA Recreation Areas and Water Intake study, 1990
Fish species	
BGL	Bluegill
CHC	Channel catfish
GSD	Gizzard shad
LMB	Largemouth bass
SAU	Sauger
STB	Stripped bass

Table A.7. Detected and total number of observations for inorganic contaminants in nearshore surface sediments in Reach 2

Analyte	Ashwood		TVA-PU	
	Det.	Obs.	Det.	Obs.
Aluminum			2	2
Antimony			1	2
Arsenic	0	2	2	2
Barium			2	2
Beryllium			1	2
Boron			2	2
Cadmium	0	2	0	2
Chromium	2	2	2	2
Copper	2	2	2	2
Cyanide			1	2
Lead	2	2	2	2
Lithium			2	2
Manganese			2	2
Mercury	2	2	1	2
Nickel	2	2	2	2
Selenium	2	2	0	2
Silver	1	2	0	2
Thallium			0	2
Vanadium			2	2
Zinc	2	2	2	2

Table A.8. Detected and total number of observations for organic contaminants in nearshore surface sediments in Reach 2

Analyte	Ashwood		TVA-PU	
	Det.	Obs.	Det.	Obs.
1,1,1-Trichloroethane			0	4
1,1,2,2-Tetrachloroethane			0	4
1,1,2-Trichloroethane			0	4
1,1-Dichloroethane			0	4
1,1-Dichloroethylene			0	4
1,2,4-Trichlorobenzene			0	2
1,2-Dichlorobenzene			0	2
1,2-Dichloroethane			0	4
1,2-Dichloropropane			0	4
1,3-Dichlorobenzene			0	2
1,4-Dichlorobenzene			0	2
2,4,6-Trichlorophenol			0	2
2,4-Dichlorophenol			0	2
2,4-Dimethylphenol			0	2
2,4-Dinitrophenol			0	2
2,4-Dinitrotoluene			0	2
2,6-Dinitrotoluene			0	2
2-Chloroethyl vinyl ether			0	4
2-Chloronaphthalene			0	2
2-Chlorophenol			0	2
2-Nitrophenol			0	2
3,3'-Dichlorobenzidine			0	2
4,6-Dinitro-2-methylphenol			0	2
4-Bromophenyl-phenylether			0	2
4-Chloro-3-methylphenol			0	2
4-Chlorophenyl-phenylether			0	2
4-Nitrophenol			0	2
Acenaphthene			0	2
Acenaphthylene			0	2

Analyte	Ashwood		TVA-PU	
	Det.	Obs.	Det.	Obs.
Acrolein			0	4
Acrylonitrile			0	4
Anthracene	0	2	0	2
Benzene			0	4
Benzidine			0	2
Benzo(a)anthracene			1	2
Benzo(a)pyrene			0	2
Benzo(b)fluoranthene			0	2
Benzo(g,h,i)perylene			0	2
Benzo(k)fluoranthene			0	2
Bis(2-chloroethoxy)methane			0	2
Bis(2-chloroethyl)ether			0	2
Bis(2-chloroisopropyl)ether			0	2
Bis(2-ethylhexyl)phthalate	1	2	1	2
Bromoform			0	4
Butylbenzylphthalate			0	2
Carbon tetrachloride			0	4
Chlorobenzene			0	4
Chlorodibromomethane			0	4
Chloroethane			0	4
Chloroform			0	4
Chloromethane			0	4
Chrysene	0	2	0	2
Di-n-butylphthalate	0	2	0	2
Di-n-octylphthalate			0	2
Dibenz(a,h)anthracene			0	2
Dichlorobromomethane			0	4
Diethylphthalate			0	2
Dimethylphthalate			0	2
Ethylbenzene			0	4

Analyte	Ashwood		TVA-PU	
	Det.	Obs.	Det.	Obs.
Fluoranthene	0	2	1	2
Fluorene			0	2
Hexachlorobenzene			0	2
Hexachlorobutadiene			0	2
Hexachlorocyclopentadiene			0	2
Hexachloroethane			0	2
Indeno(1,2,3-cd)pyrene			0	2
Isophorone			0	2
Methyl bromide			0	4
Methylene chloride			0	4
N-Nitroso-di-n-propylamine			0	2
N-Nitrosodiphenylamine			0	2
Naphthalene			0	2
Nitrobenzene			0	2
Pentachlorophenol			0	2
Phenanthrene	0	2	1	2
Phenol			0	2
Pyrene	0	2	1	2
Tetrachloroethylene			0	4
Toluene			0	4
Trichloroethylene			0	4
Trichlorofluoromethane			0	4
Vinyl chloride			0	4
Xylene			0	1

Table A.9. Detected and total number of observations for PCB contaminants in nearshore surface sediments in Reach 2

Analyte	Ashwood		TVA-PU	
	Det.	Obs.	Det.	Obs.
Aroclor-1016			0	2
Aroclor-1221			0	2
Aroclor-1232			0	2
Aroclor-1242			0	2
Aroclor-1248			0	2
Aroclor-1254	0	2	0	2
Aroclor-1260	0	2	0	2

Table A.10. Detected and total number of observations for pesticide contaminants in nearshore surface sediments in Reach 2

Analyte	TVA-PU	
	Det.	Obs.
4,4'-DDD	0	2
4,4'-DDE	0	2
4,4'-DDT	0	2
Aldrin	0	2
Alpha-BHC	0	2
Beta-BHC	0	2
Chlordane	0	2
Delta-BHC	0	2
Dieldrin	0	2
Endosulfan I	0	2
Endosulfan II	0	2
Endosulfan sulfate	0	2
Endrin	0	2
Endrin aldehyde	0	2
Gamma-BHC (Lindane)	0	2
Heptachlor	0	2
Heptachlor epoxide	0	2
Methoxychlor	0	1
Toxaphene	0	2

Table A.11. Detected and total number of observations for radionuclide contaminants in nearshore surface sediments in Reach 2

Analyte	Ashwood		CRR I		TVA-PU	
	Det.	Obs.	Det.	Obs.	Det.	Obs.
Am-241			4	39	0	1
Be-7	8	16	11	40		
Cm-242					0	1
Cm-243,244					0	1
Co-60	15	16	68	81		
Cs-137	16	16	81	81	1	1
Eu-152			0	40		
Eu-154			0	40		
K-40			40	40		
Pu-238					0	1
Pu-239,240					0	1
Pu-241					0	1
Pu-242					0	1
Sr-89					0	1
Sr-90					0	1
U-234					0	1
U-235	3	16			0	1
U-238	3	163			0	1

Table A.12. Detected and total number of observations for inorganic contaminants in nearshore surface sediments in Reach 4

Analyte	Ashwood	
	Det.	Obs.
Arsenic	0	1
Cadmium	0	1
Chromium	1	1
Copper	1	1
Lead	1	1
Mercury	1	1
Nickel	1	1
Selenium	0	1
Silver	1	1
Zinc	1	1

Table A.13. Detected and total number of observations for organic contaminants in nearshore surface sediments in Reach 4

Analyte	Ashwood	
	Det.	Obs.
Anthracene	0	1
Bis(2-ethylhexyl)phthalate	0	1
Chrysene	0	1
Di-n-butylphthalate	0	1
Fluoranthene	0	1
Phenanthrene	0	1
Pyrene	0	1

Table A.14. Detected and total number of observations for PCB contaminants in nearshore surface sediments in Reach 4

Analyte	Ashwood	
	Det.	Obs.
Aroclor-1254	0	1
Aroclor-1260	0	1

Table A.15. Detected and total number of observations for radionuclide contaminants in nearshore surface sediments in Reach 4

Analyte	Ashwood		CRR	
	Det.	Obs.	Det.	Obs.
Am-241			3	21
Be-7	1	5	11	22
Co-60	5	5	108	114
Cs-137	5	5	112	112
Eu-152			0	22
Eu-154			0	22
K-40			22	22
U-235	0	5		
U-238	0	5		

Table A.16. Detected and total number of observations for inorganic contaminants in buried sediments in Reach 2

Analyte	CRRI		ORTF	
	Det.	Obs.	Det.	Obs.
Arsenic	2	2		
Beryllium	2	2		
Cadmium	2	2		
Chromium	2	2		
Copper	2	2		
Lead	2	2		
Mercury	2	2	1	1
Nickel	2	2		
Selenium	2	2		
Silver	2	2		
Thallium	0	2		
Uranium			1	1
Zinc	2	2		

Table A.17. Detected and total number of observations for organic contaminants in buried sediments in Reach 2

Analyte	CRR	
	Det.	Obs.
1,2,4-Trichlorobenzene	0	2
1,2-Dichlorobenzene	0	2
1,3-Dichlorobenzene	0	2
1,4-Dichlorobenzene	0	2
2,4,5-Trichlorophenol	0	2
2,4,6-Trichlorophenol	0	2
2,4-Dichlorophenol	0	2
2,4-Dimethylphenol	0	2
2,4-Dinitrophenol	0	2
2,4-Dinitrotoluene	0	2
2,6-Dinitrotoluene	0	2
2-Chloronaphthalene	0	2
2-Chlorophenol	0	2
2-Methylnaphthalene	1	2
2-Methylphenol	0	2
2-Nitroaniline	0	2
2-Nitrophenol	0	2
3,3'-Dichlorobenzidine	0	2
3-Nitroaniline	0	2
4,6-Dinitro-2-methylphenol	0	2
4-Bromophenyl-phenylether	0	2
4-Chloro-3-methylphenol	0	2
4-Chloroaniline	0	2
4-Chlorophenyl-phenylether	0	2
4-Methylphenol	0	2
4-Nitroaniline	0	2
4-Nitrophenol	0	2
Acenaphthene	0	2
Acenaphthylene	0	2
Anthracene	0	2

Analyte	CRRJ	
	Det.	Obs.
Benzo(a)anthracene	1	2
Benzo(a)pyrene	1	2
Benzo(b)fluoranthene	1	2
Benzo(g,h,i)perylene	0	2
Benzo(k)fluoranthene	0	2
Benzoic acid	0	2
Benzyl alcohol	0	2
Bis(2-chloroethoxy)methane	0	2
Bis(2-chloroethyl)ether	0	2
Bis(2-chloroisopropyl)ether	0	2
Bis(2-ethylhexyl)phthalate	2	2
Butylbenzylphthalate	0	2
Chrysene	1	2
Di-n-butylphthalate	2	2
Di-n-octylphthalate	0	2
Dibenz(a,h)anthracene	0	2
Dibenzofuran	0	2
Diethylphthalate	1	2
Dimethylphthalate	0	2
Fluoranthene	2	2
Fluorene	0	2
Hexachlorobenzene	0	2
Hexachlorobutadiene	0	2
Hexachlorocyclopentadiene	0	2
Hexachloroethane	0	2
Indeno(1,2,3-cd)pyrene	1	2
Isophorone	0	2
N-Nitroso-di-n-propylamine	0	2
N-Nitrosodiphenylamine	0	2
Naphthalene	1	2
Nitrobenzene	0	2
Pentachlorophenol	0	2

Analyte	CRRl	
	Det.	Obs.
Phenanthrene	2	2
Phenol	0	2
Pyrene	2	2

Table A.18. Detected and total number of observations for PCB contaminants in buried sediments in Reach 2

Analyte	CRR I	
	Det.	Obs.
Aroclor-1016	0	2
Aroclor-1221	0	2
Aroclor-1232	0	2
Aroclor-1242	0	2
Aroclor-1248	0	2
Aroclor-1254	1	2
Aroclor-1260	1	2

Table A.19. Detected and total number of observations for pesticide contaminants in buried sediments in Reach 2

Analyte	CRR I	
	Det.	Obs.
4,4'-DDD	0	2
4,4'-DDE	0	2
4,4'-DDT	0	2
Aldrin	0	2
Alpha-BHC	0	2
Alpha-Chlordane	0	2
Beta-BHC	0	2
Delta-BHC	0	2
Dieldrin	0	2
Endosulfan I	0	2
Endosulfan II	0	2
Endosulfan sulfate	0	2
Endrin	0	2
Endrin ketone	0	2
Gamma-BHC (Lindane)	0	2
Gamma-Chlordane	0	2
Heptachlor	0	2
Heptachlor epoxide	0	2
Methoxychlor	0	2
Toxaphene	1	2

Table A.20. Detected and total number of observations for radionuclide contaminants in buried sediments in Reach 2

Analyte	CRR		ORTF		Oakes		Olsen	
	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.
Ac-228			1	1				
Alpha, gross			2	2				
Am-241	2	2	1	1	7	64		
Beta, gross			2	2				
Bi-214			1	1				
Cm-243,244	2	2						
Cm-244			1	1				
Cm-245,246	1	1						
Cm-248	1	1						
Co-60	2	2	1	1	37	137	2	2
Cs-137	2	2	1	1	80	137	2	2
K-40			1	1				
Pb-212			1	1				
Pb-214			1	1				
Pu-238	2	2	1	1	60	64		
Pu-239			1	1				
Pu-239,240	2	2			64	64		
Ra-226			1	1				
Sr-89			1	1				
Sr-90	2	2	1	1	64	64		
Th-234			1	1				
Tl-208			1	1				
U-234	2	2						
U-235	2	2						
U-238	2	2

2 of 2

Table A.21. Detected and total number of observations for inorganic contaminants in buried sediments in Reach 4

Analyte	Ashwood		CRRI		ORTF	
	Det.	Obs.	Det.	Obs.	Det.	Obs.
Antimony			1	2		
Arsenic	1	1	2	2		
Beryllium			2	2		
Cadmium	1	1	2	2		
Chromium	1	1	2	2		
Copper	1	1	2	2		
Lead	1	1	2	2		
Mercury	1	1	2	2	2	2
Nickel	1	1	2	2		
Selenium	1	1	1	2		
Silver	1	1	1	1		
Thallium			0	2		
Zinc	1	1	2	2		

Table A.22. Detected and total number of observations for organic contaminants in buried sediments in Reach 4

Analyte	Ashwood		CRR1	
	Det.	Obs.	Det.	Obs.
1,2,4-Trichlorobenzene			0	2
1,2-Dichlorobenzene			0	2
1,3-Dichlorobenzene			0	2
1,4-Dichlorobenzene			0	2
2,4,5-Trichlorophenol			0	2
2,4,6-Trichlorophenol			0	2
2,4-Dichlorophenol			0	2
2,4-Dimethylphenol			0	2
2,4-Dinitrophenol			0	2
2,4-Dinitrotoluene			0	2
2,6-Dinitrotoluene			0	2
2-Chloronaphthalene			0	2
2-Chlorophenol			0	2
2-Methylnaphthalene			0	2
2-Methylphenol			0	2
2-Nitroaniline			0	2
2-Nitrophenol			0	2
3,3'-Dichlorobenzidine			0	2
3-Nitroaniline			0	2
4,6-Dinitro-2-methylphenol			0	2
4-Bromophenyl-phenylether			0	2
4-Chloro-3-methylphenol			0	2
4-Chloroaniline			0	2
4-Chlorophenyl-phenylether			0	2
4-Methylphenol			0	2
4-Nitroaniline			0	2
4-Nitrophenol			0	2
Acenaphthene			0	2
Acenaphthylene			0	2

Analyte	Ashwood		CRR I	
	Det.	Obs.	Det.	Obs.
Anthracene	0	1	0	2
Benzo(a)anthracene			0	2
Benzo(a)pyrene			0	2
Benzo(b)fluoranthene			0	2
Benzo(g,h,i)perylene			0	2
Benzo(k)fluoranthene			0	2
Benzoic acid			0	2
Benzyl alcohol			0	2
Bis(2-chloroethoxy)methane			0	2
Bis(2-chloroethyl)ether			0	2
Bis(2-chloroisopropyl)ether			0	2
Bis(2-ethylhexyl)phthalate	0	1	1	2
Butylbenzylphthalate			0	2
Chrysene	0	1	0	2
Di-n-butylphthalate	0	1	0	2
Di-n-octylphthalate			0	2
Dibenz(a,h)anthracene			0	2
Dibenzofuran			0	2
Diethylphthalate			0	2
Dimethylphthalate			0	2
Fluoranthene			1	2
Fluorene			0	2
Hexachlorobenzene			0	2
Hexachlorobutadiene			0	2
Hexachlorocyclopentadiene			0	2
Hexachloroethane			0	2
Indeno(1,2,3-cd)pyrene			0	2
Isophorone			0	2
N-Nitroso-di-n-propylamine			1	2
N-Nitrosodiphenylamine			0	2

Analyte	Ashwood		CRR I	
	Det.	Obs.	Det.	Obs.
Naphthalene			0	2
Nitrobenzene			0	2
Pentachlorophenol			0	2
Phenanthrene	0	1	1	2
Phenol			0	2
Pyrene	0	1	1	2

Table A.23. Detected and total number of observations for PCB contaminants in buried sediments in Reach 4

Analyte	Ashwood		CRRI	
	Det.	Obs.	Det.	Obs.
Aroclor-1016			0	2
Aroclor-1221			0	2
Aroclor-1232			0	2
Aroclor-1242			0	2
Aroclor-1248			0	2
Aroclor-1254	0	1	2	2
Aroclor-1260	0	1	0	2

Table A.24. Detected and total number of observations for pesticide contaminants in buried sediments in Reach 4

Analyte	CRR I	
	Det.	Obs.
4,4'-DDD	0	2
4,4'-DDE	0	2
4,4'-DDT	0	2
Aldrin	0	2
Alpha-BHC	0	2
Alpha-Chlordane	0	2
Beta-BHC	0	2
Delta-BHC	0	2
Dieldrin	0	2
Endosulfan I	0	2
Endosulfan II	0	2
Endosulfan sulfate	0	2
Endrin	0	2
Endrin ketone	0	2
Gamma-BHC (Lindane)	0	2
Gamma-Chlordane	0	2
Heptachlor	0	2
Heptachlor epoxide	0	2
Methoxychlor	0	2
Toxaphene	0	2

Table A.25. Detected and total number of observations for radionuclide contaminants in buried sediments in Reach 4

Analyte	Ashwood		CRR1		ORTF		Oakes		Olsen	
	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.
Alpha, gross					2	2				
Am-241			1	1	2	2	5	49		
Beta, gross					2	2				
Cm-243,244			1	1						
Cm-244					2	2	5	49		
Cm-245,246			1	1						
Cm-248			1	1						
Co-60	1	1	4	5			39	89	2	2
Cs-137	1	1	5	5			63	89	2	2
Pu-238			1	1	1	1	49	49		
Pu-239					2	2				
Pu-239,240			1	1			47	49		
Ra-226	1	1								
Sr-90			1	1			49	49		
U-234			1	1						
U-235	1	1	1	1						
U-238	1	1	1	1						

Table A.26. Detected and total number of observations for inorganic contaminants in fish in Reach 2

Analyte	BGL		CHC		LMB	
	CRRI		TV/A		CRRI	
	Det.	Obs.	Det.	Obs.	Det.	Obs.
Antimony	0	11	0	1	0	2
Arsenic	3	11	1	1	2	2
Beryllium	0	11	0	1	0	2
Cadmium	0	11	1	1	0	2
Chromium	0	11	0	1	0	2
Copper	0	11	0	1	0	2
Lead	0	11	1	1	0	2
Mercury	11	11	1	1	2	2
Nickel	0	11	0	1	0	2
Selenium	10	11	1	1	1	2
Silver	0	11			0	2
Thallium	0	11	0	1	0	2
Zinc	11	11	1	1	2	2

Table A.27. Detected and total number of observations for organic contaminants in fish in Reach 2

Analyte	CHC	
	CRR	
	Det.	Obs.
1,2,4-Trichlorobenzene	0	8
1,2-Dichlorobenzene	0	8
1,3-Dichlorobenzene	0	8
1,4-Dichlorobenzene	0	8
2,4,5-Trichlorophenol	0	8
2,4,6-Trichlorophenol	0	8
2,4-Dichlorophenol	0	8
2,4-Dimethylphenol	0	8
2,4-Dinitrophenol	0	8
2,4-Dinitrotoluene	0	8
2,6-Dinitrotoluene	0	8
2-Chloronaphthalene	0	8
2-Chlorophenol	0	8
2-Methylnaphthalene	0	8
2-Methylphenol	0	8
2-Nitroaniline	0	8
2-Nitrophenol	0	8
3,3'-Dichlorobenzidine	0	8
4,6-Dinitro-2-methylphenol	0	8
4-Bromophenyl-phenylether	0	8
4-Chloro-3-methylphenol	0	8
4-Chloroaniline	0	2
4-Chlorophenyl-phenylether	0	8
4-Methylphenol	0	8
4-Nitroaniline	0	8
4-Nitrophenol	0	8
Acenaphthene	0	8
Acenaphthylene	0	8

Analyte	CHC	
	CRR I	
	Det.	Obs.
Anthracene	0	8
Benzo(a)anthracene	0	8
Benzo(a)pyrene	0	8
Benzo(b)fluoranthene	0	8
Benzo(g,h,i)perylene	0	8
Benzo(k)fluoranthene	0	8
Benzoic acid	0	8
Benzyl alcohol	0	8
Bis(2-chloroethoxy)methane	0	8
Bis(2-chloroethyl)ether	0	8
Bis(2-chloroisopropyl)ether	0	8
Bis(2-ethylhexyl)phthalate	0	8
Butylbenzylphthalate	0	8
Chrysene	0	8
Di-n-butylphthalate	0	8
Di-n-octylphthalate	0	8
Dibenz(a,h)anthracene	0	8
Dibenzofuran	0	8
Diethylphthalate	0	8
Dimethylphthalate	0	8
Fluoranthene	0	8
Fluorene	0	8
Hexachlorobenzene	0	8
Hexachlorobutadiene	0	8
Hexachlorocyclopentadiene	0	8
Hexachloroethane	0	8
Indeno(1,2,3-cd)pyrene	0	8
Isophorone	0	8
N-Nitroso-di-n-propylamine	0	8

Analyte	CHC	
	CRR	
	Det.	Obs.
N-Nitrosodiphenylamine	0	8
Naphthalene	0	8
Nitrobenzene	0	8
Pentachlorophenol	0	8
Phenanthrene	0	8
Phenol	0	8
Pyrene	0	8

Table A.28. Detected and total number of observations for PCB contaminants in fish in Reach 2

Analyte	CHC				SAU		STB	
	CRR1		TVA		TVA		TVA	
	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.
Aroclor-1016			0	1	0	12	0	3
Aroclor-1221			0	1	0	12	0	3
Aroclor-1232			0	1	0	12	0	3
Aroclor-1242			0	1	0	12	0	3
Aroclor-1248			0	1	0	12	0	3
Aroclor-1254	9	10	1	1	3	12	3	3
Aroclor-1260	14	14	1	1	10	12	3	3
PCBs, total			1	1			1	1

Table A.29. Detected and total number of observations for pesticide contaminants in fish in Reach 2

Analyte	CHC				SAU		STB	
	CRR1		TVA		TVA		TVA	
	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.
4,4'-DDD	0	14	0	1			0	1
4,4'-DDE	6	13	1	1			1	1
4,4'-DDT	2	13	0	1			0	1
Aldrin	2	14	0	1			0	1
Alpha-BHC			0	1			0	1
Alpha-Chlordane	9	10	1	1	0	2	1	1
Alpha-Chlordene	2	13	0	1	0	12	0	3
Beta-BHC			0	1			0	1
Beta-Chlordene			0	1			0	1
Chlordene	0	14	0	1	0	12	0	3
Delta-BHC			0	1			0	1
Dieldrin			0	1			0	1
Endosulfan I			0	1			0	1
Endosulfan II			0	1			0	1
Endosulfan sulfate			0	1			0	1
Endrin			0	1			0	1
Gamma-BHC (Lindane)			0	1			0	1
Gamma-Chlordane	8	11	1	1	0	12	0	3
Gamma-Chlordene	2	14	0	1	0	12	0	3
Heptachlor			0	1			0	1
Heptachlor epoxide			0	1			0	1
Mirex			0	1			0	1
Oxychlordane	6	11	0	1	0	4	0	3
Toxaphene			0	1			0	1

Table A.30. Detected and total number of observations for radionuclide contaminants in fish in Reach 2

Analyte	BGL		CHC		LMB	
	CRR1		CRR1		CRR1	
	Det.	Obs.	Det.	Obs.	Det.	Obs.
Co-60	0	11	0	14	0	2
Cs-137	10	11	11	14	2	2
Sr-90			6	6		

Table A.31. Detected and total number of observations for inorganic contaminants in fish in Reach 4

Analyte	BGL		LMB	
	CRRI		CRRI	
	Det.	Obs.	Det.	Obs.
Antimony	0	19	0	8
Arsenic	17	19	8	8
Beryllium	0	19	0	8
Cadmium	0	19	0	8
Chromium	0	19	0	8
Copper	0	19	0	8
Lead	0	9	0	8
Mercury	19	19	8	8
Nickel	0	19	0	8
Selenium	10	19	4	8
Silver	0	19	0	8
Thallium	0	19	0	8
Zinc	19	19	8	8

Table A.32. Detected and total number of observations for organic contaminants in fish in Reach 4

Analyte	CHC	
	CRR I	
	Det.	Obs.
1,2,4-Trichlorobenzene	0	6
1,2-Dichlorobenzene	0	6
1,3-Dichlorobenzene	0	6
1,4-Dichlorobenzene	0	6
2,4,5-Trichlorophenol	0	13
2,4,6-Trichlorophenol	0	13
2,4-Dichlorophenol	0	14
2,4-Dimethylphenol	0	14
2,4-Dinitrophenol	0	13
2,4-Dinitrotoluene	0	6
2,6-Dinitrotoluene	0	6
2-Chloronaphthalene	0	6
2-Chlorophenol	0	14
2-Methylnaphthalene	0	6
2-Methylphenol	0	13
2-Nitroaniline	0	5
2-Nitrophenol	0	13
3,3'-Dichlorobenzidine	0	6
3-Nitroaniline	0	2
4,6-Dinitro-2-methylphenol	0	13
4-Bromophenyl-phenylether	0	6
4-Chloro-3-methylphenol	0	15
4-Chloroaniline	0	6
4-Chlorophenyl-phenylether	0	6
4-Methylphenol	0	14
4-Nitroaniline	0	2
4-Nitrophenol	0	13
Acenaphthene	0	6

Analyte	CHC	
	CRR	
	Det.	Obs.
Acenaphthylene	0	6
Anthracene	0	6
Benzo(a)anthracene	0	6
Benzo(a)pyrene	0	6
Benzo(b)fluoranthene	0	6
Benzo(g,h,i)perylene	0	6
Benzo(k)fluoranthene	0	6
Benzoic acid	0	2
Benzyl alcohol	0	6
Bis(2-chloroethoxy)methane	0	6
Bis(2-chloroethyl)ether	0	6
Bis(2-chloroisopropyl)ether	0	6
Bis(2-ethylhexyl)phthalate	0	6
Butylbenzylphthalate	0	6
Chrysene	0	6
Di-n-butylphthalate	0	6
Di-n-octylphthalate	0	6
Dibenz(a,h)anthracene	0	6
Dibenzofuran	0	6
Diethylphthalate	0	6
Dimethylphthalate	0	6
Fluoranthene	0	6
Fluorene	0	6
Hexachlorobenzene	0	6
Hexachlorobutadiene	0	6
Hexachlorocyclopentadiene	0	6
Hexachloroethane	0	6
Indeno(1,2,3-cd)pyrene	0	6
Isophorone	0	6

Analyte	CHC	
	CRR	
	Det.	Obs.
N-Nitroso-di-n-propylamine	0	6
N-Nitrosodiphenylamine	0	6
Naphthalene	0	6
Nitrobenzene	0	6
Pentachlorophenol	0	13
Phenanthrene	0	6
Phenol	0	13
Pyrene	0	6

Table A.33. Detected and total number of observations for PCB contaminants in fish in Reach 4

Analyte	CHC				GSD		LMB				SAU	
	CRRl		TVA		TVA		CRRl		TVA		TVA	
	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.
Aroclor-1016	0	10	0	18	0	15	0	10	0	1	0	29
Aroclor-1221	0	10	0	18	0	15	0	10	0	1	0	29
Aroclor-1232	0	10	0	18	0	15	0	10	0	1	0	29
Aroclor-1242	0	10	0	18	0	15	0	10	0	1	0	29
Aroclor-1248	0	10	0	18	0	15	0	10	0	1	0	29
Aroclor-1254	25	28	15	18	14	15	10	10	1	1	26	29
Aroclor-1260	27	28	15	18	15	15	10	10	0	1	29	29
PCBs, total			17	18					1	1	10	10

Table A.34. Detected and total number of observations for pesticide contaminants in fish in Reach 4

Analyte	CHC				GSD		LMB				SAU	
	CRR1		TVA		TVA		CRR1		TVA		CRR1	
	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.
4,4'-DDD	4	18	0	10								
4,4'-DDE	12	18	6	10								
4,4'-DDT	1	18	3	10								
Aldrin	2	14	1	10								
Alpha-BHC			0	10								
Alpha-Chlordane	17	28	16	18	2	15	1	10	1	1	1	2
Alpha-Chlordene	8	28	1	18	0	15	0	10	0	1	0	20
Beta-BHC			0	10								
Beta-Chlordene			6	18					0	1	0	1
Chlordene	0	28	0	18	0	15	0	10	0	1	0	20
Delta-BHC			0	10								
Dieldrin			1	10								
Endosulfan I			4	10								
Endosulfan II			0	10								
Endosulfan sulfate			1	10								
Endrin			2	10								
Gamma-BHC (Lindane)			0	10								

Analyte	CHC				GSD		LMB				SAU	
	CRRI		TVA		TVA		CRRI		TVA		CRRI	
	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.	Det.	Obs.
Gamma-Chlordane	18	28	14	18	5	15	10	10	1	1	1	20
Gamma-Chlordene	9	27	1	18	0	15	0	10	0	1	0	20
Heptachlor			0	18					0	1	0	1
Heptachlor epoxide			0	18					0	1	0	1
Mirex			0	10								
Oxychlordane	10	28	7	18	0	15	0	10	0	1	0	10
Toxaphene			0	10								

Table A.35. Detected and total number of observations for radionuclide contaminants in fish in Reach 4

Analyte	BGL		CHC		LMB	
	CRRI		CRRI		CRRI	
	Det.	Obs.	Det.	Obs.	Det.	Obs.
Co-60	0	13	0	17	0	8
Cs-137	12	14	9	18	7	8
Sr-90			10	10		

Table A.36. Detected and total number of observations for inorganic contaminants in water in Reach 2

Analyte	CRR1		ORREM	
	Det.	Obs.	Det.	Obs.
Alkalinity			8	8
Aluminum			8	8
Ammonia			8	8
Ammonia nitrogen			0	10
Antimony	0	4	0	8
Arsenic	0	4	1	17
Barium			8	8
Beryllium	0	4	0	8
Cadmium	0	4	0	17
Calcium	4	4	8	8
Chloride			8	8
Chromium	0	4	0	17
Cobalt			0	8
Copper	1	4	1	17
Cyanide			0	15
Fluoride			3	16
Iron	3	4	5	8
Lead	0	4	0	17
Magnesium	4	4	8	8
Manganese			17	17
Mercury	0	4	0	17
Nickel	0	4	0	17
Nitrate			8	8
Nitrate nitrogen			4	6
Nitrate-nitrite			1	2
Phosphorous, total			5	8
Plutonium			3	3
Potassium	4	4	2	6
Selenium	0	4	0	8

Analyte	CRR I		ORREM	
	Det.	Obs.	Det.	Obs.
Silver	0	4	0	8
Sodium	4	4	17	17
Strontium			8	8
Sulfate			17	17
Thallium	0	4	0	6
Uranium			2	15
Vanadium			3	8
Zinc	1	4	5	17

Table A.37. Detected and total number of observations for organic contaminants in water in Reach 2

Analyte	CRRI		ORREM	
	Det.	Obs.	Det.	Obs.
1,1,1-Trichloroethane			0	4
1,1,2,2-Tetrachloroethane			0	4
1,1,2-Trichloroethane			0	4
1,1-Dichloroethane			0	4
1,1-Dichloroethylene			0	4
1,2,4-Trichlorobenzene	0	2	0	4
1,2-Dichlorobenzene	0	2	0	8
1,2-Dichloroethane			0	4
1,2-Dichloropropane			0	4
1,3-Dichlorobenzene	0	2	0	8
1,4-Dichlorobenzene	0	2	0	8
2,4,5-Trichlorophenol	0	1		
2,4,6-Trichlorophenol	0	1	0	4
2,4-Dichlorophenol	0	1	0	4
2,4-Dimethylphenol	0	1	0	4
2,4-Dinitrophenol	0	1	0	4
2,4-Dinitrotoluene	0	2	0	4
2,6-Dinitrotoluene	0	2	0	4
2-Chloroethyl vinyl ether			0	4
2-Chloronaphthalene	0	2	0	4
2-Chlorophenol	0	1	0	4
2-Methylnaphthalene	0	2		
2-Methylphenol	0	1		
2-Nitroaniline	0	2		
2-Nitrophenol	0	1	0	4
3,3'-Dichlorobenzidine	0	2	0	4
3-Nitroaniline	0	2		
4,6-Dinitro-2-methylphenol	0	1	0	4
4-Bromophenyl-phenylether	0	2	0	4

Analyte	CRRI		ORREM	
	Det.	Obs.	Det.	Obs.
4-Chloro-3-methylphenol	0	1	0	4
4-Chloroaniline	0	2		
4-Chlorophenyl-phenylether	0	2	0	4
4-Methylphenol	0	1		
4-Nitroaniline	0	2		
4-Nitrophenol	0	1	0	4
Acenaphthene	0	2	0	4
Acenaphthylene	0	2	0	4
Anthracene	0	2	0	4
Benzene			0	4
Benzidine			0	4
Benzo(a)anthracene	0	2	0	4
Benzo(a)pyrene	0	2	0	4
Benzo(b)fluoranthene	0	2	0	4
Benzo(g,h,i)perylene	0	2	0	4
Benzo(k)fluoranthene	0	2	0	4
Benzoic acid	0	2		
Benzyl alcohol	0	2		
Bis(2-chloroethoxy)methane	0	2	0	4
Bis(2-chloroethyl)ether	0	2	0	4
Bis(2-chloroisopropyl)ether	0	2	0	4
Bis(2-ethylhexyl)phthalate	0	2	0	4
Bromoform			0	4
Butylbenzylphthalate	0	2	0	4
Carbon tetrachloride			0	4
Chlorobenzene			0	4
Chlorodibromomethane			0	4
Chloroethane			2	4
Chloroform			0	4
Chloromethane			0	4

Analyte	CRRI		ORREM	
	Det.	Obs.	Det.	Obs.
Chrysene	0	2	0	4
Di-n-butylphthalate	0	2	1	4
Di-n-octylphthalate	0	2	0	4
Dibenz(a,h)anthracene	0	2	0	4
Dibenzofuran	0	2		
Dichlorobromomethane			0	4
Diethylphthalate	0	2	0	4
Dimethylphthalate	0	2	0	4
Ethylbenzene			0	4
Fluoranthene	0	2	0	4
Fluorene	0	2	0	4
Hexachlorobenzene	0	2	0	4
Hexachlorobutadiene	0	2	0	4
Hexachlorocyclopentadiene	0	2	0	4
Hexachloroethane	0	2	0	4
Indeno(1,2,3-cd)pyrene	0	2	0	4
Isophorone	0	2	0	4
Methyl bromide			0	4
Methylene chloride			2	4
N-Nitroso-di-n-propylamine	0	2	0	4
N-Nitrosodimethylamine			0	4
N-Nitrosodiphenylamine	0	2	0	4
Naphthalene	0	2	0	4
Nitrobenzene	0	2	0	4
Pentachlorophenol	0	1	0	4
Phenanthrene	0	2	0	4
Phenol	0	1	0	4
Pyrene	0	2	0	4
Tetrachloroethylene			0	4
Toluene			0	4

Analyte	CRR I		ORREM	
	Det.	Obs.	Det.	Obs.
Trichloroethylene			0	4
Trichlorofluoromethane			0	4
Vinyl chloride			0	4
cis-1,3-Dichloropropene			0	4
trans-1,2-Dichloroethylene			0	4
trans-1,3-Dichloropropene			0	4

**Table A.38. Detected and total number of observations for PCB
contaminants in water in Reach 2**

Analyte	CRR I	
	Det.	Obs.
Aroclor-1016	0	2
Aroclor-1221	0	2
Aroclor-1232	0	2
Aroclor-1242	0	2
Aroclor-1248	0	2
Aroclor-1254	0	2
Aroclor-1260	0	2

Table A.39. Detected and total number of observations for pesticide contaminants in water in Reach 2

Analyte	CRR I	
	Det.	Obs.
4,4'-DDD	0	2
4,4'-DDE	0	2
4,4'-DDT	0	2
Aldrin	0	2
Alpha-BHC	0	2
Alpha-Chlordane	0	2
Beta-BHC	0	2
Delta-BHC	0	2
Dieldrin	0	2
Endosulfan I	0	2
Endosulfan II	0	2
Endosulfan sulfate	0	2
Endrin	0	2
Endrin ketone	0	2
Gamma-BHC (Lindane)	0	2
Gamma-Chlordane	0	2
Heptachlor	0	2
Heptachlor epoxide	0	2
Methoxychlor	0	2
Toxaphene	0	2

Table A.40. Detected and total number of observations for radionuclide contaminants in water in Reach 2

Analyte	CRRI		ORREM	
	Det.	Obs.	Det.	Obs.
Alpha, gross			17	17
Beta, gross			17	17
Co-60	0	2	8	8
Cs-137	1	2	17	17
Gamma, gross			3	3
H-3			8	8
Np-237			9	9
Pa-234			7	8
Pu-238			6	6
Pu-239			8	8
Sr-90	2	2		
Tc-99			16	17
Th-234			8	8

Table A.41. Detected and total number of observations for inorganic contaminants in water in Reach 4

Analyte	CRR1		ORREM	
	Det.	Obs.	Det.	Obs.
Alkalinity			4	4
Aluminum			4	4
Ammonia			4	4
Ammonia nitrogen			0	3
Antimony	0	6	0	4
Arsenic	0	6	0	7
Barium			4	4
Beryllium	0	4	0	4
Cadmium	1	6	0	7
Calcium	4	4	4	4
Chloride			4	4
Chromium	0	4	0	7
Cobalt			0	4
Copper	0	4	1	7
Cyanide			0	6
Fluoride			2	7
Iron	2	4	3	4
Lead	2	6	0	7
Magnesium	4	4	4	4
Manganese			7	7
Mercury	0	6	0	7
Nickel	0	4	0	7
Nitrate			4	4
Nitrate nitrogen			1	2
Nitrate-nitrite			0	1
Phosphorous, total			3	4
Potassium	4	4	1	3
Selenium	0	6	0	4
Silver	0	6	0	4

Analyte	CRR I		ORREM	
	Det.	Obs.	Det.	Obs.
Sodium	4	4	7	7
Strontium			4	4
Sulfate			7	7
Thallium	0	6	0	3
Uranium			2	6
Vanadium			1	4
Zinc	0	4	2	7

Table A.42. Detected and total number of observations for organic contaminants in water in Reach 4

Analyte	CRR I	
	Det.	Obs.
1,2,4-Trichlorobenzene	0	2
1,2-Dichlorobenzene	0	2
1,3-Dichlorobenzene	0	2
1,4-Dichlorobenzene	0	2
2,4,5-Trichlorophenol	0	2
2,4,6-Trichlorophenol	0	2
2,4-Dichlorophenol	0	2
2,4-Dimethylphenol	0	2
2,4-Dinitrophenol	0	2
2,4-Dinitrotoluene	0	2
2,6-Dinitrotoluene	0	2
2-Chloronaphthalene	0	2
2-Chlorophenol	0	2
2-Methylnaphthalene	0	2
2-Methylphenol	0	2
2-Nitroaniline	0	2
2-Nitrophenol	0	2
3,3'-Dichlorobenzidine	0	2
3-Nitroaniline	0	2
4,6-Dinitro-2-methylphenol	0	2
4-Bromophenyl-phenylether	0	2
4-Chloro-3-methylphenol	0	2
4-Chloroaniline	0	2
4-Chlorophenyl-phenylether	0	2
4-Methylphenol	0	2
4-Nitroaniline	0	2
4-Nitrophenol	0	2
Acenaphthene	0	2
Acenaphthylene	0	2

Analyte	CRRI	
	Det.	Obs.
Anthracene	0	2
Benzo(a)anthracene	0	2
Benzo(a)pyrene	0	2
Benzo(b)fluoranthene	0	2
Benzo(g,h,i)perylene	0	2
Benzo(k)fluoranthene	0	2
Benzoic acid	0	2
Benzyl alcohol	0	2
Bis(2-chloroethoxy)methane	0	2
Bis(2-chloroethyl)ether	0	2
Bis(2-chloroisopropyl)ether	0	2
Bis(2-ethylhexyl)phthalate	0	2
Butylbenzylphthalate	0	2
Chrysene	0	2
Di-n-butylphthalate	0	2
Di-n-octylphthalate	0	2
Dibenz(a,h)anthracene	0	2
Dibenzofuran	0	2
Diethylphthalate	0	2
Dimethylphthalate	0	2
Fluoranthene	0	2
Fluorene	0	2
Hexachlorobenzene	0	2
Hexachlorobutadiene	0	2
Hexachlorocyclopentadiene	0	2
Hexachloroethane	0	2
Indeno(1,2,3-cd)pyrene	0	2
Isophorone	0	2
N-Nitroso-di-n-propylamine	0	2
N-Nitrosodiphenylamine	0	2

Analyte	CRR	
	Det.	Obs.
Naphthalene	0	2
Nitrobenzene	0	2
Pentachlorophenol	0	2
Phenanthrene	0	2
Phenol	0	2
Pyrene	0	2

Table A.43. Detected and total number of observations for PCB contaminants in water in Reach 4

Analyte	CRR I	
	Det.	Obs.
Aroclor-1016	0	3
Aroclor-1221	0	3
Aroclor-1232	0	3
Aroclor-1242	0	3
Aroclor-1248	0	3
Aroclor-1254	0	3
Aroclor-1260	0	3

Table A.44. Detected and total number of observations for pesticide contaminants in water in Reach 4

Analyte	CRR I	
	Det.	Obs.
4,4'-DDD	0	3
4,4'-DDE	0	3
4,4'-DDT	0	3
Aldrin	0	3
Alpha-BHC	0	3
Alpha-Chlordane	0	3
Beta-BHC	0	3
Delta-BHC	0	3
Dieldrin	0	3
Endosulfan I	0	3
Endosulfan II	0	3
Endosulfan sulfate	0	3
Endrin	0	3
Endrin ketone	0	3
Gamma-BHC (Lindane)	0	3
Gamma-Chlordane	0	3
Heptachlor	0	3
Heptachlor epoxide	0	3
Methoxychlor	0	3
Toxaphene	0	3

Table A.45. Detected and total number of observations for radionuclide contaminants in water in Reach 4

Analyte	CRRI		ORREM	
	Det.	Obs.	Det.	Obs.
Alpha, gross			7	7
Beta, gross			7	7
Co-60	0	2	4	4
Cs-137	2	2	7	7
Gamma, gross			1	1
H-3			4	4
Np-237			3	3
Pa-234			3	3
Pu-238			3	3
Pu-239			3	3
Sr-90	1	1		
Tc-99			7	7
Th-234			3	3
U-235			1	1

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